Mark3 Realtime Kernel

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The Mark3 Realtime Kernel

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--[Mark3 Realtime Platform]--------------------------------------------------

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The Mark3 Realtime Kernel is a completely free, open-source, real-time operating system aimed at bringing multi-tasking to microcontroller systems without MMUs.

It uses modern programming languages and concepts (it's written entirely in C++) to minimize code duplication, and its object-oriented design enhances readibility. The API is simple - there are only six functions required to set up the kernel, initialize threads, and start the scheduler.

The source is fully-documented with example code provided to illustrate concepts. The result is a performant RTOS, which is easy to read, easy to understand, and easy to extend to fit your needs.

But Mark3 is bigger than just a real-time kernel, it also contains a number of class-leading features:

- Device driver HAL which provides a meaningful abstraction around device-specific peripherals.
- Capable recursive-make driven build system which can be used to build all libraries, examples, tests, and documentation for any number of targets from the command-line.
- Graphics and UI code designed to simplify the implementation of systems using displays, keypads, joysticks, and touchscreens
- Standards-based custom communications protocol used to simplify the creation of host tools
- A bulletproof, well-documented bootloader for AVR microcontrollers

Chapter 2

Preface

2.1 Who should read this

As the cover clearly states, this is a book about the Mark3 real-time kernel. I assume that if you're reading this book you have an interest in some, if not all, of the following subjects:

- Embedded systems
- Real-time systems
- Operating system kernel design

And if you're interested in those topics, you're likely familiar with C and C++ and the more you know, the easier you'll find this book to read. And if C++ scares you, and you don't like embedded, real-time systems, you're probably looking for another book. If you're unfamiliar with RTOS fundamentals, I highly suggest searching through the vast amount of RTOS-related articles on the internet to familiarize yourself with the concepts.

2.2 Why Mark3?

My first job after graduating from university in 2005 was with a small company that had a very old-school, low-budget philosophy when it came to software development. Every make-or-buy decision ended with "make" when it came to tools. It was the kind of environment where vendors cost us money, but manpower was free. In retrospect, we didn't have a ton of business during the time that I worked there, and that may have had something to do with the fact that we were constantly short on ready cash for things we could code ourselves.

Early on, I asked why we didn't use industry-standard tools - like JTAG debuggers or IDEs. One senior engineer scoffed that debuggers were tools for wimps - and something that a good programmer should be able to do without. After all - we had serial ports, GPIOs, and a bi-color LED on our boards. Since these were built into the hardware, they didn't cost us a thing. We also had a single software "build" server that took 5 minutes to build a 32k binary on its best days, so when we had to debug code, it was a painful process of trial and error, with lots of Youtube between iterations. We complained that tens of thousands of dollars of productivity was being flushed away that could have been solved by implementing a proper build server - and while we eventually got our wish, it took far more time than it should have.

Needless to say, software development was painful at that company. We made life hard on ourselves purely out of pride, and for the right to say that we walked "up-hills both ways through 3 feet of snow, everyday". Our code was tied ever-so-tightly to our hardware platform, and the system code was indistinguishable from the application. While we didn't use an RTOS, we had effectively implemented a 3-priority threading scheme using a carefully designed interrupt nesting scheme with event flags and a while(1) superloop running as a background thread. Nothing was abstracted, and the code was always optimized for the platform, presumably in an effort to save on code size and wasted cycles. I asked why we didn't use an RTOS in any of our systems and received dismissive scoffs - the overhead from thread switching and maintaining multiple threads could not be tolerated in our systems according to our chief engineers. In retrospect, our ad-hoc system was likely as large as my smallest kernel, and had just as much context switching (althrough it was hidden by the compiler).

And every time a new iteration of our product was developed, the firmware took far too long to bring up, because the algorithms and data structures had to be re-tooled to work with the peripherals and sensors attached to the new boards. We worked very hard in an attempt to reinvent the wheel, all in the name of producing "efficient" code.

Regardless, I learned a lot about software development.

Most important, I learned that good design is the key to good software; and good design doesn't have to come at a price. In all but the smallest of projects, the well-designed, well-abstracted code is not only more portable, but it's usually smaller, easier to read, and easier to reuse.

Also, since we had all the time in the world to invest in developing our own tools, I gained a lot of experience building them, and making use of good, free PC tools that could be used to develop and debug a large portion of our code. I ended up writing PC-based device and peripheral simulators, state-machine frameworks, and abstractions for our horrible ad-hoc system code. At the end of the day, I had developed enough tools that I could solve a lot of our development problems without having to re-inventing the wheel at each turn. Gaining a background in how these tools worked gave me a better understanding of how to use them - making me more productive at the jobs that I've had since.

I am convinced that designing good software takes honest effort up-front, and that good application code cannot be written unless it is based on a solid framework. Just as the wise man builds his house on rocks, and not on sand, wise developers write applications based on a well-defined platforms. And while you can probably build a house using nothing but a hammer and sheer will, you can certainly build one a lot faster with all the right tools.

This conviction lead me to development my first RTOS kernel in 2009 - FunkOS. It is a small, yet surprisingly full-featured kernel. It has all the basics (semaphores, mutexes, round-robin and preemptive scheduling), and some pretty advanced features as well (device drivers and other middleware). However, it had two major problems - it doesn't scale well, and it doesn't support many devices.

While I had modest success with this kernel (it has been featured on some blogs, and still gets around 125 downloads a month), it was nothing like the success of other RTOS kernels like uC/OS-II and FreeRTOS. To be honest, as a one-man show, I just don't have the resources to support all of the devices, toolchains, and evaluation boards that a real vendor can. I had never expected my kernel to compete with the likes of them, and I don't expect Mark3 to change the embedded landscape either.

My main goal with Mark3 was to solve the technical shortfalls in the FunkOS kernel by applying my experience in kernel development. As a result, Mark3 is better than FunkOS in almost every way; it scales better, has lower interrupt latency, and is generally more thoughtfully designed (all at a small cost to code size).

Another goal I had was to create something easy to understand, that could be documented and serve as a good introduction to RTOS kernel design. The end result of these goals is the kernel as presented in this book - a full source listing of a working OS kernel, with each module completely documented and explained in detail.

Finally, I wanted to prove that a kernel written entirely in C++ could perform just as well as one written in C, without incurring any extra overhead. Comparing the same configuration of Mark2 to Mark3, the code size is remarkably similar, and the execution performance is just as good. Not only that, but there are fewer lines of code. The code is more readable and easier to understand as a result of making use of object-oriented concepts provided by C++. Applications are easier to write because common concepts are encapsulated into objects (Threads, Semaphores, Mutexes, etc.) with their own methods and data, as opposed to APIs which rely on lots of explicit pointer-passing, type casting, and other operations that are typically considered "unsafe" or "advaned topics" in C.

Chapter 3

Can you Afford an RTOS?

Of course, since you're reading the manual for an RTOS that I've been developing for the last few years, you can guess that the conclusion that I draw is a resounding "yes".

If your code is of any sort of non-trivial complexity (say, at least a few-thousand lines), then a more appropriate question would be "can you afford ∗not∗ to use an RTOS in your system?".

In short, there are simply too many benefits of an RTOS to ignore.

- Sophisticated synchronization objects
- The ability to efficiently block and wait
- Enhanced responsiveness for high-priority tasks
- Built in timers
- Built in efficient memory management

Sure, these features have a cost in code space and RAM, but from my experience the cost of trying to code around a lack of these features will cost you as much - if not more. The results are often far less maintainable, error prone, and complex. And that simply adds time and cost. Real developers ship, and the RTOS is quickly becoming one of the standard tools that help keep developers shipping.

3.1 Intro

(Note - this article was written for the C-based Mark2 kernel, which is slightly different. While the general principles are the same, the numbers are not an 100% accurate reflection of the current costs of the Mark3 kernel.)

One of the main arguments against using an RTOS in an embedded project is that the overhead incurred is too great to be justified. Concerns over "wasted" RAM caused by using multiple stacks, added CPU utilization, and the "large" code footprint from the kernel cause a large number of developers to shun using a preemptive RTOS, instead favoring a non-preemptive, application-specific solution.

I believe that not only is the impact negligible in most cases, but that the benefits of writing an application with an RTOS can lead to savings around the board (code size, quality, reliability, and development time). While these other benefits provide the most compelling case for using an RTOS, they are far more challenging to demonstrate in a quantitative way, and are clearly documented in numerous industry-based case studies.

While there is some overhead associated with an RTOS, the typical arguments are largely unfounded when an RTOS is correctly implemented in a system. By measuring the true overhead of a preemptive RTOS in a typical application, we will demonstrate that the impact to code space, RAM, and CPU usage is minimal, and indeed acceptable for a wide range of CPU targets.

To illustrate just how little an RTOS impacts the size of an embedded software design we will look at a typical microcontroller project and analyze the various types of overhead associated with using a pre-emptive realtime kernel versus a similar non-preemptive event-based framework.

RTOS overhead can be broken into three distinct areas:

- Code space: The amount of code space eaten up by the kernel (static)
- Memory overhead: The RAM associated wtih running the kernel and application threads.
- Runtime overhead: The CPU cycles required for the kernel's functionality (primarily scheduling and thread switching)

While there are other notable reasons to include or avoid the use of an RTOS in certain applications (determinism, responsiveness, and interrupt latency among others), these are not considered in this discussion - as they are difficult to consider for the scope of our "canned" application. Application description:

For the purpose of this comparison, we first create an application using the standard preemptive Mark3 kernel with 2 system threads running: A foreground thread and a background thread. This gives three total priority levels in the system - the interrupt level (high), and two application priority threads (medium and low), which is quite a common paradigm for microcontroller firmware designs. The foreground thread processes a variety of time-critical events at a fixed frequency, while the background thread processes lower priority, aperiodic events. When there are no background thread events to process, the processor enters its low-power mode until the next interrupt is acknowledged.

The contents of the threads themselves are unimportant for this comparison, but we can assume they perform a variety of I/O using various user-input devices and a serial graphics display. As a result, a number of Mark3 device drivers are also implemented.

The application is compiled for an ATMega328p processor which contains 32kB of code space in flash, and 2kB of RAM, which is a lower-mid-range microcontroller in Atmel's 8-bit AVR line of microcontrollers. Using the WinAVR GCC compiler with -O2 level optimizations, an executable is produced with the following code/RAM utilization:

31600 Bytes Code Space 2014 Bytes RAM

An alternate version of this project is created using a custom "super-loop" kernel, which uses a single application thread and provides 2 levels of priority (interrupt and application). In this case, the event handler processes the different priority application events to completion from highest to lowest priority.

This approach leaves the application itself largely unchanged. Using the same optimization levels as the preemptive kernel, the code compiles as follows:

29904 Bytes Code Space 1648 Bytes RAM

3.2 Memory overhead:

At first glance, the difference in RAM utilization seems quite a lot higher for the preemptive mode version of the application, but the raw numbers don't tell the whole story.

The first issue is that the cooperative-mode total does not take into account the system stack - whereas these values are included in the totals for RTOS version of the project. As a result, some further analysis is required to determine how the stack sizes truly compare.

In cooperative mode, there is only one thread of execution - so considering that multiple event handlers are executed in turn, the stack requirements for cooperative mode is simply determined by those of the most stack-intensive event handler.

In contrast, the preemptive kernel requires a separate stack for each active thread, and as a result the stack usage of the system is the sum of the stacks for all threads.

Since the application and idle events are the same for both preemptive and cooperative mode, we know that their (independent) stack requirements will be the same in both cases.

For cooperative mode, we see that the idle thread stack utilization is lower than that of the application thread, and so the application thread's determines the stack size requirement. Again, with the preemptive kernel the stack utilization is the sum of the stacks defined for both threads.

As a result, the difference in overhead between the two cases becomes the extra stack required for the idle thread - which in our case is (a somewhat generous) 64 bytes.

The numbers still don't add up completely, but looking into the linker output we see that the rest of the difference comes from the extra data structures used to declare the threads in preemptive mode.

With this taken into account, the true memory cost of a 2-thread system ends up being around 150 bytes of RA-M - which is less than 8% of the total memory available on this particular microcontroller. Whether or not this is reasonable certainly depends on the application, but more importantly, it is not so unreasonable as to eliminate an RTOS-based solution from being considered.

3.3 Code Space Overhead:

The difference in code space overhead between the preemptive and cooperative mode solutions is less of an issue. Part of this reason is that both the preemptive and cooperative kernels are relatively small, and even an average target device (like the Atmega328 we've chosen) has plenty of room.

Mark3 can be configured so that only features necessary for the application are included in the RTOS - you only pay for the parts of the system that you use. In this way, we can measure the overhead on a feature-by-feature basis, which is shown below for the kernel as configured for this application:

3466 Bytes

The configuration tested in this comparison uses the thread/port module with timers, drivers, and semaphores, for a total kernel size of ∼3.5KB, with the rest of the code space occupied by the application.

The custom cooperative-mode framework has a similar structure which is broken down by module as follows:

1850 Bytes

As can be seen from the compiler's output, the difference in code space between the two versions of the application is about 1.7kB - or about 5% of the available code space on the selected processor. While nearly all of this comes from the added overhead of the kernel, the rest of the difference comes the changes to the application necessary to facilitate the different frameworks.

3.4 Runtime Overhead

On the cooperative kernel, the overhead associated with running the thread is the time it takes the kernel to notice a pending event flag and launch the appropriate event handler, plus the timer interrupt execution time.

Similarly, on the preemptive kernel, the overhead is the time it takes to switch contexts to the application thread, plus the timer interrupt execution time.

The timer interrupt overhead is similar for both cases, so the overhead then becomes the difference between the following:

Preemptive mode:

- Posting the semaphore that wakes the high-priority thread
- Performing a context switch to the high-priority thread

Cooperative mode:

- Setting the high-priority thread's event flag
- Acknowledging the event from the event loop

Using the cycle-accurate AVR simulator, we find the end-to-end event sequence time to be 20.4us for the cooperative mode scheduler and 44.2us for the preemptive, giving a difference of 23.8us.

With a fixed high-priority event frequency of 33Hz, we achieve a runtime overhead of 983.4us per second, or 0.-0983% of the total available CPU time. Now, obviously this value would expand at higher event frequencies and/or slower CPU frequencies, but for this typical application we find the difference in runtime overhead to be neglible for a preemptive system. Analysis:

For the selected test application and platform, including a preemptive RTOS is entirely reasonable, as the costs are low relative to a non-preemptive kernel solution. But these costs scale relative to the speed, memory and code space of the target processor. Because of these variables, there is no "magic bullet" environment suitable for every application, but Mark3 attempts to provide a framework suitable for a wide range of targets.

On the one hand, if these tests had been performed on a higher-end microcontroller such as the ATMega1284p (containing 128kB of code space and 16kB of RAM), the overhead would be in the noise. For this type of resource-rich microcontroller, there would be no reason to avoid using the Mark3 preemptive kernel.

Conversely, using a lower-end microcontroller like an ATMega88pa (which has only 8kB of code space and 1k-B of RAM), the added overhead would likely be prohibitive for including a preemptive kernel. In this case, the cooperative-mode kernel would be a better choice.

As a rule of thumb, if one budgets 10% of a microcontroller's code space/RAM for a preemptive kernel's overhead, you should only require at minimum a microcontroller with 16k of code space and 2kB of RAM as a base platform for an RTOS. Unless there are serious constraints on the system that require much better latency or responsiveness than can be achieved with RTOS overhead, almost any modern platform is sufficient for hosting a kernel. In the event you find yourself with a microprocessor with external memory, there should be no reason to avoid using an RTOS at all.

Chapter 4

Superloops

4.1 Intro to Superloops

Before we start taking a look at designing a real-time operating system, it's worthwhile taking a look through one of the most-common design patterns that developers use to manage task execution in embedded systems - Superloops.

Systems based on superloops favor the system control logic baked directly into the application code, usually under the guise of simplicity, or memory (code and RAM) efficiency. For simple systems, superloops can definitely get the job done. However, they have some serious limitations, and are not suitable for every kind of project. In a lot of cases you can squeak by using superloops - especially in extremely constrained systems, but in general they are not a solid basis for reusable, portable code.

Nonetheless, a variety of examples are presented here- from the extremely simple, to cooperative and liimted-preemptive multitasking systems, all of which are examples are representative of real-world systems that I've either written the firmware for, or have seen in my experience.

4.2 The simplest loop

Let's start with the simplest embedded system design possible - an infinite loop that performs a single task repeatedly:

```
int main()
{
    while(1)
    {
        Do_Something();
    }
}
```

Here, the code inside the loop will run a single function forever and ever. Not much to it, is there? But you might be surprised at just how much embedded system firmware is implemented using essentially the same mechanism - there isn't anything wrong with that, but it's just not that interesting.

While the execution timeline for this program is equally boring, for the sake of completeness it would look like this:

Despite its simplicity we can see the beginnings of some core OS concepts. Here, the while(1) statement can be logically seen as the he operating system kernel - this one control statement determines what tasks can run in the system, and defines the constraints that could modify their execution. But at the end of the day, that's a big part of what a kernel is - a mechanism that controls the execution of application code.

The second concept here is the task. This is application code provided by the user to perform some useful purpose in a system. In this case Do_something() represents that task - it could be monitoring blood pressure, reading a sensor and writing its data to a terminal, or playing an MP3; anything you can think of for an embedded system to do. A simple round-robin multi-tasking system can be built off of this example by simply adding additional tasks in sequence in the main while-loop. Note that in this example the CPU is always busy running tasks - at no time is the CPU idle, meaning that it is likely burning a lot of power.

While we conceptually have two separate pieces of code involved here (an operating system kernel and a set of running tasks), they are not logically separate. The OS code is indistinguishable from the application. It's like a single-celled organism - everything is crammed together within the walls of an indivisible unit; and specialized to perform its given function relying solely on instinct.

4.3 Interrupt-Driven Super-loop

In the previous example, we had a system without any way to control the execution of the task- it just runs forever. There's no way to control when the task can (or more importantly can't) run, which greatly limits the usefulness of the system. Say you only want your task to run every 100 miliseconds - in the previous code, you have to add a hard-coded delay at the end of your task's execution to ensure your code runs only when it should.

Fortunately, there is a much more elegant way to do this. In this example, we introduce the concept of the synchronization object. A Synchronization object is some data structure which works within the bounds of the operating system to tell tasks when they can run, and in many cases includes special data unique to the synchronization event. There are a whole family of synchronization objects, which we'll get into later. In this example, we make use of the simplest synchronization primitive - the global flag.

With the addition of synchronization brings the addition of event-driven systems. If you're programming a microcontroller system, you generally have scores of peripherals available to you - timers, GPIOs, ADCs, UARTs, ethernet, USB, etc. All of which can be configured to provide a stimulus to your system by means of interrupts. This stimulus gives us the ability not only to program our micros to do_something(), but to do_something() if-and-only-if a corresponding trigger has occurred.

The following concepts are shown in the example below:

```
volatile K_BOOL something_to_do = false;

__interrupt__ My_Interrupt_Source(void)
{
    something_to_do = true;
}

int main()
{
    while(1)
    {
        if( something_to_do )
        {
            Do_something();
            something_to_do = false;
        }
        else
        {
            Idle();
        }
    }
}
```

So there you have it - an event driven system which uses a global variable to synchronize the execution of our task based on the occurrence of an interrupt. It's still just a bare-metal, OS-baked-into-the-aplication system, but it's introduced a whole bunch of added complexity (and control!) into the system.

The first thing to notice in the source is that the global variable, something_to_do, is used as a synchronization object. When an interrupt occurs from some external event, triggering the My_Interrupt_Source() ISR, program flow in main() is interrupted, the interrupt handler is run, and something_to_do is set to true, letting us know that when we get back to main(), that we should run our Do_something() task.

Another new concept at play here is that of the idle function. In general, when running an event driven system, there are times when the CPU has no application tasks to run. In order to minimize power consumption, CPUs usually contain instructions or registers that can be set up to disable non-essential subsets of the system when there's nothing to do. In general, the sleeping system can be re-activated quickly as a result of an interrupt or other external stimulus, allowing normal processing to resume.

Now, we could just call Do_something() from the interrupt itself - but that's generally not a great solution. In general, the more time we spend inside an interrupt, the more time we spend with at least some interrupts disabled. As a result, we end up with interrupt latency. Now, in this system, with only one interrupt source and only one task this might not be a big deal, but say that Do_something() takes several seconds to complete, and in that time several other interrupts occur from other sources. While executing in our long-running interrupt, no other interrupts can be processed - in many cases, if two interrupts of the same type occur before the first is processed, one of these interrupt events will be lost. This can be utterly disastrous in a real-time system and should be avoided at all costs. As a result, it's generally preferable to use synchronization objects whenever possible to defer processing outside of the ISR.

Another OS concept that is implicitly introduced in this example is that of task priority. When an interrupt occurs, the normal execution of code in main() is preempted: control is swapped over to the ISR (which runs to completion), and then control is given back to main() where it left off. The very fact that interrupts take precedence over what's running shows that main is conceptually a "low-priority" task, and that all ISRs are "high-priority" tasks. In this example, our "high-priority" task is setting a variable to tell our "low-priority" task that it can do something useful. We will investigate the concept of task priority further in the next example.

Preemption is another key principle in embedded systems. This is the notion that whatever the CPU is doing when an interrupt occurs, it should stop, cache its current state (referred to as its context), and allow the high-priority event to be processed. The context of the previous task is then restored its state before the interrupt, and resumes processing. We'll come back to preemption frequently, since the concept comes up frequently in RTOS-based systems.

4.4 Cooperative multi-tasking

Our next example takes the previous example one step further by introducing cooperative multi-tasking:

```
// Bitfield values used to represent three distinct tasks
#define TASK_1_EVENT (0x01)
#define TASK_2_EVENT (0x02)
#define TASK_3_EVENT (0x04)

volatile K_UCHAR event_flags = 0;

// Interrupt sources used to trigger event execution

__interrupt__  My_Interrupt_1(void)
{
    event_flags |= TASK_1_EVENT;
}

__interrupt__ My_Interrupt_2(void)
{
    event_flags |= TASK_2_EVENT;
}

__interrupt__ My_Interrupt_3(void)
{
    event_flags |= TASK_3_EVENT;
}

// Main tasks
int main(void)
{
    while(1)
    {
        while(event_flags)
        {
            if( event_flags & TASK_1_EVENT)
            {
                Do_Task_1();
                event_flags &= ~TASK_1_EVENT;
            } else if( event_flags & TASK_2_EVENT) {
                Do_Task_2();
                event_flags &= ~TASK_2_EVENT;
            } else if( event_flags & TASK_3_EVENT) {
                Do_Task_3();
                event_flags &= ~TASK_3_EVENT;
            }
        }
        Idle();
    }
}
```

This system is very similar to what we had before - however the differences are worth discussing. First, we have stimulus from multiple interrupt sources: each ISR is responsible for setting a single bit in our global event flag, which is then used to control execution of individual tasks from within main().

Next, we can see that tasks are explicitly given priorities inside the main loop based on the logic of the if/else if structure. As long as there is something set in the event flag, we will always try to execute Task1 first, and only when Task1 isn't set will we attempt to execute Task2, and then Task 3. This added logic provides the notion of priority. However, because each of these tasks exist within the same context (they're just different functions called from our main control loop), we don't have the same notion of preemption that we have when dealing with interrupts.

That means that even through we may be running Task2 and an event flag for Task1 is set by an interrupt, the CPU still has to finish processing Task2 to completion before Task1 can be run. And that's why this kind of scheduling is referred to ascooperative multitasking: we can have as many tasks as we want, but unless they cooperate by means of returning back to main, the system can end up with high-priority tasks getting starved for CPU time by lower-priority, long-running tasks.

This is one of the more popular Os-baked-into-the-application approaches, and is widely used in a variety of real-time embedded systems.

4.5 Hybrid cooperative/preemptive multi-tasking

The final variation on the superloop design utilizes software-triggered interrupts to simulate a hybrid cooperative/preemptive multitasking system. Consider the example code below.

```
// Bitfields used to represent high-priority tasks.  Tasks in this group
// can preempt tasks in the group below - but not eachother.
#define HP_TASK_1         (0x01)
#define HP_TASK_2         (0x02)

volatile K_UCHAR hp_tasks = 0;

// Bitfields used to represent low-priority tasks.
#define LP_TASK_1         (0x01)
#define LP_TASK_2         (0x02)

volatile K_UCHAR lp_tasks = 0;

// Interrupt sources, used to trigger both high and low priority tasks.
__interrupt__ System_Interrupt_1(void)
{
    // Set any of the other tasks from here...
    hp_tasks |= HP_TASK_1;
    // Trigger the SWI that calls the High_Priority_Tasks interrupt handler
    SWI();
}

__interrupt__ System_Interrupt_n...(void)
{
    // Set any of the other tasks from here...
}


// Interrupt handler that is used to implement the high-priority event context
__interrupt__ High_Priority_Tasks(void)
{
    // Enabled every interrupt except this one
    Disable_My_Interrupt();
    Enable_Interrupts();
    while( hp_tasks)
    {
        if( hp_tasks & HP_TASK_1)
        {
            HP_Task1();
            hp_tasks &= ~HP_TASK_1;
        }
        else if (hp_tasks & HP_TASK_2)
        {
            HP_Task2();
            hp_tasks &= ~HP_TASK_2;
        }
    }
    Restore_Interrupts();
    Enable_My_Interrupt();
}
```

```
// Main loop, used to implement the low-priority events
int main(void)
{
    // Set the function to run when a SWI is triggered
    Set_SWI(High_Priority_Tasks);

    // Run our super-loop
    while(1)
    {
        while (lp_tasks)
        {
            if (lp_tasks & LP_TASK_1)
            {
                LP_Task1();
                lp_tasks &= ~LP_TASK_1;
            }
            else if (lp_tasks & LP_TASK_2)
            {
                LP_Task2();
                lp_tasks &= ~LP_TASK_2;
            }
        }
        Idle();
    }
}
```

In this example, High_Priority_Tasks() can be triggered at any time as a result of a software interrupt (SWI),. When a high-priority event is set, the code that sets the event calls the SWI as well, which instantly preempts whatever is happening in main, switching to the high-priority interrupt handler. If the CPU is executing in an interrupt handler already, the current ISR completes, at which point control is given to the high priority interrupt handler.

Once inside the HP ISR, all interrupts (except the software interrupt) are re-enabled, which allows this interrupt to be preempted by other interrupt sources, which is called interrupt nesting. As a result, we end up with two distinct execution contexts (main and HighPriorityTasks()), in which all tasks in the high-priority group are guaranteed to preempt main() tasks, and will run to completion before returning control back to tasks in main(). This is a very basic preemptive multitasking scenario, approximating a "real" RTOS system with two threads of different priorities.

4.6 Problems with superloops

As mentioned earlier, a lot of real-world systems are implemented using a superloop design; and while they are simple to understand due to the limited and obvious control logic involved, they are not without their problems.

Hidden Costs

It's difficult to calculate the overhead of the superloop and the code required to implement workarounds for blocking calls, scheduling, and preemption. There's a cost in both the logic used to implement workarounds (usually involving state machines), as well as a cost to maintainability that comes with breaking up into chunks based on execution time instead of logical operations. In moderate firmware systems, this size cost can exceed the overhead of a reasonably well-featured RTOS, and the deficit in maintainability is something that is measurable in terms of lost productivity through debugging and profiling.

Tightly-coupled code

Because the control logic is integrated so closely with the application logic, a lot of care must be taken not to compromise the separation between application and system code. The timing loops, state machines, and architecture-specific control mechanisms used to avoid (or simulate) preemption can all contribute to the problem. As a result, a lot of superloop code ends up being difficult to port without effectively simulating or replicating the underlying system for which the application was written. Abstraction layers can mitigate the risks, but a lot of care should be taken to fully decouple the application code from the system code.

No blocking calls

In a super-loop environment, there's no such thing as a blocking call or blocking objects. Tasks cannot stop mid-execution for event-driven I/O from other contexts - they must always run to completion. If busy-waiting and polling are used as a substitute, it increases latency and wastes cycles. As a result, extra code complexity is often times necessary to work-around this lack of blocking objects, often times through implementing additional state machines. In a large enough system, the added overhead in code size and cycles can add up.

Difficult to guarantee responsiveness

Without multiple levels of priority, it may be difficult to guarantee a certain degree of real-time responsiveness without added profiling and tweaking. The latency of a given task in a priority-based cooperative multitasking system is the length of the longest task. Care must be taken to break tasks up into appropriate sized chunks in order to ensure that higher-priority tasks can run in a timely fashion - a manual process that must be repeated as new tasks are added in the system. Once again, this adds extra complexity that makes code larger, more difficult to understand and maintain due to the artificial subdivision of tasks into time-based components.

Limited preemption capability

As shown in the example code, the way to gain preemption in a superloop is through the use of nested interrupts. While this isn't unwiedly for two levels of priority, adding more levels beyond this is becomes complicated. In this case, it becomes necessary to track interrupt nesting manually, and separate sets of tasks that can run within given priority loops - and deadlock becomes more difficult to avoid.

Chapter 5

Mark3 Overview

5.1 Intro

The following section details the overall design of Mark3, the goals I've set out to achieve, the features that I've intended to provide, as well as an introduction to the programming concepts used to make it happen.

5.2 Features

Mark3 is a fully-featured real-time kernel, and is feature-competitive with other open-source and commercial RTOS's in the embedded arena.

The key features of this RTOS are:

- Flexible Scheduler
  - Unlimited number of threads with 8 priority levels
  - Unlimited threads per priority level
  - Round-robin scheduling for threads at each priority level
  - Time quantum scheduling for each thread in a given priority level
- Configurable stacks for each Thread
- Resource protection:
  - Integrated mutual-exclusion semaphores (Mutex)
  - Priority-inheritance on Mutex objects to prevent priority inversion
- Synchronization Objects
  - Binary and counting Semaphore to coordinate thread execution
  - Event flags with 16-bit bitfields for complex thread synchronization
- Efficient Timers
  - The RTOS is tickless, the OS only wakes up when a timer expires, not at a regular interval
  - One-shot and periodic timers with event callbacks
  - Timers are high-precision and long-counting (about 68000 seconds when used with a 16us resolution timer)
- Driver API
  - A hardware abstraction layer is provided to simplify driver development
- Robust Interprocess Communications
  - Threadsafe global Message pool and configurable message queues

5.3 Design Goals

Lightweight

Mark3 can be configured to have an extremely low static memory footprint. Each thread is defined with its own stack, and each thread structure can be configured to take as little as 26 bytes of RAM. The complete Mark3 kernel with all features, setup code, a serial driver, and the Mark3 protocol libraries comes in at under 9K of code space and 1K of RAM on atmel AVR.

Modular

Each system feature can be enabled or disabled by modifying the kernel configuration header file. Include what you want, and ignore the rest to save code space and RAM.

Easily Portable

Mark3 should be portable to a variety of 8, 16 and 32 bit architectures without MMUs. Porting the OS to a new architecture is relatively straightforward, requiring only device-specific implementations for the lowest-level operations such as context switching and timer setup.

Easy To Use

Mark3 is small by design - which gives it the advantage that it's also easy to develop for. This manual, the code itself, and the Doxygen documentation in the code provide ample documentation to get you up to speed quickly. Because you get to see the source, there's nothing left to assumption.

Simple to Understand

Not only is the Mark3 API rigorously documented (hey - that's what this book is for!), but the architecture and naming conventions are intuitive - it's easy to figure out where code lives, and how it works. Individual modules are small due to the "one feature per file" rule used in development. This makes Mark3 an ideal platform for learning about aspects of RTOS design.

Chapter 6

Getting Started

6.1 Kernel Setup

This section details the process of defining threads, initializing the kernel, and adding threads to the scheduler.

If you're at all familiar with real-time operating systems, then these setup and initialization steps should be familiar. I've tried very hard to ensure that as much of the heavy lifting is hidden from the user, so that only the bare minimum of calls are required to get things started.

The examples presented in this chapter are real, working examples taken from the ATmega328p port.

First, you'll need to create the necessary data structures and functions for the threads:

1. Create a Thread object for all of the "root" or "initial" tasks.
2. Allocate stacks for each of the Threads
3. Define an entry-point function for each Thread

This is shown in the example code below:

```
//---------------------------------------------------------------------------
#include "thread.h"
#include "kernel.h"

//1) Create a thread object for all of the "root" or "initial" tasks
static Thread AppThread;
static Thread IdleThread;

//2) Allocate stacks for each thread
#define STACK_SIZE_APP      (192)
#define STACK_SIZE_IDLE     (128)

static K_UCHAR aucAppStack[STACK_SIZE_APP];
static K_UCHAR aucIdleStack[STACK_SIZE_IDLE];

//3) Define entry point functions for each thread
void AppThread(void);
void IdleThread(void);
```

Next, we'll need to add the required kernel initialization code to main. This consists of running the Kernel's init routine, initializing all of the threads we defined, adding the threads to the scheduler, and finally calling Kernel::Start(), which transfers control of the system to the RTOS.

These steps are illustrated in the following example.

```
int main(void)
{
    //1) Initialize the kernel prior to use
    Kernel::Init();

    //2) Initialize all of the threads we've defined
    AppThread.Init(    aucAppStack,
                    STACK_SIZE_APP,
                    1,
                    (void*)AppEntry,
                    NULL );

    IdleThread.Init( aucIdleStack,
                     STACK_SIZE_IDLE,
                     0,
                     4,
                     (void*)IdleEntry,
                     NULL );

    //3) Add the threads to the scheduler
    AppThread.Start();
    IdleThread.Start();

    //4) Give control of the system to the kernel
    Kernel::Start();
}
```

Not much to it, is there? There are a few noteworthy points in this code, though.

In order for the kernel to work properly, a system must always contain an idle thread; that is, a thread at priority level 0 that never blocks. This thread is responsible for performing any of the low-level power management on the CPU in order to maximize battery life in an embedded device. The idle thread must also never block, and it must never exit. Either of these operations will cause undefined behavior in the system.

The App thread is at a priority level greater-than 0. This ensures that as long as the App thread has something useful to do, it will be given control of the CPU. In this case, if the app thread blocks, control will be given back to the Idle thread, which will put the CPU into a power-saving mode until an interrupt occurs.

Stack sizes must be large enough to accommodate not only the requirements of the threads, but also the requirements of interrupts - up to the maximum interrupt-nesting level used. Stack overflows are super-easy to run into in an embedded system; if you encounter strange and unexplained behavior in your code, chances are good that one of your threads is blowing its stack.

6.2 Threads

Mark3 Threads act as independent tasks in the system. While they share the same address-space, global data, device-drivers, and system peripherals, each thread has its own set of CPU registers and stack, collectively known as the thread's **context**. The context is what allows the RTOS kernel to rapidly switch between threads at a high rate, giving the illusion that multiple things are happening in a system, when really, only one thread is executing at a time.

6.2.1 Thread Setup

Each instance of the Thread class represents a thread, its stack, its CPU context, and all of the state and metadata maintained by the kernel. Before a Thread will be scheduled to run, it must first be initialized with the necessary configuration data.

The Init function gives the user the opportunity to set the stack, stack size, thread priority, entry-point function, entry-function argument, and round-robin time quantum:

Thread stacks are pointers to blobs of memory (usually K_CHAR arrays) carved out of the system's address space. Each thread must have a stack defined that's large enough to handle not only the requirements of local variables in the thread's code path, but also the maximum depth of the ISR stack.

Priorities should be chosen carefully such that the shortest tasks with the most strict determinism requirements are executed first - and are thus located in the highest priorities. Tasks that take the longest to execute (and require the least degree of responsiveness) must occupy the lower thread priorities. The idle thread must be the only thread occupying the lowest priority level.

The thread quantum only aplies when there are multiple threads in the ready queue at the same priority level. This interval is used to kick-off a timer that will cycle execution between the threads in the priority list so that they each get a fair chance to execute.

The entry function is the function that the kernel calls first when the thread instance is first started. Entry functions have at most one argument - a pointer to a data-object specified by the user during initialization.

An example thread initailization is shown below:

```
Thread clMyThread;
K_UCHAR aucStack[192];

void AppEntry(void)
{
    while(1)
    {
        // Do something!
    }
}

...
{
    clMyThread.Init(aucStack,
                    192,
                    1,
                    4,
                    (void*)AppEntry,
                    NULL );

}
```

Once a thread has been initialized, it can be added to the scheduler by calling:

```
clMyThread.Start();
```

The thread will be placed into the Scheduler's queue at the designated priority, where it will wait its turn for execution.

6.2.2 Entry Functions

Mark3 Threads should not run-to-completion - they should execute as infinite loops that perform a series of tasks, appropriately partitioned to provide the responsiveness characteristics desired in the system.

The most basic Thread loop is shown below:

```
void Thread( void *param )
{
    while(1)
    {
        // Do Something
    }
}
```

Threads can interact with eachother in the system by means of synchronization objects (Semaphore), mutual-exclusion objects (Mutex), Inter-process messaging (MessageQueue), and timers (Timer).

Threads can suspend their own execution for a predetermined period of time by using the static Thread::Sleep() method. Calling this will block the Thread's executin until the amount of time specified has ellapsed. Upon expiry, the thread will be placed back into the ready queue for its priority level, where it awaits its next turn to run.

6.3 Timers

Timer objects are used to trigger callback events periodic or on a one-shot (alarm) basis.

While extremely simple to use, they provide one of the most powerful execution contexts in the system. The timer callbacks execute from within the timer callback ISR in an interrupt-enabled context. As such, timer callbacks are considered higher-priority than any thread in the system, but lower priority than other interrupts. Care must be taken to ensure that timer callbacks execute as quickly as possible to minimize the impact of processing on the throughput of tasks in the system. Wherever possible, heavy-lifting should be deferred to the threads by way of semaphores or messages.

Below is an example showing how to start a periodic system timer which will trigger every second:

```
{
    Timer clTimer;
    clTimer.Init();

    clTimer.Start( 1000,
                   1,
                   MyCallback,
                   (void*)&my_data );

    ... // Keep doing work in the thread
}

// Callback function, executed from the timer-expiry context.
void MyCallBack( Thread *pclOwner_, void *pvData_ )
{
    LED.Flash(); // Flash an LED.
}
```

6.4 Semaphores

Semaphores are used to synchronized execution of threads based on the availability (and quantity) of application-specific resources in the system. They are extremely useful for solving producer-consumer problems, and are the method-of-choice for creating efficient, low latency systems, where ISRs post semaphores that are handled from within the context of individual threads. (Yes, Semaphores can be posted - but not pended - from the interrupt context).

The following is an example of the producer-consumer usage of a binary semaphore:

```
Semaphore clSemaphore; // Declare a semaphore shared between a producer and a consumer thread.

void Producer()
{
    clSemaphore.Init(0, 1);
    while(1)
    {
        // Do some work, create something to be consumed

        // Post a semaphore, allowing another thread to consume the data
        clSemaphore.Post();
    }
}

void Consumer()
{
    // Assumes semaphore initialized before use...
    While(1)
    {
        // Wait for new data from the producer thread
        clSemaphore.Pend();

        // Consume the data!
    }
}
```

And an example of using semaphores from the ISR context to perform event- driven processing.

```
Semaphore clSemaphore;

__interrupt__ MyISR()
{
    clSemaphore.Post(); // Post the interrupt.  Lightweight when uncontested.
}

void MyThread()
{
    clSemaphore.Init(0, 1); // Ensure this is initialized before the MyISR interrupt is enabled.
    while(1)
    {
        // Wait until we get notification from the interrupt
        clSemaphore.Pend();

        // Interrupt has fired, do the necessary work in this thread's context
        HeavyLifting();
    }
}
```

6.5 Mutexes

Mutexes (Mutual exclusion objects) are provided as a means of creating "protected sections" around a particular resource, allowing for access of these objects to be serialized. Only one thread can hold the mutex at a time - other threads have to wait until the region is released by the owner thread before they can take their turn operating on the protected resource. Note that mutexes can only be owned by threads - they are not available to other contexts (i.e. interrupts). Calling the mutex APIs from an interrupt will cause catastrophic system failures.

Note that these objects are also not recursive- that is, the owner thread can not attempt to claim a mutex more than once.

Prioritiy inheritence is provided with these objects as a means to avoid prioritiy inversions. Whenever a thread at a priority than the mutex owner blocks on a mutex, the priority of the current thread is boosted to the highest-priority waiter to ensure that other tasks at intermediate priorities cannot artificically prevent progress from being made.

Mutex objects are very easy to use, as there are only three operations supported: Initialize, Claim and Release. An example is shown below.

```
Mutex clMutex;    // Create a mutex globally.

void Init()
{
    // Initialize the mutex before use.
    clMutex.Init();
}

// Some function called from a thread
void Thread1Function()
{
    clMutex.Claim();

    // Once the mutex is owned, no other thread can
    // enter a block protect by the same mutex

    my_protected_resource.do_something();
    my_protected_resource.do_something_else();

    clMutex.Release();
}

// Some function called from another thread
void Thread2Function()
{
    clMutex.Claim();

    // Once the mutex is owned, no other thread can
    // enter a block protect by the same mutex

    my_protected_resource.do_something();
    my_protected_resource.do_different_things();

    clMutex.Release();
}
```

6.6 Event Flags

Event Flags are another synchronization object, conceptually similar to a semaphore.

Unlike a semaphore, however, the condition on which threads are unblocked is determined by a more complex set of rules. Each Event Flag object contains a 16-bit field, and threads block, waiting for combinations of bits within this field to become set.

A thread can wait on any pattern of bits from this field to be set, and any number of threads can wait on any number of different patterns. Threads can wait on a single bit, multiple bits, or bits from within a subset of bits within the field.

As a result, setting a single value in the flag can result in any number of threads becoming unblocked simultaneously. This mechanism is extremely powerful, allowing for all sorts of complex, yet efficient, thread synchronization schemes that can be created using a single shared object.

Note that Event Flags can be set from interrupts, but you cannot wait on an event flag from within an interrupt.

Examples demonstrating the use of event flags are shown below.

```
// Simple example showing a thread blocking on a multiple bits in the
// fields within an event flag.

EventFlag clEventFlag;

int main()
{
    ...
    clEventFlag.Init(); // Initialize event flag prior to use
    ...
}

void MyInterrupt()
{
    // Some interrupt corresponds to event 0x0020
    clEventFlag.Set(0x0020);
}

void MyThreadFunc()
{
    ...
    while(1)
    {
        ...
        K_USHORT usWakeCondition;

        // Allow this thread to block on multiple flags
        usWakeCondition = clEventFlag.Wait(0x00FF, EVENT_FLAG_ANY);

        // Clear the event condition that caused the thread to wake (in this case,
        // usWakeCondtion will equal 0x20 when triggered from the interrupt above)
        clEventFlag.Clear(usWakeCondition);

        // <do something>
    }
}
```

6.7 Messages

Sending messages between threads is the key means of synchronizing access to data, and the primary mechanism to perform asynchronous data processing operations.

Sending a message consists of the following operations:

- Obtain a Message object from the global message pool
- Set the message data and event fields
- Send the message to the destination message queue

While receiving a message consists of the following steps:

- Wait for a messages in the destination message queue
- Process the message data
- Return the message back to the global message pool

These operations, and the various data objects involved are discussed in more detail in the following section.

6.7.1 Message Objects

Message objects are used to communicate arbitrary data between threads in a safe and synchronous way.

The message object consists of an event code field and a data field. The event code is used to provide context to the message object, while the data field (essentially a void $*$ data pointer) is used to provide a payload of data corresponding to the particular event.

Access to these fields is marshalled by accessors - the transmitting thread uses the SetData() and SetCode() methods to seed the data, while the receiving thread uses the GetData() and GetCode() methods to retrieve it.

By providing the data as a void data pointer instead of a fixed-size message, we achieve an unprecedented measure of simplicity and flexibility. Data can be either statically or dynamically allocated, and sized appropriately for the event without having to format and reformat data by both sending and receiving threads. The choices here are left to the user - and the kernel doesn't get in the way of efficiency.

It is worth noting that you can send messages to message queues from within ISR context. This helps maintain consistency, since the same APIs can be used to provide event-driven programming facilities throughout the whole of the OS.

6.7.2 Global Message Pool

To maintain efficiency in the messaging system (and to prevent over-allocation of data), a global pool of message objects is provided. The size of this message pool is specified in the implementation, and can be adjusted depending on the requirements of the target application as a compile-time option.

Allocating a message from the message pool is as simple as calling the GlobalMessagePool::Pop() Method.

Messages are returned back to the GlobalMessagePool::Push() method once the message contents are no longer required.

One must be careful to ensure that discarded messages always are returned to the pool, otherwise a resource leak can occur, which may cripple the operating system's ability to pass data between threads.

6.7.3 Message Queues

Message objects specify data with context, but do not specify where the messages will be sent. For this purpose we have a MessageQueue object. Sending an object to a message queue involves calling the MessageQueue::Send() method, passing in a pointer to the Message object as an argument.

When a message is sent to the queue, the first thread blocked on the queue (as a result of calling the Message-Queue Receive() method) will wake up, with a pointer to the Message object returned.

It's worth noting that multiple threads can block on the same message queue, providing a means for multiple threads to share work in parallel.

6.7.4 Messaging Example

```
// Message queue object shared between threads
MessageQueue clMsgQ;

// Function that initializes the shared message queue
void MsgQInit()
{
    clMsgQ.Init();
}

// Function called by one thread to send message data to
// another
void TxMessage()
{
    // Get a message, initialize its data
    Message *pclMesg = GlobalMessagePool::Pop();

    pclMesg->SetCode(0xAB);
    pclMesg->SetData((void*)some_data);

    // Send the data to the message queue
    clMsgQ.Send(pclMesg);
}

// Function called in the other thread to block until
// a message is received in the message queue.
void RxMessage()
{
    Message *pclMesg;
    // Block until we have a message in the queue
    pclMesg = clMsgQ.Receive();

    // Do something with the data once the message is received
    pclMesg->GetCode();

    // Free the message once we're done with it.
    GlobalMessagePool::Push(pclMesg);
}
```

6.8 Sleep

There are instances where it may be necessary for a thread to poll a resource, or wait a specific amount of time before proceeding to operate on a peripheral or volatile piece of data.

While the Timer object is generally a better choice for performing time-sensitive operations (and certainly a better choice for periodic operations), the Thread::Sleep() method provides a convenient (and efficient) mechanism that allows for a thread to suspend its execution for a specified interval.

Note that when a thread is sleeping it is blocked, during which other threads can operate, or the system can enter its idle state.

```
int GetPeripheralData();
{
    int value;
    // The hardware manual for a peripheral specifies that
    // the "foo()" method will result in data being generated
    // that can be captured using the "bar()" method.
    // However, the value only becomes valid after 10ms

    peripheral.foo();
    Thread::Sleep(10);    // Wait 10ms for data to become valid
    value = peripheral.bar();
    return value;
}
```

6.9 Round-Robin Quantum

Threads at the same thread priority are scheduled using a round-robin scheme. Each thread is given a timeslice (which can be configured) of which it shares time amongst ready threads in the group. Once a thread's timeslice has expired, the next thread in the priority group is chosen to run until its quantum has expired - the cycle continues over and over so long as each thread has work to be done.

By default, the round-robin interval is set at 4ms.

This value can be overridden by calling the thread's SetQuantum() with a new interval specified in milliseconds.

Chapter 7

Inside The Scheduler

This section details the inner-working of the Mark3 Scheduler in detail.

7.1 A Bit About Threads

Before we get started talking about the internals of the Mark3 scheduler, it's necessary to go over some background material - starting with: what is a thread, anyway?

Let's look at a very basic CPU without any sort of RTOS, and without interrupts. When the CPU is powered up, the program counter is loaded with some default location, at which point the processor core will start executing instructions sequentially - running forever and ever according to whatever has been loaded into program memory. This single instance of a simple program sequence is the only thing that runs on the processor, and the execution of the program can be predicted entirely by looking at the CPU's current register state, its program, and any affected system memory (the CPU's "context").

It's simple enough, and that's exactly the definition we have for a thread in an RTOS.

Each thread contains an instance of a CPU's register context, its own stack, and any other bookkeeping information necessary to define the minimum unique execution state of a system at runtime. It is the job of a RTOS to multiplex the execution of multiple threads on a single physical CPU, thereby creating the illusion that many programs are being executed simultaneously. In reality there can only ever be one thread truly executing at any given moment on a CPU core, so it's up to the scheduler to set and enforce rules about what thread gets to run when, for how long, and under what conditions. As mentioned earlier, any system without an RTOS exeuctes as a single thread, so at least two threads are required for an RTOS to serve any useful purpose.

Note that all of this information is is common to pretty well every RTOS in existence - the implementation details, including the scheduler rules, are all part of what differentiates one RTOS from another.

7.2 Thread States and Thread Lists

Since only one thread can run on a CPU at a time, the scheduler relies on thread information to make its decisions. Mark3's scheduler relies on a variety of such information, including: The thread's current priority Round-Robin execution quanta Whether or not the thread is blocked on a synchronization object, such as a mutex or semaphore Whether or not the thread is currently suspended The scheduler further uses this information to logically place each thread into 1 of 4 possible states: Ready - The thread is currently running Running - The thread is able to run Blocked - The thread cannot run until a system condition is met Stopped - The thread cannot run because its execution has been suspended In order to determine a thread's state, threads are placed in "buckets" corresponding to these states. Ready and running threads exist in the scheduler's buckets, blocked threads exist in a buckets belonging to the object they're blocked on, and stopped threads exist in a bucket of all stopped threads.

In reality, the various buckets are just doubly-linked lists of Thread objects

- implemented in something called the ThreadList class. To facilitate this, the Thread class directly inherits from the LinkListNode class, which contains the node pointers required to implement a doubly-linked list. As a result, Threads may be effortlessly moved from one state to another using efficient linked-list operations built into the ThreadList class.

7.3 About Blocking and Unblocking

While many developers new to the concept of an RTOS assume that all threads in a system are entirely separate from eachother, the reality is that practical systems typically involve multiple threads working together, or at the very least sharing resources. In order to synchronize the execution of threads for that purpose, a number of synchronization primatives (blocking objects) are implemented to create specific sets of conditions under which threads can continue execution. The concept of "blocking" a thread until a specific condition is met is fundamental to understanding RTOS applications design, as well as any highly-multithreaded applications.

Blocking objects and primatives provided by Mark3 include:

- Semaphores (binary and counting)
- Mutexes
- Event Flags
- Thread Sleep
- Message Queues

Each of these objects inherit from the BlockingObject class, which itself contains a ThreadList object. This class contains methods to Block() a thread (remove it from the Scheduler's "Ready" or "Running" ThreadLists), as well as UnBlock() a thread (move a thread back to the "Ready" lists). This object handles transitioning threads from list-to-list (and state-to-state), as well as taking care of any other Scheduler bookkeeping required in the process. While each of the Blocking types implement a different condition, they are effectively variations on the same theme. Many simple Blocking objects are also used to build complex blocking objects - for instance, the Thread Sleep mechanism is essentially a binary semaphore and a timer object, while a message queue is a linked-list of message objects combined with a semaphore.

7.4 The Scheduling Alogrithm

At this point we've covered the following concepts:

- Threads
- Thread States and Thread Lists
- Blocking and Un-Blocking Threads

Thankfully, this is all the background required to understand how the Mark3 Scheduler works. In technical terms, Mark3 implements "strict priority scheduling, with round-robin scheduling among threads in each priority group". In plain English, this boils down to a scheduler which follows a few simple rules:

- Find the highest-priority "Ready" list that has at least one Threads.
- If the first thread in that bucket is not the current thread, select it to run next
- Otherwise, rotate the linked list, and choose the next thread in the list to run

Since context switching is one of the most common and frequent operation performed by an RTOS, this needs to be as fast and deterministic as possible. While the logic is simple, a lot of care must be put into optimizing the scheduler to achieve those goals. In the section below we discuss the optimization approaches taken in Mark3.

There are a number of ways to find the highest-priority thread. The naive approach would be to simply iterate through the scheduler's array of ThreadLists from highest to lowest, stopping when the first non-empty list is found, such as in the following block of code:

```
for (prio = num_prio - 1; prio >= 0; prio--)
{
    if (thread_list[prio].get_head() != NULL)
    {
        break;
    }
}
```

While that would certainly work and be sufficient for a variety of systems, it's a non-deterministic approach (complexity O(n)) whose cost varies substantially based on how many priorities have to be evaluated. It's simple to read and understand, but it's non-optimal.

Fortunatley, a functionally-equivalent and more deterministic approach can be implemented with a few tricks.

In addition to maintaining an array of ThreadLists, Mark3 also maintains a bitmap (one bit per priority level) that indicates which thread lists have ready threads. This bitmap is maintained automatically by the ThreadList class, and is updated every time a thread is moved to/from the Scheduler's ready lists.

By inspecting this bitmap using a technique to count the leading zero bits in the bitmap, we determine which threadlist to choose in fixed time.

Now, to implement the leading-zeros check, this can once again be performed iteratively using bitshifts and compares (which isn't any more efficient than the raw list traversal), but it can also be evaluated using either a lookup table, or via a special CPU instruction to count the leading zeros in a value. In Mark3, we opt for the lookup-table approach since we have a limited number of priorities and not all supported CPU architectures support a count leading zero instruction. To achieve a balance between performance and memory use, we use a 4-bit lookup table (costing 16 bytes) to perform the lookup.

(As a sidenote - this is actually a very common approach in OS schedulers. It's actually part of the reason why modern ARM cores implement a dedicated count-leading-zeros [CLZ] instruction!)

With a 4-bit lookup table and an 8-bit priority-level bitmap, the priority check algorithm looks something like this:

```
// Check the highest 4 priority levels, represented in the
// upper 4 bits in the bitmap
priority = priority_lookup_table[(priority_bitmap >> 4)];

// priority is non-zero if we found something there
if( priority )
{
    // Add 4 because we were looking at the higher levels
    priority += 4;
}
else
{
    // Nothing in the upper 4, look at the lowest 4 priority levels
    // represented by the lowest 4 bits in the bitmap
    priority = priority_lookup_table[priority_bitmap & 0x0F];
}
```

Deconstructing this algorithm, you can see that the priority lookup will have on O(1) complexity - and is extremely low-cost. This operation is thus fully deterministic and time bound - no matter how many threads are scheduled, the operation will always be time-bound to the most expensive of these two code paths. Even with only 8 priority levels, this is still much faster than iteratively checking the thread lists manually, compared with the previous example implementation.

Once the priority level has been found, selecting the next thread to run is trivial, consisting of something like this:

```
next_thread = thread_list[prio].get_head();
```

In the case of the get_head() calls, this evaluates to an inline-load of the "head" pointer in the particular thread list. One important thing to take away from this analysis is that the scheduler is only responsible for selecting the next-to-run thread. In fact, these two operations are totally decoupled - no context switching is performed by the scheduler, and the scheduler isn't called from the context switch. The scheduler simply produces new "next thread" values that are consumed from within the context switch code.

7.5 Considerations For Round-Robin Scheduling

One thing that isn't considered directly from the scheduler algorithm is the problem of dealing with multiple threads within a single priority group; all of the alorithms that have been explored above simply look at the firstThread in each group.

Mark3 addresses this issue indirectly, using a software timer to manage round-robin scheduling, as follows. In some instances where the scheduler is run by the kernel directly (typically as a result of calling Thread::Yield()), the kernel will perfom an additional check after running the Scheduler to determine whether or there are multiple ready Threadsin the priority of the next ready thread. If there are multiple threads within that priority, the kernel adds a one-shot software timer which is programmed to expire at the next Thread's configured quantum. When this timer expires, the timer's callback function executes to perform two simple operations: "Pivot" the current Thread's priority list.

Set a flag telling the kernel to trigger a Yield after exiting the main TimerScheduler processing loop Pivoting the thread list basically moves the head of a circular-linked-list to its next value, which in our case ensures that a new thread will be chosen the next time the scheduler is run (the scheduler only looks at the head node of the priority lists). And by calling Yield, the system forces the scheduler t run, a new round-robin software timer to be installed (if necssary), and triggers a context switch SWI to load the newly-chosen thread. Note that if the thread attached to the round-robin timer is pre-empted, the kernel will take steps to abort and invalidate that round-robin software timer, installing a new one tied to the next thread to run if necessary. Because the round-robin software timer is dynamically installed when there are multiple ready threads at the highest ready priority level, there is no CPU overhead with this feature unless that condition is met. The cost of round-robin scheduling is also fixed - no matter how many threads there are, and the cost is identical to any other one-shot software timer in the system.

7.6 Context Switching

There's really not much to say about the actual context switch operation at a high level. Context switches are triggered whenever it has been determined that a new thread needs to be swapped into the CPU core when the scheduler is run. Mark3 implements also context switches as a call to a software interrupt - on AVR platforms, we typically use INT0 or INT2 for this (although any pin-change GPIO interrupt can be used), and on ARM we achieve this by triggering a PendSV exception.

However, regardless of the architecture, the contex-switch ISR will perform the following three operations:

- Save the current Thread's context to the current Thread stack
- Make the "next to run" thread the "currently running" thread
- Restore the context of the next Thread from the Thread stack

The code to implement the context switch is entirely architecture-specific, so it won't be discussed in detail here. It's almost always gory inline-assembly which is used to load and store various CPU registers, and is highly-optimized for speed. I will dive into how this imporant bit of code works (on ARM Cortex-M0+) in a separate whitepaper.

7.7 Putting It All Together

In short, we can say that the Mark3 scheduler works as follows:

- The scheduler is run whenever a Thread::Yield() is called by a user, as part of blocking calls, or whenever a new thread is started
- The Mark3 scheduler is deterministic, selecting the next thread to run in fixed-time
- The scheduler only chooses the next thread to run, the context switch SWI consumes that information to get that thread running

- Where there are multiple ready threads in the highest populated priority level, a software timer is used to manage round-robin scheduling

While we've covered a lot of ground in this chapter, there's not a whole lot of code involved. However, the code that performs these operations is quite nuanced and subtle. If you're interested in seeing how this all works in practice, I suggest reading through the Mark3 source code (which is heavily annotated), and stepping through the code with a simulator/emulator.

Chapter 8

Porting Mark3 - An Example Using ARM Cortex-M0

This document serves as both a real-world example of how Mark3 can be ported to new architectures, and as a practical reference for using the RTOS support functionality baked in modern ARM Cortex-M series microcontrollers.

Most of this documentation here is taken directly from the source code found in the /kernel/cpu/cm0/ ports directory, with additional annotations to explain the port in more detail. Note that a familiarity with Cortex-M series parts will go a long way to understanding the subject matter presented, especially a basic understanding of the ARM CPU registers, exception models, and OS support features (PendSV, SysTick and SVC).

Porting Mark3 to a new architecture consists of a few basic pieces; for developers familiar with the target architecture and the porting process, it's not a tremendously onerous endeavour to get Mark3 up-and-running somewhere new. For starters, all non-portable components are completely isolated in the source-tree under /embedded/kernel/<-CPU>/<VARIANT>/<TOOLCHAIN>/, where <CPU> is the architecture, <VARIANT> is the vendor/part, and <TOOLCHAIN> is the compiler tool suite used to build the code.

From within the specific port folder, a developer needs only implement a few classes and headers that define the port-specific behavior of Mark3:

- KernelSWI (kernelswi.cpp/kernelswi.h) - Provides a maskable software-triggered interrupt used to perform context switching.
- KernelTimer (kerneltimer.cpp/kerneltimer.h) - Provides either a fixed-frequency or programmable-interval timer, which triggers an interrupt on expiry. This is used for implementing round-robin scheduling, thread-sleeps, and generic software timers.
- Profiler (kprofile.cpp/kprofile.h) - Contains code for runtime code-profiling. This is optional and may be stubbed out if left unimplemented (we won't cover profiling timers here).
- ThreadPort (threadport.cpp/threadport.h) - The meat-and-potatoes of the port code lives here. This class contains architecture/part-specific code used to initialize threads, implement critical-sections, perform context-switching, and start the kernel. Most of the time spent in this article focuses on the code found here.

Summarizing the above, these modules provide the following list of functionality:

- Thread stack initialization
- Kernel startup and first thread entry
- Context switch and SWI
- Kernel timers
- Critical Sections

The implementation of each of these pieces will be analyzed in detail in the sections that follow.

8.1 Thread Stack Initialization

Before a thread can be used, its stack must first be initialized to its default state. This default state ensures that when the thread is scheduled for the first time and its context restored, that it will cause the CPU to jump to the user's specified entry-point function.

All of the platform independent thread setup is handled by the generic kernel code. However, since every CPU architecture has its own register set, and stacks different information as part of an interrupt/exception, we have to implement this thread setup code for each platform we want the kernel to support (Combination of Architecture + Variant + Toolchain).

In the ARM Cortex-M0 architecture, the stack frame consists of the following information:

a) Exception Stack Frame

Contains the 8 registers which the ARM Cortex-M0 CPU automatically pushes to the stack when entering an exception. The following registers are included (in stack'd order):

```
[ XPSR ] <-- Highest address in context
[ PC   ]
[ LR   ]
[ R12  ]
[ R3   ]
[ R2   ]
[ R1   ]
[ R0   ]
```

XPSR – This is the CPU's status register. We need to set this to 0x01000000 (the "T" bit), which indicates that the CPU is executing in “thumb” mode. Note that ARMv6m and ARMv7m processors only run thumb2 instructions, so an exception is liable to occur if this bit ever gets cleared.

PC – Program Counter. This should be set with the initial entry point (function pointer) for that the user wishes to start executing with this thread.

LR - The base link register. Normally, this register contains the return address of the calling function, which is where the CPU jumps when a function returns. However, our threads generally don't return (and if they do, they're placed into the stop state). As a result we can leave this as 0.

The other registers in the stack frame are generic working registers, and have no special meaning, with the exception that R0 will hold the user's argument value passed into the entrypoint.

b) Complimentary CPU Register Context

```
[ R11   ]
...
[ R4    ] <-- Lowest address in context
```

These are the other general-purpose CPU registers that need to be backed up/restored on a context switch, but aren't stacked by default on a Cortex-M0 exception. If there were any additional hardware registers to back up, then we'd also have to include them in this part of the context as well.

As a result, these registers all need to be manually pushed to the stack on stack creation, and will need to be explicitly pushed and pop as part of a normal context switch.

With this default exception state in mind, the following code is used to initialize a thread's stack for a Cortex-M0.

```
void ThreadPort::InitStack(Thread *pclThread_)
{
    K_ULONG *pulStack;
    K_ULONG *pulTemp;
    K_ULONG ulAddr;
    K_USHORT i;

    // Get the entrypoint for the thread
    ulAddr = (K_ULONG)(pclThread_->m_pfEntryPoint);

    // Get the top-of-stack pointer for the thread
    pulStack = (K_ULONG*)pclThread_->m_pwStackTop;

    // Initialize the stack to all FF's to aid in stack depth checking
    pulTemp = (K_ULONG*)pclThread_->m_pwStack;
    for (i = 0; i < pclThread_->m_usStackSize / sizeof(K_ULONG); i++)
    {
        pulTemp[i] = 0xFFFFFFFF;
    }

    PUSH_TO_STACK(pulStack, 0);             // Apply one word of padding

    //-- Simulated Exception Stack Frame --
    PUSH_TO_STACK(pulStack, 0x01000000);    // XSPR - set "T" bit for thumb-mode
    PUSH_TO_STACK(pulStack, ulAddr);        // PC
    PUSH_TO_STACK(pulStack, 0);             // LR
    PUSH_TO_STACK(pulStack, 0x12);
    PUSH_TO_STACK(pulStack, 0x3);
    PUSH_TO_STACK(pulStack, 0x2);
    PUSH_TO_STACK(pulStack, 0x1);
    PUSH_TO_STACK(pulStack, (K_ULONG)pclThread_->m_pvArg);    // R0 = argument

    //-- Simulated Manually-Stacked Registers --
    PUSH_TO_STACK(pulStack, 0x11);
    PUSH_TO_STACK(pulStack, 0x10);
    PUSH_TO_STACK(pulStack, 0x09);
    PUSH_TO_STACK(pulStack, 0x08);
    PUSH_TO_STACK(pulStack, 0x07);
    PUSH_TO_STACK(pulStack, 0x06);
    PUSH_TO_STACK(pulStack, 0x05);
    PUSH_TO_STACK(pulStack, 0x04);
    pulStack++;

    pclThread_->m_pwStackTop = pulStack;
}
```

8.2 Kernel Startup

The same general process applies to starting the kernel on an ARM Cortex-M0 as on other platforms. Here, we initialize and start the platform specific timer and software-interrupt modules, find the first thread to run, and then jump to that first thread.

Now, to perform that last step, we have two options:

1) Simulate a return from an exception manually to start the first thread, or.. 2) Use a software interrupt to trigger the first "Context Restore/Return from Interrupt"

For 1), we basically have to restore the whole stack manually, not relying on the CPU to do any of this for us. That's certainly doable, but not all Cortex parts support this (other members of the family support privileged modes, etc.). That, and the code required to do this is generally more complex due to all of the exception-state simulation. So, we will opt for the second option instead.

To implement a software to start our first thread, we will use the SVC instruction to generate an exception. From that exception, we can then restore the context from our first thread, set the CPU up to use the right "process" stack, and return-from-exception back to our first thread. We'll explore the code for that later.

But, before we can call the SVC exception, we're going to do a couple of things.

First, we're going to reset the default MSP stack pointer to its original top-of-stack value. The rationale here is that we no longer care about the data on the MSP stack, since calling the SVC instruction triggers a chain of events from which we never return. The MSP is also used by all exception-handling, so regaining a few words of stack here can be useful. We'll also enable all maskable exceptions at this point, since this code results in the kernel being started with the CPU executing the RTOS threads, at which point a user would expect interrupts to be enabled.

Note, the default stack pointer location is stored at address 0x00000000 on all ARM Cortex M0 parts. That explains the code below.

```
void ThreadPort_StartFirstThread( void )
{
    asm(
        " ldr r1, [r0] \n" // Reset the MSP to the default base address
        " msr msp, r1 \n"
        " cpsie i \n"      // Enable interrupts
        " svc 0 \n"        // Jump to SVC Call
        );
}
```

8.3 First Thread Entry

This handler has the job of taking the first thread object's stack, and restoring the default state data in a way that ensures that the thread starts executing when returning from the call.

We also keep in mind that there's an 8-byte offset from the beginning of the thread object to the location of the thread stack pointer. This offset is a result of the thread object inheriting from the linked-list node class, which has 8-bytes of data. This is stored first in the object, before the first element of the class, which is the "stack top" pointer.

The following assembly code shows how the SVC call is implemented in Mark3 for the purpose of starting the first thread.

```
get_thread_stack:
    ; Get the stack pointer for the current thread
    ldr r0, g_pstCurrent
    ldr r1, [r0]
    add r1, #8
    ldr r2, [r1]         ; r2 contains the current stack-top

load_manually_placed_context_r11_r8:
    ; Handle the bottom 32-bytes of the stack frame
    ; Start with r11-r8, because only r0-r7 can be used
    ; with ldmia on CM0.
    add r2, #16
    ldmia r2!, {r4-r7}
    mov r11, r7
    mov r10, r6
    mov r9, r5
    mov r8, r4

set_psp:
    ; Since r2 is coincidentally back to where the stack pointer should be,
    ; Set the program stack pointer such that returning from the exception handler
    msr psp, r2

load_manually_placed_context_r7_r4:
    ; Get back to the bottom of the manually stacked registers and pop.
    sub r2, #32
    ldmia r2!, {r4-r7}  ; Register r4-r11 are restored.

set_thread_and_privilege_modes:
    ; Also modify the control register to force use of thread mode as well
    ; For CM3 forward-compatibility, also set user mode.
    mrs r0, control
    mov r1, #0x03
    orr r0, r1
    control, r0

set_lr:
    ; Set up the link register such that on return, the code operates in thread mode using the PSP
    ; To do this, we or 0x0D to the value stored in the lr by the exception hardware EXC_RETURN.
    ; Alternately, we could just force lr to be 0xFFFFFFFD (we know that's what we want from the hardware,
       anyway)
    mov  r0, #0x0D
    mov  r1, lr
    orr r0, r1

exit_exception:
    ; Return from the exception handler.  The CPU will automagically unstack R0-R3, R12, PC, LR, and xPSR
    ; for us.  If all goes well, our thread will start execution at the entrypoint, with the us-specified
    ; argument.
    bx r0
```

8.4 Context Switching

On ARM Cortex parts, there's dedicated hardware that's used primarily to support RTOS (or RTOS-like) funcationlity. This functionality includes the SysTick timer, and the PendSV Exception. SysTick is used for a tick-based kernel timer, while the PendSV exception is used for performing context switches. In reality, it's a "special SVC" call that's designed to be lower-overhead, in that it isn't mux'd with a bunch of other system or application functionality.

So how do we go about actually implementing a context switch here? There are a lot of different parts involved, but it essentially comes down to 3 steps:

1) Saving the context. Thread's top-of-stack value is stored, all registers are stacked. We're good to go!

2) Swap threads. We swap the Scheduler's “next” thread with the “current” thread.

3) Restore Context. This is more or less identical to what we did when restoring the first context. Some operations may be optimized for data already stored in registers.

The code used to implement these steps on Cortex-M0 is presented below:

```
void PendSV_Handler(void)
{
    ASM(
    // Thread_SaveContext()
    " ldr r1, CURR_ \n"
    " ldr r1, [r1] \n "
    " mov r3, r1 \n "
    " add r3, #8 \n "

    //  Grab the psp and adjust it by 32 based on the extra registers we're going
    // to be manually stacking.
    " mrs r2, psp \n "
    " sub r2, #32 \n "

    // While we're here, store the new top-of-stack value
    " str r2, [r3] \n "

    // And, while r2 is at the bottom of the stack frame, stack r7-r4
    " stmia r2!, {r4-r7} \n "

    // Stack r11-r8
    " mov r7, r11 \n "
    " mov r6, r10 \n "
    " mov r5, r9 \n "
    " mov r4, r8 \n "
    " stmia r2!, {r4-r7} \n "

    // Equivalent of Thread_Swap() - performs g_pstCurrent = g_pstNext
    " ldr r1, CURR_ \n"
    " ldr r0, NEXT_ \n"
    " ldr r0, [r0] \n"
    " str r0, [r1] \n"

    // Thread_RestoreContext()
    // Get the pointer to the next thread's stack
    " add r0, #8 \n "
    " ldr r2, [r0] \n "

    // Stack pointer is in r2, start loading registers from the "manually-stacked" set
    // Start with r11-r8, since these can't be accessed directly.
    " add r2, #16 \n "
    " ldmia r2!, {r4-r7} \n "
    " mov r11, r7 \n "
    " mov r10, r6 \n "
    " mov r9, r5 \n "
    " mov r8, r4 \n "

    // After subbing R2 #16 manually, and #16 through ldmia, our PSP is where it
    // needs to be when we return from the exception handler
    " msr psp, r2 \n "

    // Pop manually-stacked R4-R7
    " sub r2, #32 \n "
    " ldmia r2!, {r4-r7} \n "

    // lr contains the proper EXC_RETURN value
    // we're done with the exception, so return back to the newly-chosen thread
    " bx lr \n "
    " nop \n "

    // Must be 4-byte aligned.  Also - GNU assembler, I hate you for making me resort to this.
    " NEXT_: .word g_pstNext \n"
    " CURR_: .word g_pstCurrent \n"
    );
}
```

8.5 Kernel Timers

ARM Cortex-M series microcontrollers each contain a SysTick timer, which was designed to facilitate a fixed-interval RTOS timer-tick. This timer is a precise 24-bit down-count timer, run at the main CPU clock frequency, that can be programmed to trigger an exception when the timer expires. The handler for this exception can thus be used to drive software timers throughout the system on a fixed interval.

Unfortunately, this hardware is extremely simple, and does not offer the flexibility of other timer hardware commonly implemented by MCU vendors - specifically a suitable timer prescalar that can be used to generate efficient, long-counting intervals. As a result, while the "generic" port of Mark3 for Cortex-M0 leverages the common SysTick timer interface, it only supports the tick-based version of the kernel's timer (note that specific Cortex-M0 ports such as the Atmel SAMD20 do have tickless timers).

Setting up a tick-based KernelTimer class to use the SysTick timer is, however, extremely easy, as is illustrated below:

```
void KernelTimer::Start(void)
{
    SysTick_Config(SYSTEM_FREQ / 1000); // 1KHz fixed clock...
    NVIC_EnableIRQ(SysTick_IRQn);
}
```

In this instance, the call to SysTick_Config() generates a 1kHz system-tick signal, and the NVIC_EnableIRQ() call ensures that a SysTick exception is generated for each tick. All other functions in the Cortex version of the Kernel-Timer class are essentially stubbed out (see the source for more details).

Note that the functions used in this call are part of the ARM Cortex Microcontroller Software Interface Standard (cmsis), and are supplied by all parts vendors selling Cortex hardware. This greatly simplifies the design of our port-code, since we can be reasonably assured that these APIs will work the same on all devices.

The handler code called when a SysTick exception occurs is basically the same as on other platforms (such as AV-R), except that we explicitly clear the "exception pending" bit before returning. This is implemented in the following code:

```
void SysTick_Handler(void)
{
#if KERNEL_USE_TIMERS
    TimerScheduler::Process();
#endif
#if KERNEL_USE_QUANTUM
    Quantum::UpdateTimer();
#endif

    // Clear the systick interrupt pending bit.
    SCB->ICSR |= SCB_ICSR_PENDSTCLR_Msk;
}
```

8.6 Critical Sections

A "critical section" is a block of code whose execution cannot be interrupted by means of context switches or an interrupt. In a traditional single-core operating system, it is typically implemented as a block of code where the interrupts are disabled - this is also the approach taken by Mark3. Given that every CPU has its own means of disabling/enabling interrupts, the implementation of the critical section APIs is also non-portable.

In the Cortex-M0 port, we implement the two critical section APIs (CS_ENTER() and CS_EXIT()) as function-like macros containing inline assembly. All uses of these calls are called in pairs within a function and must take place at the same level-of-scope. Also, as nesting may occur (critical section within a critical section), this must be taken into account in the code.

In general, CS_ENTER() performs the following tasks:

- Cache the current interrupt-enabled state within a local variable in the thread's state
- Disable interrupts

Conversely, CS_EXIT() performs the following tasks:

- Read the original interrupt-enabled state from the cached value
- Restore interrupts to the original value

On Cortex-M series micrcontrollers, the PRIMASK special register contains a single status bit which can be used to enable/disable all maskable interrupts at once. This register can be read directly to examine or modify its state. For convenience, ARMv6m provides two instructions to enable/disable interrupts - cpsid (disable interrupts) and cpsie (enable interrupts). Mark3 Implements these steps according to the following code:

```
//------------------------------------------------------------------------
#define CS_ENTER()    \
{    \
    K_ULONG __ulRegState;    \
    asm    ( \
    " mrs r0, PRIMASK \n"    \
    " mov %[STATUS], r0 \n" \
    " cpsid i \n "    \
    : [STATUS] "=r" (__ulRegState) \
    );

//------------------------------------------------------------------------
#define CS_EXIT() \
    asm    ( \
    " mov r0, %[STATUS] \n" \
    " msr primask, r0 \n"    \
    : \
    : [STATUS] "r" (__ulRegState) \
    ); \
}
```

8.7 Conclusion

In this chapter we have investigated how the main non-portable areas of the Mark3 RTOS are implemented on a Cortex-M0 microcontroller. Mark3 leverages all of the hardware blocks designed to enable RTOS functionality on ARM Cortex-M series microcontrollers: the SVC call provides the mechanism by which we start the kernel, the PendSV exception provides the necessary software interrupt, and the SysTick timer provides an RTOS tick. As a result, Mark3 is a perfect fit for these devices - and as a result of this approach, the same RTOS port code should work with little to no modification on all ARM Cortex-M parts.

We have discussed what functionality in the RTOS is not portable, and what interfaces must be implemented in order to complete a fully-functional port. The five specific areas which are non-portable (stack initialization, kernel startup/entry, kernel timers, context switching, and critical sections) have been discussed in detail, with the platform-specifc source provided as a practical reference to ARM-specific OS features, as well as Mark3's porting infrastructure. From this example (and the accompanying source), it should be possible for an experienced developers to create a port Mark3 to other microcontroller targets.

Chapter 9

Build System

Mark3 is distributed with a recursive makefile build system, allowing the entire source tree to be built into a series of libraries with simple make commands.

The way the scripts work, every directory with a valid makefile is scanned, as well as all of its subdirectories. The build then generates binary components for all of the components it finds -libraries and executables. All libraries that are generated can then be imported into an application using the linker without having to copy-and-paste files on a module-by-module basis. Applications built during this process can then be loaded onto a device directly, without requiring a GUI-based IDE. As a result, Mark3 integrates well with 3rd party tools for continuous-integration and automated testing.

This modular framework allows for large volumes of libraries and binaries to be built at once - the default build script leverages this to build all of the examples and unit tests at once, linking against the pre-built kernel, services, and drivers. Whatever can be built as a library is built as a library, promoting reuse throughout the platform, and enabling Mark3 to be used as a platform, with an ecosystem of libraries, services, drivers and applications.

9.1 Source Layout

One key aspect of Mark3 is that system features are organized into their own separate modules. These modules are further grouped together into folders based on the type of features represented:

```
Root         Base folder, contains recursive makefiles for build system
    bootloader   Mark3 Bootloader code for AVR
    build        Makefile support for various platforms
    doc          Documentation (including this)
    drivers      Device driver code
    example      Example applications
    kernel       Basic Mark3 Components (the focus of this manual)
        cpu      CPU-specific porting code
    services     Utility code and services, extended system features
    stage        Staging directory, where the build system places artifacts
    tests        Unit tests, written as C/C++ applications
```

9.2 Building the kernel

The base.mak file determines how the kernel, drivers, and libraries are built, for what targets, and with what options. Most of these options can be copied directly from the options found in your IDE managed projects. Below is an overview of the main variables used to configure the build.

```
STAGE          - Location in the filesystem where the build output is stored
ROOT_DIR     - The location of the root source tree
ARCH        - The CPU architecture to build against
VARIANT        - The variant of the above CPU to target
TOOLCHAIN    - Which toolchain to build with (dependent on ARCH and VARIANT)
```

Build.mak contains the logic which is used to perform the recursive make in all directories. Unless you really know what you're doing, it's best to leave this as-is.

You must make sure that all required paths are set in your system environment variables so that they are accessible through from the command-line.

Once configured, you can build the source tree using the various make targets:

- make headers
  - copy all headers in each module's /public subdirectory to the location specified by STAGE environment variable's ./inc subdirectory.
- make library
  - regenerate all objects copy marked as libraries (i.e. the kernel + drivers). Resulting binaries are copied into STAGE's ./lib subdirectory.
- make binary
  - build all executable projects in the root directory structure. In the default distribution, this includes the basic set of demos.

To add new components to the recursive build system, simply add your code into a new folder beneath the root install location.

Source files, the module makefile and private header files go directly in the new folder, while public headers are placed in a ./public subdirectory. Create a ./obj directory to hold the output from the builds.

The contents of the module makefile looks something like this:

```
# Include common prelude make file
include $(ROOT_DIR)base.mak

# If we're building a library, set IS_LIB and LIBNAME
# If we're building an app, set IS_APP and APPNAME
IS_LIB=1
LIBNAME=mylib

#this is the list of the source modules required to build the kernel
CPP_SOURCE = mylib.cpp \
             someotherfile.cpp

# Similarly, C-language source would be under the C_SOURCE variable.

# Include the rest of the script that is actually used for building the
# outputs
include $(ROOT_DIR)build.mak
```

Once you've placed your code files in the right place, and configured the makefile appropriately, a fresh call to make headers, make library, then make binary will guarantee that your code is built.

Now, you can still copy-and-paste the required kernel, port, and drivers, directly into your application avoiding the whole process of using make from the command line. To do this, run "make source" from the root directory in svn, and copy the contents of /stage/src into your project. This should contain the source to the kernel, all drivers, and all services that are in the tree - along with the necessary header files.

9.3 Building on Windows

Building Mark3 on Windows is the same as on Linux, but there are a few prerequisites that need to be taken into consideration before the build scripts and makefiles will work as expected.

Step 1 - Install Latest Atmel Studio IDE

Atmel Studio contains the AVR8 GCC toolchain, which contains the necessary compilers, assemblers, and platform support required to turn the source modules into libraries and executables.

To get Atmel Studio, go to the Atmel website (http://www.atmel.com) and register to download the latest version. This is a free download (and rather large). The included IDE (if you choose to use it) is very slick, as it's based on Visual Studio, and contains a wonderful cycle-accurate simulator for AVR devices. In fact, the simulator is so good that most of the kernel and its drivers were developed using this tool.

Once you have downloaded and installed Atmel Studio, you will need to add the location of the AVR toolcahin to the PATH environment variable.

To do this, go to Control Panel -> System and Security -> System -> Advanced System Settings, and edit the PATH variable. Append the location of the toolchain bin folder to the end of the variable.

On Windows 7 x64, it should look something like this:

C: Files (x86) Toolchain GCC\Native\3.4.2.1002-gnu-toolchain

Step 2 - Install MinGW and MinSys

MinGW (and MinSys in particular) provide a unix-like environment that runs under windows. Some of the utilities provided include a version of the bash shell, and GNU standard make - both which are required by the Mark3 recursive build system.

The MinGW installer can be downloaded from its project page on SourceForge. When installing, be sure to select the "MinSys" component.

Once installed, add the MinSys binary path to the PATH environment variable, in a similar fashion as with Atmel Studio in Step 1.

Step 3 - Setup Include Paths in Platform Makefile

The AVR header file path must be added to the "platform.mak" makefile for each AVR Target you are attempting to build for. These files can be located under /embedded/build/avr/atmegaXXX/. The path to the includes directory should be added to the end of the CFLAGS and CPPFLAGS variables, as shown in the following:

```
TEST_INC="/c/Program Files (x86)/Atmel/Atmel Toolchain/AVR8
       GCC/Native/3.4.2.1002/avr8-gnu-toolchain/include"
CFLAGS += -I$(TEST_INC)
CPPFLAGS += -I$(TEST_INC)
```

Step 4 - Build Mark3 using Bash

Launch a terminal to your Mark3 base directory, and cd into the "embedded" folder. You should now be able to build Mark3 by running "bash ./build.sh" from the command-line.

Alternately, you can run bash itself, building Mark3 by running ./build.sh or the various make targets using the same synatx as documented previously.

Note - building on Windows is *slow*. This has a lot to do with how "make" performs under windows. There are faster substitutes for make (such as cs-make) that are exponentially quicker, and approach the performance of make on Linux. Other mechanisms, such as running make with multiple concurrent jobs (i.e. "make -j4") also helps significantly, especially on systems with multicore CPUs.

9.4 Exporting the Source

In addition to providing a full recursive-make based build system, the kernel source for a given target can be exported directly to a .zip file for convenience. Run export.sh for any supported target (the full list of targets is listed below) to create a .zip archive of the kernel source and port code. If doxygen and pdflatex are available from your OS, documentation will also be generated (HTML and PDF) on the fly and included in the archive.

9.4.1 Supported targets

Currently, Mark3 supports the following AVR parts:

- atmega328p

- arduino
- atmega644
- atmega1284p
- atxmega256a3 (∗experimental)

The following Cortex M0 parts are supported as well:

- Atmel samd20
- ST Micro stm32f0

Chapter 10

License

10.1 License

Chapter 11

Profiling Results

The following profiling results were obtained using an ATMega328p @ 16MHz.

The test cases are designed to make use of the kernel profiler, which accurately measures the performance of the fundamental system APIs, in order to provide information for user comparison, as well as to ensure that regressions are not being introduced into the system.

11.1 Date Performed

Sat Jun 1 10:43:06 EDT 2013

11.2 Compiler Information

The kernel and test code used in these results were built using the following compiler: ./profile.sh: 55: ./profile.sh: /home/moslevin/atmel/bin/avr-gcc: not found

11.3 Profiling Results

- Semaphore Initialization: 7 cycles (averaged over 83 iterations)
- Semaphore Post (uncontested): 180 cycles (averaged over 83 iterations)
- Semaphore Pend (uncontested): 67 cycles (averaged over 83 iterations)
- Semaphore Flyback Time (Contested Pend): 1553 cycles (averaged over 83 iterations)
- Mutex Init: 0 cycles (averaged over 83 iterations)
- Mutex Claim: 143 cycles (averaged over 83 iterations)
- Mutex Release: 49 cycles (averaged over 83 iterations)
- Thread Initialize: 7800 cycles (averaged over 83 iterations)
- Thread Start: 803 cycles (averaged over 83 iterations)
- Context Switch: 198 cycles (averaged over 83 iterations)
- Thread Schedule: 47 cycles (averaged over 83 iterations)

Chapter 12

Code Size Profiling

The following report details the size of each module compiled into the kernel.

The size of each component is dependent on the flags specified in mark3cfg.h at compile time. Note that these sizes represent the maximum size of each module before dead code elimination and any additional link-time optimization, and represent the maximum possible size that any module can take.

The results below are for profiling on Atmel AVR atmega328p-based targets using gcc. Results are not necessarily indicative of relative or absolute performance on other platforms or toolchains.

12.1 Information

Subversion Repository Information:

- Repository Root: `https://svn.code.sf.net/p/mark3/source`
- Revision: 154
- URL: `https://svn.code.sf.net/p/mark3/source/trunk/embedded`

Date Profiled: Sat Jan 25 15:29:37 EST 2014

12.2 Compiler Version

avr-gcc (GCC) 4.7.2 Copyright (C) 2012 Free Software Foundation, Inc. This is free software; see the source for copying conditions. There is NO warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

12.3 Profiling Results

Mark3 Module Size Report:

- Atomic Operations.............................. : 478 Bytes
- Synchronization Objects - Base Class........... : 270 Bytes
- Device Driver Framework (including /dev/null)... : 236 Bytes
- Synchronization Object - Event Flag............ : 1160 Bytes
- Fundamental Kernel Linked-List Classes.......... : 610 Bytes

- Message-based IPC............................... : 500 Bytes
- Mutex (Synchronization Object).................. : 1004 Bytes
- Performance-profiling timers.................... : 556 Bytes
- Round-Robin Scheduling Support.................. : 299 Bytes
- Thread Scheduling............................... : 499 Bytes
- Semaphore (Synchronization Object).............. : 868 Bytes
- Thread Implementation........................... : 1441 Bytes
- Fundamental Kernel Thread-list Data Structures.. : 212 Bytes
- Mark3 Kernel Base Class......................... : 80 Bytes
- Software Timer Implementation................... : 1035 Bytes
- Kernel Transaction Queues....................... : 308 Bytes
- Runtime Kernel Trace Implementation............. : 0 Bytes
- Circular Logging Buffer Base Class.............. : 524 Bytes
- Atmel AVR - Basic Threading Support............. : 528 Bytes
- Atmel AVR - Kernel Interrupt Implemenation....... : 56 Bytes
- Atmel AVR - Kernel Timer Implementation.......... : 338 Bytes
- Atmel AVR - Profiling Timer Implementation....... : 256 Bytes

Mark3 Kernel Size Summary:

- Kernel : 3420 Bytes
- Synchronization Objects : 3532 Bytes
- Port : 1178 Bytes
- Features : 2650 Bytes
- Total Size : 10780 Bytes

Chapter 13

Hierarchical Index

13.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 14

Class Index

14.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 15

File Index

15.1 File List

Here is a list of all documented files with brief descriptions:

Chapter 16

Class Documentation

16.1 Atomic Class Reference

The Atomic class.

`#include <atomic.h>`

Static Public Member Functions

- static K_UCHAR Set (K_UCHAR ∗pucSource_, K_UCHAR ucVal_)

  Set Set a variable to a given value in an uninterruptable operation.
- static K_USHORT **Set** (K_USHORT ∗pusSource_, K_USHORT usVal_)
- static K_ULONG **Set** (K_ULONG ∗pulSource_, K_ULONG ulVal_)
- static K_UCHAR Add (K_UCHAR ∗pucSource_, K_UCHAR ucVal_)

  Add Add a value to a variable in an uninterruptable operation.
- static K_USHORT **Add** (K_USHORT ∗pusSource_, K_USHORT usVal_)
- static K_ULONG **Add** (K_ULONG ∗pulSource_, K_ULONG ulVal_)
- static K_UCHAR Sub (K_UCHAR ∗pucSource_, K_UCHAR ucVal_)

  Sub Subtract a value from a variable in an uninterruptable operation.
- static K_USHORT **Sub** (K_USHORT ∗pusSource_, K_USHORT usVal_)
- static K_ULONG **Sub** (K_ULONG ∗pulSource_, K_ULONG ulVal_)
- static K_BOOL TestAndSet (K_BOOL ∗pbLock)

  TestAndSet Test to see if a variable is set, and set it if is not already set.

16.1.1 Detailed Description

The Atomic class.

This utility class provides primatives for atomic operations - that is, operations that are guaranteed to execute uninterrupted. Basic atomic primatives provided here include Set/Add/Delete for 8, 16, and 32-bit integer types, as well as an atomic test-and-set.

Definition at line 39 of file atomic.h.

16.1.2 Member Function Documentation

16.1.2.1 K_UCHAR Atomic::Add (K_UCHAR ∗ *pucSource_*, K_UCHAR *ucVal_*) `[static]`

Add Add a value to a variable in an uninterruptable operation.

Parameters

*pucSource_*	Pointer to a variable
*ucVal_*	Value to add to the variable

Returns

Previously-held value in pucSource_

Definition at line 60 of file atomic.cpp.

16.1.2.2 K_UCHAR Atomic::Set (K_UCHAR * *pucSource_*, K_UCHAR *ucVal_*) [static]

Set Set a variable to a given value in an uninterruptable operation.

Parameters

*pucSource_*	Pointer to a variable to set the value of
*ucVal_*	New value to set in the variable

Returns

Previously-set value

Definition at line 29 of file atomic.cpp.

16.1.2.3 K_UCHAR Atomic::Sub (K_UCHAR * *pucSource_*, K_UCHAR *ucVal_*) [static]

Sub Subtract a value from a variable in an uninterruptable operation.

Parameters

*pucSource_*	Pointer to a variable
*ucVal_*	Value to subtract from the variable

Returns

Previously-held value in pucSource_

Definition at line 93 of file atomic.cpp.

16.1.2.4 K_BOOL Atomic::TestAndSet (K_BOOL * *pbLock*) [static]

TestAndSet Test to see if a variable is set, and set it if is not already set.

This is an uninterruptable operation.

```
If the value is false, set the variable to true, and return
the previously-held value.

If the value is already true, return true.
```

Parameters

pbLock	Pointer to a value to test against. This will always be set to "true" at the end of a call to TestAndSet.

Returns

true - Lock value was "true" on entry, false - Lock was set

Definition at line 126 of file atomic.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/atomic.h
- /home/mo/mark3-source/embedded/stage/src/atomic.cpp

16.2 BitStreamer Class Reference

Public Member Functions

- void Init (K_UCHAR ∗pucData_, K_USHORT usSize_)

  Init.
- void AdvanceByte (void)

  AdvanceByte.
- K_UCHAR ReadBits (K_UCHAR ucNumBits_)

  ReadBits.

Private Attributes

- K_UCHAR ∗ m_pucData

  Pointer to the data being streamed.
- K_UCHAR m_ucBitIndex

  Current "bit" index in the current byte.
- K_USHORT m_usByteIndex

  Current "byte" index in the stream.
- K_USHORT m_usSize

  Length of data (in bytes)

16.2.1 Detailed Description

Definition at line 21 of file bitstream.h.

16.2.2 Member Function Documentation

16.2.2.1 void BitStreamer::AdvanceByte (void)

AdvanceByte.

Advance byte index to the next full byte if the current bit index is non-zero. If the current bit index is zero, no action is taken. This is used to byte-align 2-dimensional data, such as images.

Definition at line 28 of file bitstream.cpp.

16.2.2.2 void BitStreamer::Init (K_UCHAR ∗ *pucData_*, K_USHORT *usSize_*)

Init.

Initialize the BitStreamer object prior to use

Parameters

*pucData_*	Pointer to raw data to be streamed
*usSize_*	Size of pucData_ in bytes

Definition at line 19 of file bitstream.cpp.

16.2.2.3 K_UCHAR BitStreamer::ReadBits (K_UCHAR *ucNumBits_*)

ReadBits.

Read the next "n" bits from the stream, returning the result into an 8-bit unsigned integer.

Parameters

*ucNumBits_*	Number of bits to read (less than 8)

Returns

Bits read as an 8-bit unsigned integer.

Definition at line 38 of file bitstream.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/bitstream.h
- /home/mo/mark3-source/embedded/stage/src/bitstream.cpp

16.3 BlockHeap Class Reference

Single-block-size heap.

```
#include <fixed_heap.h>
```

Public Member Functions

- void ∗ Create (void ∗pvHeap_, K_USHORT usSize_, K_USHORT usBlockSize_)

  Create a single list heap in the blob of memory provided, with the selected heap size, and the selected number of blocks.
- void ∗ Alloc ()

  Allocate a block of memory from this heap.
- void Free (void ∗pvData_)

  Free a previously allocated block of memory.
- K_BOOL IsFree ()

  Returns the state of a heap - whether or not it has free elements.

Protected Attributes

- K_USHORT m_usBlocksFree

  Number of blocks free in the heap.

Private Attributes

- DoubleLinkList m_clList

  Linked list used to manage the blocks.

16.3.1 Detailed Description

Single-block-size heap.

Definition at line 29 of file fixed_heap.h.

16.3.2 Member Function Documentation

16.3.2.1 void ∗ BlockHeap::Alloc ( )

Allocate a block of memory from this heap.

Returns

pointer to a block of memory, or 0 on failure

Definition at line 83 of file fixed_heap.cpp.

16.3.2.2 void ∗ BlockHeap::Create (void ∗ *pvHeap_*, K_USHORT *usSize_*, K_USHORT *usBlockSize_*)

Create a single list heap in the blob of memory provided, with the selected heap size, and the selected number of blocks.

Will create as many blocks as will fit in the usSize_ parameter

Parameters

*pvHeap_*	Pointer to the heap data to initialize
*usSize_*	Size of the heap range in bytes
*usBlockSize_*	Size of each heap block in bytes

Returns

Pointer to the next heap element to initialize

Definition at line 48 of file fixed_heap.cpp.

16.3.2.3 void BlockHeap::Free (void ∗ *pvData_*)

Free a previously allocated block of memory.

Parameters

*pvData_*	Pointer to a block of data previously allocated off the heap.

Definition at line 102 of file fixed_heap.cpp.

16.3.2.4 K_BOOL BlockHeap::IsFree ( ) `[inline]`

Returns the state of a heap - whether or not it has free elements.

Returns

true if the heap is not full, false if the heap is full

Definition at line 74 of file fixed_heap.h.

The documentation for this class was generated from the following files:

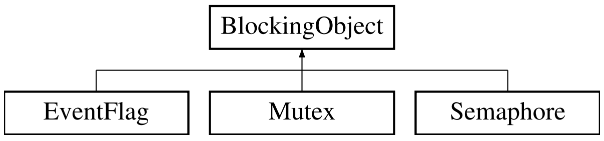
- /home/mo/mark3-source/embedded/stage/src/fixed_heap.h
- /home/mo/mark3-source/embedded/stage/src/fixed_heap.cpp

16.4 BlockingObject Class Reference

Class implementing thread-blocking primatives.

`#include <blocking.h>`

Inheritance diagram for BlockingObject:



Protected Member Functions

- void Block (Thread ∗pclThread_)
- void UnBlock (Thread ∗pclThread_)
- K_UCHAR UnLock ()

  Unlock.
- K_BOOL LockAndQueue (K_USHORT usCode_, void ∗pvData_, K_BOOL ∗pbSchedState_)

  LockAndQueue.

Protected Attributes

- ThreadList m_clBlockList

  ThreadList which is used to hold the list of threads blocked on a given object.
- TransactionQueue m_clKTQ

  Kernel Transaction Queue used to serialize acceses to this blocking object.
- K_UCHAR m_ucLocks

  The current count of locks held by this blocking object.

16.4.1 Detailed Description

Class implementing thread-blocking primatives.

Used for implementing things like semaphores, mutexes, message queues, or anything else that could cause a thread to suspend execution on some external stimulus.

Definition at line 67 of file blocking.h.

16.4.2 Member Function Documentation

16.4.2.1 void BlockingObject::Block (Thread ∗ *pclThread_*) `[protected]`

Parameters

*pclThread_*	Pointer to the thread object that will be blocked.

Blocks a thread on this object. This is the fundamental operation performed by any sort of blocking operation in the operating system. All semaphores/mutexes/sleeping/messaging/etc ends up going through the blocking code at some point as part of the code that manages a transition from an "active" or "waiting" thread to a "blocked" thread.

The steps involved in blocking a thread (which are performed in the function itself) are as follows;

1) Remove the specified thread from the current owner's list (which is likely one of the scheduler's thread lists) 2) Add the thread to this object's thread list 3) Setting the thread's "current thread-list" point to reference this object's threadlist.

Definition at line 36 of file blocking.cpp.

16.4.2.2 K_BOOL BlockingObject::LockAndQueue (K_USHORT *usCode_*, void ∗ *pvData_*, K_BOOL ∗ *pbSchedState_*) [protected]

LockAndQueue.

Lock the object and endqueue data on its transaction queue. If the object is already locked, enqueue the data and return back. Otherwise, disable the scheduler and return its state in addition to enqueuing the given transaction

Parameters

*usCode_*	Transaction code value
*pvData_*	Abstract transaction data pointer
*pbSchedState_*	Pointer to a flag used to store the scheduler's original state.

Returns

true - Object was previously locked, false - object was not previously locked.

Definition at line 87 of file blocking.cpp.

16.4.2.3 void BlockingObject::UnBlock (Thread ∗ *pclThread_*) [protected]

Parameters

*pclThread_*	Pointer to the thread to unblock.

Unblock a thread that is already blocked on this object, returning it to the "ready" state by performing the following steps:

1) Removing the thread from this object's threadlist 2) Restoring the thread to its "original" owner's list

Definition at line 54 of file blocking.cpp.

16.4.2.4 K_UCHAR BlockingObject::UnLock ( ) [protected]

Unlock.

See Also

Lock

Returns

Count of pending locks held on this blocking oject

This function will atomically-decrement the internal lock count held on the object, returning the new lock count value.

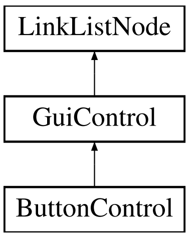
Definition at line 73 of file blocking.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/blocking.h
- /home/mo/mark3-source/embedded/stage/src/blocking.cpp

16.5 ButtonControl Class Reference

Inheritance diagram for ButtonControl:



Public Member Functions

- virtual void Init ()

    Initiailize the control - must be called before use.
- virtual void Draw ()

    Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

    Process an event sent to the control.
- virtual void Activate (bool bActivate_)

    Activate or deactivate the current control - used when switching from one active control to another.
- void **SetBGColor** (COLOR eColor_)
- void **SetLineColor** (COLOR eColor_)
- void **SetFillColor** (COLOR eColor_)
- void **SetTextColor** (COLOR eColor_)
- void **SetActiveColor** (COLOR eColor_)
- void **SetFont** (Font_t ∗pstFont_)
- void **SetCaption** (const K_CHAR ∗szCaption_)
- void **SetCallback** (ButtonCallback pfCallback_, void ∗pvData_)

Private Attributes

- const K_CHAR ∗ **m_szCaption**
- Font_t ∗ **m_pstFont**
- COLOR **m_uBGColor**
- COLOR **m_uActiveColor**
- COLOR **m_uLineColor**
- COLOR **m_uFillColor**
- COLOR **m_uTextColor**
- bool **m_bState**
- void ∗ **m_pvCallbackData**
- ButtonCallback **m_pfCallback**

Additional Inherited Members

16.5.1 Detailed Description

Definition at line 32 of file control_button.h.

16.5.2 Member Function Documentation

16.5.2.1 void ButtonControl::Activate (bool *bActivate_*) `[virtual]`

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 215 of file control_button.cpp.

16.5.2.2 void ButtonControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 39 of file control_button.cpp.

16.5.2.3 void ButtonControl::Init ( ) [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 25 of file control_button.cpp.

16.5.2.4 GuiReturn_t ButtonControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

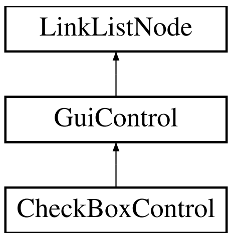
Definition at line 117 of file control_button.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_button.h
- /home/mo/mark3-source/embedded/stage/src/control_button.cpp

16.6 CheckBoxControl Class Reference

Inheritance diagram for CheckBoxControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetFont** (Font_t ∗pstFont_)
- void **SetCaption** (const char ∗szCaption_)
- void **SetCheck** (bool bChecked_)
- void **SetFontColor** (COLOR uFontColor_)
- void **SetBoxColor** (COLOR uBoxColor_)
- void **SetBackColor** (COLOR uBackColor_)
- bool **IsChecked** (void)

Private Attributes

- const char ∗ **m_szCaption**
- COLOR **m_uBackColor**
- COLOR **m_uBoxColor**
- COLOR **m_uFontColor**
- Font_t ∗ **m_pstFont**
- bool **m_bChecked**

Additional Inherited Members

16.6.1 Detailed Description

Definition at line 29 of file control_checkbox.h.

16.6.2 Member Function Documentation

16.6.2.1 virtual void CheckBoxControl::Activate (bool *bActivate_*) [inline], [virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 35 of file control_checkbox.h.

16.6.2.2 void CheckBoxControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 59 of file control_checkbox.cpp.

16.6.2.3 void CheckBoxControl::Init ( ) [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 53 of file control_checkbox.cpp.

16.6.2.4 GuiReturn_t CheckBoxControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 130 of file control_checkbox.cpp.

The documentation for this class was generated from the following files:

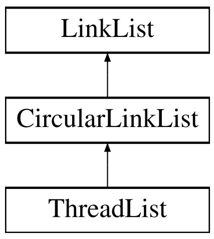
- /home/mo/mark3-source/embedded/stage/src/control_checkbox.h
- /home/mo/mark3-source/embedded/stage/src/control_checkbox.cpp

16.7 CircularLinkList Class Reference

Circular-linked-list data type, inherited from the base LinkList type.

`#include <ll.h>`

Inheritance diagram for CircularLinkList:



Public Member Functions

- virtual void Add (LinkListNode ∗node_)

  Add the linked list node to this linked list.
- virtual void Remove (LinkListNode ∗node_)

  Add the linked list node to this linked list.
- void PivotForward ()

  Pivot the head of the circularly linked list forward (Head = Head->next, Tail = Tail->next)
- void PivotBackward ()

  Pivot the head of the circularly linked list backward (Head = Head->prev, Tail = Tail->prev)

Additional Inherited Members

16.7.1 Detailed Description

Circular-linked-list data type, inherited from the base LinkList type.

Definition at line 197 of file ll.h.

16.7.2 Member Function Documentation

16.7.2.1 void CircularLinkList::Add (**LinkListNode** ∗ *node_*) `[virtual]`

Add the linked list node to this linked list.

Parameters

*node_*	Pointer to the node to add

Implements LinkList.

Reimplemented in ThreadList.

Definition at line 102 of file ll.cpp.

16.7.2.2 void CircularLinkList::Remove (**LinkListNode** ∗ *node_*) `[virtual]`

Add the linked list node to this linked list.

Parameters

*node_*	Pointer to the node to remove

Implements LinkList.

Reimplemented in ThreadList.

Definition at line 127 of file ll.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/ll.h
- /home/mo/mark3-source/embedded/stage/src/ll.cpp

16.8 CommandLine_t Struct Reference

Structure containing multiple representations for command-line data.

`#include <shell_support.h>`

Public Attributes

- Token_t ∗ pastTokenList

  Pointer to the list of tokens in the commandline.
- K_UCHAR ucTokenCount

  Count of tokens in the token list.
- Token_t ∗ pstCommand

  Pointer to the token corresponding to the shell command.
- Option_t astOptions [12]

  Option strucure array built from the token list.

- K_UCHAR ucNumOptions

  Number of options parsed from the token list.

16.8.1 Detailed Description

Structure containing multiple representations for command-line data.

Definition at line 93 of file shell_support.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/shell_support.h

16.9 DCPU Class Reference

DCPU emulator, used for running code out of EEPROM, RAM, or other memory interfaces than FLASH.

```
#include <dcpu.h>
```

Public Member Functions

- void Init (K_USHORT ∗pusRAM_, K_USHORT usRAMSize_, const K_USHORT ∗pusROM_, K_USHORT usROMSize_)

  Initialize the CPU emulator, specifying which driver supplies the memory read interface.
- void RunOpcode ()

  Execute the next opcode at the VM's current PC.
- DCPU_Registers ∗ GetRegisters ()

  Return a pointer to the VM's register structure.
- void SendInterrupt (K_USHORT usMessage_)

  Send an interrupt to the CPU with a given message.
- void AddPlugin (DCPUPlugin ∗pclPlugin_)

  Add a plugin to the CPU.

Private Member Functions

- void **SET** ()
- void **ADD** ()
- void **SUB** ()
- void **MUL** ()
- void **MLI** ()
- void **DIV** ()
- void **DVI** ()
- void **MOD** ()
- void **MDI** ()
- void **AND** ()
- void **BOR** ()
- void **XOR** ()
- void **SHR** ()
- void **ASR** ()
- void **SHL** ()
- bool **IFB** ()
- bool **IFC** ()
- bool **IFE** ()

- bool **IFN** ()
- bool **IFG** ()
- bool **IFA** ()
- bool **IFL** ()
- bool **IFU** ()
- void **ADX** ()
- void **SBX** ()
- void **STI** ()
- void **STD** ()
- void **JSR** ()
- void **INT** ()
- void **IAG** ()
- void **IAS** ()
- void RFI ()
- void IAQ ()
- void HWN ()
- void **HWQ** ()
- void **HWI** ()
- K_UCHAR GetOperand (K_UCHAR ucOpType_, K_USHORT ∗∗pusResult_)
- void ProcessInterruptQueue ()

    Process the next interrupt in the Queue.

Private Attributes

- DCPU_Registers m_stRegisters

    CPU Register file.
- K_USHORT ∗ a

    Temporary "a" operand pointer.
- K_USHORT ∗ b

    Temporary "b" operand pointer.
- K_USHORT m_usTempA

    Local-storage for staging literal "a" values.
- K_USHORT ∗ m_pusRAM

    Pointer to the RAM buffer.
- K_USHORT m_usRAMSize

    Size to the RAM (including stack)
- K_USHORT ∗ m_pusROM

    Pointer to the CPU ROM storage.
- K_USHORT m_usROMSize

    Size of the ROM.
- K_ULONG m_ulCycleCount

    Current cycle count.
- K_BOOL m_bInterruptQueueing

    CPU flag indicating whether or not interrupts are queued.
- K_UCHAR m_ucQueueLevel

    Current interrupt Queue level.
- K_USHORT m_ausInterruptQueue [8]

    Interrupt queue.
- DoubleLinkList m_clPluginList

    Linked-list of plug-ins.

16.9.1 Detailed Description

DCPU emulator, used for running code out of EEPROM, RAM, or other memory interfaces than FLASH.

Definition at line 359 of file dcpu.h.

16.9.2 Member Function Documentation

16.9.2.1 void DCPU::AddPlugin (**DCPUPlugin** ∗ *pclPlugin_*)

Add a plugin to the CPU.

Parameters

*pclPlugin_*	Pointer to the plugin object to add

Definition at line 948 of file dcpu.cpp.

16.9.2.2 K_UCHAR DCPU::GetOperand (K_UCHAR *ucOpType_*, K_USHORT ∗∗ *pusResult_*) `[private]`

Parameters

*ucOpType_*	The operand type, as specified in DCPU_Argument
*pusResult_*	Pointer to the pointer that corresponds to the argument's location in memory.

Definition at line 722 of file dcpu.cpp.

16.9.2.3 **DCPU_Registers** ∗ DCPU::GetRegisters ( ) `[inline]`

Return a pointer to the VM's register structure.

Returns

Pointer to the VM's register structure

Definition at line 391 of file dcpu.h.

16.9.2.4 void DCPU::HWN ( ) `[private]`

Returns the number of connected hardware devices to "a"

Definition at line 642 of file dcpu.cpp.

16.9.2.5 void DCPU::IAQ ( ) `[private]`

Add an interrupt to the interrupt queue if non-zero, if a = 0 then interrupts will be triggered as normal

Interrupts queued

Interrups triggered

Definition at line 624 of file dcpu.cpp.

16.9.2.6 void DCPU::Init (K_USHORT ∗ *pusRAM_*, K_USHORT *usRAMSize_*, const K_USHORT ∗ *pusROM_*, K_USHORT *usROMSize_*)

Initialize the CPU emulator, specifying which driver supplies the memory read interface.

This allows us to abstract RAM/FLASH/EEPROM or other memory. The VM must be initialized before any other method in the class is run.

Parameters

*pusRAM_*	Pointer to the CPU's RAM buffer
*usRAMSize_*	Size of the RAM Buffer in words
*pusROM_*	Pointer to the CPU's ROM buffer
*usROMSize_*	Size of the ROM buffer in words

Definition at line 697 of file dcpu.cpp.

16.9.2.7 void DCPU::RFI ( ) [private]

Disables interrupt queueing, pop A from the stack, then pops PC from the stack. By disabling interrupt Queueing, we're essentially re-enabling interrupts.

Definition at line 609 of file dcpu.cpp.

16.9.2.8 void DCPU::SendInterrupt (K_USHORT *usMessage_*)

Send an interrupt to the CPU with a given message.

Parameters

*usMessage_*	Message to send along with the interrupt

Definition at line 922 of file dcpu.cpp.

16.9.3 Member Data Documentation

16.9.3.1 DoubleLinkList DCPU::m_clPluginList [private]

Linked-list of plug-ins.

Definition at line 489 of file dcpu.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/dcpu.h
- /home/mo/mark3-source/embedded/stage/src/dcpu.cpp

16.10 DCPU_Registers Struct Reference

Structure defining the DCPU hardware registers.

`#include <dcpu.h>`

Public Attributes

- union {
  struct {
    K_USHORT **A**
    K_USHORT **B**
    K_USHORT **C**
    K_USHORT **X**
    K_USHORT **Y**
    K_USHORT **Z**
    K_USHORT **I**
    K_USHORT **J**

```
            K_USHORT PC
            K_USHORT SP
            K_USHORT EX
            K_USHORT IA
        }
        K_USHORT ausRegisters [12]
    };
```

16.10.1 Detailed Description

Structure defining the DCPU hardware registers.

Definition at line 72 of file dcpu.h.

The documentation for this struct was generated from the following file:

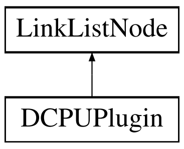
- /home/mo/mark3-source/embedded/stage/src/dcpu.h

16.11 DCPUPlugin Class Reference

Class used to provide the hardware device abstraction between the DCPU-16 emulator/VM and the host system.

`#include <dcpu.h>`

Inheritance diagram for DCPUPlugin:



Public Member Functions

- void Init (K_USHORT usDeviceNumber_, K_ULONG ulHWID_, K_ULONG ulVID_, K_USHORT usVersion_, DCPU_Callback pfCallback_)

    Initialize the DCPU plugin extension.
- void Enumerate (DCPU_Registers ∗pstRegisters_)

    Perform hardware enumeration to the target VM specified by the register set.
- void Interrupt (DCPU ∗pclCPU_)

    Execute the hardware callback.
- K_USHORT GetDeviceNumber ()

    Return the device number associated with this plugin.

Private Attributes

- K_USHORT m_usDeviceNumber

    Location of the device on the "bus".
- K_ULONG m_ulHWID

    Hardware ID.
- K_ULONG m_ulVID

    Vendor ID.

- K_USHORT m_usVersion

  Hardware Version.
- DCPU_Callback m_pfCallback

  HWI Callback.

Friends

- class **DCPUPluginList**

Additional Inherited Members

16.11.1 Detailed Description

Class used to provide the hardware device abstraction between the DCPU-16 emulator/VM and the host system.

Definition at line 267 of file dcpu.h.

16.11.2 Member Function Documentation

16.11.2.1 void DCPUPlugin::Enumerate (**DCPU_Registers** ∗ *pstRegisters_*) [inline]

Perform hardware enumeration to the target VM specified by the register set.

Parameters

*pstRegisters_*	Pointer to the VM's CPU registers, which are filled with enumeration data. See the DCPU 1.7 spec for details.

Definition at line 311 of file dcpu.h.

16.11.2.2 K_USHORT DCPUPlugin::GetDeviceNumber ( ) [inline]

Return the device number associated with this plugin.

Returns

Device number associated with this plugin

Definition at line 339 of file dcpu.h.

16.11.2.3 void DCPUPlugin::Init (K_USHORT *usDeviceNumber_*, K_ULONG *ulHWID_*, K_ULONG *ulVID_*, K_USHORT *usVersion_*, **DCPU_Callback** *pfCallback_*) [inline]

Initialize the DCPU plugin extension.

Plug

Parameters

*usDevice-Number_*	Unique plugin device enumeration associated with this plugin

*ulHWID_*	Unique hardware type identifier
*ulVID_*	Hardware Vendor ID
*usVersion_*	Version identifier for this hardware piece
*pfCallback_*	Callback function invoked from the VM when a HWI instruction is called on this device. This is essentially the interrupt handler.

Definition at line 288 of file dcpu.h.

16.11.2.4 void DCPUPlugin::Interrupt (DCPU ∗ *pclCPU_*) `[inline]`

Execute the hardware callback.

Parameters

*pclCPU_*	Pointer to the VM triggering the interrupt

Definition at line 327 of file dcpu.h.

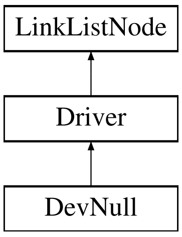
The documentation for this class was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/dcpu.h

16.12 DevNull Class Reference

This class implements the "default" driver (/dev/null)

Inheritance diagram for DevNull:



Public Member Functions

- virtual void Init ()

  Initialize a driver, must be called prior to use.
- virtual K_UCHAR Open ()

  Open a device driver prior to use.
- virtual K_UCHAR Close ()

  Close a previously-opened device driver.
- virtual K_USHORT Read (K_USHORT usBytes_, K_UCHAR ∗pucData_)

  Read a specified number of bytes from the device into a specific buffer.
- virtual K_USHORT Write (K_USHORT usBytes_, K_UCHAR ∗pucData_)

  Write a payload of data of a given length to the device.
- virtual K_USHORT Control (K_USHORT usEvent_, void ∗pvDataIn_, K_USHORT usSizeIn_, void ∗pvDataOut_, K_USHORT usSizeOut_)

  This is the main entry-point for device-specific io and control operations.

Additional Inherited Members

16.12.1 Detailed Description

This class implements the "default" driver (/dev/null)

Definition at line 40 of file driver.cpp.

16.12.2 Member Function Documentation

16.12.2.1 virtual K_UCHAR DevNull::Close ( ) [inline], [virtual]

Close a previously-opened device driver.

Returns

Driver-specific return code, 0 = OK, non-0 = error

Implements Driver.

Definition at line 45 of file driver.cpp.

16.12.2.2 virtual K_USHORT DevNull::Control (K_USHORT *usEvent_*, void ∗ *pvDataIn_*, K_USHORT *usSizeIn_*, void ∗ *pvDataOut_*, K_USHORT *usSizeOut_*) [inline], [virtual]

This is the main entry-point for device-specific io and control operations.

This is used for implementing all "side-channel" communications with a device, and any device-specific IO operations that do not conform to the typical POSIX read/write paradigm. Use of this funciton is analagous to the non-POSIX (yet still common) devctl() or ioctl().

Parameters

*usEvent_*	Code defining the io event (driver-specific)
*pvDataIn_*	Pointer to the intput data
*usSizeIn_*	Size of the input data (in bytes)
*pvDataOut_*	Pointer to the output data
*usSizeOut_*	Size of the output data (in bytes)

Returns

Driver-specific return code, 0 = OK, non-0 = error

Implements Driver.

Definition at line 53 of file driver.cpp.

16.12.2.3 virtual K_UCHAR DevNull::Open ( ) [inline], [virtual]

Open a device driver prior to use.

Returns

Driver-specific return code, 0 = OK, non-0 = error

Implements Driver.

Definition at line 44 of file driver.cpp.

16.12.2.4 virtual K_USHORT DevNull::Read (K_USHORT *usBytes_*, K_UCHAR ∗ *pucData_*) [inline], [virtual]

Read a specified number of bytes from the device into a specific buffer.

Depending on the driver-specific implementation, this may be a number less than the requested number of bytes read, indicating that there there was less input than desired, or that as a result of buffering, the data may not be available.

Parameters

*usBytes_*	Number of bytes to read (<= size of the buffer)
*pucData_*	Pointer to a data buffer receiving the read data

Returns

Number of bytes actually read

Implements Driver.

Definition at line 47 of file driver.cpp.

16.12.2.5 virtual K_USHORT DevNull::Write (K_USHORT *usBytes_*, K_UCHAR ∗ *pucData_*) [inline], [virtual]

Write a payload of data of a given length to the device.

Depending on the implementation of the driver, the amount of data written to the device may be less than the requested number of bytes. A result less than the requested size may indicate that the device buffer is full, indicating that the user must retry the write at a later point with the remaining data.

Parameters

*usBytes_*	Number of bytes to write (<= size of the buffer)
*pucData_*	Pointer to a data buffer containing the data to write

Returns

Number of bytes actually written

Implements Driver.

Definition at line 50 of file driver.cpp.

The documentation for this class was generated from the following file:

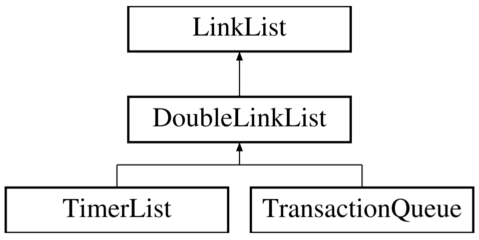
- /home/mo/mark3-source/embedded/stage/src/driver.cpp

16.13 DoubleLinkList Class Reference

Doubly-linked-list data type, inherited from the base LinkList type.

`#include <ll.h>`

Inheritance diagram for DoubleLinkList:



Public Member Functions

- DoubleLinkList ()

  Default constructor - initializes the head/tail nodes to NULL.
- virtual void Add (LinkListNode ∗node_)

  Add the linked list node to this linked list.
- virtual void Remove (LinkListNode ∗node_)

  Add the linked list node to this linked list.

Additional Inherited Members

16.13.1 Detailed Description

Doubly-linked-list data type, inherited from the base LinkList type.

Definition at line 166 of file ll.h.

16.13.2 Member Function Documentation

16.13.2.1 void DoubleLinkList::Add (LinkListNode ∗ *node_*) [virtual]

Add the linked list node to this linked list.

Parameters

*node_*	Pointer to the node to add

Implements LinkList.

Definition at line 41 of file ll.cpp.

16.13.2.2 void DoubleLinkList::Remove (LinkListNode ∗ *node_*) [virtual]

Add the linked list node to this linked list.

Parameters

*node_*	Pointer to the node to remove

Implements LinkList.

Definition at line 65 of file ll.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/ll.h
- /home/mo/mark3-source/embedded/stage/src/ll.cpp

16.14 DrawBitmap_t Struct Reference

Defines a bitmap.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usX

Leftmost pixel.
- K_USHORT usY

  Uppermost pixel.
- K_USHORT usWidth

  Width of the bitmap in pixels.
- K_USHORT usHeight

  Height of the bitmap in pixels.
- K_UCHAR ucBPP

  Bits-per-pixel.
- K_UCHAR * pucData

  Pixel data pointer.

16.14.1 Detailed Description

Defines a bitmap.

Definition at line 117 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.15 DrawCircle_t Struct Reference

Defines a circle.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usX

  Center X pixel.
- K_USHORT usY

  Center Y pixel.
- K_USHORT usRadius

  Radius in pixels.
- COLOR uLineColor

  Color of the circle perimeter.
- K_BOOL bFill

  Whether or not to fill the interior of the circle.
- COLOR uFillColor

  Fill color for the circle.

16.15.1 Detailed Description

Defines a circle.

Definition at line 92 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.16 DrawEllipse_t Struct Reference

Defines a ellipse.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usX

  Center X pixel.
- K_USHORT usY

  Center Y pixel.
- K_USHORT usHeight

  Height of the ellipse.
- K_USHORT usWidth

  Width of the ellipse.
- COLOR uColor

  Color of the ellipse perimeter.

16.16.1 Detailed Description

Defines a ellipse.

Definition at line 105 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.17 DrawLine_t Struct Reference

Defines a simple line.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usX1

  Starting X coordinate.
- K_USHORT usX2

  Ending X coordinate.
- K_USHORT usY1

  Starting Y Coordinate.
- K_USHORT usY2

  Ending Y coordinate.
- COLOR uColor

  Color of the pixel.

16.17.1 Detailed Description

Defines a simple line.

Definition at line 66 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.18 DrawMove_t Struct Reference

Simple 2D copy/paste.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usSrcX

  Source X pixel (leftmost)
- K_USHORT usSrcY

  Source Y pixel (topmost)
- K_USHORT usDstX

  Destination X pixel (leftmost)
- K_USHORT usDstY

  Destination Y pixel (topmost)
- K_USHORT usCopyHeight

  Number of rows to copy.
- K_USHORT usCopyWidth

  Number of columns to copy.

16.18.1 Detailed Description

Simple 2D copy/paste.

Moves a bitmap specified by the given source coordinates on-surface to the destination coordinates.

Definition at line 188 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.19 DrawPoint_t Struct Reference

Defines a pixel.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usX

  X coordinate of the pixel.
- K_USHORT usY

Y coordinate of the pixel.
- COLOR uColor

  Color of the pixel.

16.19.1 Detailed Description

Defines a pixel.

Definition at line 55 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.20 DrawPoly_t Struct Reference

Defines the structure of an arbitrary polygon.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usNumPoints

  Number of points in the polygon.
- COLOR uColor

  Color to use for lines/fill.
- K_BOOL bFill

  Display as wireframe or filled.
- DrawVector_t ∗ pstVector

  Vector points making the polygon.

16.20.1 Detailed Description

Defines the structure of an arbitrary polygon.

Can be used to specify the

Definition at line 215 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.21 DrawRectangle_t Struct Reference

Defines a rectangle.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usLeft

  Leftmost pixel of the rectangle.

- K_USHORT usTop

    Topmost pixel of the rectangle.
- K_USHORT usRight

    Rightmost pixel of the rectangle.
- K_USHORT usBottom

    Bottom pixel of the rectangle.
- COLOR uLineColor

    Color of the line.
- K_BOOL bFill

    Whether or not to floodfill the interior.
- COLOR uFillColor

    Color of the interior of the rectangle.

16.21.1 Detailed Description

Defines a rectangle.

Definition at line 78 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.22 DrawStamp_t Struct Reference

Defines a 1-bit 2D bitmap of arbitrary resolution.

```
#include <draw.h>
```

Public Attributes

- K_USHORT usX

    Leftmost pixel.
- K_USHORT usY

    Uppermost pixel.
- K_USHORT usWidth

    Width of the stamp.
- K_USHORT usHeight

    Height of the stamp.
- COLOR uColor

    Color of the stamp.
- K_UCHAR $*$ pucData

    Pointer to the stamp data.

16.22.1 Detailed Description

Defines a 1-bit 2D bitmap of arbitrary resolution.

Definition at line 130 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.23 DrawText_t Struct Reference

Defines a bitmap-rendered string.

`#include <draw.h>`

Public Attributes

- K_USHORT usLeft

    Leftmost pixel of the text.
- K_USHORT usTop

    Uppermost pixel of the text.
- COLOR uColor

    Color of the text.
- Font_t ∗ pstFont

    Pointer to the font used to render the text.
- const K_CHAR ∗ pcString

    ASCII String to render.

16.23.1 Detailed Description

Defines a bitmap-rendered string.

Definition at line 144 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.24 DrawVector_t Struct Reference

Specifies a single 2D point.

`#include <draw.h>`

Public Attributes

- K_USHORT **usX**
- K_USHORT **usY**

16.24.1 Detailed Description

Specifies a single 2D point.

When used in arrays, this provides a way to draw vector paths, which form the basis of the polygon data structures.

Definition at line 204 of file draw.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/draw.h

16.25 DrawWindow_t Struct Reference

Defines the active window - establishes boundaries for drawing on the current display.

`#include <draw.h>`

Public Attributes

- K_USHORT usLeft

  Left boundary.
- K_USHORT usRight

  Right boundary.
- K_USHORT usTop

  Upper boundary.
- K_USHORT usBottom

  Bottom boundary.

16.25.1 Detailed Description

Defines the active window - establishes boundaries for drawing on the current display.

Only pixels drawn inside the surface boundaries are rendered to the output

Definition at line 175 of file draw.h.

The documentation for this struct was generated from the following file:

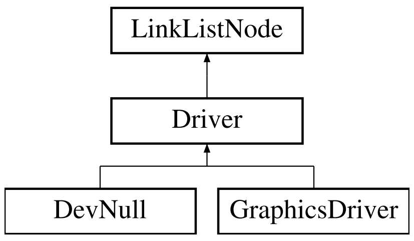
- /home/mo/mark3-source/embedded/stage/src/draw.h

16.26 Driver Class Reference

Base device-driver class used in hardware abstraction.

`#include <driver.h>`

Inheritance diagram for Driver:



Public Member Functions

- virtual void Init ()=0

  Initialize a driver, must be called prior to use.
- virtual K_UCHAR Open ()=0

  Open a device driver prior to use.
- virtual K_UCHAR Close ()=0

  Close a previously-opened device driver.

- virtual K_USHORT Read (K_USHORT usBytes_, K_UCHAR ∗pucData_)=0

  Read a specified number of bytes from the device into a specific buffer.
- virtual K_USHORT Write (K_USHORT usBytes_, K_UCHAR ∗pucData_)=0

  Write a payload of data of a given length to the device.
- virtual K_USHORT Control (K_USHORT usEvent_, void ∗pvDataIn_, K_USHORT usSizeIn_, void ∗pvData-Out_, K_USHORT usSizeOut_)=0

  This is the main entry-point for device-specific io and control operations.
- void SetName (const K_CHAR ∗pcName_)

  Set the path for the driver.
- const K_CHAR ∗ GetPath ()

  Returns a string containing the device path.

Private Attributes

- const K_CHAR ∗ m_pcPath

  string pointer that holds the driver path (name)

Additional Inherited Members

16.26.1 Detailed Description

Base device-driver class used in hardware abstraction.

All other device drivers inherit from this class

Definition at line 121 of file driver.h.

16.26.2 Member Function Documentation

16.26.2.1 K_UCHAR Driver::Close ( ) `[pure virtual]`

Close a previously-opened device driver.

Returns

Driver-specific return code, 0 = OK, non-0 = error

Implemented in DevNull.

16.26.2.2 K_USHORT Driver::Control (K_USHORT *usEvent_*, void ∗ *pvDataIn_*, K_USHORT *usSizeIn_*, void ∗ *pvDataOut_*, K_USHORT *usSizeOut_*) `[pure virtual]`

This is the main entry-point for device-specific io and control operations.

This is used for implementing all "side-channel" communications with a device, and any device-specific IO operations that do not conform to the typical POSIX read/write paradigm. Use of this funciton is analagous to the non-POSIX (yet still common) devctl() or ioctl().

Parameters

*usEvent_*	Code defining the io event (driver-specific)

*pvDataIn_*	Pointer to the intput data
*usSizeIn_*	Size of the input data (in bytes)
*pvDataOut_*	Pointer to the output data
*usSizeOut_*	Size of the output data (in bytes)

Returns

Driver-specific return code, 0 = OK, non-0 = error

Implemented in DevNull.

16.26.2.3 const K_CHAR ∗ Driver::GetPath ( ) `[inline]`

Returns a string containing the device path.

Returns

pcName_ Return the string constant representing the device path

Definition at line 231 of file driver.h.

16.26.2.4 K_UCHAR Driver::Open ( ) `[pure virtual]`

Open a device driver prior to use.

Returns

Driver-specific return code, 0 = OK, non-0 = error

Implemented in DevNull.

16.26.2.5 K_USHORT Driver::Read (K_USHORT *usBytes_*, K_UCHAR ∗ *pucData_*) `[pure virtual]`

Read a specified number of bytes from the device into a specific buffer.

Depending on the driver-specific implementation, this may be a number less than the requested number of bytes read, indicating that there there was less input than desired, or that as a result of buffering, the data may not be available.

Parameters

*usBytes_*	Number of bytes to read (<= size of the buffer)
*pucData_*	Pointer to a data buffer receiving the read data

Returns

Number of bytes actually read

Implemented in DevNull.

16.26.2.6 void Driver::SetName (const K_CHAR ∗ *pcName_*) `[inline]`

Set the path for the driver.

Name must be set prior to access (since driver access is name-based).

Parameters

*pcName_*	String constant containing the device path

Definition at line 222 of file driver.h.

16.26.2.7 K_USHORT Driver::Write (K_USHORT *usBytes_*, K_UCHAR ∗ *pucData_*) `[pure virtual]`

Write a payload of data of a given length to the device.

Depending on the implementation of the driver, the amount of data written to the device may be less than the requested number of bytes. A result less than the requested size may indicate that the device buffer is full, indicating that the user must retry the write at a later point with the remaining data.

Parameters

*usBytes_*	Number of bytes to write (<= size of the buffer)
*pucData_*	Pointer to a data buffer containing the data to write

Returns

Number of bytes actually written

Implemented in DevNull.

The documentation for this class was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/driver.h

16.27 DriverList Class Reference

List of Driver objects used to keep track of all device drivers in the system.

`#include <driver.h>`

Static Public Member Functions

- static void Init ()
  Initialize the list of drivers.
- static void Add (Driver ∗pclDriver_)
  Add a Driver object to the managed global driver-list.
- static void Remove (Driver ∗pclDriver_)
  Remove a driver from the global driver list.
- static Driver ∗ FindByPath (const K_CHAR ∗m_pcPath)
  Look-up a driver in the global driver-list based on its path.

Static Private Attributes

- static DoubleLinkList m_clDriverList
  LinkedList object used to implementing the driver object management.

16.27.1 Detailed Description

List of Driver objects used to keep track of all device drivers in the system.

By default, the list contains a single entity, "/dev/null".

Definition at line 244 of file driver.h.

16.27.2 Member Function Documentation

16.27.2.1 DriverList::Add (**Driver** ∗ *pclDriver_*) `[inline]`, `[static]`

Add a Driver object to the managed global driver-list.

Parameters

*pclDriver_*	pointer to the driver object to add to the global driver list.

Definition at line 264 of file driver.h.

16.27.2.2 **Driver** ∗ DriverList::FindByPath (const K_CHAR ∗ *m_pcPath*) `[static]`

Look-up a driver in the global driver-list based on its path.

In the event that the driver is not found in the list, a pointer to the default "/dev/null" object is returned. In this way, unimplemented drivers are automatically stubbed out.

Definition at line 94 of file driver.cpp.

16.27.2.3 void DriverList::Init ( ) `[static]`

Initialize the list of drivers.

Must be called prior to using the device driver library.

Definition at line 85 of file driver.cpp.

16.27.2.4 void DriverList::Remove (**Driver** ∗ *pclDriver_*) `[inline]`, `[static]`

Remove a driver from the global driver list.

Parameters

*pclDriver_*	Pointer to the driver object to remove from the global table

Definition at line 274 of file driver.h.

The documentation for this class was generated from the following files:

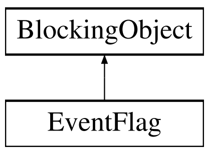
- /home/mo/mark3-source/embedded/stage/src/driver.h
- /home/mo/mark3-source/embedded/stage/src/driver.cpp

16.28 EventFlag Class Reference

The EventFlag class is a blocking object, similar to a semaphore or mutex, commonly used for synchronizing thread execution based on events occurring within the system.

`#include <eventflag.h>`

Inheritance diagram for EventFlag:



Public Member Functions

- void Init ()
  Init Initializes the EventFlag object prior to use.
- K_USHORT Wait (K_USHORT usMask_, EventFlagOperation_t eMode_)
  Wait - Block a thread on the specific flags in this event flag group.
- K_USHORT Wait (K_USHORT usMask_, EventFlagOperation_t eMode_, K_ULONG ulTimeMS_)
  Wait - Block a thread on the specific flags in this event flag group.
- void **Timeout** (Thread ∗pclOwner_)
- void Set (K_USHORT usMask_)
  Set - Set additional flags in this object (logical OR).
- void Clear (K_USHORT usMask_)
  ClearFlags - Clear a specific set of flags within this object, specific by bitmask.
- K_USHORT GetMask ()
  GetMask Returns the state of the 16-bit bitmask within this object.

Private Member Functions

- K_BOOL ProcessQueue ()
  ProcessQueue.
- void WaitTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)
  WaitTransaction.
- void SetTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)
  SetTransaction.
- void ClearTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)
  ClearTransaction.
- void TimeoutTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)
  TimeoutTransaction.

Private Attributes

- K_USHORT m_usSetMask
  Currently set bits in the event mask.

Additional Inherited Members

16.28.1 Detailed Description

The EventFlag class is a blocking object, similar to a semaphore or mutex, commonly used for synchronizing thread execution based on events occurring within the system.

Each EventFlag object contains a 16-bit bitmask, which is used to trigger events on associated threads. Threads wishing to block, waiting for a specific event to occur can wait on any pattern within this 16-bit bitmask to be set. Here, we provide the ability for a thread to block, waiting for ANY bits in a specified mask to be set, or for ALL bits within a specific mask to be set. Depending on how the object is configured, the bits that triggered the wakeup can be automatically cleared once a match has occurred.

Definition at line 47 of file eventflag.h.

16.28.2 Member Function Documentation

16.28.2.1 void EventFlag::Clear (K_USHORT *usMask_*)

ClearFlags - Clear a specific set of flags within this object, specific by bitmask.

Parameters

*usMask_*	- Bitmask of flags to clear

Definition at line 368 of file eventflag.cpp.

16.28.2.2 void EventFlag::ClearTransaction (Transaction ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

ClearTransaction.

Clear event flags synchrnously, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 326 of file eventflag.cpp.

16.28.2.3 K_USHORT EventFlag::GetMask ( )

GetMask Returns the state of the 16-bit bitmask within this object.

Returns

The state of the 16-bit bitmask

Definition at line 386 of file eventflag.cpp.

16.28.2.4 K_BOOL EventFlag::ProcessQueue ( ) [private]

ProcessQueue.

Process the kernel transaction queue associated with this event-flag object. This executes all queued accesses in first-in first-out order, ensuring that state is preserved and results are deterministic. When this function returns, the event flag object is no longer blocked.

Returns

true - the sheduler must be re-run when enabled. false - the scheduler does not need to be re-run.

Definition at line 124 of file eventflag.cpp.

16.28.2.5 void EventFlag::Set (K_USHORT *usMask_*)

Set - Set additional flags in this object (logical OR).

This API can potentially result in threads blocked on Wait() to be unblocked.

Parameters

*usMask_*	- Bitmask of flags to set.

Definition at line 350 of file eventflag.cpp.

16.28.2.6 void EventFlag::SetTransaction (Transaction ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

SetTransaction.

Set an event-flag mask in a synchronous operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 219 of file eventflag.cpp.

16.28.2.7 void EventFlag::TimeoutTransaction (Transaction ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

TimeoutTransaction.

Perform an event flag "timeout" operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 333 of file eventflag.cpp.

16.28.2.8 K_USHORT EventFlag::Wait (K_USHORT *usMask_*, EventFlagOperation_t *eMode_*)

Wait - Block a thread on the specific flags in this event flag group.

Parameters

*usMask_*	- 16-bit bitmask to block on
*eMode_*	- EVENT_FLAG_ANY: Thread will block on any of the bits in the mask • EVENT_FLAG_ALL: Thread will block on all of the bits in the mask

Returns

Bitmask condition that caused the thread to unblock, or 0 on error or timeout

Definition at line 73 of file eventflag.cpp.

16.28.2.9 K_USHORT EventFlag::Wait (K_USHORT *usMask_*, EventFlagOperation_t *eMode_*, K_ULONG *ulTimeMS_*)

Wait - Block a thread on the specific flags in this event flag group.

Parameters

*usMask_*	- 16-bit bitmask to block on
*eMode_*	- EVENT_FLAG_ANY: Thread will block on any of the bits in the mask • EVENT_FLAG_ALL: Thread will block on all of the bits in the mask
*ulTimeMS_*	- Time to block (in ms)

Returns

Bitmask condition that caused the thread to unblock, or 0 on error or timeout

! If the Yield operation causes a new thread to be chosen, there will ! Be a context switch at the above SetScheduler() call. The original calling ! thread will not return back until a matching SetFlags call is made.

Definition at line 77 of file eventflag.cpp.

16.28.2.10 void EventFlag::WaitTransaction (Transaction ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

WaitTransaction.

Perform a synchronous even-flag blocking operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 160 of file eventflag.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/eventflag.h
- /home/mo/mark3-source/embedded/stage/src/eventflag.cpp

16.29 FixedHeap Class Reference

Fixed-size-block heap allocator with multiple block sizes.

`#include <fixed_heap.h>`

Public Member Functions

- void Create (void ∗pvHeap_, HeapConfig ∗pclHeapConfig_)

  Creates a heap in a provided blob of memory with lists of fixed-size blocks configured based on the associated configuration data.
- void ∗ Alloc (K_USHORT usSize_)

  Allocate a blob of memory from the heap.

Static Public Member Functions

- static void Free (void ∗pvNode_)

  Free a previously-allocated block of memory to the heap it was originally allocated from.

Private Attributes

- HeapConfig ∗ m_paclHeaps

  Pointer to the configuration data used by the heap.

16.29.1 Detailed Description

Fixed-size-block heap allocator with multiple block sizes.

Definition at line 104 of file fixed_heap.h.

16.29.2 Member Function Documentation

16.29.2.1 void ∗ FixedHeap::Alloc (K_USHORT *usSize_*)

Allocate a blob of memory from the heap.

If no appropriately-sized data block is available, will return NULL. Note, this API is thread- safe, and interrupt safe.

Parameters

*usSize_*	Size (in bytes) to allocate from the heap

Returns

Pointer to a block of data allocated, or 0 on error.

Definition at line 130 of file fixed_heap.cpp.

16.29.2.2 void FixedHeap::Create (void ∗ *pvHeap_*, HeapConfig ∗ *pclHeapConfig_*)

Creates a heap in a provided blob of memory with lists of fixed-size blocks configured based on the associated configuration data.

A heap must be created before it can be allocated/freed.

Parameters

*pvHeap_*	Pointer to the data blob that will contain the heap
*pclHeapConfig_*	Pointer to the array of config objects that define how the heap is laid out in memory, and how many blocks of what size are included. The objects in the array must be initialized, starting from smallest block-size to largest, with the final entry in the table have a 0-block size, indicating end-of-configuration.

Definition at line 113 of file fixed_heap.cpp.

16.29.2.3 void FixedHeap::Free (void ∗ *pvNode_*) [static]

Free a previously-allocated block of memory to the heap it was originally allocated from.

This must point to the block of memory at its originally-returned pointer, and not an address within an allocated blob (as supported by some allocators).

Parameters

*pvNode_*	Pointer to the previously-allocated block of memory

Definition at line 160 of file fixed_heap.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/fixed_heap.h
- /home/mo/mark3-source/embedded/stage/src/fixed_heap.cpp

16.30 Font_t Struct Reference

Public Attributes

- K_UCHAR **ucSize**
- K_UCHAR **ucFlags**
- K_UCHAR **ucStartChar**
- K_UCHAR **ucMaxChar**
- const K_CHAR ∗ **szName**
- const FONT_STORAGE_TYPE ∗ **pucFontData**

16.30.1 Detailed Description

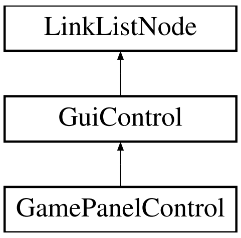
Definition at line 43 of file font.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/font.h

16.31 GamePanelControl Class Reference

Inheritance diagram for GamePanelControl:



Public Member Functions

- virtual void Init ()

    Initiailize the control - must be called before use.
- virtual void Draw ()

    Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

    Process an event sent to the control.
- virtual void Activate (bool bActivate_)

    Activate or deactivate the current control - used when switching from one active control to another.

Private Attributes

- JoystickEvent_t **m_stLastJoy**
- JoystickEvent_t **m_stCurrentJoy**

Additional Inherited Members

16.31.1 Detailed Description

Definition at line 32 of file control_gamepanel.h.

16.31.2 Member Function Documentation

16.31.2.1 virtual void GamePanelControl::Activate (bool *bActivate_*) [inline], [virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 38 of file control_gamepanel.h.

16.31.2.2 void GamePanelControl::Draw ( ) `[virtual]`

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 27 of file control_gamepanel.cpp.

16.31.2.3 virtual void GamePanelControl::Init ( ) `[inline]`, `[virtual]`

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 35 of file control_gamepanel.h.

16.31.2.4 GuiReturn_t GamePanelControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) `[virtual]`

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 33 of file control_gamepanel.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_gamepanel.h
- /home/mo/mark3-source/embedded/stage/src/control_gamepanel.cpp

16.32 GlobalMessagePool Class Reference

Implements a list of message objects shared between all threads.

`#include <message.h>`

Static Public Member Functions

- static void Init ()

  Initialize the message queue prior to use.
- static void Push (Message ∗pclMessage_)

  Return a previously-claimed message object back to the global queue.
- static Message ∗ Pop ()

  Pop a message from the global queue, returning it to the user to be populated before sending by a transmitter.

Static Private Attributes

- static Message m_aclMessagePool [GLOBAL_MESSAGE_POOL_SIZE]

  Array of message objects that make up the message pool.
- static DoubleLinkList m_clList

  Linked list used to manage the Message objects.

16.32.1 Detailed Description

Implements a list of message objects shared between all threads.

Definition at line 157 of file message.h.

16.32.2 Member Function Documentation

16.32.2.1 Message ∗ GlobalMessagePool::Pop ( ) [static]

Pop a message from the global queue, returning it to the user to be populated before sending by a transmitter.

Returns

Pointer to a Message object

Definition at line 69 of file message.cpp.

16.32.2.2 void GlobalMessagePool::Push (Message ∗ *pclMessage_*) [static]

Return a previously-claimed message object back to the global queue.

Used once the message has been processed by a receiver.

Parameters

*pclMessage_*	Pointer to the Message object to return back to the global queue

Definition at line 57 of file message.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/message.h
- /home/mo/mark3-source/embedded/stage/src/message.cpp

16.33 Glyph_t Struct Reference

Public Attributes

- K_UCHAR ucWidth

  Width of this font glyph in pixels.
- K_UCHAR ucHeight

  Height of this font glyph in pixels.
- K_UCHAR ucVOffset

  Vertical offset of this glyph.
- K_UCHAR aucData [1]

  Glyph data array.

16.33.1 Detailed Description

Definition at line 26 of file font.h.

The documentation for this struct was generated from the following file:

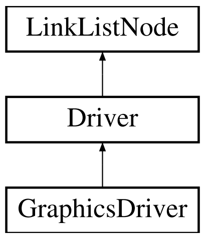
- /home/mo/mark3-source/embedded/stage/src/font.h

16.34 GraphicsDriver Class Reference

Defines the base graphics driver class, which is inherited by all other graphics drivers.

`#include <graphics.h>`

Inheritance diagram for GraphicsDriver:



Public Member Functions

- virtual void DrawPixel (DrawPoint_t ∗pstPoint_)

  Draw a single pixel to the display.
- virtual void ReadPixel (DrawPoint_t ∗pstPoint_)

  Read a single pixel from the display.
- virtual void ClearScreen ()

  Clear the screen (initializes to all black pixels)
- virtual void Point (DrawPoint_t ∗pstPoint_)

  Draw a pixel to the display.
- virtual void Line (DrawLine_t ∗pstLine_)

  Draw a line to the display using Bresenham's line drawing algorithm.
- virtual void Rectangle (DrawRectangle_t ∗pstRectangle_)

  Draws a rectangle on the display.
- virtual void Circle (DrawCircle_t ∗pstCircle_)

  Draw a circle to the display.
- virtual void Ellipse (DrawEllipse_t ∗pstEllipse_)

  Draw an ellipse to the display.
- virtual void Bitmap (DrawBitmap_t ∗pstBitmap_)

  Draw an RGB image on the display.
- virtual void Stamp (DrawStamp_t ∗pstStamp_)

  Draws a stamp (a 1-bit bitmap) on the display.
- virtual void Move (DrawMove_t ∗pstMove_)

  Move a the contents from one rectangle on screen to another rectangle, specified by the values of the input structure.
- virtual void TriangleWire (DrawPoly_t ∗pstPoly_)

  Draw a wireframe triangle to the display.
- virtual void TriangleFill (DrawPoly_t ∗pstPoly_)

  Draw a filled triangle to the display.

- virtual void **Polygon** (DrawPoly_t ∗pstPoly_)
- virtual void Text (DrawText_t ∗pstText_)

  Draw a string of text to the display using a bitmap font.
- void TextFX (DrawText_t ∗pstText_, TextFX_t ∗pstFX_)

  Render a string of text to the display with effects.
- virtual K_USHORT **TextWidth** (DrawText_t ∗pstText_)
- void SetWindow (DrawWindow_t ∗pstWindow_)

  Set the drawable window of the screen.
- void ClearWindow ()

  Clear the window - resetting the boundaries to the entire drawable area of the screen.

Protected Attributes

- K_USHORT **m_usResX**
- K_USHORT **m_usResY**
- K_USHORT **m_usLeft**
- K_USHORT **m_usTop**
- K_USHORT **m_usRight**
- K_USHORT **m_usBottom**
- K_UCHAR **m_ucBPP**

Additional Inherited Members

16.34.1 Detailed Description

Defines the base graphics driver class, which is inherited by all other graphics drivers.

Per-pixel rendering functions for all raster operations is provided by default. These can be overridden with more efficient hardware-supported operations where available.

Definition at line 32 of file graphics.h.

16.34.2 Member Function Documentation

16.34.2.1 void GraphicsDriver::Bitmap (**DrawBitmap_t** ∗ *pstBitmap_*) `[virtual]`

Draw an RGB image on the display.

Parameters

*pstBitmap_*	- pointer to the bitmap object to display

Definition at line 302 of file graphics.cpp.

16.34.2.2 void GraphicsDriver::Circle (**DrawCircle_t** ∗ *pstCircle_*) `[virtual]`

Draw a circle to the display.

Parameters

*pstCircle_*	- pointer to the circle to draw

Definition at line 178 of file graphics.cpp.

16.34.2.3 void GraphicsDriver::DrawPixel (**DrawPoint_t** ∗ *pstPoint_*) `[inline]`, `[virtual]`

Draw a single pixel to the display.

Parameters

*pstPoint_*	Structure containing the pixel data (color/location) to be written.

Definition at line 49 of file graphics.h.

16.34.2.4 void GraphicsDriver::Ellipse (**DrawEllipse_t** ∗ *pstEllipse_*) [virtual]

Draw an ellipse to the display.

Parameters

*pstEllipse_*	- pointer to the ellipse to draw on the display

Definition at line 250 of file graphics.cpp.

16.34.2.5 void GraphicsDriver::Line (**DrawLine_t** ∗ *pstLine_*) [virtual]

Draw a line to the display using Bresenham's line drawing algorithm.

Parameters

*pstLine_*	- pointer to the line structure

Definition at line 50 of file graphics.cpp.

16.34.2.6 void GraphicsDriver::Move (**DrawMove_t** ∗ *pstMove_*) [virtual]

Move a the contents from one rectangle on screen to another rectangle, specified by the values of the input structure.

Parameters

*pstMove_*	- object describing the graphics movement operation (framebuffer operations only).

Definition at line 440 of file graphics.cpp.

16.34.2.7 void GraphicsDriver::Point (**DrawPoint_t** ∗ *pstPoint_*) [virtual]

Draw a pixel to the display.

Parameters

*pstPoint_*	- pointer to the struct containing the pixel to draw

Definition at line 44 of file graphics.cpp.

16.34.2.8 void GraphicsDriver::ReadPixel (**DrawPoint_t** ∗ *pstPoint_*) [inline], [virtual]

Read a single pixel from the display.

Parameters

*pstPoint_*	Structure containing the pixel location of the pixel to be read. The color value will contain the value from the display when read.

Definition at line 58 of file graphics.h.

16.34.2.9 void GraphicsDriver::Rectangle (**DrawRectangle_t** ∗ *pstRectangle_*) [virtual]

Draws a rectangle on the display.

Parameters

*pstRectangle_*	- pointer to the rectangle struct

Definition at line 133 of file graphics.cpp.

16.34.2.10 void GraphicsDriver::SetWindow (**DrawWindow_t** * *pstWindow_*)

Set the drawable window of the screen.

Parameters

*pstWindow_*	- pointer to the window struct defining the drawable area

Definition at line 1050 of file graphics.cpp.

16.34.2.11 void GraphicsDriver::Stamp (**DrawStamp_t** * *pstStamp_*) `[virtual]`

Draws a stamp (a 1-bit bitmap) on the display.

Parameters

*pstStamp_*	- pointer to the stamp object to draw

Definition at line 401 of file graphics.cpp.

16.34.2.12 void GraphicsDriver::Text (**DrawText_t** * *pstText_*) `[virtual]`

Draw a string of text to the display using a bitmap font.

Parameters

*pstText_*	- pointer to the text object to render

Definition at line 501 of file graphics.cpp.

16.34.2.13 GraphicsDriver::TextFX (**DrawText_t** * *pstText_*, **TextFX_t** * *pstFX_*)

Render a string of text to the display with effects.

Parameters

*pstText_*	- pointer to the text object to render
*pstFX_*	- struct defining special text formatting to apply

ToDo - Add rotation

Definition at line 589 of file graphics.cpp.

16.34.2.14 void GraphicsDriver::TriangleFill (**DrawPoly_t** * *pstPoly_*) `[virtual]`

Draw a filled triangle to the display.

Parameters

*pstPoly_*	Pointer to the polygon to draw.

Definition at line 823 of file graphics.cpp.

16.34.2.15 void GraphicsDriver::TriangleWire (**DrawPoly_t** * *pstPoly_*) `[virtual]`

Draw a wireframe triangle to the display.

Parameters

*pstPoly_*	Pointer to the polygon to draw.

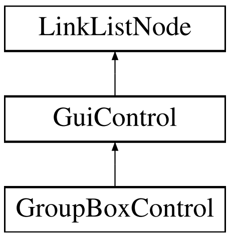
Definition at line 798 of file graphics.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/graphics.h
- /home/mo/mark3-source/embedded/stage/src/graphics.cpp

16.35 GroupBoxControl Class Reference

Inheritance diagram for GroupBoxControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetPanelColor** (COLOR eColor_)
- void **SetLineColor** (COLOR eColor_)
- void **SetFontColor** (COLOR eColor_)
- void **SetFont** (Font_t ∗pstFont_)
- void **SetCaption** (const K_CHAR ∗pcCaption_)

Private Attributes

- COLOR **m_uPanelColor**
- COLOR **m_uLineColor**
- COLOR **m_uFontColor**
- Font_t ∗ **m_pstFont**
- const K_CHAR ∗ **m_pcCaption**

Additional Inherited Members

16.35.1 Detailed Description

Definition at line 29 of file control_groupbox.h.

16.35.2 Member Function Documentation

16.35.2.1 virtual void GroupBoxControl::Activate (bool *bActivate_*) `[inline]`, `[virtual]`

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 38 of file control_groupbox.h.

16.35.2.2 void GroupBoxControl::Draw ( ) `[virtual]`

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 30 of file control_groupbox.cpp.

16.35.2.3 virtual void GroupBoxControl::Init ( ) `[inline]`, `[virtual]`

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 32 of file control_groupbox.h.

16.35.2.4 virtual GuiReturn_t GroupBoxControl::ProcessEvent (GuiEvent_t $*$ *pstEvent_*) `[inline]`, `[virtual]`

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 37 of file control_groupbox.h.

The documentation for this class was generated from the following files:

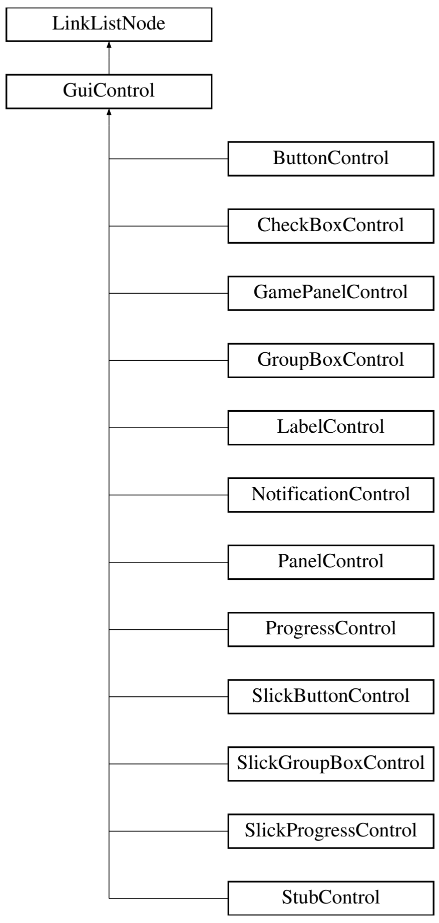
- /home/mo/mark3-source/embedded/stage/src/control_groupbox.h
- /home/mo/mark3-source/embedded/stage/src/control_groupbox.cpp

16.36 GuiControl Class Reference

GUI Control Base Class.

```
#include <gui.h>
```

Inheritance diagram for GuiControl:



Public Member Functions

- virtual void Init ()=0

    Initiailize the control - must be called before use.
- virtual void Draw ()=0

    Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)=0

    Process an event sent to the control.
- void SetTop (K_USHORT usTop_)

    Set the location of the topmost pixel of the control.
- void SetLeft (K_USHORT usLeft_)

    Set the location of the leftmost pixel of the control.
- void SetHeight (K_USHORT usHeight_)

    Set the height of the control (in pixels)
- void SetWidth (K_USHORT usWidth_)

    Set the width of the control (in pixels)
- void SetZOrder (K_UCHAR ucZ_)

    Set the Z-order (depth) of the control.
- void SetControlIndex (K_UCHAR ucIdx_)

    Set the index of the control, used for cycling through focus (ala tab order in VB).
- K_USHORT GetTop ()

    Return the topmost pixel of the control.
- K_USHORT GetLeft ()

    Return the leftmost pixel of the control.

- K_USHORT GetHeight ()

  Get the height of the control in pixels.
- K_USHORT GetWidth ()

  Get the width of the control in pixels.
- K_UCHAR GetZOrder ()

  Return the Z-order of the control.
- K_UCHAR GetControlIndex ()

  Return the Control Index of the control.
- K_BOOL IsStale ()

  Return whether or not the control needs to be redrawn or not.
- void GetControlOffset (K_USHORT ∗pusX_, K_USHORT ∗pusY_)

  Return the absolute offset of the control within an event surface.
- K_BOOL IsInFocus ()

  Return whether or not the current control has the focus in the window.
- virtual void Activate (bool bActivate_)=0

  Activate or deactivate the current control - used when switching from one active control to another.

Protected Member Functions

- void SetParentControl (GuiControl ∗pclParent_)

  Set the parent control of this control.
- void SetParentWindow (GuiWindow ∗pclWindow_)

  Set the parent window of this control.
- GuiControl ∗ GetParentControl ()

  Return the pointer to the control's currently-assigned parent control.
- GuiWindow ∗ GetParentWindow ()

  Get the parent window of this control.
- void ClearStale ()

  Clear the stale flag for this control.
- void SetStale ()

  Signal that the object needs to be redrawn.
- void SetAcceptFocus (bool bFocus_)

  Tell the control whether or not to accept focus.
- bool AcceptsFocus ()

  Returns whether or not this control accepts focus.

Private Attributes

- K_BOOL m_bStale

  true if the control is stale and needs to be redrawn, false otherwise
- K_BOOL m_bAcceptsFocus

  Whether or not the control accepts focus or not.
- K_UCHAR m_ucZOrder

  The Z-Order (depth) of the control.
- K_UCHAR m_ucControlIndex

  Index of the control in the window.
- K_USHORT m_usTop

  Topmost location of the control on the window.
- K_USHORT m_usLeft

  Leftmost location of the control on the window.

- K_USHORT m_usWidth

    Width of the control in pixels.
- K_USHORT m_usHeight

    Height of the control in pixels.
- GuiControl ∗ m_pclParentControl

    Pointer to the parent control.
- GuiWindow ∗ m_pclParentWindow

    Pointer to the parent window associated with this control.

Friends

- class **GuiWindow**
- class **GuiEventSurface**

Additional Inherited Members

16.36.1 Detailed Description

GUI Control Base Class.

This class is the common ancestor to all GUI control elements. It defines a base set of properties common to all controls, as well as methods for initialization, event handling, and redrawing. Controls are directly related to Windows, which are used to manage and organize controls.

Definition at line 538 of file gui.h.

16.36.2 Member Function Documentation

16.36.2.1 void GuiControl::Activate (bool *bActivate_*) [pure virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implemented in StubControl, NotificationControl, LabelControl, ButtonControl, PanelControl, SlickButtonControl, GamePanelControl, GroupBoxControl, ProgressControl, SlickProgressControl, CheckBoxControl, and SlickGroupBoxControl.

16.36.2.2 void GuiControl::ClearStale ( ) [inline], [protected]

Clear the stale flag for this control.

Should only be done after a redraw has been completed

Definition at line 741 of file gui.h.

16.36.2.3 void GuiControl::Draw ( ) [pure virtual]

Redraw the control "cleanly".

Subclass specific.

Implemented in StubControl, NotificationControl, LabelControl, ButtonControl, PanelControl, SlickButtonControl, GamePanelControl, GroupBoxControl, ProgressControl, SlickProgressControl, CheckBoxControl, and SlickGroupBoxControl.

16.36.2.4 K_UCHAR GuiControl::GetControlIndex ( ) [inline]

Return the Control Index of the control.

Returns

The control index of the control

Definition at line 648 of file gui.h.

16.36.2.5 void GuiControl::GetControlOffset (K_USHORT ∗ *pusX_*, K_USHORT ∗ *pusY_*)

Return the absolute offset of the control within an event surface.

This function will traverse through all of the object's parents, and their parents, until the root control and root window are identified. The absolute pixel locations of the Topmost (Y) and Leftmost (X) pixels are populated in the

Parameters

*pusX_*	Pointer to the K_USHORT containing the leftmost pixel
*pusY_*	Pointer to the K_USHORT containing the topmost pixel

Definition at line 669 of file gui.cpp.

16.36.2.6 K_USHORT GuiControl::GetHeight ( ) [inline]

Get the height of the control in pixels.

Returns

Height of the control in pixels

Definition at line 627 of file gui.h.

16.36.2.7 K_USHORT GuiControl::GetLeft ( ) [inline]

Return the leftmost pixel of the control.

Returns

Leftmost pixel of the control

Definition at line 620 of file gui.h.

16.36.2.8 GuiControl ∗ GuiControl::GetParentControl ( ) [inline], [protected]

Return the pointer to the control's currently-assigned parent control.

Returns

Pointer to the Control's currently assigned parent control.

Definition at line 725 of file gui.h.

16.36.2.9 GuiWindow * GuiControl::GetParentWindow ( ) [inline], [protected]

Get the parent window of this control.

Returns

Pointer to the control's window

Definition at line 733 of file gui.h.

16.36.2.10 K_USHORT GuiControl::GetTop ( ) [inline]

Return the topmost pixel of the control.

Returns

Topmost pixel of the control

Definition at line 613 of file gui.h.

16.36.2.11 K_USHORT GuiControl::GetWidth ( ) [inline]

Get the width of the control in pixels.

Returns

Width of the control in pixels

Definition at line 634 of file gui.h.

16.36.2.12 K_UCHAR GuiControl::GetZOrder ( ) [inline]

Return the Z-order of the control.

Returns

Z-order of the control

Definition at line 641 of file gui.h.

16.36.2.13 void GuiControl::Init ( ) [pure virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implemented in StubControl, ButtonControl, PanelControl, SlickButtonControl, GamePanelControl, LabelControl, ProgressControl, SlickProgressControl, CheckBoxControl, GroupBoxControl, NotificationControl, and SlickGroupBoxControl.

16.36.2.14 K_BOOL GuiControl::IsInFocus ( ) [inline]

Return whether or not the current control has the focus in the window.

Returns

true if this control is in focus, false otherwise

Definition at line 677 of file gui.h.

16.36.2.15 K_BOOL GuiControl::IsStale ( ) [inline]

Return whether or not the control needs to be redrawn or not.

Returns

true - control needs redrawing, false - control is intact.

Definition at line 655 of file gui.h.

16.36.2.16 GuiReturn_t GuiControl::ProcessEvent (GuiEvent_t * *pstEvent_*) [pure virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implemented in StubControl, NotificationControl, LabelControl, ButtonControl, PanelControl, SlickButtonControl, GamePanelControl, GroupBoxControl, ProgressControl, SlickProgressControl, CheckBoxControl, and SlickGroup-BoxControl.

16.36.2.17 void GuiControl::SetControlIndex (K_UCHAR *ucIdx_*) [inline]

Set the index of the control, used for cycling through focus (ala tab order in VB).

Parameters

*ucIdx_*	Focus index of the control

Definition at line 606 of file gui.h.

16.36.2.18 void GuiControl::SetHeight (K_USHORT *usHeight_*) [inline]

Set the height of the control (in pixels)

Parameters

*usHeight_*	Height of the control in pixels

Definition at line 584 of file gui.h.

16.36.2.19 void GuiControl::SetLeft (K_USHORT *usLeft_*) [inline]

Set the location of the leftmost pixel of the control.

Parameters

*usLeft_*	Leftmost pixel of the control

Definition at line 577 of file gui.h.

16.36.2.20 void GuiControl::SetParentControl (GuiControl * *pclParent_*) [inline], [protected]

Set the parent control of this control.

When a control has its parent set, it is considered "nested" within that control. Moving the control will thus result in all of its child controls to become invalidated, thus requiring redraws. The control's object offsets (Top, Bottom, Height, and Width) also become relative to the origin of the parent control.

Parameters

*pclParent_*	Pointer to the control's parent control

Definition at line 706 of file gui.h.

16.36.2.21 void GuiControl::SetParentWindow (GuiWindow ∗ *pclWindow_*) [inline], [protected]

Set the parent window of this control.

All controls within the same window are all associated together, and share events targetted towards a specific window. Event tabbing, focus, and Z-ordering is also shared between controls within a window.

Parameters

*pclWindow_*	Pointer to the control's parent window.

Definition at line 717 of file gui.h.

16.36.2.22 void GuiControl::SetTop (K_USHORT *usTop_*) [inline]

Set the location of the topmost pixel of the control.

Parameters

*usTop_*	Topmost pixel of the control

Definition at line 570 of file gui.h.

16.36.2.23 void GuiControl::SetWidth (K_USHORT *usWidth_*) [inline]

Set the width of the control (in pixels)

Parameters

*usWidth_*	Width of the control in pixels

Definition at line 591 of file gui.h.

16.36.2.24 void GuiControl::SetZOrder (K_UCHAR *ucZ_*) [inline]

Set the Z-order (depth) of the control.

Parameters

*ucZ_*	Z order of the control

Definition at line 598 of file gui.h.

16.36.3 Member Data Documentation

16.36.3.1 K_UCHAR GuiControl::m_ucControlIndex [private]

Index of the control in the window.

This is used for setting focus when transitioning from control to control on a window

Definition at line 770 of file gui.h.

16.36.3.2 K_UCHAR GuiControl::m_ucZOrder `[private]`

The Z-Order (depth) of the control.

Only the highest order controls are visible at any given location

Definition at line 766 of file gui.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/gui.h
- /home/mo/mark3-source/embedded/stage/src/gui.cpp

16.37 GuiEvent_t Struct Reference

Composite UI event structure.

`#include <gui.h>`

Public Attributes

- K_UCHAR ucEventType

  GuiEventType_t event type.
- K_UCHAR ucTargetID

  Control index that this event is targeted towards.
- union {
  KeyEvent_t stKey
    Keyboard data.
  MouseEvent_t stMouse
    Mouse data.
  TouchEvent_t stTouch
    Touchscreen data.
  JoystickEvent_t stJoystick
    Joystick data.
  TimerEvent_t stTimer
    Timer data.
  };

16.37.1 Detailed Description

Composite UI event structure.

Depending on the event type, can contain either a keyboard, mouse, touch, joystick, timer event, etc.

Definition at line 187 of file gui.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/gui.h

16.38 GuiEventSurface Class Reference

GUI Event Surface Object.

`#include <gui.h>`

Public Member Functions

- void Init ()

  Initialize an event surface before use.
- void AddWindow (GuiWindow ∗pclWindow_)

  Add a window to the event surface.
- void RemoveWindow (GuiWindow ∗pclWindow_)

  Remove a window from the event surface.
- K_BOOL SendEvent (GuiEvent_t ∗pstEvent_)

  Send an event to this window surface.
- K_BOOL ProcessEvent ()

  Process an event in the event queue.
- K_UCHAR GetEventCount ()

  Get the count of pending events in the event surface's queue.
- GuiWindow ∗ FindWindowByName (const K_CHAR ∗szName_)

  Return a pointer to a window by name, or NULL on failure.
- void InvalidateRegion (K_USHORT usLeft_, K_USHORT usTop_, K_USHORT usWidth_, K_USHORT usHeight_)

  Invalidate a region of the window, specified by the bounding box.

Private Member Functions

- void CopyEvent (GuiEvent_t ∗pstDst_, GuiEvent_t ∗pstSrc_)

  Copy the contents of one message structure to another.

Private Attributes

- DoubleLinkList m_clWindowList

  List of windows managed on this event surface.
- MessageQueue m_clMessageQueue

  Message queue used to manage window events.

16.38.1 Detailed Description

GUI Event Surface Object.

An event surface is the lowest-level UI object. It maintains a list of windows which are associated with it, and manages the transmission and routing of events to each window, and their appropriate controls

All windows located on the event surface are assumed to share a common display, and coordinate frame. In this way, multiple GUIs can be implemented in the system, each tied to separate physical or virtual displays.

Definition at line 452 of file gui.h.

16.38.2 Member Function Documentation

16.38.2.1 void GuiEventSurface::AddWindow (GuiWindow ∗ *pclWindow_*)

Add a window to the event surface.

Parameters

*pclWindow_*	Pointer to the window object to add to the sruface

Definition at line 525 of file gui.cpp.

16.38.2.2 void GuiEventSurface::CopyEvent (GuiEvent_t ∗ *pstDst_*, GuiEvent_t ∗ *pstSrc_*) [private]

Copy the contents of one message structure to another.

Parameters

*pstDst_*	Destination event pointer
*pstSrc_*	Source event pointer

Definition at line 645 of file gui.cpp.

16.38.2.3 void GuiEventSurface::Init ( ) [inline]

Initialize an event surface before use.

Must be called prior to any other object methods.

Definition at line 459 of file gui.h.

16.38.2.4 void GuiEventSurface::InvalidateRegion (K_USHORT *usLeft_*, K_USHORT *usTop_*, K_USHORT *usWidth_*, K_USHORT *usHeight_*)

Invalidate a region of the window, specified by the bounding box.

The coordinates specified in the parameters (top and left) refer to absolute display coordinates, and are not relative to coordinates within a window.

Definition at line 658 of file gui.cpp.

16.38.2.5 K_BOOL GuiEventSurface::ProcessEvent ( )

Process an event in the event queue.

If no events are pending, the call will block until an event is available.

Definition at line 577 of file gui.cpp.

16.38.2.6 void GuiEventSurface::RemoveWindow (GuiWindow ∗ *pclWindow_*)

Remove a window from the event surface.

Parameters

*pclWindow_*	Pointer to the window object to remove from the surface

Definition at line 533 of file gui.cpp.

16.38.2.7 K_BOOL GuiEventSurface::SendEvent (GuiEvent_t ∗ *pstEvent_*)

Send an event to this window surface.

The event will be forwraded to all windows managed by this service.

Parameters

*pstEvent_*	Pointer to an event to send

Returns

true on success, false on failure

Definition at line 541 of file gui.cpp.

The documentation for this class was generated from the following files:

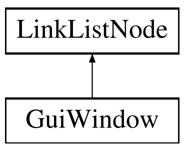
- /home/mo/mark3-source/embedded/stage/src/gui.h
- /home/mo/mark3-source/embedded/stage/src/gui.cpp

16.39 GuiWindow Class Reference

Basic Window Class.

```
#include <gui.h>
```

Inheritance diagram for GuiWindow:



Public Member Functions

- void Init ()

  Initialize the GUI Window object prior to use.
- void SetDriver (GraphicsDriver ∗pclDriver_)

  Set the graphics driver to use for rendering controls on the window.
- GraphicsDriver ∗ GetDriver ()

  Set the graphics driver to use for rendering controls on the window.
- void AddControl (GuiControl ∗pclControl_, GuiControl ∗pclParent_)

  Assign a GUI Control to this window object.
- void RemoveControl (GuiControl ∗pclControl_)

  Removes a previously-added control from the Window.
- K_UCHAR GetMaxZOrder ()

  Returns the highest Z-Order of all controls attached to this window.
- void Redraw (K_BOOL bRedrawAll_)

  Redraw objects in the window.
- void ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to this window.
- void SetFocus (GuiControl ∗pclControl_)

  Set the control used to accept "focus" events.
- K_BOOL IsInFocus (GuiControl ∗pclControl_)

  Return whether or not the selected control is in focus or not.
- void SetTop (K_USHORT usTop_)

  Set the location of the topmost pixel of the window.

- void SetLeft (K_USHORT usLeft_)

  Set the location of the leftmost pixel of the window.
- void SetHeight (K_USHORT usHeight_)

  Set the height of the window (in pixels)
- void SetWidth (K_USHORT usWidth_)

  Set the width of the window (in pixels)
- K_USHORT GetTop ()

  Return the topmost pixel of the window.
- K_USHORT GetLeft ()

  Return the leftmost pixel of the window.
- K_USHORT GetHeight ()

  Get the height of the window in pixels.
- K_USHORT GetWidth ()

  Get the width of the window in pixels.
- K_UCHAR GetZOrder ()

  Get the Z-order of the window on the event surface.
- void SetZOrder (K_UCHAR ucZ_)

  Set the Z-order of the window on the event surface.
- void CycleFocus (bool bForward_)

  Cycle the focus to the next active control in the window.
- void SetName (const K_CHAR ∗szName_)

  Set the name for this window.
- const K_CHAR ∗ GetName ()

  Return the name of this window.
- void InvalidateRegion (K_USHORT usLeft_, K_USHORT usTop_, K_USHORT usWidth_, K_USHORT usHeight_)

  Invalidate a region of the window, specified by the bounding box.

Private Attributes

- K_USHORT m_usTop

  Topmost pixel of the window on the event surface.
- K_USHORT m_usLeft

  Leftmost pixel of the window on the event surface.
- K_USHORT m_usHeight

  Height of the window in pixels.
- K_USHORT m_usWidth

  Width of the window in pixels.
- K_UCHAR m_ucZ

  Z-order of the window on the event surface.
- const K_CHAR ∗ m_szName

  Name applied to this window.
- DoubleLinkList m_clControlList

  List of controls managed by this window.
- GuiControl ∗ m_pclInFocus

  Pointer to the control in event focus.
- K_UCHAR m_ucControlCount

  Number of controls in this window.
- GraphicsDriver ∗ m_pclDriver

  Graphics driver for this window.

Additional Inherited Members

16.39.1 Detailed Description

Basic Window Class.

A Window is loosely defined as a container of controls, all sharing a coordinate reference coordinate frame. Events are managed on a per-window basis, and each window is isolated from eachother.

Definition at line 223 of file gui.h.

16.39.2 Member Function Documentation

16.39.2.1 GuiWindow::AddControl (**GuiControl** ∗ *pclControl_*, **GuiControl** ∗ *pclParent_*)

Assign a GUI Control to this window object.

Adding an object to a window ensures that the object will be drawn on the specific window surface, and ensures that events directed to this window will be forwarded to the controls appropriately.

Parameters

*pclControl_*	Pointer to the control object to add
*pclParent_*	Pointer to the control's "parent" object (or NULL)

Definition at line 27 of file gui.cpp.

16.39.2.2 void GuiWindow::CycleFocus (bool *bForward_*)

Cycle the focus to the next active control in the window.

Parameters

*bForward_*	- Cycle to the next control when true, previous control when false

Definition at line 395 of file gui.cpp.

16.39.2.3 **GraphicsDriver** ∗ GuiWindow::GetDriver ( ) `[inline]`

Set the graphics driver to use for rendering controls on the window.

Returns

Pointer to the Window's graphics driver

Definition at line 252 of file gui.h.

16.39.2.4 K_USHORT GuiWindow::GetHeight ( ) `[inline]`

Get the height of the window in pixels.

Returns

Height of the window in pixels

Definition at line 379 of file gui.h.

16.39.2.5 K_USHORT GuiWindow::GetLeft ( ) [inline]

Return the leftmost pixel of the window.

Returns

Leftmost pixel of the window

Definition at line 372 of file gui.h.

16.39.2.6 K_UCHAR GuiWindow::GetMaxZOrder ( )

Returns the highest Z-Order of all controls attached to this window.

Returns

The highest Z-Order used by controls in this window

Definition at line 61 of file gui.cpp.

16.39.2.7 K_USHORT GuiWindow::GetTop ( ) [inline]

Return the topmost pixel of the window.

Returns

Topmost pixel of the window

Definition at line 365 of file gui.h.

16.39.2.8 K_USHORT GuiWindow::GetWidth ( ) [inline]

Get the width of the window in pixels.

Returns

Width of the window in pixels

Definition at line 386 of file gui.h.

16.39.2.9 void GuiWindow::Init ( ) [inline]

Initialize the GUI Window object prior to use.

Must be called before calling other methods on this object

Definition at line 231 of file gui.h.

16.39.2.10 void GuiWindow::InvalidateRegion (K_USHORT *usLeft_*, K_USHORT *usTop_*, K_USHORT *usWidth_*, K_USHORT *usHeight_*)

Invalidate a region of the window, specified by the bounding box.

The coordinates specified in the parameters (top and left) refer to absolute display coordinates, and are not relative to coordinates within a window.

Definition at line 127 of file gui.cpp.

16.39.2.11 K_BOOL GuiWindow::IsInFocus (GuiControl * *pclControl_*) [inline]

Return whether or not the selected control is in focus or not.

Parameters

*pclControl_*	Pointer to the control object to evaluate

Returns

true - the selected control is the active control on the window false - otherwise

Definition at line 323 of file gui.h.

16.39.2.12 void GuiWindow::ProcessEvent (GuiEvent_t ∗ *pstEvent_*)

Process an event sent to this window.

This method handles all of the plumbing required to target the event towards specific controls, or all controls in the window depending on the event payload.

Definition at line 245 of file gui.cpp.

16.39.2.13 void GuiWindow::Redraw (K_BOOL *bRedrawAll_*)

Redraw objects in the window.

Typically, only the affected controls will need to be redrawn, but in some cases (such as window initialization), the entire window will need to be redrawn cleanly. This behavior is defined by the value of the bRedrawAll_ parameter.

Definition at line 85 of file gui.cpp.

16.39.2.14 GuiWindow::RemoveControl (GuiControl ∗ *pclControl_*)

Removes a previously-added control from the Window.

Parameters

*pclControl_*	Pointer to the control object to remove

Definition at line 40 of file gui.cpp.

16.39.2.15 void GuiWindow::SetDriver (GraphicsDriver ∗ *pclDriver_*) `[inline]`

Set the graphics driver to use for rendering controls on the window.

Parameters

*pclDriver_*	Pointer to the graphics driver

Definition at line 244 of file gui.h.

16.39.2.16 void GuiWindow::SetFocus (GuiControl ∗ *pclControl_*)

Set the control used to accept "focus" events.

Such events include keyboard events.

Parameters

*pclControl_*	Pointer to the control object to set focus on.

Definition at line 387 of file gui.cpp.

16.39.2.17 void GuiWindow::SetHeight (K_USHORT *usHeight_*) [inline]

Set the height of the window (in pixels)

Parameters

*usHeight_*	Height of the window in pixels

Definition at line 351 of file gui.h.

16.39.2.18 void GuiWindow::SetLeft (K_USHORT *usLeft_*) [inline]

Set the location of the leftmost pixel of the window.

Parameters

*usLeft_*	Leftmost pixel of the window

Definition at line 344 of file gui.h.

16.39.2.19 void GuiWindow::SetTop (K_USHORT *usTop_*) [inline]

Set the location of the topmost pixel of the window.

Parameters

*usTop_*	Topmost pixel of the window

Definition at line 337 of file gui.h.

16.39.2.20 void GuiWindow::SetWidth (K_USHORT *usWidth_*) [inline]

Set the width of the window (in pixels)

Parameters

*usWidth_*	Width of the window in pixels

Definition at line 358 of file gui.h.

16.39.3 Member Data Documentation

16.39.3.1 GraphicsDriver∗ GuiWindow::m_pclDriver [private]

Graphics driver for this window.

Definition at line 436 of file gui.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/gui.h
- /home/mo/mark3-source/embedded/stage/src/gui.cpp

16.40 HeapConfig Class Reference

Heap configuration object.

```
#include <fixed_heap.h>
```

Public Attributes

- K_USHORT m_usBlockSize

  Block size in bytes.
- K_USHORT m_usBlockCount

  Number of blocks to create @ this size.

Protected Attributes

- BlockHeap m_clHeap

  BlockHeap object used by the allocator.

Friends

- class **FixedHeap**

16.40.1 Detailed Description

Heap configuration object.

Definition at line 90 of file fixed_heap.h.

The documentation for this class was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/fixed_heap.h

16.41 JoystickEvent_t Struct Reference

Joystick UI event structure.

```
#include <gui.h>
```

Public Attributes

- union {
  K_USHORT usRawData
  Raw joystick data.
  struct {
  unsigned int bUp:1
  D-pad UP state.
  unsigned int bDown:1
  D-pad DOWN state.
  unsigned int bLeft:1
  D-pad LEFT state.
  unsigned int bRight:1
  D-pad RIGHT state.
  unsigned int bButton1:1

Joystick Button1 state.
unsigned int bButton2:1
Joystick Button2 state.
unsigned int bButton3:1
Joystick Button3 state.
unsigned int bButton4:1
Joystick Button4 state.
unsigned int bButton5:1
Joystick Button5 state.
unsigned int bButton6:1
Joystick Button6 state.
unsigned int bButton7:1
Joystick Button7 state.
unsigned int bButton8:1
Joystick Button8 state.
unsigned int bButton9:1
Joystick Button9 state.
unsigned int bButton10:1
Joystick Button10 state.
unsigned int bSelect:1
Start button state.
unsigned int bStart:1
Select button state.
}
};

16.41.1 Detailed Description

Joystick UI event structure.

Definition at line 144 of file gui.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/gui.h

16.42 Kernel Class Reference

Class that encapsulates all of the kernel startup functions.

```
#include <kernel.h>
```

Static Public Member Functions

- static void Init (void)

  Kernel Initialization Function, call before any other OS function.
- static void Start (void)

  Start the kernel; function never returns.
- static bool IsStarted ()

  IsStarted.
- static void SetPanic (panic_func_t pfPanic_)

  SetPanic Set a function to be called when a kernel panic occurs, giving the user to determine the behavior when a catastrophic failure is observed.
- static bool IsPanic ()

IsPanic Returns whether or not the kernel is in a panic state.

- static void Panic (K_USHORT usCause_)

  Panic Cause the kernel to enter its panic state.

Static Private Attributes

- static bool m_bIsStarted

  true if kernel is running, false otherwise
- static bool m_bIsPanic

  true if kernel is in panic state, false otherwise
- static panic_func_t m_pfPanic

  user-set panic function

16.42.1 Detailed Description

Class that encapsulates all of the kernel startup functions.

Definition at line 42 of file kernel.h.

16.42.2 Member Function Documentation

16.42.2.1 Kernel::Init (void) `[static]`

Kernel Initialization Function, call before any other OS function.

Initializes all global resources used by the operating system. This must be called before any other kernel function is invoked.

Definition at line 48 of file kernel.cpp.

16.42.2.2 static bool Kernel::IsPanic ( ) `[inline]`, `[static]`

IsPanic Returns whether or not the kernel is in a panic state.

Returns

Whether or not the kernel is in a panic state

Definition at line 89 of file kernel.h.

16.42.2.3 static bool Kernel::IsStarted ( ) `[inline]`, `[static]`

IsStarted.

Returns

Whether or not the kernel has started - true = running, false = not started

Definition at line 74 of file kernel.h.

16.42.2.4 void Kernel::Panic (K_USHORT *usCause_*) `[static]`

Panic Cause the kernel to enter its panic state.

Parameters

*usCause_*	Reason for the kernel panic

Definition at line 88 of file kernel.cpp.

16.42.2.5 static void Kernel::SetPanic (panic_func_t *pfPanic_*) [inline], [static]

SetPanic Set a function to be called when a kernel panic occurs, giving the user to determine the behavior when a catastrophic failure is observed.

Parameters

*pfPanic_*	Panic function pointer

Definition at line 83 of file kernel.h.

16.42.2.6 Kernel::Start (void) [static]

Start the kernel; function never returns.

Start the operating system kernel - the current execution context is cancelled, all kernel services are started, and the processor resumes execution at the entrypoint for the highest-priority thread.

You must have at least one thread added to the kernel before calling this function, otherwise the behavior is undefined.

Definition at line 78 of file kernel.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/kernel.h
- /home/mo/mark3-source/embedded/stage/src/kernel.cpp

16.43 KernelSWI Class Reference

Class providing the software-interrupt required for context-switching in the kernel.

`#include <kernelswi.h>`

Static Public Member Functions

- static void Config (void)

  Configure the software interrupt - must be called before any other software interrupt functions are called.
- static void Start (void)

  Enable ("Start") the software interrupt functionality.
- static void Stop (void)

  Disable the software interrupt functionality.
- static void Clear (void)

  Clear the software interrupt.
- static void Trigger (void)

  Call the software interrupt.
- static K_UCHAR DI ()

  Disable the SWI flag itself.
- static void RI (K_UCHAR bEnable_)

  Restore the state of the SWI to the value specified.

16.43.1 Detailed Description

Class providing the software-interrupt required for context-switching in the kernel.

Definition at line 32 of file kernelswi.h.

16.43.2 Member Function Documentation

16.43.2.1 K_UCHAR KernelSWI::DI ( ) `[static]`

Disable the SWI flag itself.

Returns

previous status of the SWI, prior to the DI call

Definition at line 50 of file kernelswi.cpp.

16.43.2.2 void KernelSWI::RI (K_UCHAR *bEnable_*) `[static]`

Restore the state of the SWI to the value specified.

Parameters

*bEnable_*	true - enable the SWI, false - disable SWI

Definition at line 58 of file kernelswi.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/kernelswi.h
- /home/mo/mark3-source/embedded/stage/src/kernelswi.cpp

16.44 KernelTimer Class Reference

Hardware timer interface, used by all scheduling/timer subsystems.

`#include <kerneltimer.h>`

Static Public Member Functions

- static void Config (void)

  Initializes the kernel timer before use.
- static void Start (void)

  Starts the kernel time (must be configured first)
- static void Stop (void)

  Shut down the kernel timer, used when no timers are scheduled.
- static K_UCHAR DI (void)

  Disable the kernel timer's expiry interrupt.
- static void RI (K_UCHAR bEnable_)

  Retstore the state of the kernel timer's expiry interrupt.
- static void EI (void)

  Enable the kernel timer's expiry interrupt.
- static K_ULONG SubtractExpiry (K_ULONG ulInterval_)

  Subtract the specified number of ticks from the timer's expiry count register.

- static K_ULONG TimeToExpiry (void)

  Returns the number of ticks remaining before the next timer expiry.
- static K_ULONG SetExpiry (K_ULONG ulInterval_)

  Resets the kernel timer's expiry interval to the specified value.
- static K_ULONG GetOvertime (void)

  Return the number of ticks that have elapsed since the last expiry.
- static void ClearExpiry (void)

  Clear the hardware timer expiry register.

Static Private Member Functions

- static K_USHORT Read (void)

  Safely read the current value in the timer register.

16.44.1 Detailed Description

Hardware timer interface, used by all scheduling/timer subsystems.

Definition at line 33 of file kerneltimer.h.

16.44.2 Member Function Documentation

16.44.2.1 K_ULONG KernelTimer::GetOvertime (void) [static]

Return the number of ticks that have elapsed since the last expiry.

Returns

Number of ticks that have elapsed after last timer expiration

Definition at line 115 of file kerneltimer.cpp.

16.44.2.2 K_USHORT KernelTimer::Read (void) [static], [private]

Safely read the current value in the timer register.

Returns

Value held in the timer register

Definition at line 66 of file kerneltimer.cpp.

16.44.2.3 void KernelTimer::RI (K_UCHAR *bEnable_*) [static]

Retstore the state of the kernel timer's expiry interrupt.

Parameters

*bEnable_*	1 enable, 0 disable

Definition at line 168 of file kerneltimer.cpp.

16.44.2.4 K_ULONG KernelTimer::SetExpiry (K_ULONG *ulInterval_*) [static]

Resets the kernel timer's expiry interval to the specified value.

Parameters

*ulInterval_*	Desired interval in ticks to set the timer for

Returns

Actual number of ticks set (may be less than desired)

Definition at line 121 of file kerneltimer.cpp.

16.44.2.5 K_ULONG KernelTimer::SubtractExpiry (K_ULONG *ulInterval_*) [static]

Subtract the specified number of ticks from the timer's expiry count register.

Returns the new expiry value stored in the register.

Parameters

*ulInterval_*	Time (in HW-specific) ticks to subtract

Returns

Value in ticks stored in the timer's expiry register

Definition at line 84 of file kerneltimer.cpp.

16.44.2.6 K_ULONG KernelTimer::TimeToExpiry (void) [static]

Returns the number of ticks remaining before the next timer expiry.

Returns

Time before next expiry in platform-specific ticks

Definition at line 95 of file kerneltimer.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/kerneltimer.h
- /home/mo/mark3-source/embedded/stage/src/kerneltimer.cpp

16.45 KeyEvent_t Struct Reference

Keyboard UI event structure definition.

`#include <gui.h>`

Public Attributes

- K_UCHAR ucKeyCode

  8-bit value representing a keyboard scan code
- union {
  K_UCHAR ucFlags
  Flags indicating modifiers to the event.
  struct {
  unsigned int bKeyState:1

Key is being pressed or released.
unsigned int bShiftState:1
Whether or not shift is pressed.
unsigned int bCtrlState:1
Whether or not CTRL is pressed.
unsigned int bAltState:1
Whether or not ALT it pressed.
unsigned int bWinState:1
Whether or not the Window/Clover key is pressed.
unsigned int bFnState:1
Whether or not a special function key is pressed.
}
};

16.45.1 Detailed Description

Keyboard UI event structure definition.

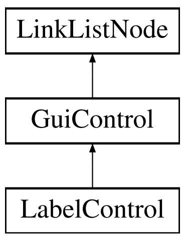
Definition at line 80 of file gui.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/gui.h

16.46 LabelControl Class Reference

Inheritance diagram for LabelControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetBackColor** (COLOR eColor_)
- void **SetFontColor** (COLOR eColor_)
- void **SetFont** (Font_t ∗pstFont_)
- void **SetCaption** (const K_CHAR ∗pcData_)

Private Attributes

- Font_t ∗ **m_pstFont**
- const K_CHAR ∗ **m_pcCaption**
- COLOR **m_uBackColor**
- COLOR **m_uFontColor**

Additional Inherited Members

16.46.1 Detailed Description

Definition at line 30 of file control_label.h.

16.46.2 Member Function Documentation

16.46.2.1 virtual void LabelControl::Activate (bool *bActivate_*) [inline], [virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 40 of file control_label.h.

16.46.2.2 void LabelControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 26 of file control_label.cpp.

16.46.2.3 virtual void LabelControl::Init ( ) [inline], [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 33 of file control_label.h.

16.46.2.4 virtual GuiReturn_t LabelControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) [inline], [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 39 of file control_label.h.

The documentation for this class was generated from the following files:

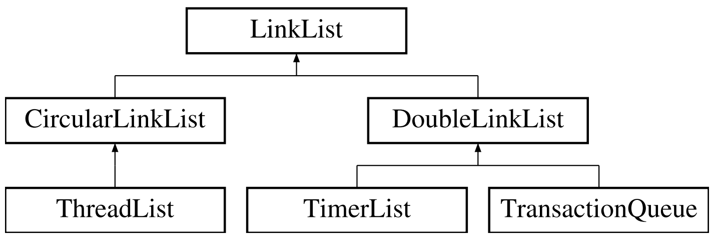
- /home/mo/mark3-source/embedded/stage/src/control_label.h
- /home/mo/mark3-source/embedded/stage/src/control_label.cpp

16.47 LinkList Class Reference

Abstract-data-type from which all other linked-lists are derived.

`#include <ll.h>`

Inheritance diagram for LinkList:



Public Member Functions

- void Init ()

    Clear the linked list.
- virtual void Add (LinkListNode ∗node_)=0

    Add the linked list node to this linked list.
- virtual void Remove (LinkListNode ∗node_)=0

    Add the linked list node to this linked list.
- LinkListNode ∗ GetHead ()

    Get the head node in the linked list.
- LinkListNode ∗ GetTail ()

    Get the tail node of the linked list.

Protected Attributes

- LinkListNode ∗ m_pstHead

    Pointer to the head node in the list.
- LinkListNode ∗ m_pstTail

    Pointer to the tail node in the list.

16.47.1 Detailed Description

Abstract-data-type from which all other linked-lists are derived.

Definition at line 113 of file ll.h.

16.47.2 Member Function Documentation

16.47.2.1 void LinkList::Add (**LinkListNode** ∗ *node_*) `[pure virtual]`

Add the linked list node to this linked list.

Parameters

*node_*	Pointer to the node to add

Implemented in CircularLinkList, DoubleLinkList, and ThreadList.

16.47.2.2 **LinkListNode** ∗ LinkList::GetHead ( ) `[inline]`

Get the head node in the linked list.

Returns

Pointer to the head node in the list

Definition at line 150 of file ll.h.

16.47.2.3 **LinkListNode** ∗ LinkList::GetTail ( ) `[inline]`

Get the tail node of the linked list.

Returns

Pointer to the tail node in the list

Definition at line 159 of file ll.h.

16.47.2.4 void LinkList::Remove (**LinkListNode** ∗ *node_*) `[pure virtual]`

Add the linked list node to this linked list.

Parameters

*node_*	Pointer to the node to remove

Implemented in CircularLinkList, DoubleLinkList, and ThreadList.

The documentation for this class was generated from the following file:

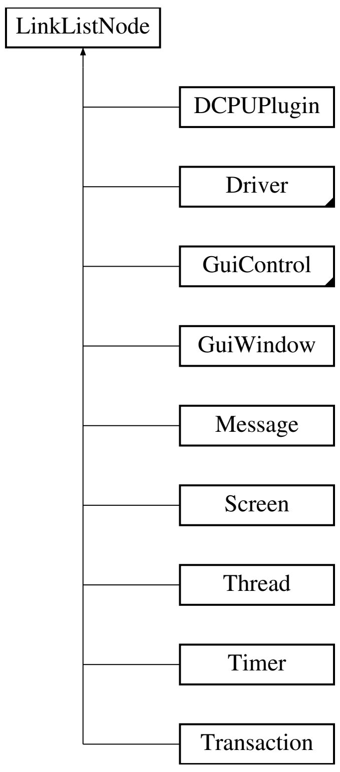
- /home/mo/mark3-source/embedded/stage/src/ll.h

16.48 LinkListNode Class Reference

Basic linked-list node data structure.

`#include <ll.h>`

Inheritance diagram for LinkListNode:



Public Member Functions

- LinkListNode ∗ GetNext (void)

    Returns a pointer to the next node in the list.
- LinkListNode ∗ GetPrev (void)

    Returns a pointer to the previous node in the list.

Protected Member Functions

- void ClearNode ()

    Initialize the linked list node, clearing its next and previous node.

Protected Attributes

- LinkListNode ∗ next

    Pointer to the next node in the list.
- LinkListNode ∗ prev

    Pointer to the previous node in the list.

Friends

- class **LinkList**
- class **DoubleLinkList**
- class **CircularLinkList**

16.48.1 Detailed Description

Basic linked-list node data structure.

This data is managed by the linked-list class types, and can be used transparently between them.

Definition at line 69 of file ll.h.

16.48.2 Member Function Documentation

16.48.2.1 LinkListNode ∗ LinkListNode::GetNext (void) [inline]

Returns a pointer to the next node in the list.

Returns

a pointer to the next node in the list.

Definition at line 93 of file ll.h.

16.48.2.2 LinkListNode ∗ LinkListNode::GetPrev (void) [inline]

Returns a pointer to the previous node in the list.

Returns

a pointer to the previous node in the list.

Definition at line 102 of file ll.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/ll.h
- /home/mo/mark3-source/embedded/stage/src/ll.cpp

16.49 MemUtil Class Reference

String and Memory manipulation class.

`#include <memutil.h>`

Static Public Member Functions

- static void DecimalToHex (K_UCHAR ucData_, char ∗szText_)

  Convert an 8-bit unsigned binary value as a hexadecimal string.
- static void **DecimalToHex** (K_USHORT usData_, char ∗szText_)
- static void **DecimalToHex** (K_ULONG ulData_, char ∗szText_)
- static void DecimalToString (K_UCHAR ucData_, char ∗szText_)

  Convert an 8-bit unsigned binary value as a decimal string.
- static void **DecimalToString** (K_USHORT usData_, char ∗szText_)
- static void **DecimalToString** (K_ULONG ulData_, char ∗szText_)
- static K_UCHAR Checksum8 (const void ∗pvSrc_, K_USHORT usLen_)

  Compute the 8-bit addative checksum of a memory buffer.
- static K_USHORT Checksum16 (const void ∗pvSrc_, K_USHORT usLen_)

  Compute the 16-bit addative checksum of a memory buffer.

- static K_USHORT StringLength (const char ∗szStr_)

  Compute the length of a string in bytes.
- static bool CompareStrings (const char ∗szStr1_, const char ∗szStr2_)

  Compare the contents of two zero-terminated string buffers to eachother.
- static void CopyMemory (void ∗pvDst_, const void ∗pvSrc_, K_USHORT usLen_)

  Copy one buffer in memory into another.
- static void CopyString (char ∗szDst_, const char ∗szSrc_)

  Copy a string from one buffer into another.
- static K_SHORT StringSearch (const char ∗szBuffer_, const char ∗szPattern_)

  Search for the presence of one string as a substring within another.
- static bool CompareMemory (const void ∗pvMem1_, const void ∗pvMem2_, K_USHORT usLen_)

  Compare the contents of two memory buffers to eachother.
- static void SetMemory (void ∗pvDst_, K_UCHAR ucVal_, K_USHORT usLen_)

  Initialize a buffer of memory to a specified 8-bit pattern.
- static K_UCHAR Tokenize (const char ∗szBuffer_, Token_t ∗pastTokens_, K_UCHAR ucMaxTokens_)

  Tokenize Function to tokenize a string based on a space delimeter.

16.49.1 Detailed Description

String and Memory manipulation class.

Utility method class implementing common memory and string manipulation functions, without relying on an external standard library implementation which might not be available on some toolchains, may be closed source, or may not be thread-safe.

Definition at line 47 of file memutil.h.

16.49.2 Member Function Documentation

16.49.2.1 static K_USHORT MemUtil::Checksum16 (const void ∗ *pvSrc_*, K_USHORT *usLen_*) [static]

Compute the 16-bit addative checksum of a memory buffer.

Parameters

*pvSrc_*	Memory buffer to compute a 16-bit checksum of.
*usLen_*	Length of the buffer in bytes.

Returns

16-bit checksum of the memory block.

Definition at line 215 of file memutil.cpp.

16.49.2.2 static K_USHORT MemUtil::Checksum8 (const void ∗ *pvSrc_*, K_USHORT *usLen_*) [static]

Compute the 8-bit addative checksum of a memory buffer.

Parameters

*pvSrc_*	Memory buffer to compute a 8-bit checksum of.

*usLen_*	Length of the buffer in bytes.

Returns

8-bit checksum of the memory block.

Definition at line 199 of file memutil.cpp.

16.49.2.3 static bool MemUtil::CompareMemory (const void ∗ *pvMem1_*, const void ∗ *pvMem2_*, K_USHORT *usLen_*) [static]

Compare the contents of two memory buffers to eachother.

Parameters

*pvMem1_*	First buffer to compare
*pvMem2_*	Second buffer to compare
*usLen_*	Length of buffer (in bytes) to compare

Returns

true if the buffers match, false if they do not.

Definition at line 342 of file memutil.cpp.

16.49.2.4 static bool MemUtil::CompareStrings (const char ∗ *szStr1_*, const char ∗ *szStr2_*) [static]

Compare the contents of two zero-terminated string buffers to eachother.

Parameters

*szStr1_*	First string to compare
*szStr2_*	Second string to compare

Returns

true if strings match, false otherwise.

Definition at line 247 of file memutil.cpp.

16.49.2.5 static void MemUtil::CopyMemory (void ∗ *pvDst_*, const void ∗ *pvSrc_*, K_USHORT *usLen_*) [static]

Copy one buffer in memory into another.

Parameters

*pvDst_*	Pointer to the destination buffer
*pvSrc_*	Pointer to the source buffer
*usLen_*	Number of bytes to copy from source to destination

Definition at line 273 of file memutil.cpp.

16.49.2.6 static void MemUtil::CopyString (char ∗ *szDst_*, const char ∗ *szSrc_*) [static]

Copy a string from one buffer into another.

Parameters

*szDst_*	Pointer to the buffer to copy into
*szSrc_*	Pointer to the buffer to copy data from

Definition at line 290 of file memutil.cpp.

16.49.2.7 static void MemUtil::DecimalToHex (K_UCHAR *ucData_*, char ∗ *szText_*) [static]

Convert an 8-bit unsigned binary value as a hexadecimal string.

Parameters

*ucData_*	Value to convert into a string
*szText_*	Destination string buffer (3 bytes minimum)

Definition at line 28 of file memutil.cpp.

16.49.2.8 static void MemUtil::DecimalToString (K_UCHAR *ucData_*, char ∗ *szText_*) [static]

Convert an 8-bit unsigned binary value as a decimal string.

Parameters

*ucData_*	Value to convert into a string
*szText_*	Destination string buffer (4 bytes minimum)

Definition at line 122 of file memutil.cpp.

16.49.2.9 static void MemUtil::SetMemory (void ∗ *pvDst_*, K_UCHAR *ucVal_*, K_USHORT *usLen_*) [static]

Initialize a buffer of memory to a specified 8-bit pattern.

Parameters

*pvDst_*	Destination buffer to set
*ucVal_*	8-bit pattern to initialize each byte of destination with
*usLen_*	Length of the buffer (in bytes) to initialize

Definition at line 363 of file memutil.cpp.

16.49.2.10 static K_USHORT MemUtil::StringLength (const char ∗ *szStr_*) [static]

Compute the length of a string in bytes.

Parameters

*szStr_*	Pointer to the zero-terminated string to calculate the length of

Returns

length of the string (in bytes), not including the 0-terminator.

Definition at line 232 of file memutil.cpp.

16.49.2.11 static K_SHORT MemUtil::StringSearch (const char ∗ *szBuffer_*, const char ∗ *szPattern_*) [static]

Search for the presence of one string as a substring within another.

Parameters

*szBuffer_*	Buffer to search for pattern within
*szPattern_*	Pattern to search for in the buffer

Returns

Index of the first instance of the pattern in the buffer, or -1 on no match.

Definition at line 307 of file memutil.cpp.

16.49.2.12 K_UCHAR MemUtil::Tokenize (const char ∗ *szBuffer_*, Token_t ∗ *pastTokens_*, K_UCHAR *ucMaxTokens_*) `[static]`

Tokenize Function to tokenize a string based on a space delimeter.

This is a non-destructive function, which populates a Token_t descriptor array.

Parameters

*szBuffer_*	String to tokenize
*pastTokens_*	Pointer to the array of token descriptors
*ucMaxTokens_*	Maximum number of tokens to parse (i.e. size of pastTokens_)

Returns

Count of tokens parsed

Definition at line 376 of file memutil.cpp.

The documentation for this class was generated from the following files:

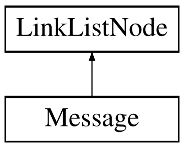
- /home/mo/mark3-source/embedded/stage/src/memutil.h
- /home/mo/mark3-source/embedded/stage/src/memutil.cpp

16.50 Message Class Reference

Class to provide message-based IPC services in the kernel.

`#include <message.h>`

Inheritance diagram for Message:



Public Member Functions

- void Init ()

  Initialize the data and code in the message.
- void SetData (void ∗pvData_)

  Set the data pointer for the message before transmission.
- void ∗ GetData ()

Get the data pointer stored in the message upon receipt.
- void SetCode (K_USHORT usCode_)

  Set the code in the message before transmission.
- K_USHORT GetCode ()

  Return the code set in the message upon receipt.

Private Attributes

- void ∗ m_pvData

  Pointer to the message data.
- K_USHORT m_usCode

  Message code, providing context for the message.

Additional Inherited Members

16.50.1 Detailed Description

Class to provide message-based IPC services in the kernel.

Definition at line 99 of file message.h.

16.50.2 Member Function Documentation

16.50.2.1 K_USHORT Message::GetCode ( ) `[inline]`

Return the code set in the message upon receipt.

Returns

User code set in the object

Definition at line 143 of file message.h.

16.50.2.2 void ∗ Message::GetData ( ) `[inline]`

Get the data pointer stored in the message upon receipt.

Returns

Pointer to the data set in the message object

Definition at line 125 of file message.h.

16.50.2.3 Message::SetCode (K_USHORT *usCode_*) `[inline]`

Set the code in the message before transmission.

Parameters

*usCode_*	Data code to set in the object

Definition at line 134 of file message.h.

16.50.2.4 void Message::SetData (void ∗ *pvData_*) `[inline]`

Set the data pointer for the message before transmission.

Parameters

*pvData_*	Pointer to the data object to send in the message

Definition at line 116 of file message.h.

The documentation for this class was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/message.h

16.51 MessageQueue Class Reference

List of messages, used as the channel for sending and receiving messages between threads.

`#include <message.h>`

Public Member Functions

- void Init ()

  Initialize the message queue prior to use.
- Message ∗ Receive ()

  Receive a message from the message queue.
- Message ∗ Receive (K_ULONG ulTimeWaitMS_)

  Receive a message from the message queue.
- void Send (Message ∗pclSrc_)

  Send a message object into this message queue.
- K_USHORT GetCount ()

  Return the number of messages pending in the "receive" queue.

Private Attributes

- Semaphore m_clSemaphore

  Counting semaphore used to manage thread blocking.
- DoubleLinkList m_clLinkList

  List object used to store messages.

16.51.1 Detailed Description

List of messages, used as the channel for sending and receiving messages between threads.

Definition at line 201 of file message.h.

16.51.2 Member Function Documentation

16.51.2.1 K_USHORT MessageQueue::GetCount ( )

Return the number of messages pending in the "receive" queue.

Returns

Count of pending messages in the queue.

Definition at line 149 of file message.cpp.

16.51.2.2 Message ∗ MessageQueue::Receive ( )

Receive a message from the message queue.

If the message queue is empty, the thread will block until a message is available.

Returns

Pointer to a message object at the head of the queue

Definition at line 91 of file message.cpp.

16.51.2.3 Message ∗ MessageQueue::Receive (K_ULONG *ulWaitTimeMS_*)

Receive a message from the message queue.

If the message queue is empty, the thread will block until a message is available for the duration specified. If no message arrives within that duration, the call will return with NULL.

Parameters

*ulWaitTimeMS_*	The amount of time in ms to wait for a message before timing out and unblocking the waiting thread.

Returns

Pointer to a message object at the head of the queue or NULL on timeout.

Definition at line 111 of file message.cpp.

16.51.2.4 void MessageQueue::Send (Message ∗ *pclSrc_*)

Send a message object into this message queue.

Will un-block the first waiting thread blocked on this queue if that occurs.

Parameters

*pclSrc_*	Pointer to the message object to add to the queue

Definition at line 133 of file message.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/message.h
- /home/mo/mark3-source/embedded/stage/src/message.cpp

16.52 MouseEvent_t Struct Reference

Mouse UI event structure.

```
#include <gui.h>
```

Public Attributes

- K_USHORT usX

  absolute X location of the mouse (pixel)
- K_USHORT usY

absolute Y location of the mouse (pixel)

- union {
  K_UCHAR ucFlags
  modifier flags for the event
  struct {
  unsigned int bLeftState:1
  State of the left mouse button.
  unsigned int bRightState:1
  State of the right mouse button.
  unsigned int bMiddleState:1
  State of the middle mouse button.
  unsigned int bScrollUp:1
  State of the scroll wheel (UP)
  unsigned int bScrollDown:1
  State of the scroll wheel (DOWN)
  }
  };

16.52.1 Detailed Description

Mouse UI event structure.

Definition at line 102 of file gui.h.

The documentation for this struct was generated from the following file:

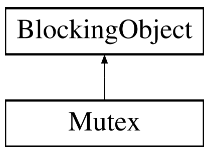
- /home/mo/mark3-source/embedded/stage/src/gui.h

16.53 Mutex Class Reference

Mutual-exclusion locks, based on BlockingObject.

`#include <mutex.h>`

Inheritance diagram for Mutex:



Public Member Functions

- void Init ()

  Initialize a mutex object for use - must call this function before using the object.
- void Claim ()

  Claim the mutex.
- bool Claim (K_ULONG ulWaitTimeMS_)
- void Timeout (Thread ∗pclOwner_)

  Wake a thread blocked on the mutex.
- void Release ()

  Release the mutex.

Private Member Functions

- K_UCHAR WakeNext ()

  Wake the next thread waiting on the Mutex.
- K_BOOL **ProcessQueue** ()
- void ClaimTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)

  ClaimTransaction.
- void ReleaseTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)

  ReleaseTransaction.
- void TimeoutTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)

  TimeoutTransaction.

Private Attributes

- K_UCHAR m_ucRecurse

  The recursive lock-count when a mutex is claimed multiple times by the same owner.
- K_UCHAR m_bReady

  State of the mutex - true = ready, false = claimed.
- K_UCHAR m_ucMaxPri

  Maximum priority of thread in queue, used for priority inheritence.
- Thread ∗ m_pclOwner

  Pointer to the thread that owns the mutex (when claimed)

Additional Inherited Members

16.53.1 Detailed Description

Mutual-exclusion locks, based on BlockingObject.

Definition at line 69 of file mutex.h.

16.53.2 Member Function Documentation

16.53.2.1 void Mutex::Claim ( )

Claim the mutex.

When the mutex is claimed, no other thread can claim a region protected by the object.

Definition at line 282 of file mutex.cpp.

16.53.2.2 bool Mutex::Claim (K_ULONG *ulWaitTimeMS_*)

Parameters

*ulWaitTimeMS_*	

Returns

true - mutex was claimed within the time period specified false - mutex operation timed-out before the claim operation.

Definition at line 286 of file mutex.cpp.

16.53.2.3 void Mutex::ClaimTransaction (**Transaction** ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

ClaimTransaction.

Perform a mutex Claim (Lock) operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 115 of file mutex.cpp.

16.53.2.4 void Mutex::Release ( )

Release the mutex.

When the mutex is released, another object can enter the mutex-protected region.

Definition at line 325 of file mutex.cpp.

16.53.2.5 void Mutex::ReleaseTransaction (**Transaction** ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

ReleaseTransaction.

Perform a Mutex Release/Unlock operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 185 of file mutex.cpp.

16.53.2.6 void Mutex::Timeout (**Thread** ∗ *pclOwner_*)

Wake a thread blocked on the mutex.

This is an internal function used for implementing timed mutexes relying on timer callbacks. Since these do not have access to the private data of the mutex and its base classes, we have to wrap this as a public method - do not use this for any other purposes.

Parameters

*pclOwner_*	Thread to unblock from this object.

Definition at line 55 of file mutex.cpp.

16.53.2.7 void Mutex::TimeoutTransaction (**Transaction** ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

TimeoutTransaction.

Perform a Mutex "timeout" operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 233 of file mutex.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/mutex.h

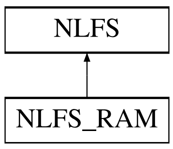
- /home/mo/mark3-source/embedded/stage/src/mutex.cpp

16.54 NLFS Class Reference

Nice Little File System class.

`#include <nlfs.h>`

Inheritance diagram for NLFS:



Public Member Functions

- void Format (NLFS_Host_t ∗puHost_, K_ULONG ulTotalSize_, K_USHORT usNumFiles_, K_USHORT usDataBlockSize_)

  Format/Create a new filesystem with the configuration specified in the parameters.
- void Mount (NLFS_Host_t ∗puHost_)

  Re-mount a previously-cerated filesystem using this FS object.
- K_USHORT Create_File (const K_CHAR ∗szPath_)

  Create_File creates a new file object at the specified path.
- K_USHORT Create_Dir (const K_CHAR ∗szPath_)

  Create_Dir creates a new directory at the specified path.
- K_USHORT Delete_File (const K_CHAR ∗szPath_)

  Delete_File Removes a file from disk.
- K_USHORT Delete_Folder (const K_CHAR ∗szPath_)

  Delete_Folder Remove a folder from disk.
- void Cleanup_Node_Links (K_USHORT usNode_, NLFS_Node_t ∗pstNode_)

  Cleanup_Node_Links Remove the links between the given node and its parent/peer nodes.
- K_USHORT Find_Parent_Dir (const K_CHAR ∗szPath_)

  Find_Parent_Dir returns the directory under which the specified file object lives.
- K_USHORT Find_File (const K_CHAR ∗szPath_)

  Find_File returns the file node ID of the object at a given path.
- void Print (void)

  Print displays a summary of files in the filesystem.
- K_ULONG GetBlockSize (void)

  GetBlockSize retrieves the data block size for the filesystem.
- K_ULONG GetNumBlocks (void)

  GetNumBlocks retrieves the number of data blocks in the filesystem.
- K_ULONG GetNumBlocksFree (void)

  GetNumBlocksFree retrieves the number of free data blocks in the filesystem.
- K_ULONG GetNumFiles (void)

  GetNumFiles retrieves the maximum number of files in the filesystem.
- K_USHORT GetNumFilesFree (void)

  GetNumFilesFree retrieves the number of free blocks in the filesystem.
- K_USHORT GetFirstChild (K_USHORT usNode_)

  GetFirstChild Return the first child node for a node representing a directory.

- K_USHORT GetNextPeer (K_USHORT usNode_)

  GetNextPeer Return the Node ID of a File/Directory's next peer.
- K_BOOL GetStat (K_USHORT usNode_, NLFS_File_Stat_t ∗pstStat_)

  GetStat Get the status of a file on-disk.

Protected Member Functions

- K_CHAR Find_Last_Slash (const K_CHAR ∗szPath_)

  Find_Last_Slash Finds the location of the last '/' character in a path.
- K_BOOL File_Names_Match (const K_CHAR ∗szPath_, NLFS_Node_t ∗pstNode_)

  File_Names_Match Determines if a given path matches the name in a file node.
- virtual void Read_Node (K_USHORT usNode_, NLFS_Node_t ∗pstNode_)=0

  Read_Node is an implementation-specific method used to read a file node from physical storage into a local data struture.
- virtual void Write_Node (K_USHORT usNode_, NLFS_Node_t ∗pstNode_)=0

  Write_Node is an implementation-specific method used to write a file node from a local structure back to the physical storage.
- virtual void Read_Block_Header (K_ULONG ulBlock_, NLFS_Block_t ∗pstBlock_)=0

  Read_Block_Header is an implementation-specific method used to read a file block header from physical storage into a local struct.
- virtual void Write_Block_Header (K_ULONG ulBlock_, NLFS_Block_t ∗pstFileBlock_)=0

  Write_Block_Header is an implementation-specific method used to write a file block header back to physical storage from a local struct.
- virtual void Read_Block (K_ULONG ulBlock_, K_ULONG ulOffset_, void ∗pvData_, K_ULONG ulLen_)=0

  Read_Block is an implementation-specific method used to read raw file data from physical storage into a local buffer.
- virtual void Write_Block (K_ULONG ulBlock_, K_ULONG ulOffset_, void ∗pvData_, K_ULONG ulLen_)=0

  Write_Block is an implementation-specific method used to write a piece of file data to its data block in the underlying physical storage.
- void RootSync ()

  RootSync Synchronize the filesystem config in the object back to the underlying storage mechanism.
- void Repair ()

  Repair Checks a filesystem for inconsistencies and makes repairs in order to avoid losing storage blocks.
- void Print_Free_Details (K_USHORT usNode_)

  Print_Free_Details Print details about a free node.
- void Print_File_Details (K_USHORT usNode_)

  Print_File_Details displays information about a given file node.
- void Print_Dir_Details (K_USHORT usNode_)

  Print_Dir_Details displays information about a given directory node.
- void Print_Node_Details (K_USHORT usNode_)

  Print_Node_Details prints details about a node, the details differ based on whether it's a file/directory/root node.
- void Push_Free_Node (K_USHORT usNode_)

  Push_Free_Node returns a file node back to the free node list.
- K_USHORT Pop_Free_Node (void)

  Pop_Free_Node returns the first free file node in the free list.
- void Push_Free_Block (K_ULONG ulBlock_)

  Push_Free_Block returns a file block back to the head of the free block list.
- K_ULONG Pop_Free_Block (void)

  Pop_Free_Block pops a file data block from the head of the free list.
- K_ULONG Append_Block_To_Node (NLFS_Node_t ∗pstFile_)

  Append_Block_To_Node adds a file data block to the end of a file.
- K_USHORT Create_File_i (const K_CHAR ∗szPath_, NLFS_Type_t eType_)

  Create_File_i is the private method used to create a file or directory.
- void Set_Node_Name (NLFS_Node_t ∗pstFileNode_, const K_CHAR ∗szPath_)

  Set_Node_Name sets the name of a file or directory node.

Protected Attributes

- NLFS_Host_t ∗ m_puHost

  Local, cached copy of host FS pointer.
- NLFS_Root_Node_t m_stLocalRoot

  Local, cached copy of root.

Friends

- class **NLFS_File**

16.54.1 Detailed Description

Nice Little File System class.

Definition at line 280 of file nlfs.h.

16.54.2 Member Function Documentation

16.54.2.1 K_ULONG NLFS::Append_Block_To_Node (NLFS_Node_t ∗ *pstFile_*) [protected]

Append_Block_To_Node adds a file data block to the end of a file.

Parameters

in	*pstFile_*	- Pointer to the file node to add a block to

Returns

Data block ID of the allocated block, or INVALID_BLOCK on failure.

Definition at line 245 of file nlfs.cpp.

16.54.2.2 void NLFS::Cleanup_Node_Links (K_USHORT *usNode_*, NLFS_Node_t ∗ *pstNode_*)

Cleanup_Node_Links Remove the links between the given node and its parent/peer nodes.

Parameters

*usNode_*	Index of the node
*pstNode_*	Pointer to a local copy of the node data

Definition at line 598 of file nlfs.cpp.

16.54.2.3 K_USHORT NLFS::Create_Dir (const K_CHAR ∗ *szPath_*)

Create_Dir creates a new directory at the specified path.

Parameters

in	*szPath_*	- Path to the directory to create

Returns

ID of the created dir, or INVALID_NODE if the path cannot be resolved, or the file already exists.

Definition at line 586 of file nlfs.cpp.

16.54.2.4 K_USHORT NLFS::Create_File (const K_CHAR ∗ *szPath_*)

Create_File creates a new file object at the specified path.

Parameters

in	*szPath_*	- Path to the file to create

Returns

ID of the created file, or INVALID_NODE if the path cannot be resolved, or the file already exists.

Definition at line 573 of file nlfs.cpp.

16.54.2.5 K_USHORT NLFS::Create_File_i (const K_CHAR ∗ *szPath_*, NLFS_Type_t *eType_*) [protected]

Create_File_i is the private method used to create a file or directory.

Parameters

in	*szPath_*	- Path of the file or directory to create
in	*eType_*	- Type of file to create

Returns

File node ID of the newly created file, or INVALID_NODE on failure.

! ToDo - set real user/group IDs

Definition at line 490 of file nlfs.cpp.

16.54.2.6 K_USHORT NLFS::Delete_File (const K_CHAR ∗ *szPath_*)

Delete_File Removes a file from disk.

Parameters

*szPath_*	Path of the file to remove

Returns

Index of the node deleted or INVALID_NODE on error

Definition at line 705 of file nlfs.cpp.

16.54.2.7 K_USHORT NLFS::Delete_Folder (const K_CHAR ∗ *szPath_*)

Delete_Folder Remove a folder from disk.

Parameters

*szPath_*	Path of the folder to remove

Returns

Index of the node deleted or INVALID_NODE on error

Definition at line 662 of file nlfs.cpp.

16.54.2.8 K_BOOL NLFS::File_Names_Match (const K_CHAR ∗ *szPath_*, NLFS_Node_t ∗ *pstNode_*) [protected]

File_Names_Match Determines if a given path matches the name in a file node.

Parameters

in	*szPath_*	- file path to search for
in	*pstNode_*	- pointer to a fs node

Returns

true if the filename in the path matches the filename in the node.

Definition at line 42 of file nlfs.cpp.

16.54.2.9 K_USHORT NLFS::Find_File (const K_CHAR ∗ *szPath_*)

Find_File returns the file node ID of the object at a given path.

Parameters

in	*szPath_*	- Path of the file to search for

Returns

file node ID, or INVALID_NODE if the path is invalid.

Definition at line 405 of file nlfs.cpp.

16.54.2.10 K_CHAR NLFS::Find_Last_Slash (const K_CHAR ∗ *szPath_*) [protected]

Find_Last_Slash Finds the location of the last '/' character in a path.

Parameters

in	*szPath_*	- String representing a '/' delimited path.

Returns

the byte offset of the last slash char in the path.

Definition at line 26 of file nlfs.cpp.

16.54.2.11 K_USHORT NLFS::Find_Parent_Dir (const K_CHAR ∗ *szPath_*)

Find_Parent_Dir returns the directory under which the specified file object lives.

Parameters

in	*szPath_*	- Path of the file to find parent directory node for

Returns

directory node ID, or INVALID_NODE if the path is invalid.

Definition at line 289 of file nlfs.cpp.

16.54.2.12 void NLFS::Format (NLFS_Host_t ∗ *puHost_*, K_ULONG *ulTotalSize_*, K_USHORT *usNumFiles_*, K_USHORT *usDataBlockSize_*)

Format/Create a new filesystem with the configuration specified in the parameters.

Parameters

in	*puHost_*	- Pointer to the FS storage object, interpreted by the physical medium driver.
in	*ulTotalSize_*	- Total size of the object to format (in bytes)
in	*usNumFiles_*	- Number of file nodes to create in the FS. This parameter determines the maximum number of files and directories that can exist simultaneously in the filesystem. All filesystem storage not allocated towards file nodes is automatically used as data-blocks.
	*usDataBlock-Size_*	- Size of each data block (in bytes). Setting a lower block size is a good way to avoid wasting space in small-files due to over-allocation of storage (size on-disk vs. actual file size). However, each block requires a metadata object, which can also add to overhead. Also, file read/write speed can vary significantly based on the block size - in many scenarios, larger blocks can lead to higher throughput.

Definition at line 756 of file nlfs.cpp.

16.54.2.13 K_ULONG NLFS::GetBlockSize (void) [inline]

GetBlockSize retrieves the data block size for the filesystem.

Returns

The size of a data block in the filesystem, as configured at format.

Definition at line 382 of file nlfs.h.

16.54.2.14 K_USHORT NLFS::GetFirstChild (K_USHORT *usNode_*)

GetFirstChild Return the first child node for a node representing a directory.

Parameters

*usNode_*	Index of a directory node

Returns

Node ID of the first child node or INVALID_NODE on failure

Definition at line 890 of file nlfs.cpp.

16.54.2.15 K_USHORT NLFS::GetNextPeer (K_USHORT *usNode_*)

GetNextPeer Return the Node ID of a File/Directory's next peer.

Parameters

*usNode_*	Node index of the current object

Returns

Node ID of the next peer object

Definition at line 908 of file nlfs.cpp.

16.54.2.16 K_ULONG NLFS::GetNumBlocks (void) [inline]

GetNumBlocks retrieves the number of data blocks in the filesystem.

Returns

The total number of blocks in the filesystem

Definition at line 388 of file nlfs.h.

16.54.2.17 K_ULONG NLFS::GetNumBlocksFree (void) [inline]

GetNumBlocksFree retrieves the number of free data blocks in the filesystem.

Returns

The number of available blocks in the filesystem

Definition at line 395 of file nlfs.h.

16.54.2.18 K_ULONG NLFS::GetNumFiles (void) [inline]

GetNumFiles retrieves the maximum number of files in the filesystem.

Returns

The maximum number of files that can be allocated in the system

Definition at line 401 of file nlfs.h.

16.54.2.19 K_USHORT NLFS::GetNumFilesFree (void) [inline]

GetNumFilesFree retrieves the number of free blocks in the filesystem.

Returns

The number of free file nodes in the filesystem

Definition at line 407 of file nlfs.h.

16.54.2.20 K_BOOL NLFS::GetStat (K_USHORT *usNode_*, NLFS_File_Stat_t ∗ *pstStat_*)

GetStat Get the status of a file on-disk.

Parameters

*usNode_*	Node representing the file
*pstStat_*	Pointer to the object containing the status

Returns

true on success, false on failure

Definition at line 920 of file nlfs.cpp.

16.54.2.21 void NLFS::Mount (NLFS_Host_t ∗ *puHost_*)

Re-mount a previously-cerated filesystem using this FS object.

Parameters

in	*puHost_*	- Pointer to the filesystem object

! Must set the host pointer first.

Definition at line 859 of file nlfs.cpp.

16.54.2.22 K_ULONG NLFS::Pop_Free_Block (void) [protected]

Pop_Free_Block pops a file data block from the head of the free list.

Returns

the block index of the file node popped from the head of the free block list

Definition at line 192 of file nlfs.cpp.

16.54.2.23 K_USHORT NLFS::Pop_Free_Node (void) [protected]

Pop_Free_Node returns the first free file node in the free list.

Returns

the index of the file node popped off the free list

Definition at line 145 of file nlfs.cpp.

16.54.2.24 void NLFS::Print_Dir_Details (K_USHORT *usNode_*) [protected]

Print_Dir_Details displays information about a given directory node.

Parameters

in	*usNode_*	- directory index to display details for

Definition at line 90 of file nlfs.cpp.

16.54.2.25 void NLFS::Print_File_Details (K_USHORT *usNode_*) [protected]

Print_File_Details displays information about a given file node.

Parameters

in	*usNode_*	- file index to display details for

Definition at line 68 of file nlfs.cpp.

16.54.2.26 void NLFS::Print_Free_Details (K_USHORT *usNode_*) [protected]

Print_Free_Details Print details about a free node.

Parameters

*usNode_*	Node to print details for

Definition at line 106 of file nlfs.cpp.

16.54.2.27 void NLFS::Print_Node_Details (K_USHORT *usNode_*) [protected]

Print_Node_Details prints details about a node, the details differ based on whether it's a file/directory/root node.

Parameters

in	*usNode_*	- node to show details for

Definition at line 115 of file nlfs.cpp.

16.54.2.28 void NLFS::Push_Free_Block (K_ULONG *ulBlock_*) [protected]

Push_Free_Block returns a file block back to the head of the free block list.

Parameters

in	*ulBlock_*	- index of the data block to free

Definition at line 224 of file nlfs.cpp.

16.54.2.29 void NLFS::Push_Free_Node (K_USHORT *usNode_*) [protected]

Push_Free_Node returns a file node back to the free node list.

Parameters

in	*usNode_*	- index of the file node to push back to the free list.

Definition at line 172 of file nlfs.cpp.

16.54.2.30 virtual void NLFS::Read_Block (K_ULONG *ulBlock_*, K_ULONG *ulOffset_*, void ∗ *pvData_*, K_ULONG *ulLen_*) [protected], [pure virtual]

Read_Block is an implementation-specific method used to read raw file data from physical storage into a local buffer.

Parameters

in	*ulBlock_*	- filesystem block ID corresponding to the file
in	*ulOffset_*	- offset (in bytes) from the beginning of the block
out	*pvData_*	- output buffer to read into
in	*ulLen_*	- length of data to read (in bytes)

Implemented in NLFS_RAM.

16.54.2.31 virtual void NLFS::Read_Block_Header (K_ULONG *ulBlock_*, NLFS_Block_t ∗ *pstBlock_*) [protected], [pure virtual]

Read_Block_Header is an implementation-specific method used to read a file block header from physical storage into a local struct.

Parameters

in	*ulBlock_*	- data block index
out	*pstBlock_*	- block header structure to read into

Implemented in NLFS_RAM.

16.54.2.32 virtual void NLFS::Read_Node (K_USHORT *usNode_*, NLFS_Node_t ∗ *pstNode_*) [protected], [pure virtual]

Read_Node is an implementation-specific method used to read a file node from physical storage into a local data struture.

Parameters

in	*usNode_*	- File node index
out	*pstNode_*	- Pointer to the file node object to read into

Implemented in NLFS_RAM.

16.54.2.33 void NLFS::RootSync ( ) [protected]

RootSync Synchronize the filesystem config in the object back to the underlying storage mechanism.

This needs to be called to ensure that underlying storage is kept consistent when creating or deleting files.

Definition at line 879 of file nlfs.cpp.

16.54.2.34 void NLFS::Set_Node_Name (NLFS_Node_t * *pstFileNode_*, const K_CHAR * *szPath_*) [protected]

Set_Node_Name sets the name of a file or directory node.

Parameters

in	*pstFileNode_*	- Pointer to a file node structure to name
in	*szPath_*	- Name for the file

Definition at line 458 of file nlfs.cpp.

16.54.2.35 virtual void NLFS::Write_Block (K_ULONG *ulBlock_*, K_ULONG *ulOffset_*, void * *pvData_*, K_ULONG *ulLen_*) [protected], [pure virtual]

Write_Block is an implementation-specific method used to write a piece of file data to its data block in the underlying physical storage.

Parameters

in	*ulBlock_*	- filesystem block ID corresponding to the file
in	*ulOffset_*	- offset (in bytes) from the beginning of the block
in	*pvData_*	- data buffer to write to disk
in	*ulLen_*	- length of data to write (in bytes)

Implemented in NLFS_RAM.

16.54.2.36 virtual void NLFS::Write_Block_Header (K_ULONG *ulBlock_*, NLFS_Block_t * *pstFileBlock_*) [protected], [pure virtual]

Write_Block_Header is an implementation-specific method used to write a file block header back to physical storage from a local struct.

Parameters

in	*ulBlock_*	- data block index
in	*pstFileBlock_*	- pointer to the local data structure to write from

Implemented in NLFS_RAM.

16.54.2.37 virtual void NLFS::Write_Node (K_USHORT *usNode_*, NLFS_Node_t * *pstNode_*) [protected], [pure virtual]

Write_Node is an implementation-specific method used to write a file node from a local structure back to the physical storage.

Parameters

in	*usNode_*	- File node index
in	*pstNode_*	- Pointer to the file node object to write from

Implemented in NLFS_RAM.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/nlfs.h
- /home/mo/mark3-source/embedded/stage/src/nlfs.cpp

16.55 NLFS_Block_t Struct Reference

Block data structure.

`#include <nlfs.h>`

Public Attributes

- K_ULONG ulNextBlock

  Index of the next block.
- union {
  K_UCHAR ucFlags
  Block Flags.
  struct {
  unsigned int uAllocated
  1 if allocated
  unsigned int uCheckBit
  Used for continuity checks.
  }
  };

16.55.1 Detailed Description

Block data structure.

Contains the block index of the next data block (either in the file, or in the free-data pool), as well as any special flags.

Definition at line 232 of file nlfs.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/nlfs.h

16.56 NLFS_File Class Reference

The NLFS_File class.

`#include <nlfs_file.h>`

Public Member Functions

- int Open (NLFS ∗pclFS_, const K_CHAR ∗szPath_, NLFS_File_Mode_t eMode_)

Open Opens a file from a given filesystem.
- int Read (void ∗pvBuf_, K_ULONG ulLen_)

  Read Read bytes from a file into a specified data buffer.
- int Write (void ∗pvBuf_, K_ULONG ulLen_)

  Write Write a specified blob of data to the file.
- int Seek (K_ULONG ulOffset_)

  Seek Seek to the specified byte offset within the file.
- int Close (void)

  Close Is used to close an open file buffer.

Private Attributes

- NLFS ∗ m_pclFileSystem

  Pointer to the host filesystem.
- K_ULONG m_ulOffset

  Current byte offset within the file.
- K_ULONG m_ulCurrentBlock

  Index of the current filesystem block.
- K_USHORT m_usFile

  File index of the current file.
- NLFS_File_Mode_t m_ucFlags

  File mode flags.
- NLFS_Node_t m_stNode

  Local copy of the file node.

16.56.1 Detailed Description

The NLFS_File class.

This class contains an implementation of file-level access built on-top of the NLFS filesystem architecture. An instance of this class represents an active/open file from inside the NLFSfilesystem.

Definition at line 45 of file nlfs_file.h.

16.56.2 Member Function Documentation

16.56.2.1 int NLFS_File::Close (void)

Close Is used to close an open file buffer.

Returns

0 on success, -1 on failure.

Definition at line 272 of file nlfs_file.cpp.

16.56.2.2 int NLFS_File::Open (NLFS ∗ *pclFS_*, const K_CHAR ∗ *szPath_*, NLFS_File_Mode_t *eMode_*)

Open Opens a file from a given filesystem.

Parameters

*pclFS_*	- Pointer to the NLFS filesystem containing the file
*szPath_*	- Path to the file within the NLFS filesystem
*eMode_*	- File open mode

Returns

0 on success, -1 on failure

Definition at line 26 of file nlfs_file.cpp.

16.56.2.3 int NLFS_File::Read (void ∗ *pvBuf_*, K_ULONG *ulLen_*)

Read Read bytes from a file into a specified data buffer.

Parameters

`in`	*ulLen_*	- Length (in bytes) of data to read
`out`	*pvBuf_*	- Pointer to the buffer to read into

Returns

Number of bytes read from the file

Definition at line 151 of file nlfs_file.cpp.

16.56.2.4 int NLFS_File::Seek (K_ULONG *ulOffset_*)

Seek Seek to the specified byte offset within the file.

Parameters

`in`	*ulOffset_*	Offset in bytes from the beginning of the file

Returns

0 on success, -1 on failure

Definition at line 112 of file nlfs_file.cpp.

16.56.2.5 int NLFS_File::Write (void ∗ *pvBuf_*, K_ULONG *ulLen_*)

Write Write a specified blob of data to the file.

Parameters

`in`	*ulLen_*	- Length (in bytes) of the source buffer
`in`	*pvBuf_*	- Pointer to the data buffer containing the data to be written

Returns

Number of bytes written to the file

Definition at line 217 of file nlfs_file.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/nlfs_file.h
- /home/mo/mark3-source/embedded/stage/src/nlfs_file.cpp

16.57 NLFS_File_Node_t Struct Reference

Data structure for the "file" FS-node type.

```
#include <nlfs.h>
```

Public Attributes

- K_CHAR acFileName [16]

  Arbitrary, 16-char filename.
- K_USHORT usNextPeer

  Index of the next peer file node.
- K_USHORT usPrevPeer

  Index of the previous peer node.
- K_UCHAR ucGroup

  Group ID of the owner.
- K_UCHAR ucUser

  User ID of the owner.
- K_USHORT usPerms

  File permissions (POSIX-style)
- K_USHORT usParent

  Index of the parent file node.
- K_USHORT usChild

  Index of the first child node.
- K_ULONG ulAllocSize

  Size of the file (allocated)
- K_ULONG ulFileSize

  Size of the file (in-bytes)
- K_ULONG ulFirstBlock

  Index of the first file block.
- K_ULONG ulLastBlock

  Index of the last file block.

16.57.1 Detailed Description

Data structure for the "file" FS-node type.

Note that this is the same as for a directory node (although fewer fields are used for that case, as documented).

Definition at line 168 of file nlfs.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/nlfs.h

16.58 NLFS_File_Stat_t Struct Reference

Structure used to report the status of a given file.

```
#include <nlfs.h>
```

Public Attributes

- K_ULONG ulAllocSize
  Size of the file including partial blocks.
- K_ULONG ulFileSize
  Actual size of the file.
- K_USHORT usPerms
  Permissions attached to the file.
- K_UCHAR ucUser
  User associated with this file.
- K_UCHAR ucGroup
  Group associated with this file.
- K_CHAR acFileName [16]
  Copy of the file name.

16.58.1 Detailed Description

Structure used to report the status of a given file.

Definition at line 266 of file nlfs.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/nlfs.h

16.59 NLFS_Host_t Union Reference

Union used for managing host-specific pointers/data-types.

```
#include <nlfs.h>
```

Public Attributes

- void ∗ **pvData**
- uint32_t **u32Data**
- uint64_t **u64Data**
- K_ADDR **kaData**

16.59.1 Detailed Description

Union used for managing host-specific pointers/data-types.

This is all pretty abstract, as the data represented here is only accessed by the underlying physical media drive.

Definition at line 253 of file nlfs.h.

The documentation for this union was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/nlfs.h

16.60 NLFS_Node_t Struct Reference

Filesystem node data structure.

```
#include <nlfs.h>
```

Public Attributes

- NLFS_Type_t eBlockType

  Block type ID.
- union {
  NLFS_Root_Node_t stRootNode
  Root Filesystem Node.
  NLFS_File_Node_t stFileNode
  File/Directory Node.
  };

16.60.1 Detailed Description

Filesystem node data structure.

Contains the block type, as well as the union between the various FS-node data structures. This is also the same data format as how data is stored "on-disk"

Definition at line 215 of file nlfs.h.

The documentation for this struct was generated from the following file:

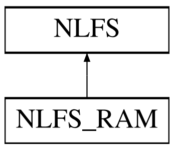
- /home/mo/mark3-source/embedded/stage/src/nlfs.h

16.61 NLFS_RAM Class Reference

The NLFS_RAM class.

`#include <nlfs_ram.h>`

Inheritance diagram for NLFS_RAM:



Private Member Functions

- virtual void Read_Node (K_USHORT usNode_, NLFS_Node_t *pstNode_)

  Read_Node is an implementation-specific method used to read a file node from physical storage into a local data struture.
- virtual void Write_Node (K_USHORT usNode_, NLFS_Node_t *pstNode_)

  Write_Node is an implementation-specific method used to write a file node from a local structure back to the physical storage.
- virtual void Read_Block_Header (K_ULONG ulBlock_, NLFS_Block_t *pstBlock_)

  Read_Block_Header is an implementation-specific method used to read a file block header from physical storage into a local struct.
- virtual void Write_Block_Header (K_ULONG ulBlock_, NLFS_Block_t *pstFileBlock_)

  Write_Block_Header is an implementation-specific method used to write a file block header back to physical storage from a local struct.
- virtual void Read_Block (K_ULONG ulBlock_, K_ULONG ulOffset_, void *pvData_, K_ULONG ulLen_)

  Read_Block is an implementation-specific method used to read raw file data from physical storage into a local buffer.

- void Write_Block (K_ULONG ulBlock_, K_ULONG ulOffset_, void ∗pvData_, K_ULONG ulLen_)

  Write_Block is an implementation-specific method used to write a piece of file data to its data block in the underlying physical storage.

Additional Inherited Members

16.61.1 Detailed Description

The NLFS_RAM class.

This class implements an NLFS filesystem in a RAM buffer. In this case, the host pointer passed into the "format" call is a pointer to the locally- allocated buffer in which the filesystem lives.

Definition at line 31 of file nlfs_ram.h.

16.61.2 Member Function Documentation

16.61.2.1 void NLFS_RAM::Read_Block (K_ULONG *ulBlock_*, K_ULONG *ulOffset_*, void ∗ *pvData_*, K_ULONG *ulLen_*) `[private]`, `[virtual]`

Read_Block is an implementation-specific method used to read raw file data from physical storage into a local buffer.

Parameters

`in`	*ulBlock_*	- filesystem block ID corresponding to the file
`in`	*ulOffset_*	- offset (in bytes) from the beginning of the block
`out`	*pvData_*	- output buffer to read into
`in`	*ulLen_*	- length of data to read (in bytes)

Implements NLFS.

Definition at line 63 of file nlfs_ram.cpp.

16.61.2.2 void NLFS_RAM::Read_Block_Header (K_ULONG *ulBlock_*, NLFS_Block_t ∗ *pstBlock_*) `[private]`, `[virtual]`

Read_Block_Header is an implementation-specific method used to read a file block header from physical storage into a local struct.

Parameters

`in`	*ulBlock_*	- data block index
`out`	*pstBlock_*	- block header structure to read into

Implements NLFS.

Definition at line 43 of file nlfs_ram.cpp.

16.61.2.3 void NLFS_RAM::Read_Node (K_USHORT *usNode_*, NLFS_Node_t ∗ *pstNode_*) `[private]`, `[virtual]`

Read_Node is an implementation-specific method used to read a file node from physical storage into a local data struture.

Parameters

in	*usNode_*	- File node index
out	*pstNode_*	- Pointer to the file node object to read into

Implements NLFS.

Definition at line 25 of file nlfs_ram.cpp.

16.61.2.4 void NLFS_RAM::Write_Block (K_ULONG *ulBlock_*, K_ULONG *ulOffset_*, void ∗ *pvData_*, K_ULONG *ulLen_*) [private], [virtual]

Write_Block is an implementation-specific method used to write a piece of file data to its data block in the underlying physical storage.

Parameters

in	*ulBlock_*	- filesystem block ID corresponding to the file
in	*ulOffset_*	- offset (in bytes) from the beginning of the block
in	*pvData_*	- data buffer to write to disk
in	*ulLen_*	- length of data to write (in bytes)

Implements NLFS.

Definition at line 73 of file nlfs_ram.cpp.

16.61.2.5 void NLFS_RAM::Write_Block_Header (K_ULONG *ulBlock_*, NLFS_Block_t ∗ *pstFileBlock_*) [private], [virtual]

Write_Block_Header is an implementation-specific method used to write a file block header back to physical storage from a local struct.

Parameters

in	*ulBlock_*	- data block index
in	*pstFileBlock_*	- pointer to the local data structure to write from

Implements NLFS.

Definition at line 53 of file nlfs_ram.cpp.

16.61.2.6 void NLFS_RAM::Write_Node (K_USHORT *usNode_*, NLFS_Node_t ∗ *pstNode_*) [private], [virtual]

Write_Node is an implementation-specific method used to write a file node from a local structure back to the physical storage.

Parameters

in	*usNode_*	- File node index
in	*pstNode_*	- Pointer to the file node object to write from

Implements NLFS.

Definition at line 34 of file nlfs_ram.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/nlfs_ram.h
- /home/mo/mark3-source/embedded/stage/src/nlfs_ram.cpp

16.62 NLFS_Root_Node_t Struct Reference

Data structure for the Root-configuration FS-node type.

```
#include <nlfs.h>
```

Public Attributes

- K_USHORT usNumFiles

  Number of file nodes in the FS.
- K_USHORT usNumFilesFree

  Number of free file nodes.
- K_USHORT usNextFreeNode

  Index of the next free file.
- K_ULONG ulNumBlocks

  Number of blocks in the FS.
- K_ULONG ulNumBlocksFree

  Number of free blocks.
- K_ULONG ulNextFreeBlock

  Index of the next free block.
- K_ULONG ulBlockSize

  Size of each block on disk.
- K_ULONG ulBlockOffset

  Byte-offset to the first block struct.
- K_ULONG ulDataOffset

  Byte-offset to the first data block.

16.62.1 Detailed Description

Data structure for the Root-configuration FS-node type.

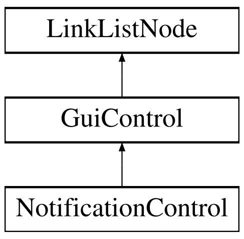
Definition at line 194 of file nlfs.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/nlfs.h

16.63 NotificationControl Class Reference

Inheritance diagram for NotificationControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetFont** (Font_t ∗pstFont_)
- void **SetCaption** (const K_CHAR ∗szCaption_)
- void **Trigger** (K_USHORT usTimeout_)

Private Attributes

- const K_CHAR ∗ **m_szCaption**
- Font_t ∗ **m_pstFont**
- K_USHORT **m_usTimeout**
- bool **m_bTrigger**
- bool **m_bVisible**

Additional Inherited Members

16.63.1 Detailed Description

Definition at line 29 of file control_notification.h.

16.63.2 Member Function Documentation

16.63.2.1 virtual void NotificationControl::Activate (bool *bActivate_*) [inline], [virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 43 of file control_notification.h.

16.63.2.2 void NotificationControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 26 of file control_notification.cpp.

16.63.2.3 virtual void NotificationControl::Init ( ) [inline], [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 32 of file control_notification.h.

16.63.2.4 GuiReturn_t NotificationControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 92 of file control_notification.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_notification.h
- /home/mo/mark3-source/embedded/stage/src/control_notification.cpp

16.64 Option_t Struct Reference

Structure used to represent a command-line option with its arguments.

`#include <shell_support.h>`

Public Attributes

- Token_t ∗ pstStart

    Pointer to the beginning of a token array contain the option and its arguments.
- K_UCHAR ucCount

    Number of tokens in the token array.

16.64.1 Detailed Description

Structure used to represent a command-line option with its arguments.

An option is defined as any token beginning with a "-" value. The tokens arguments are subsequent tokens that do not begin with "-".

Where no "-" values are specified, each token becomes its own option.
i.e. given the following command-line

```
mycmd -opt1 a b c -opt2 d e f -opt 3
```

The possible Option_t structures would be:

```
pstStart => Array containing tokens for -opt1, a, b, c
ucCount  => 4 (4 tokens, including the option token, "-opt1")

pstStart => Array containing tokens for -opt2, d, e, f
```

```
ucCount  => 4 (4 tokens, including the option token, "-opt2")

pstStart => Array containing tokens for -opt, 3
ucCount  => 2 (2 tokens, including the option token, "-opt3")
```

in the case of:

```
mycmd a b c
```

Possible token values would be:

```
pstStart => Array containing tokens for a
ucCount  => 1

pstStart => Array containing tokens for b
ucCount  => 1

pstStart => Array containing tokens for c
ucCount  => 1
```

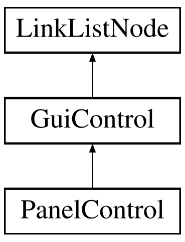
Definition at line 83 of file shell_support.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/shell_support.h

16.65 PanelControl Class Reference

Inheritance diagram for PanelControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetColor** (COLOR eColor_)

Private Attributes

- COLOR **m_uColor**

Additional Inherited Members

16.65.1 Detailed Description

Definition at line 33 of file control_panel.h.

16.65.2 Member Function Documentation

16.65.2.1 virtual void PanelControl::Activate (bool *bActivate_*) `[inline]`, `[virtual]`

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 39 of file control_panel.h.

16.65.2.2 void PanelControl::Draw ( ) `[virtual]`

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 26 of file control_panel.cpp.

16.65.2.3 virtual void PanelControl::Init ( ) `[inline]`, `[virtual]`

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 36 of file control_panel.h.

16.65.2.4 virtual GuiReturn_t PanelControl::ProcessEvent (GuiEvent_t * *pstEvent_*) `[inline]`, `[virtual]`

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 38 of file control_panel.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_panel.h
- /home/mo/mark3-source/embedded/stage/src/control_panel.cpp

16.66 Profiler Class Reference

System profiling timer interface.

```
#include <kprofile.h>
```

Static Public Member Functions

- static void Init ()

  Initialize the global system profiler.
- static void Start ()

  Start the global profiling timer service.
- static void Stop ()

  Stop the global profiling timer service.
- static K_USHORT Read ()

  Read the current tick count in the timer.
- static void Process ()

  Process the profiling counters from ISR.
- static K_ULONG GetEpoch ()

  Return the current timer epoch.

Static Private Attributes

- static K_ULONG **m_ulEpoch**

16.66.1 Detailed Description

System profiling timer interface.

Definition at line 37 of file kprofile.h.

16.66.2 Member Function Documentation

16.66.2.1 void Profiler::Init (void) [static]

Initialize the global system profiler.

Must be called prior to use.

Definition at line 32 of file kprofile.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/kprofile.h
- /home/mo/mark3-source/embedded/stage/src/kprofile.cpp

16.67 ProfileTimer Class Reference

Profiling timer.

```
#include <profile.h>
```

Public Member Functions

- void Init ()

  Initialize the profiling timer prior to use.
- void Start ()

  Start a profiling session, if the timer is not already active.
- void Stop ()

  Stop the current profiling session, adding to the cumulative time for this timer, and the total iteration count.
- K_ULONG GetAverage ()

  Get the average time associated with this operation.
- K_ULONG GetCurrent ()

  Return the current tick count held by the profiler.

Private Member Functions

- K_ULONG ComputeCurrentTicks (K_USHORT usCount_, K_ULONG ulEpoch_)

  Figure out how many ticks have elapsed in this iteration.

Private Attributes

- K_ULONG m_ulCumulative

  Cumulative tick-count for this timer.
- K_ULONG m_ulCurrentIteration

  Tick-count for the current iteration.
- K_USHORT m_usInitial

  Initial count.
- K_ULONG m_ulInitialEpoch

  Initial Epoch.
- K_USHORT m_usIterations

  Number of iterations executed for this profiling timer.
- K_UCHAR m_bActive

  Wheter or not the timer is active or stopped.

16.67.1 Detailed Description

Profiling timer.

This class is used to perform high-performance profiling of code to see how K_LONG certain operations take. Useful in instrumenting the performance of key algorithms and time-critical operations to ensure real-timer behavior.

Definition at line 69 of file profile.h.

16.67.2 Member Function Documentation

16.67.2.1 K_ULONG ProfileTimer::ComputeCurrentTicks (K_USHORT *usCount_*, K_ULONG *ulEpoch_*) [private]

Figure out how many ticks have elapsed in this iteration.

Parameters

*usCount_*	Current timer count
*ulEpoch_*	Current timer epoch

Returns

Current tick count

Definition at line 106 of file profile.cpp.

16.67.2.2 K_ULONG ProfileTimer::GetAverage ( )

Get the average time associated with this operation.

Returns

Average tick count normalized over all iterations

Definition at line 79 of file profile.cpp.

16.67.2.3 K_ULONG ProfileTimer::GetCurrent ( )

Return the current tick count held by the profiler.

Valid for both active and stopped timers.

Returns

The currently held tick count.

Definition at line 89 of file profile.cpp.

16.67.2.4 void ProfileTimer::Init (void)

Initialize the profiling timer prior to use.

Can also be used to reset a timer that's been used previously.

Definition at line 37 of file profile.cpp.

16.67.2.5 void ProfileTimer::Start (void)

Start a profiling session, if the timer is not already active.

Has no effect if the timer is already active.

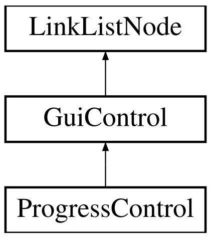
Definition at line 46 of file profile.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/profile.h
- /home/mo/mark3-source/embedded/stage/src/profile.cpp

16.68 ProgressControl Class Reference

Inheritance diagram for ProgressControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetBackColor** (COLOR eColor_)
- void **SetProgressColor** (COLOR eColor_)
- void **SetBorderColor** (COLOR eColor_)
- void **SetProgress** (K_UCHAR ucProgress_)

Private Attributes

- COLOR **m_uBackColor**
- COLOR **m_uProgressColor**
- COLOR **m_uBorderColor**
- K_UCHAR **m_ucProgress**

Additional Inherited Members

16.68.1 Detailed Description

Definition at line 30 of file control_progress.h.

16.68.2 Member Function Documentation

16.68.2.1 virtual void ProgressControl::Activate (bool *bActivate_*) `[inline]`, `[virtual]`

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 36 of file control_progress.h.

16.68.2.2 void ProgressControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 36 of file control_progress.cpp.

16.68.2.3 void ProgressControl::Init ( ) [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 27 of file control_progress.cpp.

16.68.2.4 GuiReturn_t ProgressControl::ProcessEvent (GuiEvent_t * *pstEvent_*) [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 102 of file control_progress.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_progress.h
- /home/mo/mark3-source/embedded/stage/src/control_progress.cpp

16.69 Quantum Class Reference

Static-class used to implement Thread quantum functionality, which is a key part of round-robin scheduling.

`#include <quantum.h>`

Static Public Member Functions

- static void UpdateTimer ()

  This function is called to update the thread quantum timer whenever something in the scheduler has changed.
- static void AddThread (Thread *pclThread_)

  Add the thread to the quantum timer.
- static void RemoveThread ()

  Remove the thread from the quantum timer.

Static Private Member Functions

- static void SetTimer (Thread *pclThread_)

  Set up the quantum timer in the timer scheduler.

Static Private Attributes

- static Timer **m_clQuantumTimer**
- static K_UCHAR **m_bActive**

16.69.1 Detailed Description

Static-class used to implement Thread quantum functionality, which is a key part of round-robin scheduling.

Definition at line 39 of file quantum.h.

16.69.2 Member Function Documentation

16.69.2.1 void Quantum::AddThread (**Thread** ∗ *pclThread_*) [static]

Add the thread to the quantum timer.

Only one thread can own the quantum, since only one thread can be running on a core at a time.

Definition at line 70 of file quantum.cpp.

16.69.2.2 void Quantum::RemoveThread (void) [static]

Remove the thread from the quantum timer.

This will cancel the timer.

Definition at line 87 of file quantum.cpp.

16.69.2.3 void Quantum::SetTimer (**Thread** ∗ *pclThread_*) [static], [private]

Set up the quantum timer in the timer scheduler.

This creates a one-shot timer, which calls a static callback in quantum.cpp that on expiry will pivot the head of the threadlist for the thread's priority. This is the mechanism that provides round-robin scheduling in the system.

Parameters

*pclThread_*	Pointer to the thread to set the Quantum timer on

Definition at line 60 of file quantum.cpp.

16.69.2.4 void Quantum::UpdateTimer (void) [static]

This function is called to update the thread quantum timer whenever something in the scheduler has changed.

This can result in the timer being re-loaded or started. The timer is never stopped, but if may be ignored on expiry.

Definition at line 100 of file quantum.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/quantum.h
- /home/mo/mark3-source/embedded/stage/src/quantum.cpp

16.70 Scheduler Class Reference

Priority-based round-robin Thread scheduling, using ThreadLists for housekeeping.

```
#include <scheduler.h>
```

Static Public Member Functions

- static void Init ()

  Intiailize the scheduler, must be called before use.
- static void Schedule ()

  Run the scheduler, determines the next thread to run based on the current state of the threads.
- static void Add (Thread ∗pclThread_)

  Add a thread to the scheduler at its current priority level.
- static void Remove (Thread ∗pclThread_)

  Remove a thread from the scheduler at its current priority level.
- static K_BOOL SetScheduler (K_BOOL bEnable_)

  Set the active state of the scheduler.
- static Thread ∗ GetCurrentThread ()

  Return the pointer to the currently-running thread.
- static Thread ∗ GetNextThread ()

  Return the pointer to the thread that should run next, according to the last run of the scheduler.
- static ThreadList ∗ GetThreadList (K_UCHAR ucPriority_)

  Return the pointer to the active list of threads that are at the given priority level in the scheduler.
- static ThreadList ∗ GetStopList ()

  Return the pointer to the list of threads that are in the scheduler's stopped state.
- static K_UCHAR IsEnabled ()

  Return the current state of the scheduler - whether or not scheudling is enabled or disabled.
- static void **QueueScheduler** ()

Static Private Attributes

- static K_BOOL m_bEnabled

  Scheduler's state - enabled or disabled.
- static K_BOOL m_bQueuedSchedule

  Variable representing whether or not there's a queued scheduler operation.
- static ThreadList m_clStopList

  ThreadList for all stopped threads.
- static ThreadList m_aclPriorities [NUM_PRIORITIES]

  ThreadLists for all threads at all priorities.
- static K_UCHAR m_ucPriFlag

  Bitmap flag for each.

16.70.1 Detailed Description

Priority-based round-robin Thread scheduling, using ThreadLists for housekeeping.

Definition at line 62 of file scheduler.h.

16.70.2 Member Function Documentation

16.70.2.1 void Scheduler::Add (Thread ∗ *pclThread_*) [static]

Add a thread to the scheduler at its current priority level.

Parameters

*pclThread_*	Pointer to the thread to add to the scheduler

Definition at line 81 of file scheduler.cpp.

16.70.2.2 static Thread∗ Scheduler::GetCurrentThread ( ) [inline], [static]

Return the pointer to the currently-running thread.

Returns

Pointer to the currently-running thread

Definition at line 119 of file scheduler.h.

16.70.2.3 static Thread∗ Scheduler::GetNextThread ( ) [inline], [static]

Return the pointer to the thread that should run next, according to the last run of the scheduler.

Returns

Pointer to the next-running thread

Definition at line 127 of file scheduler.h.

16.70.2.4 static ThreadList∗ Scheduler::GetStopList ( ) [inline], [static]

Return the pointer to the list of threads that are in the scheduler's stopped state.

Returns

Pointer to the ThreadList containing the stopped threads

Definition at line 145 of file scheduler.h.

16.70.2.5 static ThreadList∗ Scheduler::GetThreadList (K_UCHAR *ucPriority_*) [inline], [static]

Return the pointer to the active list of threads that are at the given priority level in the scheduler.

Parameters

*ucPriority_*	Priority level of

Returns

Pointer to the ThreadList for the given priority level

Definition at line 137 of file scheduler.h.

16.70.2.6 K_UCHAR Scheduler::IsEnabled ( ) [inline], [static]

Return the current state of the scheduler - whether or not scheudling is enabled or disabled.

Returns

true - scheduler enabled, false - disabled

Definition at line 155 of file scheduler.h.

16.70.2.7 void Scheduler::Remove (Thread ∗ *pclThread_*) [static]

Remove a thread from the scheduler at its current priority level.

Parameters

*pclThread_*	Pointer to the thread to be removed from the scheduler

Definition at line 88 of file scheduler.cpp.

16.70.2.8 Scheduler::Schedule ( ) [static]

Run the scheduler, determines the next thread to run based on the current state of the threads.

Note that the next-thread chosen from this function is only valid while in a critical section.

Definition at line 64 of file scheduler.cpp.

16.70.2.9 void Scheduler::SetScheduler (K_BOOL *bEnable_*) [static]

Set the active state of the scheduler.

When the scheduler is disabled, the *next thread* is never set; the currently running thread will run forever until the scheduler is enabled again. Care must be taken to ensure that we don't end up trying to block while the scheduler is disabled, otherwise the system ends up in an unusable state.

Parameters

*bEnable_*	true to enable, false to disable the scheduler

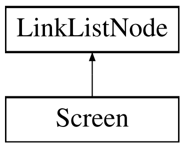
Definition at line 95 of file scheduler.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/scheduler.h
- /home/mo/mark3-source/embedded/stage/src/scheduler.cpp

16.71 Screen Class Reference

Inheritance diagram for Screen:



Public Member Functions

- void Activate ()

  This is called when a new screen needs to be created.
- void Deactivate ()

  This is called when a screen is torn-down.
- void SetWindowAffinity (const K_CHAR ∗szWindowName_)

  Indicate by name which window this screen is to be bound.
- void SetName (const K_CHAR ∗szName_)

  Set the name of the current screen.
- const K_CHAR ∗ GetName ()

  Return the name of the current screen.

Protected Member Functions

- void SetManager (ScreenManager ∗pclScreenManager_)

  Function called by the ScreenManager to set the screen affinity.

Protected Attributes

- const K_CHAR ∗ **m_szName**
- ScreenManager ∗ **m_pclScreenManager**
- GuiWindow ∗ **m_pclWindow**

Private Member Functions

- virtual void **Create** ()=0
- virtual void **Destroy** ()=0

Friends

- class **ScreenManager**

16.71.1 Detailed Description

Definition at line 31 of file screen.h.

16.71.2 Member Function Documentation

16.71.2.1 void Screen::Activate ( ) [inline]

This is called when a new screen needs to be created.

This calls the underlying virtual "create" method, which performs all control object initialization and allocation. Calling a redraw(true) on the bound window will result in the new window being rendered to display.

Definition at line 40 of file screen.h.

16.71.2.2 void Screen::Deactivate ( ) [inline]

This is called when a screen is torn-down.

Essentially removes the controls from the named window and deallocates any memory used to build up the screen.

Definition at line 47 of file screen.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/screen.h
- /home/mo/mark3-source/embedded/stage/src/screen.cpp

16.72 ScreenList Class Reference

Public Member Functions

- void Add (Screen ∗pclScreen_)

Add a screen to the screen list.

- void Remove (Screen ∗pclScreen_)

  Remove a screen from the screen list.
- Screen ∗ GetHead ()

  Get the beginning of the screen list.

Private Attributes

- DoubleLinkList m_clList

  Double link-list used to manage screen objects.

16.72.1 Detailed Description

Definition at line 84 of file screen.h.

The documentation for this class was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/screen.h

16.73 ScreenManager Class Reference

Public Member Functions

- void AddScreen (Screen ∗pclScreen_)

  Add a new screen to the screen manager.
- void RemoveScreen (Screen ∗pclScreen_)

  Remove an existing screen from the screen manager.
- void SetEventSurface (GuiEventSurface ∗pclSurface_)

  Set the event surface on which this screen manager's screens will be displayed.
- GuiWindow ∗ FindWindowByName (const K_CHAR ∗m_szName_)

  Return a pointer to a window by name.
- Screen ∗ FindScreenByName (const K_CHAR ∗m_szName_)

  Return a pointer to a screen by name.

Private Attributes

- ScreenList m_clScreenList

  Screen list object used to manage individual screens.
- GuiEventSurface ∗ m_pclSurface

  Pointer to the GUI Event Surface on which the screens are displayed.

16.73.1 Detailed Description

Definition at line 109 of file screen.h.

The documentation for this class was generated from the following files:

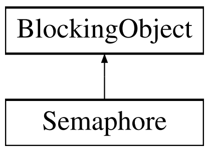
- /home/mo/mark3-source/embedded/stage/src/screen.h
- /home/mo/mark3-source/embedded/stage/src/screen.cpp

16.74 Semaphore Class Reference

Counting semaphore, based on BlockingObject base class.

```
#include <ksemaphore.h>
```

Inheritance diagram for Semaphore:



Public Member Functions

- void Init (K_USHORT usInitVal_, K_USHORT usMaxVal_)

  Initialize a semaphore before use.
- void Post ()

  Increment the semaphore count.
- void Pend ()

  Decrement the semaphore count.
- K_USHORT GetCount ()

  Return the current semaphore counter.
- bool Pend (K_ULONG ulWaitTimeMS_)

  Decrement the semaphore count.
- void Timeout (Thread ∗pclChosenOne_)

  Wake a thread blocked on the semaphore.

Private Member Functions

- K_UCHAR WakeNext ()

  Wake the next thread waiting on the semaphore.
- K_BOOL ProcessQueue ()

  ProcessQueue.
- void PostTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)

  PostTransaction.
- void PendTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)

  PendTransaction.
- void TimeoutTransaction (Transaction ∗pclTRX_, K_BOOL ∗pbReschedule_)

  TimeoutTransaction.

Private Attributes

- K_USHORT m_usValue

  Current value in the semaphore.
- K_USHORT m_usMaxValue

  Maximum value that the semaphore can hold.

Additional Inherited Members

16.74.1 Detailed Description

Counting semaphore, based on BlockingObject base class.

Definition at line 39 of file ksemaphore.h.

16.74.2 Member Function Documentation

16.74.2.1 K_USHORT Semaphore::GetCount ( )

Return the current semaphore counter.

This can be used by a thread to bypass blocking on a semaphore - allowing it to do other things until a non-zero count is returned, instead of blocking until the semaphore is posted.

Returns

The current semaphore counter value.

Definition at line 283 of file ksemaphore.cpp.

16.74.2.2 void Semaphore::Init (K_USHORT *usInitVal_*, K_USHORT *usMaxVal_*)

Initialize a semaphore before use.

Must be called before post/pend operations.

Parameters

*usInitVal_*	Initial value held by the semaphore
*usMaxVal_*	Maximum value for the semaphore

Definition at line 194 of file ksemaphore.cpp.

16.74.2.3 void Semaphore::Pend ( )

Decrement the semaphore count.

If the count is zero, the thread will block until the semaphore is pended.

Definition at line 232 of file ksemaphore.cpp.

16.74.2.4 bool Semaphore::Pend (K_ULONG *ulWaitTimeMS_*)

Decrement the semaphore count.

If the count is zero, the thread will block until the semaphore is pended. If the specified interval expires before the thread is unblocked, then the status is returned back to the user.

Returns

true - semaphore was acquired before the timeout false - timeout occurred before the semaphore was claimed.

Definition at line 237 of file ksemaphore.cpp.

16.74.2.5 void Semaphore::PendTransaction (Transaction ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

PendTransaction.

Perform a semaphore "pend" operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 130 of file ksemaphore.cpp.

16.74.2.6 void Semaphore::Post ( )

Increment the semaphore count.

Returns

true if the semaphore was posted, false if the count is already maxed out.

Definition at line 206 of file ksemaphore.cpp.

16.74.2.7 void Semaphore::PostTransaction (Transaction ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

PostTransaction.

Perform a semaphore "post" operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 109 of file ksemaphore.cpp.

16.74.2.8 K_BOOL Semaphore::ProcessQueue ( ) [private]

ProcessQueue.

Process all pending actions on the semaphore's transaction queue. This should only be called from within a context where the blocking object's Lock() value has already been called. When ProcessQueue returns, the Lock() value will be reset to 0 - as all pending transactions have been processed.

Returns

true - A thread scheduling operation must be performed. false - No rescheduling is required.

Definition at line 78 of file ksemaphore.cpp.

16.74.2.9 void Semaphore::Timeout (Thread ∗ *pclChosenOne_*)

Wake a thread blocked on the semaphore.

This is an internal function used for implementing timed semaphores relying on timer callbacks. Since these do not have access to the private data of the semaphore and its base classes, we have to wrap this as a public method - do not use this for any other purposes.

Definition at line 60 of file ksemaphore.cpp.

16.74.2.10 void Semaphore::TimeoutTransaction (Transaction ∗ *pclTRX_*, K_BOOL ∗ *pbReschedule_*) [private]

TimeoutTransaction.

Perform a semaphore "timeout" operation, as specified from an object on the transaction queue.

Parameters

*pclTRX_*	- Pointer to the transaction object
*pbReschedule_*	- Pointer to boolean to be set true if rescheduling is required.

Definition at line 161 of file ksemaphore.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/ksemaphore.h
- /home/mo/mark3-source/embedded/stage/src/ksemaphore.cpp

16.75 ShellCommand_t Struct Reference

Data structure defining a lookup table correlating a command name to its handler function.

```
#include <shell_support.h>
```

Public Attributes

- const K_CHAR ∗ szCommand

  Command name.
- fp_internal_command pfHandler

  Command handler function.

16.75.1 Detailed Description

Data structure defining a lookup table correlating a command name to its handler function.

Definition at line 117 of file shell_support.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/shell_support.h

16.76 ShellSupport Class Reference

The ShellSupport class features utility functions which handle token processing, option/parameter lookup, and functions making it generally trivial to implement a lightweight custom shell.

```
#include <shell_support.h>
```

Static Public Member Functions

- static K_CHAR RunCommand (CommandLine_t ∗pstCommand_, const ShellCommand_t ∗pastShellCommands_)

  RunCommand Given a command-line, attempts to run the corresponding shell command based where it exists within the supplied ShellCommand_t array.
- static void UnescapeToken (Token_t ∗pstToken_, K_CHAR ∗szDest_)

  UnescapeToken Convert a token which has special parsing characters in it to a "flattened" string, where all unescaped double quotes and escaped tab, newline, space, etc.
- static Option_t ∗ CheckForOption (CommandLine_t ∗pstCommand_, const K_CHAR ∗szOption_)

  CheckForOption Check to see whether or not a specific option has been set within the commandline arguments.

- static K_CHAR TokensToCommandLine (Token_t ∗pastTokens_, K_UCHAR ucTokens_, CommandLine_t ∗pstCommand_)

  TokensToCommandLine Convert an array of tokens to a commandline object.

16.76.1 Detailed Description

The ShellSupport class features utility functions which handle token processing, option/parameter lookup, and functions making it generally trivial to implement a lightweight custom shell.

Definition at line 129 of file shell_support.h.

16.76.2 Member Function Documentation

16.76.2.1 Option_t ∗ ShellSupport::CheckForOption (CommandLine_t ∗ *pstCommand_*, const K_CHAR ∗ *szOption_*) `[static]`

CheckForOption Check to see whether or not a specific option has been set within the commandline arguments.

Parameters

*pstCommand_*	Pointer to the commandline object containing the options
*szOption_*	0-terminated string corresponding to the command-line option.

Returns

Pointer to the command line option on match, or 0 on faiulre.

Definition at line 104 of file shell_support.cpp.

16.76.2.2 K_CHAR ShellSupport::RunCommand (CommandLine_t ∗ *pstCommand_*, const ShellCommand_t ∗ *pastShellCommands_*) `[static]`

RunCommand Given a command-line, attempts to run the corresponding shell command based where it exists within the supplied ShellCommand_t array.

Parameters

*pstCommand_*	Pointer to the command-line to execute
*pstCommands_*	Pointer to an array of shell commands to execute against

Returns

1 on success, 0 on error (command not found)

Definition at line 28 of file shell_support.cpp.

16.76.2.3 K_CHAR ShellSupport::TokensToCommandLine (Token_t ∗ *pastTokens_*, K_UCHAR *ucTokens_*, CommandLine_t ∗ *pstCommand_*) `[static]`

TokensToCommandLine Convert an array of tokens to a commandline object.

```
This operation is non-destructive to the source token
array.
```

Parameters

*pastTokens_*	Pointer to the token array to process
*ucTokens_*	Number of tokens in the token array
*pstCommand_*	Pointer to the CommandLine_t object which will represent the shell command and its arguments.

Returns

Number of options processed

Definition at line 123 of file shell_support.cpp.

16.76.2.4 void ShellSupport::UnescapeToken (Token_t ∗ *pstToken_*, K_CHAR ∗ *szDest_*) [static]

UnescapeToken Convert a token which has special parsing characters in it to a "flattened" string, where all unescaped double quotes and escaped tab, newline, space, etc.

characters are converted into their ascii-code equivalents.

Parameters

*pstToken_*	Pointer to the source token to convert
*szDest_*	Pointer to a destination string which will contain the parsed result string

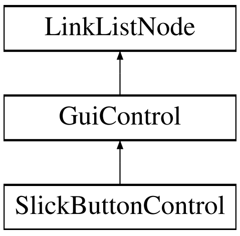
Definition at line 49 of file shell_support.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/shell_support.h
- /home/mo/mark3-source/embedded/stage/src/shell_support.cpp

16.77 SlickButtonControl Class Reference

Inheritance diagram for SlickButtonControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetFont** (Font_t ∗pstFont_)
- void **SetCaption** (const K_CHAR ∗szCaption_)
- void **SetCallback** (ButtonCallback pfCallback_, void ∗pvData_)

Private Attributes

- const K_CHAR ∗ **m_szCaption**
- Font_t ∗ **m_pstFont**
- bool **m_bState**
- K_UCHAR **m_ucTimeout**
- void ∗ **m_pvCallbackData**
- ButtonCallback **m_pfCallback**

Additional Inherited Members

16.77.1 Detailed Description

Definition at line 32 of file control_slickbutton.h.

16.77.2 Member Function Documentation

16.77.2.1 void SlickButtonControl::Activate (bool *bActivate_*) [virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 286 of file control_slickbutton.cpp.

16.77.2.2 void SlickButtonControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 51 of file control_slickbutton.cpp.

16.77.2.3 void SlickButtonControl::Init ( ) [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 40 of file control_slickbutton.cpp.

16.77.2.4 GuiReturn_t SlickButtonControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

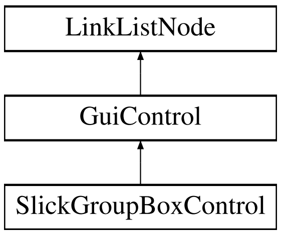
Definition at line 164 of file control_slickbutton.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_slickbutton.h
- /home/mo/mark3-source/embedded/stage/src/control_slickbutton.cpp

16.78 SlickGroupBoxControl Class Reference

Inheritance diagram for SlickGroupBoxControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.
- void **SetFont** (Font_t ∗pstFont_)
- void **SetCaption** (const K_CHAR ∗pcCaption_)
- void **SetBGColor** (COLOR uColor_)

Private Attributes

- Font_t ∗ **m_pstFont**
- const K_CHAR ∗ **m_pcCaption**
- COLOR **m_uBGColor**

Additional Inherited Members

16.78.1 Detailed Description

Definition at line 29 of file control_slickgroupbox.h.

16.78.2 Member Function Documentation

16.78.2.1 virtual void SlickGroupBoxControl::Activate (bool *bActivate_*) `[inline]`, `[virtual]`

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 35 of file control_slickgroupbox.h.

16.78.2.2 void SlickGroupBoxControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 31 of file control_slickgroupbox.cpp.

16.78.2.3 virtual void SlickGroupBoxControl::Init ( ) [inline], [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 32 of file control_slickgroupbox.h.

16.78.2.4 virtual GuiReturn_t SlickGroupBoxControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) [inline], [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

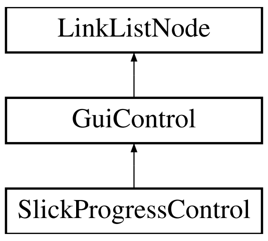
Definition at line 34 of file control_slickgroupbox.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_slickgroupbox.h
- /home/mo/mark3-source/embedded/stage/src/control_slickgroupbox.cpp

16.79 SlickProgressControl Class Reference

Inheritance diagram for SlickProgressControl:



Public Member Functions

- virtual void Init ()

    Initiailize the control - must be called before use.
- virtual void Draw ()

    Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

    Process an event sent to the control.
- virtual void Activate (bool bActivate_)

    Activate or deactivate the current control - used when switching from one active control to another.
- void **SetProgress** (K_UCHAR ucProgress_)

Private Attributes

- K_UCHAR **m_ucProgress**

Additional Inherited Members

16.79.1 Detailed Description

Definition at line 30 of file control_slickprogress.h.

16.79.2 Member Function Documentation

16.79.2.1 virtual void SlickProgressControl::Activate (bool *bActivate_*) [inline], [virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 36 of file control_slickprogress.h.

16.79.2.2 void SlickProgressControl::Draw ( ) [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 33 of file control_slickprogress.cpp.

16.79.2.3 void SlickProgressControl::Init ( ) [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 27 of file control_slickprogress.cpp.

16.79.2.4 GuiReturn_t SlickProgressControl::ProcessEvent (GuiEvent_t ∗ *pstEvent_*) [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 107 of file control_slickprogress.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/control_slickprogress.h
- /home/mo/mark3-source/embedded/stage/src/control_slickprogress.cpp

16.80 Slip Class Reference

Object used to frame communications over an abstract device using the serial-line internet protocol (SLIP).

```
#include <slip.h>
```

Public Member Functions

- void SetDriver (Driver ∗pclDriver_)

  Set the driver to attach to this object.
- Driver ∗ GetDriver ()

  Return the pointer to the driver attached to this object.
- void WriteData (K_UCHAR ucChannel_, const K_CHAR ∗aucBuf_, K_USHORT usLen_)

  Write a packet of data in the FunkenSlip format.
- K_USHORT ReadData (K_UCHAR ∗pucChannel_, K_CHAR ∗aucBuf_, K_USHORT usLen_)

  Read a packet from a specified device, parse, and copy to a specified output buffer.
- void WriteVector (K_UCHAR ucChannel_, SlipDataVector ∗astData_, K_USHORT usLen_)

  Write a single message composed of multiple data-vector fragments.
- void SendAck ()

  Send an acknowledgement character to the host.
- void SendNack ()

  Send a negative-acknowledgement character to the host.

Static Public Member Functions

- static K_USHORT EncodeByte (K_UCHAR ucChar_, K_UCHAR ∗aucBuf_)

  Encode a single byte into a stream, returning the size of the encoded value (either 1 or 2 bytes).
- static K_USHORT DecodeByte (K_UCHAR ∗ucChar_, const K_UCHAR ∗aucBuf_)

  Decode a byte from a stream into a specified value.

Private Member Functions

- void **WriteByte** (K_UCHAR ucData_)

Private Attributes

- Driver ∗ **m_pclDriver**

16.80.1 Detailed Description

Object used to frame communications over an abstract device using the serial-line internet protocol (SLIP).

Definition at line 70 of file slip.h.

16.80.2 Member Function Documentation

16.80.2.1 K_USHORT Slip::DecodeByte (K_UCHAR ∗ *ucChar_*, const K_UCHAR ∗ *aucBuf_*) [static]

Decode a byte from a stream into a specified value.

Returns the number of bytes from the source array that were processed, (1 or 2), or 0 if an end-of-packet (192) was encountered.

Parameters

*ucChar_*	Destination K_CHAR
*aucBuf_*	Source buffer

Returns

# bytes read, or 0 on terminating character (192)

Definition at line 56 of file slip.cpp.

16.80.2.2 K_USHORT Slip::EncodeByte (K_UCHAR *ucChar_*, K_UCHAR ∗ *aucBuf_*) [static]

Encode a single byte into a stream, returning the size of the encoded value (either 1 or 2 bytes).

Parameters

*ucChar_*	Character to encode
*aucBuf_*	Buffer to encode into

Returns

# bytes read

Definition at line 34 of file slip.cpp.

16.80.2.3 Driver∗ Slip::GetDriver ( ) [inline]

Return the pointer to the driver attached to this object.

Returns

Pointer to the driver attached

Definition at line 85 of file slip.h.

16.80.2.4 K_USHORT Slip::ReadData (K_UCHAR ∗ *pucChannel_*, K_CHAR ∗ *aucBuf_*, K_USHORT *usLen_*)

Read a packet from a specified device, parse, and copy to a specified output buffer.

Parameters

*pucChannel_*	Pointer to a uchar that stores the message channel
*aucBuf_*	Buffer where the message will be decoded
*usLen_*	Length of the buffer to decode

Returns

data bytes read, 0 on failure.

Definition at line 104 of file slip.cpp.

16.80.2.5 void Slip::SetDriver (**Driver** ∗ *pclDriver_*) `[inline]`

Set the driver to attach to this object.

Parameters

*pclDriver_*	Pointer to the driver to attach

Definition at line 78 of file slip.h.

16.80.2.6 void Slip::WriteData (K_UCHAR *ucChannel_*, const K_CHAR ∗ *aucBuf_*, K_USHORT *usLen_*)

Write a packet of data in the FunkenSlip format.

Returns the number of bytes from the source array that were processed, (1 or 2), or 0 if an end-of-packet (192) was encountered.

Parameters

*ucChannel_*	Channel to encode the packet to
*aucBuf_*	Payload to encode
*usLen_*	Length of payload data

Definition at line 164 of file slip.cpp.

16.80.2.7 void Slip::WriteVector (K_UCHAR *ucChannel_*, **SlipDataVector** ∗ *astData_*, K_USHORT *usLen_*)

Write a single message composed of multiple data-vector fragments.

Allows for transmitting complex data structures without requiring buffering. This operation is zero-copy.

Parameters

*ucChannel_*	Message channel
*astData_*	Pointer to the data vector
*usLen_*	Number of elements in the data vector

Definition at line 223 of file slip.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/slip.h
- /home/mo/mark3-source/embedded/stage/src/slip.cpp

16.81 SlipDataVector Struct Reference

Data structure used for vector-based SLIP data transmission.

`#include <slip.h>`

Public Attributes

- K_UCHAR ucSize

  Size of the data buffer.
- K_UCHAR ∗ pucData

  Pointer to the data buffer.

16.81.1 Detailed Description

Data structure used for vector-based SLIP data transmission.

Allows for building and transmitting complex data structures without having to copy data into intermediate buffers.

Definition at line 59 of file slip.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/slip.h

16.82 SlipMux Class Reference

Static-class which implements a multiplexed stream of SLIP data over a single interface.

```
#include <slip_mux.h>
```

Static Public Member Functions

- static void Init (const K_CHAR ∗pcDriverPath_, K_USHORT usRxSize_, K_UCHAR ∗aucRx_, K_USHORT usTxSize_, K_UCHAR ∗aucTx_)

  Attach a driver to the Slip-stream multiplexer and initialize the internal data associated with the module.
- static void InstallHandler (K_UCHAR ucChannel_, Slip_Channel pfHandler_)

  Install a slip handler function for the given communication channel.
- static void MessageReceive ()

  Wait for a valid packet to arrive, and call the appropriate handler function for the channel the message was attached to.
- static Driver ∗ GetDriver ()

  Return the pointer of the current driver used by the SlipMux module.
- static MessageQueue ∗ GetQueue ()

  Return the pointer to the message queue attached to the slip mux channel.
- static void SetQueue (MessageQueue ∗pclMessageQueue_)

  Set the message queue that will receive the notification when the slip mux channel has received data.
- static Slip ∗ GetSlip ()

  Return the pointer to the SlipMux' Slip object.

Static Private Attributes

- static MessageQueue ∗ **m_pclMessageQueue**
- static Driver ∗ **m_pclDriver**
- static Slip_Channel **m_apfChannelHandlers** [SLIP_CHANNEL_COUNT] = {0}
- static K_UCHAR **m_aucData** [SLIP_BUFFER_SIZE]
- static Semaphore **m_clSlipSem**
- static Slip **m_clSlip**

16.82.1 Detailed Description

Static-class which implements a multiplexed stream of SLIP data over a single interface.

Definition at line 43 of file slip_mux.h.

16.82.2 Member Function Documentation

16.82.2.1 static **Driver**∗ SlipMux::GetDriver ( ) [inline], [static]

Return the pointer of the current driver used by the SlipMux module.

Returns

Pointer to the current handle owned by SlipMux

Definition at line 91 of file slip_mux.h.

16.82.2.2 static **MessageQueue**∗ SlipMux::GetQueue ( ) [inline], [static]

Return the pointer to the message queue attached to the slip mux channel.

Returns

Pointer to the message Queue

Definition at line 99 of file slip_mux.h.

16.82.2.3 static **Slip**∗ SlipMux::GetSlip ( ) [inline], [static]

Return the pointer to the SlipMux' Slip object.

Returns

Pointer to the Slip object

Definition at line 117 of file slip_mux.h.

16.82.2.4 void SlipMux::Init (const K_CHAR ∗ *pcDriverPath_*, K_USHORT *usRxSize_*, K_UCHAR ∗ *aucRx_*, K_USHORT *usTxSize_*, K_UCHAR ∗ *aucTx_*) [static]

Attach a driver to the Slip-stream multiplexer and initialize the internal data associated with the module.

Must be called before any of the other functions in this module are called.

Parameters

*pcDriverPath_*	Filesystem path to the driver to attach to
*usRxSize_*	Size of the RX Buffer to attach to the driver
*aucRx_*	Pointer to the RX Buffer to attach to the driver
*usTxSize_*	Size of the TX Buffer to attach to the driver
*aucTx_*	Pointer to the TX Buffer to attach to the driver

Definition at line 59 of file slip_mux.cpp.

16.82.2.5 void SlipMux::InstallHandler (K_UCHAR *ucChannel_*, Slip_Channel *pfHandler_*) [static]

Install a slip handler function for the given communication channel.

Parameters

*ucChannel_*	Channel to attach the handler to
*pfHandler_*	Pointer to the handler function to attach

Definition at line 76 of file slip_mux.cpp.

16.82.2.6 void SlipMux::MessageReceive (void) [static]

Wait for a valid packet to arrive, and call the appropriate handler function for the channel the message was attached to.

This is essentially the entry point for a thread whose purpose is to service slip Rx data.

Definition at line 85 of file slip_mux.cpp.

16.82.2.7 static void SlipMux::SetQueue (MessageQueue ∗ *pclMessageQueue_*) [inline], [static]

Set the message queue that will receive the notification when the slip mux channel has received data.

Parameters

*pclMessage-Queue_*	Pointer to the message queue to use for notification.

Definition at line 108 of file slip_mux.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/slip_mux.h
- /home/mo/mark3-source/embedded/stage/src/slip_mux.cpp

16.83 SlipTerm Class Reference

Class implementing a simple debug terminal interface.

```
#include <slipterm.h>
```

Public Member Functions

- void Init ()

  Initialize the terminal by opening a handle to the serial interface attached at /dev/tty.
- void PrintLn (const char ∗szLine_)

  Print a string of text to the SLIP interface, multiplexed using the FunkenSlip terminal channel.
- void PrintLn (K_UCHAR ucSeverity_, const char ∗szLine_)

  Print a string of text to the SLIP interface, but only if the current logging verbosity level is greater than or equal to the specified message severity.
- void SetVerbosity (K_UCHAR ucLevel_)

  Set the logging verbosity level - the minimum severity level that will be printed to the terminal.

Private Member Functions

- K_USHORT StrLen (const char ∗szString_)

  Quick 'n' dirty StrLen functionality used for printing the string.

Private Attributes

- K_UCHAR m_ucVerbosity

  level greater than this Are not displayed.
- Slip m_clSlip

  Slip object that this module interfaces with.

16.83.1 Detailed Description

Class implementing a simple debug terminal interface.

This is useful for printf style debugging.

Definition at line 40 of file slipterm.h.

16.83.2 Member Function Documentation

16.83.2.1 void SlipTerm::Init (void)

Initialize the terminal by opening a handle to the serial interface attached at /dev/tty.

Must be called prior to using the print functionality.

Definition at line 26 of file slipterm.cpp.

16.83.2.2 void SlipTerm::PrintLn (const char ∗ *szLine_*)

Print a string of text to the SLIP interface, multiplexed using the FunkenSlip terminal channel.

Parameters

*szLine_*	String to print

Definition at line 44 of file slipterm.cpp.

16.83.2.3 void SlipTerm::PrintLn (K_UCHAR *ucSeverity_*, const char ∗ *szLine_*)

Print a string of text to the SLIP interface, but only if the current logging verbosity level is greater than or equal to the specified message severity.

Parameters

*ucSeverity_*	Message severity level, 0 = highest severity
*szLine_*	String to print

Definition at line 56 of file slipterm.cpp.

16.83.2.4 void SlipTerm::SetVerbosity (K_UCHAR *ucLevel_*) [inline]

Set the logging verbosity level - the minimum severity level that will be printed to the terminal.

The higher the number, the more chatty the output.

Definition at line 81 of file slipterm.h.

16.83.2.5 K_USHORT SlipTerm::StrLen (const char ∗ *szString_*) [private]

Quick 'n' dirty StrLen functionality used for printing the string.

Returns

Length of the string (in bytes)

Definition at line 33 of file slipterm.cpp.

16.83.3 Member Data Documentation

16.83.3.1 K_UCHAR SlipTerm::m_ucVerbosity [private]

level greater than this Are not displayed.

Verbosity level. Messages with a severity

Definition at line 92 of file slipterm.h.

The documentation for this class was generated from the following files:

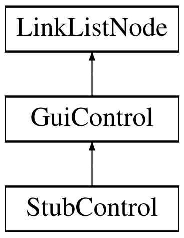
- /home/mo/mark3-source/embedded/stage/src/slipterm.h
- /home/mo/mark3-source/embedded/stage/src/slipterm.cpp

16.84 StubControl Class Reference

Stub control class, used for testing out the GUI framework where certain controls have not yet been implemented.

```
#include <gui.h>
```

Inheritance diagram for StubControl:



Public Member Functions

- virtual void Init ()

  Initiailize the control - must be called before use.
- virtual void Draw ()

  Redraw the control "cleanly".
- virtual GuiReturn_t ProcessEvent (GuiEvent_t ∗pstEvent_)

  Process an event sent to the control.
- virtual void Activate (bool bActivate_)

  Activate or deactivate the current control - used when switching from one active control to another.

Additional Inherited Members

16.84.1 Detailed Description

Stub control class, used for testing out the GUI framework where certain controls have not yet been implemented.

Definition at line 796 of file gui.h.

16.84.2 Member Function Documentation

16.84.2.1 virtual void StubControl::Activate (bool *bActivate_*) [inline], [virtual]

Activate or deactivate the current control - used when switching from one active control to another.

Parameters

*bActivate_*	- true to activate, false to deactivate

Implements GuiControl.

Definition at line 802 of file gui.h.

16.84.2.2 virtual void StubControl::Draw ( ) [inline], [virtual]

Redraw the control "cleanly".

Subclass specific.

Implements GuiControl.

Definition at line 800 of file gui.h.

16.84.2.3 virtual void StubControl::Init ( ) [inline], [virtual]

Initiailize the control - must be called before use.

Implementation is subclass specific.

Implements GuiControl.

Definition at line 799 of file gui.h.

16.84.2.4 virtual GuiReturn_t StubControl::ProcessEvent (GuiEvent_t * *pstEvent_*) [inline], [virtual]

Process an event sent to the control.

Subclass specific implementation.

Parameters

*pstEvent_*	Pointer to a struct containing the event data

Implements GuiControl.

Definition at line 801 of file gui.h.

The documentation for this class was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/gui.h

16.85 SystemHeap Class Reference

The SystemHeap class implements a heap which is accessible from all components in the system.

`#include <system_heap.h>`

Static Public Member Functions

- static void Init (void)

Init Initialize the system heap prior to usage.

- static void ∗ Alloc (K_USHORT usSize_)

  Alloc allocate a block of data from the heap.
- static void Free (void ∗pvData_)

  Free free a block of data previously allocated from the heap.

Static Private Attributes

- static K_UCHAR m_pucRawHeap [HEAP_RAW_SIZE]

  Raw heap buffer.
- static HeapConfig m_pclSystemHeapConfig [HEAP_NUM_SIZES+1]

  Heap configuration metadata.
- static FixedHeap m_clSystemHeap

  Heap management object.
- static bool m_bInit

  True if initialized, false if uninitialized.

16.85.1 Detailed Description

The SystemHeap class implements a heap which is accessible from all components in the system.

Definition at line 189 of file system_heap.h.

16.85.2 Member Function Documentation

16.85.2.1 void ∗ SystemHeap::Alloc (K_USHORT *usSize_*) [static]

Alloc allocate a block of data from the heap.

Parameters

*usSize_*	size of the block (in bytes) to allocate

Returns

pointer to a block of data allocated from the heap, or NULL on failure.

Definition at line 130 of file system_heap.cpp.

16.85.2.2 void SystemHeap::Free (void ∗ *pvData_*) [static]

Free free a block of data previously allocated from the heap.

Parameters

*pvData_*	Pointer to a block of data allocated from the system heap

Definition at line 140 of file system_heap.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/system_heap.h
- /home/mo/mark3-source/embedded/stage/src/system_heap.cpp

16.86 TextFX_t Struct Reference

Public Attributes

- K_UCHAR ucFlags

  Text effects applied.
- COLOR uBGColor

  Background color for opaque backgrounds.
- K_USHORT usRotateDeg

  Rotation in degrees.
- K_USHORT usScaleX100

  Scaling factor, fixed point modulo 100.
- K_USHORT usScaleY100

  Scaling factor, fixed point modulo 100.

16.86.1 Detailed Description

Definition at line 160 of file draw.h.

The documentation for this struct was generated from the following file:

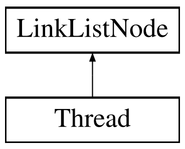
- /home/mo/mark3-source/embedded/stage/src/draw.h

16.87 Thread Class Reference

Object providing fundamental multitasking support in the kernel.

`#include <thread.h>`

Inheritance diagram for Thread:



Public Member Functions

- void Init (K_WORD ∗paucStack_, K_USHORT usStackSize_, K_UCHAR ucPriority_, ThreadEntry_t pfEntry-Point_, void ∗pvArg_)

  Initialize a thread prior to its use.
- void Start ()

  Start the thread - remove it from the stopped list, add it to the scheduler's list of threads (at the thread's set priority), and continue along.
- void Stop ()

  Stop a thread that's actively scheduled without destroying its stacks.
- void SetName (const K_CHAR ∗szName_)

  Set the name of the thread - this is purely optional, but can be useful when identifying issues that come along when multiple threads are at play in a system.
- const K_CHAR ∗ GetName ()
- ThreadList ∗ GetOwner (void)

Return the ThreadList where the thread belongs when it's in the active/ready state in the scheduler.
- ThreadList ∗ GetCurrent (void)

    Return the ThreadList where the thread is currently located.
- K_UCHAR GetPriority (void)

    Return the priority of the current thread.
- K_UCHAR GetCurPriority (void)

    Return the priority of the current thread.
- void SetQuantum (K_USHORT usQuantum_)

    Set the thread's round-robin execution quantum.
- K_USHORT GetQuantum (void)

    Get the thread's round-robin execution quantum.
- void SetCurrent (ThreadList ∗pclNewList_)

    Set the thread's current to the specified thread list.
- void SetOwner (ThreadList ∗pclNewList_)

    Set the thread's owner to the specified thread list.
- void SetPriority (K_UCHAR ucPriority_)

    Set the priority of the Thread (running or otherwise) to a different level.
- void InheritPriority (K_UCHAR ucPriority_)

    Allow the thread to run at a different priority level (temporarily) for the purpose of avoiding priority inversions.
- void Exit ()

    Remove the thread from being scheduled again.
- void SetID (K_UCHAR ucID_)

    Set an 8-bit ID to uniquely identify this thread.
- K_UCHAR GetID ()

    Return the 8-bit ID corresponding to this thread.
- K_USHORT GetStackSlack ()

    Performs a (somewhat lengthy) check on the thread stack to check the amount of stack margin (or "slack") remaining on the stack.
- K_USHORT GetEventFlagMask ()

    GetEventFlagMask returns the thread's current event-flag mask, which is used in conjunction with the EventFlag blocking object type.
- void SetEventFlagMask (K_USHORT usMask_)

    SetEventFlagMask Sets the active event flag bitfield mask.
- void SetEventFlagMode (EventFlagOperation_t eMode_)

    SetEventFlagMode Sets the active event flag operation mode.
- EventFlagOperation_t GetEventFlagMode ()

    GetEventFlagMode Returns the thread's event flag's operating mode.
- Timer ∗ GetTimer ()

    Return a pointer to the thread's timer object.
- void **SetExpired** (K_BOOL bExpired_)
- K_BOOL **GetExpired** ()

Static Public Member Functions

- static void Sleep (K_ULONG ulTimeMs_)

    Put the thread to sleep for the specified time (in milliseconds).
- static void USleep (K_ULONG ulTimeUs_)

    Put the thread to sleep for the specified time (in microseconds).
- static void Yield (void)

    Yield the thread - this forces the system to call the scheduler and determine what thread should run next.

Private Member Functions

- void SetPriorityBase (K_UCHAR ucPriority_)

Static Private Member Functions

- static void ContextSwitchSWI (void)

  This code is used to trigger the context switch interrupt.

Private Attributes

- K_WORD ∗ m_pwStackTop

  Pointer to the top of the thread's stack.
- K_WORD ∗ m_pwStack

  Pointer to the thread's stack.
- K_USHORT m_usStackSize

  Size of the stack (in bytes)
- K_USHORT m_usQuantum

  Thread quantum (in milliseconds)
- K_UCHAR m_ucThreadID

  Thread ID.
- K_UCHAR m_ucPriority

  Default priority of the thread.
- K_UCHAR m_ucCurPriority

  Current priority of the thread (priority inheritence)
- ThreadEntry_t m_pfEntryPoint

  The entry-point function called when the thread starts.
- void ∗ m_pvArg

  Pointer to the argument passed into the thread's entrypoint.
- const K_CHAR ∗ m_szName

  Thread name.
- K_USHORT m_usFlagMask

  Event-flag mask.
- EventFlagOperation_t m_eFlagMode

  Event-flag mode.
- Timer m_clTimer

  Timer used for blocking-object timeouts.
- K_BOOL **m_bExpired**
- ThreadList ∗ m_pclCurrent

  Pointer to the thread-list where the thread currently resides.
- ThreadList ∗ m_pclOwner

  Pointer to the thread-list where the thread resides when active.

Friends

- class **ThreadPort**

Additional Inherited Members

16.87.1 Detailed Description

Object providing fundamental multitasking support in the kernel.

Definition at line 57 of file thread.h.

16.87.2 Member Function Documentation

16.87.2.1 void Thread::ContextSwitchSWI (void) [static], [private]

This code is used to trigger the context switch interrupt.

Called whenever the kernel decides that it is necessary to swap out the current thread for the "next" thread.

Definition at line 351 of file thread.cpp.

16.87.2.2 void Thread::Exit ( )

Remove the thread from being scheduled again.

The thread is effectively destroyed when this occurs. This is extremely useful for cases where a thread encounters an unrecoverable error and needs to be restarted, or in the context of systems where threads need to be created and destroyed dynamically.

This must not be called on the idle thread.

Definition at line 149 of file thread.cpp.

16.87.2.3 K_UCHAR Thread::GetCurPriority (void) [inline]

Return the priority of the current thread.

Returns

Priority of the current thread

Definition at line 160 of file thread.h.

16.87.2.4 ThreadList ∗ Thread::GetCurrent (void) [inline]

Return the ThreadList where the thread is currently located.

Returns

Pointer to the thread's current list

Definition at line 141 of file thread.h.

16.87.2.5 K_USHORT Thread::GetEventFlagMask ( ) [inline]

GetEventFlagMask returns the thread's current event-flag mask, which is used in conjunction with the EventFlag blocking object type.

Returns

A copy of the thread's event flag mask

Definition at line 313 of file thread.h.

16.87.2.6 EventFlagOperation_t Thread::GetEventFlagMode ( ) [inline]

GetEventFlagMode Returns the thread's event flag's operating mode.

Returns

The thread's event flag mode.

Definition at line 332 of file thread.h.

16.87.2.7 K_UCHAR Thread::GetID ( ) [inline]

Return the 8-bit ID corresponding to this thread.

Returns

Thread's 8-bit ID, set by the user

Definition at line 288 of file thread.h.

16.87.2.8 const K_CHAR * Thread::GetName ( ) [inline]

Returns

Pointer to the name of the thread. If this is not set, will be NULL.

Definition at line 121 of file thread.h.

16.87.2.9 ThreadList * Thread::GetOwner (void) [inline]

Return the ThreadList where the thread belongs when it's in the active/ready state in the scheduler.

Returns

Pointer to the Thread's owner list

Definition at line 132 of file thread.h.

16.87.2.10 K_UCHAR Thread::GetPriority (void) [inline]

Return the priority of the current thread.

Returns

Priority of the current thread

Definition at line 151 of file thread.h.

16.87.2.11 K_USHORT Thread::GetQuantum (void) [inline]

Get the thread's round-robin execution quantum.

Returns

The thread's quantum

Definition at line 179 of file thread.h.

16.87.2.12 K_USHORT Thread::GetStackSlack ( )

Performs a (somewhat lengthy) check on the thread stack to check the amount of stack margin (or "slack") remaining on the stack.

If you're having problems with blowing your stack, you can run this function at points in your code during development to see what operations cause problems. Also useful during development as a tool to optimally size thread stacks.

Returns

The amount of slack (unused bytes) on the stack

! ToDo: Take into account stacks that grow up

Definition at line 240 of file thread.cpp.

16.87.2.13 void Thread::InheritPriority (K_UCHAR *ucPriority_*)

Allow the thread to run at a different priority level (temporarily) for the purpose of avoiding priority inversions.

This should only be called from within the implementation of blocking-objects.

Parameters

*ucPriority_*	New Priority to boost to.

Definition at line 344 of file thread.cpp.

16.87.2.14 void Thread::Init (K_WORD ∗ *paucStack_*, K_USHORT *usStackSize_*, K_UCHAR *ucPriority_*, ThreadEntry_t *pfEntryPoint_*, void ∗ *pvArg_*)

Initialize a thread prior to its use.

Initialized threads are placed in the stopped state, and are not scheduled until the thread's start method has been invoked first.

Parameters

*paucStack_*	Pointer to the stack to use for the thread
*usStackSize_*	Size of the stack (in bytes)
*ucPriority_*	Priority of the thread (0 = idle, 7 = max)
*pfEntryPoint_*	This is the function that gets called when the thread is started
*pvArg_*	Pointer to the argument passed into the thread's entrypoint function.

< Default round-robin thread quantum of 4ms

Definition at line 41 of file thread.cpp.

16.87.2.15 void Thread::SetCurrent (ThreadList ∗ *pclNewList_*) [inline]

Set the thread's current to the specified thread list.

Parameters

*pclNewList_*	Pointer to the threadlist to apply thread ownership

Definition at line 189 of file thread.h.

16.87.2.16 void Thread::SetEventFlagMask (K_USHORT *usMask_*) [inline]

SetEventFlagMask Sets the active event flag bitfield mask.

Parameters

*usMask_*	

Definition at line 319 of file thread.h.

16.87.2.17 void Thread::SetEventFlagMode (EventFlagOperation_t *eMode_*) [inline]

SetEventFlagMode Sets the active event flag operation mode.

Parameters

*eMode_*	Event flag operation mode, defines the logical operator to apply to the event flag.

Definition at line 326 of file thread.h.

16.87.2.18 void Thread::SetID (K_UCHAR *ucID_*) [inline]

Set an 8-bit ID to uniquely identify this thread.

Parameters

*ucID_*	8-bit Thread ID, set by the user

Definition at line 279 of file thread.h.

16.87.2.19 void Thread::SetName (const K_CHAR ∗ *szName_*) [inline]

Set the name of the thread - this is purely optional, but can be useful when identifying issues that come along when multiple threads are at play in a system.

Parameters

*szName_*	Char string containing the thread name

Definition at line 113 of file thread.h.

16.87.2.20 void Thread::SetOwner (ThreadList ∗ *pclNewList_*) [inline]

Set the thread's owner to the specified thread list.

Parameters

*pclNewList_*	Pointer to the threadlist to apply thread ownership

Definition at line 198 of file thread.h.

16.87.2.21 void Thread::SetPriority (K_UCHAR *ucPriority_*)

Set the priority of the Thread (running or otherwise) to a different level.

This activity involves re-scheduling, and must be done so with due caution, as it may effect the determinism of the system.

This should *always* be called from within a critical section to prevent system issues.

Parameters

*ucPriority_*	New priority of the thread

Definition at line 301 of file thread.cpp.

16.87.2.22 void Thread::SetPriorityBase (K_UCHAR *ucPriority_*) [private]

Parameters

*ucPriority_*	

Definition at line 291 of file thread.cpp.

16.87.2.23 void Thread::SetQuantum (K_USHORT *usQuantum_*) [inline]

Set the thread's round-robin execution quantum.

Parameters

*usQuantum_*	Thread's execution quantum (in milliseconds)

Definition at line 170 of file thread.h.

16.87.2.24 void Thread::Sleep (K_ULONG *ulTimeMs_*) [static]

Put the thread to sleep for the specified time (in milliseconds).

Actual time slept may be longer (but not less than) the interval specified.

Parameters

*ulTimeMs_*	Time to sleep (in ms)

Definition at line 195 of file thread.cpp.

16.87.2.25 void Thread::Stop (void)

Stop a thread that's actively scheduled without destroying its stacks.

Stopped threads can be restarted using the Start() API.

Definition at line 121 of file thread.cpp.

16.87.2.26 void Thread::USleep (K_ULONG *ulTimeUs_*) [static]

Put the thread to sleep for the specified time (in microseconds).

Actual time slept may be longer (but not less than) the interval specified.

Parameters

*ulTimeUs_*	Time to sleep (in microseconds)

Definition at line 217 of file thread.cpp.

16.87.2.27 void Thread::Yield (void) [static]

Yield the thread - this forces the system to call the scheduler and determine what thread should run next.

This is typically used when threads are moved in and out of the scheduler.

Definition at line 261 of file thread.cpp.

The documentation for this class was generated from the following files:

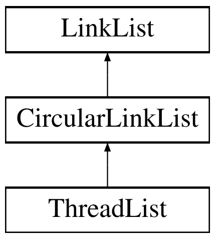
- /home/mo/mark3-source/embedded/stage/src/thread.h
- /home/mo/mark3-source/embedded/stage/src/thread.cpp

16.88 ThreadList Class Reference

This class is used for building thread-management facilities, such as schedulers, and blocking objects.

`#include <threadlist.h>`

Inheritance diagram for ThreadList:



Public Member Functions

- ThreadList ()

  Default constructor - zero-initializes the data.
- void SetPriority (K_UCHAR ucPriority_)

  Set the priority of this threadlist (if used for a scheduler).
- void SetFlagPointer (K_UCHAR ∗pucFlag_)

  Set the pointer to a bitmap to use for this threadlist.
- void Add (LinkListNode ∗node_)

  Add a thread to the threadlist.
- void Add (LinkListNode ∗node_, K_UCHAR ∗pucFlag_, K_UCHAR ucPriority_)

  Add a thread to the threadlist, specifying the flag and priority at the same time.
- void Remove (LinkListNode ∗node_)

  Remove the specified thread from the threadlist.
- Thread ∗ HighestWaiter ()

  Return a pointer to the highest-priority thread in the thread-list.

Private Attributes

- K_UCHAR m_ucPriority

  Priority of the threadlist.
- K_UCHAR ∗ m_pucFlag

  Pointer to the bitmap/flag to set when used for scheduling.

Additional Inherited Members

16.88.1 Detailed Description

This class is used for building thread-management facilities, such as schedulers, and blocking objects.

Definition at line 34 of file threadlist.h.

16.88.2 Member Function Documentation

16.88.2.1 void ThreadList::Add (LinkListNode ∗ *node_*) [virtual]

Add a thread to the threadlist.

Parameters

*node_*	Pointer to the thread (link list node) to add to the list

Reimplemented from CircularLinkList.

Definition at line 46 of file threadlist.cpp.

16.88.2.2 void ThreadList::Add (LinkListNode ∗ *node_*, K_UCHAR ∗ *pucFlag_*, K_UCHAR *ucPriority_*)

Add a thread to the threadlist, specifying the flag and priority at the same time.

Parameters

*node_*	Pointer to the thread to add (link list node)
*pucFlag_*	Pointer to the bitmap flag to set (if used in a scheduler context), or NULL for non-scheduler.
*ucPriority_*	Priority of the threadlist

Definition at line 62 of file threadlist.cpp.

16.88.2.3 Thread ∗ ThreadList::HighestWaiter ( )

Return a pointer to the highest-priority thread in the thread-list.

Returns

Pointer to the highest-priority thread

Definition at line 87 of file threadlist.cpp.

16.88.2.4 void ThreadList::Remove (LinkListNode ∗ *node_*) [virtual]

Remove the specified thread from the threadlist.

Parameters

*node_*	Pointer to the thread to remove

Reimplemented from CircularLinkList.

Definition at line 71 of file threadlist.cpp.

16.88.2.5 void ThreadList::SetFlagPointer (K_UCHAR ∗ *pucFlag_*)

Set the pointer to a bitmap to use for this threadlist.

Once again, only needed when the threadlist is being used for scheduling purposes.

Parameters

*pucFlag_*	Pointer to the bitmap flag

Definition at line 40 of file threadlist.cpp.

16.88.2.6 void ThreadList::SetPriority (K_UCHAR *ucPriority_*)

Set the priority of this threadlist (if used for a scheduler).

Parameters

*ucPriority_*	Priority level of the thread list

Definition at line 34 of file threadlist.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/threadlist.h
- /home/mo/mark3-source/embedded/stage/src/threadlist.cpp

16.89 ThreadPort Class Reference

Class defining the architecture specific functions required by the kernel.

```
#include <threadport.h>
```

Static Public Member Functions

- static void StartThreads ()

  Function to start the scheduler, initial threads, etc.

Static Private Member Functions

- static void InitStack (Thread ∗pstThread_)

  Initialize the thread's stack.

Friends

- class **Thread**

16.89.1 Detailed Description

Class defining the architecture specific functions required by the kernel.

This is limited (at this point) to a function to start the scheduler, and a function to initialize the default stack-frame for a thread.

Definition at line 167 of file threadport.h.

16.89.2 Member Function Documentation

16.89.2.1 void ThreadPort::InitStack (Thread ∗ *pstThread_*) [static], [private]

Initialize the thread's stack.

Parameters

*pstThread_*	Pointer to the thread to initialize

Definition at line 37 of file threadport.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/threadport.h
- /home/mo/mark3-source/embedded/stage/src/threadport.cpp

16.90 Tile_8x8 Class Reference

Public Member Functions

- void LoadTile (TileDef_t ∗pstTileDef_)

  LoadTile.
- void Render (GraphicsDriver ∗pclDriver_, K_USHORT usX_, K_USHORT usY_)

  Render.

Private Attributes

- COLOR m_auTileBuffer [TILE_8x8_BUFFER_SIZE]

  m_auTileBuffer Object's local storage for tile data
- K_UCHAR m_ucWidth

  m_ucWidth Width of the tile (may be smaller than width of buffer)
- K_UCHAR m_ucHeight

  m_ucHeight Height of the tile (may be smaler than the height of buffer)

16.90.1 Detailed Description

Definition at line 63 of file tiles.h.

16.90.2 Member Function Documentation

16.90.2.1 void Tile_8x8::LoadTile (TileDef_t ∗ *pstTileDef_*)

LoadTile.

Load the tile specified by pstTileDef_ into memory. This takes some time as it parses the indexed colors, does a lookup, and then writes to the local tile buffer. Once a tile has been loaded, it can be rendered any number of times.

Parameters

*pstTileDef_*	Pointer to a struct containing configuration data for the tile to be loaded.

Definition at line 24 of file tiles.cpp.

16.90.2.2 void Tile_8x8::Render (GraphicsDriver ∗ *pclDriver_*, K_USHORT *usX_*, K_USHORT *usY_*)

Render.

Render loaded tile data to a specific location on a specified display.

Parameters

*pclDriver_*	Pointer to the graphics driver to render with
*usX_*	Leftmost pixel index
*usY_*	Topmost pixel index

Definition at line 51 of file tiles.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/tiles.h
- /home/mo/mark3-source/embedded/stage/src/tiles.cpp

16.91 TileDef_t Struct Reference

TileDef_t Structure defining parameters for a color-indexed tile.

```
#include <tiles.h>
```

Public Attributes

- TileFormat_t m_eFormat

  Color-indexing of the tile (bits-per-pixel)
- K_UCHAR ∗ m_pucData

  Pointer to color-indexed tile data.
- COLOR ∗ m_puPalette

  Pointer to a palette assigned to this tile.
- K_UCHAR m_ucHeight

  Height of the tile (in pixels)
- K_UCHAR m_ucWidth

  Width of the tile (in pixels)

16.91.1 Detailed Description

TileDef_t Structure defining parameters for a color-indexed tile.

Definition at line 48 of file tiles.h.

The documentation for this struct was generated from the following file:

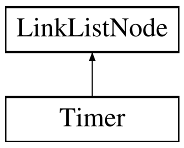
- /home/mo/mark3-source/embedded/stage/src/tiles.h

16.92 Timer Class Reference

Timer - an event-driven execution context based on a specified time interval.

```
#include <timerlist.h>
```

Inheritance diagram for Timer:



Public Member Functions

- Timer ()

  Default Constructor - zero-initializes all internal data.
- void Init ()

  Re-initialize the Timer to default values.
- void Start (K_UCHAR bRepeat_, K_ULONG ulIntervalMs_, TimerCallback_t pfCallback_, void ∗pvData_)

  Start a timer using default ownership, using repeats as an option, and millisecond resolution.
- void Start (K_UCHAR bRepeat_, K_ULONG ulIntervalMs_, K_ULONG ulToleranceMs_, TimerCallback_t pf-Callback_, void ∗pvData_)

Start a timer using default ownership, using repeats as an option, and millisecond resolution.
- void Stop ()

  Stop a timer already in progress.
- void SetFlags (K_UCHAR ucFlags_)

  Set the timer's flags based on the bits in the ucFlags_ argument.
- void SetCallback (TimerCallback_t pfCallback_)

  Define the callback function to be executed on expiry of the timer.
- void SetData (void ∗pvData_)

  Define a pointer to be sent to the timer callbcak on timer expiry.
- void SetOwner (Thread ∗pclOwner_)

  Set the owner-thread of this timer object (all timers must be owned by a thread).
- void SetIntervalTicks (K_ULONG ulTicks_)

  Set the timer expiry in system-ticks (platform specific!)
- void SetIntervalSeconds (K_ULONG ulSeconds_)

  ! The next three cost us 330 bytes of flash on AVR...
- K_ULONG **GetInterval** ()
- void SetIntervalMSeconds (K_ULONG ulMSeconds_)

  Set the timer expiry interval in milliseconds (platform agnostic)
- void SetIntervalUSeconds (K_ULONG ulUSeconds_)

  Set the timer expiry interval in microseconds (platform agnostic)
- void SetTolerance (K_ULONG ulTicks_)

  Set the timer's maximum tolerance in order to synchronize timer processing with other timers in the system.

Private Attributes

- K_UCHAR m_ucFlags

  Flags for the timer, defining if the timer is one-shot or repeated.
- TimerCallback_t m_pfCallback

  Pointer to the callback function.
- K_ULONG m_ulInterval

  Interval of the timer in timer ticks.
- K_ULONG m_ulTimeLeft

  Time remaining on the timer.
- K_ULONG m_ulTimerTolerance

  Maximum tolerance (used for timer harmonization)
- Thread ∗ m_pclOwner

  Pointer to the owner thread.
- void ∗ m_pvData

  Pointer to the callback data.

Friends

- class **TimerList**

Additional Inherited Members

16.92.1 Detailed Description

Timer - an event-driven execution context based on a specified time interval.

This inherits from a LinkListNode for ease of management by a global TimerList object.

Definition at line 98 of file timerlist.h.

16.92.2 Member Function Documentation

16.92.2.1 void Timer::SetCallback (TimerCallback_t *pfCallback_*) [inline]

Define the callback function to be executed on expiry of the timer.

Parameters

*pfCallback_*	Pointer to the callback function to call

Definition at line 159 of file timerlist.h.

16.92.2.2 void Timer::SetData (void ∗ *pvData_*) [inline]

Define a pointer to be sent to the timer callbcak on timer expiry.

Parameters

*pvData_*	Pointer to data to pass as argument into the callback

Definition at line 168 of file timerlist.h.

16.92.2.3 void Timer::SetFlags (K_UCHAR *ucFlags_*) [inline]

Set the timer's flags based on the bits in the ucFlags_ argument.

Parameters

*ucFlags_*	Flags to assign to the timer object. TIMERLIST_FLAG_ONE_SHOT for a one-shot timer, 0 for a continuous timer.

Definition at line 150 of file timerlist.h.

16.92.2.4 void Timer::SetIntervalMSeconds (K_ULONG *ulMSeconds_*)

Set the timer expiry interval in milliseconds (platform agnostic)

Parameters

*ulMSeconds_*	Time in milliseconds

Definition at line 297 of file timerlist.cpp.

16.92.2.5 void Timer::SetIntervalSeconds (K_ULONG *ulSeconds_*)

! The next three cost us 330 bytes of flash on AVR...

Set the timer expiry interval in seconds (platform agnostic)

Parameters

*ulSeconds_*	Time in seconds

Definition at line 291 of file timerlist.cpp.

16.92.2.6 void Timer::SetIntervalTicks (K_ULONG *ulTicks_*)

Set the timer expiry in system-ticks (platform specific!)

Parameters

*ulTicks_*	Time in ticks

Definition at line 283 of file timerlist.cpp.

16.92.2.7 void Timer::SetIntervalUSeconds (K_ULONG *ulUSeconds_*)

Set the timer expiry interval in microseconds (platform agnostic)

Parameters

*ulUSeconds_*	Time in microseconds

Definition at line 303 of file timerlist.cpp.

16.92.2.8 void Timer::SetOwner (Thread * *pclOwner_*) [inline]

Set the owner-thread of this timer object (all timers must be owned by a thread).

Parameters

*pclOwner_*	Owner thread of this timer object

Definition at line 178 of file timerlist.h.

16.92.2.9 void Timer::SetTolerance (K_ULONG *ulTicks_*)

Set the timer's maximum tolerance in order to synchronize timer processing with other timers in the system.

Parameters

*ulTicks_*	Maximum tolerance in ticks

Definition at line 309 of file timerlist.cpp.

16.92.2.10 void Timer::Start (K_UCHAR *bRepeat_*, K_ULONG *ulIntervalMs_*, TimerCallback_t *pfCallback_*, void * *pvData_*)

Start a timer using default ownership, using repeats as an option, and millisecond resolution.

Parameters

*bRepeat_*	0 - timer is one-shot. 1 - timer is repeating.
*ulIntervalMs_*	- Interval of the timer in miliseconds
*pfCallback_*	- Function to call on timer expiry
*pvData_*	- Data to pass into the callback function

Definition at line 252 of file timerlist.cpp.

16.92.2.11 void Timer::Start (K_UCHAR *bRepeat_*, K_ULONG *ulIntervalMs_*, K_ULONG *ulToleranceMs_*, TimerCallback_t *pfCallback_*, void * *pvData_*)

Start a timer using default ownership, using repeats as an option, and millisecond resolution.

Parameters

*bRepeat_*	0 - timer is one-shot. 1 - timer is repeating.

*ulIntervalMs_*	- Interval of the timer in miliseconds
ulToleranceMs	- Allow the timer expiry to be delayed by an additional maximum time, in order to have as many timers expire at the same time as possible.
*pfCallback_*	- Function to call on timer expiry
*pvData_*	- Data to pass into the callback function

Definition at line 270 of file timerlist.cpp.

16.92.2.12 void Timer::Stop (void)

Stop a timer already in progress.

Has no effect on timers that have already been stopped.

Definition at line 277 of file timerlist.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/timerlist.h
- /home/mo/mark3-source/embedded/stage/src/timerlist.cpp

16.93 TimerEvent_t Struct Reference

Timer UI event structure.

`#include <gui.h>`

Public Attributes

- K_USHORT usTicks

    Number of clock ticks (arbitrary) that have elapsed.

16.93.1 Detailed Description

Timer UI event structure.

Definition at line 177 of file gui.h.

The documentation for this struct was generated from the following file:

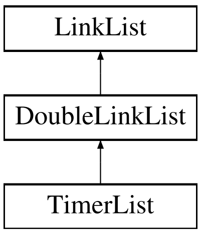
- /home/mo/mark3-source/embedded/stage/src/gui.h

16.94 TimerList Class Reference

TimerList class - a doubly-linked-list of timer objects.

`#include <timerlist.h>`

Inheritance diagram for TimerList:



Public Member Functions

- void Init ()

  Initialize the TimerList object.
- void Add (Timer ∗pclListNode_)

  Add a timer to the TimerList.
- void Remove (Timer ∗pclListNode_)

  Remove a timer from the TimerList, cancelling its expiry.
- void Process ()

  Process all timers in the timerlist as a result of the timer expiring.

Private Attributes

- K_ULONG m_ulNextWakeup

  The time (in system clock ticks) of the next wakeup event.
- K_UCHAR m_bTimerActive

  Whether or not the timer is active.

Additional Inherited Members

16.94.1 Detailed Description

TimerList class - a doubly-linked-list of timer objects.

Definition at line 260 of file timerlist.h.

16.94.2 Member Function Documentation

16.94.2.1 void TimerList::Add (Timer ∗ *pclListNode_*)

Add a timer to the TimerList.

Parameters

*pclListNode_*	Pointer to the Timer to Add

Definition at line 48 of file timerlist.cpp.

16.94.2.2 void TimerList::Init (void)

Initialize the TimerList object.

Must be called before using the object.

Definition at line 41 of file timerlist.cpp.

16.94.2.3 void TimerList::Process (void)

Process all timers in the timerlist as a result of the timer expiring.

This will select a new timer epoch based on the next timer to expire. ToDo - figure out if we need to deal with any overtime here.

Definition at line 113 of file timerlist.cpp.

16.94.2.4 void TimerList::Remove (Timer ∗ *pclListNode_*)

Remove a timer from the TimerList, cancelling its expiry.

Parameters

*pclListNode_*	Pointer to the Timer to remove

Definition at line 96 of file timerlist.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/timerlist.h
- /home/mo/mark3-source/embedded/stage/src/timerlist.cpp

16.95 TimerScheduler Class Reference

"Static" Class used to interface a global TimerList with the rest of the kernel.

```
#include <timerlist.h>
```

Static Public Member Functions

- static void Init ()

  Initialize the timer scheduler.
- static void Add (Timer ∗pclListNode_)

  Add a timer to the timer scheduler.
- static void Remove (Timer ∗pclListNode_)

  Remove a timer from the timer scheduler.
- static void Process ()

  This function must be called on timer expiry (from the timer's ISR context).

Static Private Attributes

- static TimerList m_clTimerList

  TimerList object manipulated by the Timer Scheduler.

16.95.1 Detailed Description

"Static" Class used to interface a global TimerList with the rest of the kernel.

Definition at line 310 of file timerlist.h.

16.95.2 Member Function Documentation

16.95.2.1 void TimerScheduler::Add (Timer ∗ *pclListNode_*) [inline], [static]

Add a timer to the timer scheduler.

Adding a timer implicitly starts the timer as well.

Parameters

*pclListNode_*	Pointer to the timer list node to add

Definition at line 329 of file timerlist.h.

16.95.2.2 void TimerScheduler::Init (void) [inline], [static]

Initialize the timer scheduler.

Must be called before any timer, or timer-derived functions are used.

Definition at line 319 of file timerlist.h.

16.95.2.3 void TimerScheduler::Process (void) [inline], [static]

This function must be called on timer expiry (from the timer's ISR context).

This will result in all timers being updated based on the epoch that just elapsed. New timer epochs are set based on the next timer to expire.

Definition at line 351 of file timerlist.h.

16.95.2.4 void TimerScheduler::Remove (Timer ∗ *pclListNode_*) [inline], [static]

Remove a timer from the timer scheduler.

May implicitly stop the timer if this is the only active timer scheduled.

Parameters

*pclListNode_*	Pointer to the timer list node to remove

Definition at line 340 of file timerlist.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/timerlist.h
- /home/mo/mark3-source/embedded/stage/src/timerlist.cpp

16.96 Token_t Struct Reference

Token descriptor struct format.

`#include <memutil.h>`

Public Attributes

- const K_CHAR ∗ pcToken

    Pointer to the beginning of the token string.
- K_UCHAR ucLen

    Length of the token (in bytes)

16.96.1 Detailed Description

Token descriptor struct format.

Definition at line 32 of file memutil.h.

The documentation for this struct was generated from the following file:

- /home/mo/mark3-source/embedded/stage/src/memutil.h

16.97 TouchEvent_t Struct Reference

Touch UI event structure.

```
#include <gui.h>
```

Public Attributes

- K_USHORT usX

    Absolute touch location (pixels)
- K_USHORT usY

    Absolute touch location (pixels)
- union {
    K_USHORT ucFlags
      Modifier flags.
    struct {
      unsigned int bTouch:1
        Whether or not touch is up or down.
    }
  };

16.97.1 Detailed Description

Touch UI event structure.

Definition at line 125 of file gui.h.

The documentation for this struct was generated from the following file:

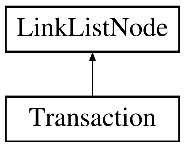
- /home/mo/mark3-source/embedded/stage/src/gui.h

16.98 Transaction Class Reference

The Transaction class.

```
#include <transaction.h>
```

Inheritance diagram for Transaction:



Public Member Functions

- void Set (K_USHORT usCode_, void ∗pvData_)

  Set.
- K_USHORT GetCode ()

  GetCode.
- void ∗ GetData ()

  GetData.

Private Attributes

- K_USHORT m_usCode

  Data code, defined by the blocking object using transactions.
- void ∗ m_pvData

  Abstract data, which is defined by the code.

Additional Inherited Members

16.98.1 Detailed Description

The Transaction class.

The Transaction class implements "kernel transaction" functionality used by blocking objects within the kernel.

Each Transaction object is essentially a FIFO node, which is used to represent an operation that takes place on a blocking object. These operations include things like posting or pending a semaphore, claiming or releasing a mutex, or a thread timeout on a blocking object. Transactions are used exclusively with TransactionQueue's to serialize access to blocking objects in order to implement lockless kernel operations with interrupts enabled.

For simplicity, each transaction is implemented as a simple Key/Value pair - the "Code" value is interpreted differently based on the type of blocking object, and the "Data" value is depending on the value held in the code. For examples of how Transactions are used, see the kernel, mutex and event-flag code.

Definition at line 51 of file transaction.h.

16.98.2 Member Function Documentation

16.98.2.1 K_USHORT Transaction::GetCode ( ) `[inline]`

GetCode.

Return the value held by the Code field

Returns

value of the Code field

Definition at line 75 of file transaction.h.

16.98.2.2 void∗ Transaction::GetData ( ) `[inline]`

GetData.

Return the abstract data value held in the object

Returns

Abstract data value held in the object

Definition at line 87 of file transaction.h.

16.98.2.3 void Transaction::Set (K_USHORT *usCode_*, void ∗ *pvData_*) [inline]

Set.

Provide access to set the code/data fields in the object

Parameters

*usCode_*	Code value to set
*pvData_*	Abstract data value to set

Definition at line 62 of file transaction.h.

The documentation for this class was generated from the following file:

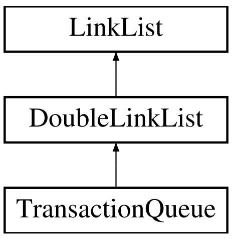
- /home/mo/mark3-source/embedded/stage/src/transaction.h

16.99 TransactionQueue Class Reference

The TransactionQueue class.

`#include <transaction.h>`

Inheritance diagram for TransactionQueue:



Public Member Functions

- void Enqueue (K_USHORT usData_, void ∗pvData_)

  Enqueue.
- Transaction ∗ Dequeue ()

  Dequeue.
- void Finish (Transaction ∗pclTransaction_)

  Finish.

Static Public Member Functions

- static void GlobalQueueInit ()

  GlobalQueueInit.

Static Private Attributes

- static DoubleLinkList m_clGlobalQueue

  List object used to manage all transactions.
- static Transaction m_aclTransactions [TRANSACTION_QUEUE_SIZE]

  Static array of objects managed in the above list.

Additional Inherited Members

16.99.1 Detailed Description

The TransactionQueue class.

A kernel transaction queue is a construct used to build blocking objects which disable interrupts for as short a period of time as possible. Instead of disabling interrupts for the duration of a blocking object operation (i.e. mutex claim or semaphore post), we instead serialize access to the object using a FIFO containing a list of pending actions, Coupled with Atomic locking operations, the kernel can guarantee that only one thread has permission to process the object's transaction queue, while all other concurrent threads/interrupts (which then fail to claim the object's lock) are only allowed to add transactions to it. In this way, we can keep interrupts enabled for the vast majority of kernel/blocking-object calls, resulting in a much more deterministic, responsive system.

Transactions are very short-lived - i.e. a queue will only have more than 1 pending transaction if pre-empted by interrupts during queue processing within a kernel call. As a result, we maintain a small, global pool of transaction objects which are allocated as-necessary in order to service demand. These Transaction objects are shared among all blocking objects within the system.

Typical usage of a TransactionQueue object is as follows:

Enqueue(code, data); // Add a new node to the queue to be processed after

// – somewhere else in the code –

// Process the queue, one node at a time Transaction ∗pclTransaction; while ((pclTransaction = Dequeue()) != 0) { // Do something with the transaction data MyProcessFuntion(pclTransaction);

// Return the object back to the global queue when done. Finish(pclTransaction); }

Definition at line 138 of file transaction.h.

16.99.2 Member Function Documentation

16.99.2.1 Transaction ∗ TransactionQueue::Dequeue ( )

Dequeue.

Pops the first item in the queue, returning its pointer back to the caller.

Note - Dequeue() does not return the node back to the global pool. Once the transaction has been processed, it must be returned back by calling the Finish() method.

Returns

Pointer to the head node in the list, 0 if empty

Definition at line 56 of file transaction.cpp.

16.99.2.2 void TransactionQueue::Enqueue (K_USHORT *usData_*, void ∗ *pvData_*)

Enqueue.

Enqueue a new entry to the tail of the transaction queue. This pops a node from the global transaction pool, populates it with the data in the fields, and adds the node to the end of this queue.

Parameters

*usData_*	Data value to encode
*pvData_*	Abstract data associated with the node

Definition at line 37 of file transaction.cpp.

16.99.2.3 void TransactionQueue::Finish (**Transaction** ∗ *pclTransaction_*)

Finish.

Return a previously dequeued transaction object back to the global transaction queue. Any Dequeue'd object must be returned by calling this function to avoid leaks.

Parameters

*pclTransaction_*	Pointer to a transaction object to return back to the queue.

Definition at line 72 of file transaction.cpp.

16.99.2.4 void TransactionQueue::GlobalQueueInit ( ) `[static]`

GlobalQueueInit.

This static method is called to initialize the global transaction pool and its included transaction objects.

Definition at line 28 of file transaction.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/transaction.h
- /home/mo/mark3-source/embedded/stage/src/transaction.cpp

16.100 UnitTest Class Reference

Class used to implement a simple unit-testing framework.

`#include <unit_test.h>`

Public Member Functions

- void SetName (const K_CHAR ∗szName_)

  Set the name of the test object.
- void Start ()

  Start a new test iteration.
- void Pass ()

  Stop the current iteration (if started), and register that the test was successful.
- void Fail ()

  Stop the current iterations (if started), and register that the current test failed.
- void **ExpectTrue** (bool bExpression_)
- void **ExpectFalse** (bool bExpression_)
- void **ExpectEquals** (bool bVal_, bool bExpression_)
- void **ExpectEquals** (K_UCHAR ucVal_, K_UCHAR ucExpression_)
- void **ExpectEquals** (K_USHORT usVal_, K_USHORT usExpression_)
- void **ExpectEquals** (K_ULONG ulVal_, K_ULONG ulExpression_)
- void **ExpectEquals** (K_CHAR cVal_, K_CHAR cExpression_)
- void **ExpectEquals** (K_SHORT sVal_, K_SHORT sExpression_)

- void **ExpectEquals** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectEquals** (void ∗pvVal_, void ∗pvExpression_)
- void **ExpectFailTrue** (bool bExpression_)
- void **ExpectFailFalse** (bool bExpression_)
- void **ExpectFailEquals** (bool bVal_, bool bExpression_)
- void **ExpectFailEquals** (K_UCHAR ucVal_, K_UCHAR ucExpression_)
- void **ExpectFailEquals** (K_USHORT usVal_, K_USHORT usExpression_)
- void **ExpectFailEquals** (K_ULONG ulVal_, K_ULONG ulExpression_)
- void **ExpectFailEquals** (K_CHAR cVal_, K_CHAR cExpression_)
- void **ExpectFailEquals** (K_SHORT sVal_, K_SHORT sExpression_)
- void **ExpectFailEquals** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectFailEquals** (void ∗pvVal_, void ∗pvExpression_)
- void **ExpectGreaterThan** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectLessThan** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectGreaterThanEquals** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectLessThanEquals** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectFailGreaterThan** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectFailLessThan** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectFailGreaterThanEquals** (K_LONG lVal_, K_LONG lExpression_)
- void **ExpectFailLessThanEquals** (K_LONG lVal_, K_LONG lExpression_)
- void Complete ()

  Complete the test.
- const K_CHAR ∗ GetName ()

  Get the name of the tests associated with this object.
- K_BOOL GetResult ()

  Return the result of the last test.
- K_USHORT GetPassed ()

  Return the total number of test points/iterations passed.
- K_USHORT GetFailed ()

  Return the number of failed test points/iterations.
- K_USHORT GetTotal ()

  Return the total number of iterations/test-points executed.

Private Attributes

- const K_CHAR ∗ m_szName

  Name of the tests performed.
- K_BOOL m_bIsActive

  Whether or not the test is active.
- K_UCHAR m_bComplete

  Whether or not the test is complete.
- K_BOOL m_bStatus

  Status of the last-run test.
- K_USHORT m_usIterations

  Number of iterations executed.
- K_USHORT m_usPassed

  Number of iterations that have passed.

16.100.1 Detailed Description

Class used to implement a simple unit-testing framework.

Definition at line 28 of file unit_test.h.

16.100.2 Member Function Documentation

16.100.2.1 void UnitTest::Complete ( ) [inline]

Complete the test.

Once a test has been completed, no new iterations can be started (i.e Start()/Pass()/Fail() will have no effect).

Definition at line 157 of file unit_test.h.

16.100.2.2 K_USHORT UnitTest::GetFailed ( ) [inline]

Return the number of failed test points/iterations.

Returns

Failed test point/iteration count

Definition at line 193 of file unit_test.h.

16.100.2.3 const K_CHAR ∗ UnitTest::GetName ( ) [inline]

Get the name of the tests associated with this object.

Returns

Name of the test

Definition at line 166 of file unit_test.h.

16.100.2.4 K_USHORT UnitTest::GetPassed ( ) [inline]

Return the total number of test points/iterations passed.

Returns

Count of all successful test points/iterations

Definition at line 184 of file unit_test.h.

16.100.2.5 K_BOOL UnitTest::GetResult ( ) [inline]

Return the result of the last test.

Returns

Status of the last run test (false = fail, true = pass)

Definition at line 175 of file unit_test.h.

16.100.2.6 K_USHORT UnitTest::GetTotal ( ) [inline]

Return the total number of iterations/test-points executed.

Returns

Total number of ierations/test-points executed

Definition at line 202 of file unit_test.h.

16.100.2.7 void UnitTest::SetName (const K_CHAR ∗ *szName_*) [inline]

Set the name of the test object.

Parameters

*szName_*	Name of the tests associated with this object

Definition at line 41 of file unit_test.h.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/unit_test.h
- /home/mo/mark3-source/embedded/stage/src/unit_test.cpp

16.101 WriteBuffer16 Class Reference

This class is used to provide a general-purpose, fully thread-safe circular buffer implementation which can be used for creating tracebuffers, data logging queues, transaction queues, etc.

`#include <writebuf16.h>`

Public Member Functions

- void SetBuffers (K_USHORT ∗pusData_, K_USHORT usSize_)

    Assign the data to be used as storage for this circular buffer.
- void SetCallback (WriteBufferCallback pfCallback_)

    Set the callback function to be called when the buffer hits 50% of its capacity, and again when the buffer rolls over completely.
- void WriteData (K_USHORT ∗pusBuf_, K_USHORT usLen_)

    Write an array of values to the circular buffer.
- void WriteVector (K_USHORT ∗∗ppusBuf_, K_USHORT ∗pusLen_, K_UCHAR ucCount_)

    Write a multi-part vector to the circular buffer.

Private Attributes

- K_USHORT ∗ m_pusData

    Pointer to the circular buffer data.
- volatile K_USHORT m_usSize

    Size of the buffer.
- volatile K_USHORT m_usHead

    Current head element (where data is written)
- volatile K_USHORT m_usTail

    Current tail element (where data is read)
- WriteBufferCallback m_pfCallback

    Buffer callback function.

16.101.1 Detailed Description

This class is used to provide a general-purpose, fully thread-safe circular buffer implementation which can be used for creating tracebuffers, data logging queues, transaction queues, etc.

We use it for implementing a debug print journal.

Definition at line 37 of file writebuf16.h.

16.101.2 Member Function Documentation

16.101.2.1 void WriteBuffer16::SetBuffers (K_USHORT ∗ *pusData_*, K_USHORT *usSize_*) `[inline]`

Assign the data to be used as storage for this circular buffer.

Parameters

*pusData_*	Pointer to the array of data to be managed as a circular buffer by this object.
*usSize_*	Size of the buffer in 16-bit elements

Definition at line 50 of file writebuf16.h.

16.101.2.2 void WriteBuffer16::SetCallback (WriteBufferCallback *pfCallback_*) [inline]

Set the callback function to be called when the buffer hits 50% of its capacity, and again when the buffer rolls over completely.

Parameters

*pfCallback_*	Function pointer to call whenever the buffer has reached 50% capacity, or has rolled over completely.

Definition at line 69 of file writebuf16.h.

16.101.2.3 void WriteBuffer16::WriteData (K_USHORT ∗ *pusBuf_*, K_USHORT *usLen_*)

Write an array of values to the circular buffer.

Parameters

*pusBuf_*	Source data array to write to the circular buffer
*usLen_*	Length of the source data array in 16-bit elements

Definition at line 25 of file writebuf16.cpp.

16.101.2.4 void WriteBuffer16::WriteVector (K_USHORT ∗∗ *ppusBuf_*, K_USHORT ∗ *pusLen_*, K_UCHAR *ucCount_*)

Write a multi-part vector to the circular buffer.

Parameters

*ppusBuf_*	Pointer to the array of source data pointers
*pusLen_*	Array of buffer lengths
*ucCount_*	Number of source-data arrays to write to the buffer

Definition at line 37 of file writebuf16.cpp.

The documentation for this class was generated from the following files:

- /home/mo/mark3-source/embedded/stage/src/writebuf16.h
- /home/mo/mark3-source/embedded/stage/src/writebuf16.cpp

Chapter 17

File Documentation

17.1 /home/mo/mark3-source/embedded/stage/src/atomic.cpp File Reference

Basic Atomic Operations.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "atomic.h"
#include "threadport.h"
```

17.1.1 Detailed Description

Basic Atomic Operations.

Definition in file atomic.cpp.

17.2 atomic.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "atomic.h"
#include "threadport.h"

#if KERNEL_USE_ATOMIC

//---------------------------------------------------------------------------
K_UCHAR Atomic::Set( K_UCHAR *pucSource_, K_UCHAR ucVal_ )
{
    K_UCHAR ucRet;
    CS_ENTER();
    ucRet = *pucSource_;
    *pucSource_ = ucVal_;
    CS_EXIT();
    return ucRet;
}
//---------------------------------------------------------------------------
K_USHORT Atomic::Set( K_USHORT *pusSource_, K_USHORT usVal_ )
{
    K_USHORT usRet;
    CS_ENTER();
    usRet = *pusSource_;
    *pusSource_ = usVal_;
    CS_EXIT();
    return usRet;
}
//---------------------------------------------------------------------------
K_ULONG Atomic::Set( K_ULONG *pulSource_, K_ULONG ulVal_ )
{
    K_ULONG ulRet;
    CS_ENTER();
    ulRet = *pulSource_;
    *pulSource_ = ulVal_;
    CS_EXIT();
    return ulRet;
}

//---------------------------------------------------------------------------
K_UCHAR Atomic::Add( K_UCHAR *pucSource_, K_UCHAR ucVal_ )
{
    K_UCHAR ucRet;
    CS_ENTER();
    ucRet = *pucSource_;
    *pucSource_ += ucVal_;
    CS_EXIT();
    return ucRet;
}

//---------------------------------------------------------------------------
K_USHORT Atomic::Add( K_USHORT *pusSource_, K_USHORT usVal_ )
{
    K_USHORT usRet;
    CS_ENTER();
    usRet = *pusSource_;
    *pusSource_ += usVal_;
    CS_EXIT();
    return usRet;
}

//---------------------------------------------------------------------------
K_ULONG Atomic::Add( K_ULONG *pulSource_, K_ULONG ulVal_ )
{
    K_ULONG ulRet;
    CS_ENTER();
    ulRet = *pulSource_;
    *pulSource_ += ulVal_;
    CS_EXIT();
    return ulRet;
}

//---------------------------------------------------------------------------
K_UCHAR Atomic::Sub( K_UCHAR *pucSource_, K_UCHAR ucVal_ )
{
    K_UCHAR ucRet;
    CS_ENTER();
    ucRet = *pucSource_;
    *pucSource_ -= ucVal_;
    CS_EXIT();
    return ucRet;
}

//---------------------------------------------------------------------------
K_USHORT Atomic::Sub( K_USHORT *pusSource_, K_USHORT usVal_ )
{
    K_USHORT usRet;
    CS_ENTER();
    usRet = *pusSource_;
    *pusSource_ -= usVal_;
    CS_EXIT();
    return usRet;
}

//---------------------------------------------------------------------------
K_ULONG Atomic::Sub( K_ULONG *pulSource_, K_ULONG ulVal_ )
{
    K_ULONG ulRet;
    CS_ENTER();
    ulRet = *pulSource_;
    *pulSource_ -= ulVal_;
    CS_EXIT();
    return ulRet;
}

//---------------------------------------------------------------------------
K_BOOL Atomic::TestAndSet( K_BOOL *pbLock_ )
{
    K_UCHAR ucRet;
    CS_ENTER();
    ucRet = *pbLock_;
    if (!ucRet)
    {
        *pbLock_ = 1;
    }
    CS_EXIT();
    return ucRet;
}

#endif // KERNEL_USE_ATOMIC
```

17.3 /home/mo/mark3-source/embedded/stage/src/atomic.h File Reference

Basic Atomic Operations.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "threadport.h"
```

Classes

- class Atomic

  The Atomic class.

17.3.1 Detailed Description

Basic Atomic Operations.

Definition in file atomic.h.

17.4 atomic.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __ATOMIC_H__
#define __ATOMIC_H__

#include "kerneltypes.h"
#include "mark3cfg.h"
#include "threadport.h"

#if KERNEL_USE_ATOMIC

class Atomic
{
public:
    static K_UCHAR Set( K_UCHAR *pucSource_, K_UCHAR ucVal_ );
    static K_USHORT Set( K_USHORT *pusSource_, K_USHORT usVal_ );
    static K_ULONG Set( K_ULONG *pulSource_, K_ULONG ulVal_ );

    static K_UCHAR Add( K_UCHAR *pucSource_, K_UCHAR ucVal_ );
    static K_USHORT Add( K_USHORT *pusSource_, K_USHORT usVal_ );
    static K_ULONG Add( K_ULONG *pulSource_, K_ULONG ulVal_ );

    static K_UCHAR Sub( K_UCHAR *pucSource_, K_UCHAR ucVal_ );
    static K_USHORT Sub( K_USHORT *pusSource_, K_USHORT usVal_ );
    static K_ULONG Sub( K_ULONG *pulSource_, K_ULONG ulVal_ );

    static K_BOOL TestAndSet( K_BOOL *pbLock );
};

#endif // KERNEL_USE_ATOMIC

#endif //__ATOMIC_H__
```

17.5 /home/mo/mark3-source/embedded/stage/src/blocking.cpp File Reference

Implementation of base class for blocking objects.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"
#include "blocking.h"
#include "thread.h"
```

Macros

- #define **__FILE_ID__** BLOCKING_CPP

17.5.1 Detailed Description

Implementation of base class for blocking objects.

Definition in file blocking.cpp.

17.6 blocking.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"

#include "blocking.h"
#include "thread.h"

//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     BLOCKING_CPP

#if KERNEL_USE_SEMAPHORE || KERNEL_USE_MUTEX
//---------------------------------------------------------------------------
void BlockingObject::Block(Thread *pclThread_)
{
    KERNEL_ASSERT( pclThread_ );
    KERNEL_TRACE_1( STR_THREAD_BLOCK_1, (K_USHORT)pclThread_->GetID() );

    // Remove the thread from its current thread list (the "owner" list)
    // ... And add the thread to this object's block list
    CS_ENTER();
    Scheduler::Remove(pclThread_);
    CS_EXIT();

    m_clBlockList.Add(pclThread_);

    // Set the "current" list location to the blocklist for this thread
    pclThread_->SetCurrent(&m_clBlockList);
}

//---------------------------------------------------------------------------
void BlockingObject::UnBlock(Thread *pclThread_)
{
    KERNEL_ASSERT( pclThread_ );
    KERNEL_TRACE_1( STR_THREAD_UNBLOCK_1, (K_USHORT)pclThread_->GetID() );

    // Remove the thread from its current thread list (the "owner" list)
    pclThread_->GetCurrent()->Remove(pclThread_);

    // Put the thread back in its active owner's list.  This is usually
    // the ready-queue at the thread's original priority.
    CS_ENTER();
    Scheduler::Add(pclThread_);
    CS_EXIT();

    // Tag the thread's current list location to its owner
    pclThread_->SetCurrent(pclThread_->GetOwner());
}

//---------------------------------------------------------------------------
K_UCHAR BlockingObject::UnLock()
{
    K_UCHAR ucRet;
    CS_ENTER();
    ucRet = m_ucLocks;
    if (m_ucLocks)
    {
        m_ucLocks--;
    }
    CS_EXIT();
    return ucRet;
}

//---------------------------------------------------------------------------
K_BOOL BlockingObject::LockAndQueue( K_USHORT usCode_, void *pvData_, K_BOOL *
pbSchedState_)
{
    K_UCHAR ucRet;
    CS_ENTER();
    m_clKTQ.Enqueue(usCode_, pvData_);
    if (!m_ucLocks)
    {
        *pbSchedState_ = Scheduler::SetScheduler(false);
    }
    ucRet = m_ucLocks;
    m_ucLocks++;
    CS_EXIT();
    return (ucRet);
}

#endif
```

17.7 /home/mo/mark3-source/embedded/stage/src/blocking.h File Reference

Blocking object base class declarations.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"
#include "threadlist.h"
#include "thread.h"
#include "transaction.h"
```

Classes

- class BlockingObject

Class implementing thread-blocking primatives.

17.7.1 Detailed Description

Blocking object base class declarations. A Blocking object in Mark3 is essentially a thread list. Any blocking object implementation (being a semaphore, mutex, event flag, etc.) can be built on top of this class, utilizing the provided functions to manipulate thread location within the Kernel.

Blocking a thread results in that thread becoming de-scheduled, placed in the blocking object's own private list of threads which are waiting on the object.

Unblocking a thread results in the reverse: The thread is moved back to its original location from the blocking list.

The only difference between a blocking object based on this class is the logic used to determine what consitutes a Block or Unblock condition.

For instance, a semaphore Pend operation may result in a call to the Block() method with the currently-executing thread in order to make that thread wait for a semaphore Post. That operation would then invoke the UnBlock() method, removing the blocking thread from the semaphore's list, and back into the the appropriate thread inside the scheduler.

Care must be taken when implementing blocking objects to ensure that critical sections are used judiciously, otherwise asynchronous events like timers and interrupts could result in non-deterministic and often catastrophic behavior.

Definition in file blocking.h.

17.8 blocking.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__ _______
|    \  /  | ||    \     ||     |     || |/ /     ||___   |
|     \/   | ||     \    ||     \     ||    \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __BLOCKING_H__
#define __BLOCKING_H__

#include "kerneltypes.h"
#include "mark3cfg.h"

#include "ll.h"
#include "threadlist.h"
#include "thread.h"

#include "transaction.h"

#if KERNEL_USE_MUTEX || KERNEL_USE_SEMAPHORE || KERNEL_USE_EVENTFLAG

//---------------------------------------------------------------------------
class BlockingObject
{
public:
    BlockingObject()
    {
        m_ucLocks = 0;
    }

protected:
    void Block(Thread *pclThread_ );

    void UnBlock(Thread *pclThread_);

    K_UCHAR UnLock();


    K_BOOL  LockAndQueue( K_USHORT usCode_, void *pvData_, K_BOOL *pbSchedState_);

    ThreadList m_clBlockList;

    TransactionQueue m_clKTQ;

    K_UCHAR     m_ucLocks;
};

#endif

#endif
```

17.9 /home/mo/mark3-source/embedded/stage/src/control_button.cpp File Reference

GUI Button Control Implementation.

```
#include "control_button.h"
#include "gui.h"
```

17.9.1 Detailed Description

GUI Button Control Implementation. Basic pushbutton control with an up/down state.

Definition in file control_button.cpp.

17.10 control_button.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__ ______
|    \  /  | ||    \    ||     |     ||  |/ /    ||___   |
|     \/   | ||     \   ||     \     ||     \    ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "control_button.h"
#include "gui.h"


void ButtonControl::Init()
{
    m_szCaption = "Button";
    m_pstFont = NULL;
    m_uBGColor = COLOR_GREY50;
    m_uActiveColor = COLOR_GREY25;
    m_uLineColor = COLOR_GREY62;
    m_uTextColor = COLOR_WHITE;
    m_bState = false;
    m_pfCallback = NULL;
    m_pvCallbackData = NULL;
    SetAcceptFocus(true);
}
//---------------------------------------------------------------------------
void ButtonControl::Draw()
{
    DrawText_t stText;
    DrawLine_t stLine;

    GraphicsDriver *pclDriver = GetParentWindow()->
GetDriver();

    K_USHORT usXOffset = 0;
    K_USHORT usHalfWidth = 0;
    K_USHORT usYOffset = 0;

    // Get the location of the control relative to elements higher in the heirarchy
    GetControlOffset(&usXOffset, &usYOffset);

    // Draw the rounded-off rectangle
    stLine.usX1 = GetLeft() + usXOffset;
    stLine.usX2 = stLine.usX1 + GetWidth() - 1;
    stLine.usY1 = GetTop() + usYOffset;
    stLine.usY2 = stLine.usY1;
    stLine.uColor = m_uLineColor;
    pclDriver->Line(&stLine);

    stLine.usY1 = GetTop() + GetHeight() + usYOffset - 1;
    stLine.usY2 = stLine.usY1;
    pclDriver->Line(&stLine);

    stLine.usX1 = GetLeft() + usXOffset;
    stLine.usX2 = stLine.usX1;
    stLine.usY1 = GetTop() + usYOffset + 1;
    stLine.usY2 = GetTop() + GetHeight() - 2;
    pclDriver->Line(&stLine);

    stLine.usX1 = GetLeft() + GetWidth() + usXOffset - 1;
    stLine.usX2 = stLine.usX1;
    pclDriver->Line(&stLine);

    // Draw a rectangle before the text if the BG is specified.
    {
        DrawRectangle_t stRect;
        stRect.usLeft = GetLeft() + usXOffset + 1;
        stRect.usRight = GetLeft() + GetWidth() + usXOffset - 2;
        stRect.usTop = GetTop() + usYOffset + 1;
        stRect.usBottom = GetTop() + GetHeight() + usYOffset - 2;
        stRect.bFill = true;

        if (m_bState)
        {
            stRect.uFillColor = m_uActiveColor;
        }
        else
        {
            stRect.uFillColor = m_uBGColor;
        }

        if (GetParentWindow()->IsInFocus(this))
        {
            stRect.uLineColor = m_uLineColor;
        }
        else
        {
            stRect.uLineColor = m_uFillColor;
        }

        pclDriver->Rectangle(&stRect);
    }

    // Draw the Text
    stText.pstFont = m_pstFont;
    stText.pcString = m_szCaption;
    stText.uColor = m_uTextColor;
    usHalfWidth = pclDriver->TextWidth(&stText);
    usHalfWidth >>= 1;
    stText.usLeft = GetLeft() + (GetWidth()>>1) - usHalfWidth + usXOffset;
    stText.usTop = GetTop() + usYOffset;
    pclDriver->Text(&stText);
}

//---------------------------------------------------------------------------
GuiReturn_t ButtonControl::ProcessEvent(
GuiEvent_t *pstEvent_ )
{
    K_USHORT usXOffset, usYOffset;

    GetControlOffset(&usXOffset, &usYOffset);

    GUI_DEBUG_PRINT("ButtonControl::ProcessEvent\n");

    switch (pstEvent_->ucEventType)
    {
        case EVENT_TYPE_KEYBOARD:
        {
            // If this is a space bar or an enter key, behave like a mouse click.
            if ((KEYCODE_SPACE == pstEvent_->stKey.ucKeyCode) ||
                (KEYCODE_RETURN == pstEvent_->stKey.ucKeyCode))
            {
                if (pstEvent_->stKey.bKeyState)
                {
                    m_bState = true;
                }
                else
                {
                    m_bState = false;
                    if (m_pfCallback)
                    {
                        m_pfCallback(m_pvCallbackData);
                    }
                }
                SetStale();
            }
        }
            break;
        case EVENT_TYPE_MOUSE:
        {
            // Is this control currently in the "active"/pressed state?
            if (m_bState)
            {
                // Check to see if the movement is out-of-bounds based on the coordinates.
                // If so, de-activate the control
                if (pstEvent_->stMouse.bLeftState)
                {
                    if ((pstEvent_->stMouse.usX < GetLeft() + usXOffset) ||
                        (pstEvent_->stMouse.usX >= GetLeft() + usXOffset + GetWidth()-1) ||
                        (pstEvent_->stMouse.usY < GetTop() + usYOffset) ||
                        (pstEvent_->stMouse.usY >= GetTop() + usYOffset + GetHeight() - 1))
                    {
                        m_bState = false;
                        SetStale();
                    }
                }
                // left button state is now up, and the control was previously active.
                // Run the event callback for the mouse, and go from there.
                else
                {
                    if ((pstEvent_->stMouse.usX >= GetLeft() + usXOffset) &&
                        (pstEvent_->stMouse.usX < GetLeft() + usXOffset + GetWidth()-1) &&
                        (pstEvent_->stMouse.usY >= GetTop() + usYOffset) &&
                        (pstEvent_->stMouse.usY < GetTop() + usYOffset + GetHeight() - 1))
                    {
                        m_bState = false;
                        SetStale();
                        if (m_pfCallback)
                        {
                            m_pfCallback(m_pvCallbackData);
                        }
                    }
                }
            }
            else if (!m_bState)
            {
                // If we registered a down-click in the bounding box, set the state of the
                // control to activated.
                if (pstEvent_->stMouse.bLeftState)
                {
                    if ((pstEvent_->stMouse.usX >= GetLeft() + usXOffset) &&
                        (pstEvent_->stMouse.usX < GetLeft() + usXOffset + GetWidth()-1) &&
                        (pstEvent_->stMouse.usY >= GetTop() + usYOffset) &&
                        (pstEvent_->stMouse.usY < GetTop() + usYOffset + GetHeight() - 1))
                    {
                        m_bState = true;
                        SetStale();
                    }
                }
            }

            if (!IsInFocus())
            {
                GetParentWindow()->SetFocus(this);
                SetStale();
            }

        }
            break;
    }

}

//---------------------------------------------------------------------------
void ButtonControl::Activate( bool bActivate_ )
{
    // When we de-activate the control, simply disarm the control and force
    // a redraw
    if (!bActivate_)
    {
        m_bState = false;
    }
    SetStale();
}
```

17.11 /home/mo/mark3-source/embedded/stage/src/control_button.h File Reference

GUI Button Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"
```

Classes

- class ButtonControl

Typedefs

- typedef void(∗ **ButtonCallback**)(void ∗pvData_)

17.11.1 Detailed Description

GUI Button Control. Basic pushbutton control with an up/down state.

Definition in file control_button.h.

17.12 control_button.h

```

/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __CONTROL_BUTTON_H__
#define __CONTROL_BUTTON_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"

typedef void (*ButtonCallback)( void *pvData_ );

class ButtonControl : public GuiControl
{
public:

    virtual void Init();
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ );
    virtual void Activate( bool bActivate_ );

    void SetBGColor( COLOR eColor_ )        { m_uBGColor = eColor_; }
    void SetLineColor( COLOR eColor_ )      { m_uLineColor = eColor_; }
    void SetFillColor( COLOR eColor_ )      { m_uFillColor = eColor_; }
    void SetTextColor( COLOR eColor_ )      { m_uTextColor = eColor_; }
    void SetActiveColor( COLOR eColor_ )    { m_uActiveColor = eColor_; }

    void SetFont( Font_t *pstFont_ )        { m_pstFont = pstFont_; }

    void SetCaption( const K_CHAR *szCaption_ )     { m_szCaption = szCaption_;}

    void SetCallback( ButtonCallback pfCallback_, void *pvData_ )
        { m_pfCallback = pfCallback_; m_pvCallbackData = pvData_; }
private:

    const K_CHAR *m_szCaption;
    Font_t *m_pstFont;
    COLOR   m_uBGColor;
    COLOR   m_uActiveColor;
    COLOR   m_uLineColor;
    COLOR   m_uFillColor;
    COLOR   m_uTextColor;
    bool    m_bState;

    void *m_pvCallbackData;
    ButtonCallback m_pfCallback;
};


#endif

```

17.13 /home/mo/mark3-source/embedded/stage/src/control_checkbox.cpp File Reference

Checkbox Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"
#include "control_checkbox.h"
```

Macros

- #define **TEXT_X_OFFSET** (13)

Variables

- static const K_UCHAR **aucBox** []
- static const K_UCHAR **aucCheck** []

17.13.1 Detailed Description

Checkbox Control. A binary On/Off switch control

Definition in file control_checkbox.cpp.

17.13.2 Variable Documentation

17.13.2.1 const K_UCHAR aucBox[ ] [static]

Initial value:

```
=
{ 0x7E,
  0x81,
  0x81,
  0x81,
  0x81,
  0x81,
  0x81,
  0x7E }
```

Definition at line 31 of file control_checkbox.cpp.

17.13.2.2 const K_UCHAR aucCheck[ ] [static]

Initial value:

```
=
{ 0,
  0,
  0x3C,
  0x3C,
  0x3C,
  0x3C,
  0,
  0 }
```

Definition at line 42 of file control_checkbox.cpp.

17.14 control_checkbox.cpp

```
00001 /*===========================================================================
00002      _____     _____     _____     _____
00003  ___|    _|__ __|_    |__ __|__   |__ __| __  |__ ______
00004 |    \  /  | ||    \    ||     |    ||  |/ /     ||___   |
00005 |     \/   | ||     \   ||     \    ||     \     ||___   |
00006 |__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||______|
00007     |_____|      |_____|      |_____|      |_____|
00008
00009 --[Mark3 Realtime Platform]--------------------------------------------------
00010
00011 Copyright (c) 2012 Funkenstein Software Consulting, all rights reserved.
00012 See license.txt for more information
00013 ===========================================================================*/
00021 #include "gui.h"
00022 #include "kerneltypes.h"
00023 #include "draw.h"
00024 #include "font.h"
00025 #include "control_checkbox.h"
00026
00027 //---------------------------------------------------------------------------
00028 #define TEXT_X_OFFSET        (13)
00029
00030 //---------------------------------------------------------------------------
00031 static const K_UCHAR aucBox[] =
00032 { 0x7E,
00033   0x81,
00034   0x81,
00035   0x81,
00036   0x81,
00037   0x81,
00038   0x81,
00039   0x7E };
00040
00041 //---------------------------------------------------------------------------
00042 static const K_UCHAR aucCheck[] =
00043 { 0,
00044   0,
00045   0x3C,
00046   0x3C,
00047   0x3C,
00048   0x3C,
00049   0,
00050   0 };
00051
00052 //---------------------------------------------------------------------------
00053 void CheckBoxControl::Init()
```

```
{
    SetAcceptFocus(true);
}

//---------------------------------------------------------------------------
void CheckBoxControl::Draw()
{
    GraphicsDriver *pclDriver = GetParentWindow()->
  GetDriver();
    K_USHORT usX, usY;
    K_USHORT usTextWidth;

    GetControlOffset(&usX, &usY);

    // Draw the box, (and check, if necessary)
    {
        DrawRectangle_t stRect;

        if (GetParentWindow()->IsInFocus(this))
        {
            stRect.uLineColor = m_uActiveColor;
        }
        else
        {
            stRect.uLineColor = m_uBackColor;
        }

        stRect.uFillColor = m_uBackColor;
        stRect.usTop = usY + GetTop();
        stRect.usLeft = usX + GetLeft();
        stRect.usRight = stRect.usLeft + GetWidth() - 1;
        stRect.usBottom = stRect.usTop + GetHeight() - 1;
        stRect.bFill = true;
        pclDriver->Rectangle(&stRect);

        stRect.uLineColor = m_uBoxBGColor;
        stRect.uFillColor = m_uBoxBGColor;
        stRect.usTop = usY + GetTop() + ((GetHeight() - 5) >> 1) - 1;
        stRect.usLeft = usX + GetLeft() + 2;
        stRect.usRight = stRect.usLeft + 7;
        stRect.usBottom = stRect.usTop + 7;
        stRect.bFill = true;
        pclDriver->Rectangle(&stRect);
    }

    {
        DrawStamp_t stStamp;
        stStamp.uColor = m_uBoxColor;
        stStamp.usY = usY + GetTop() + ((GetHeight() - 5) >> 1) - 1;
        stStamp.usX = usX + GetLeft() + 2;
        stStamp.usWidth = 8;
        stStamp.usHeight = 8;
        stStamp.pucData = (K_UCHAR*)aucBox;
        pclDriver->Stamp(&stStamp);

        if (m_bChecked)
        {
            stStamp.pucData = (K_UCHAR*)aucCheck;
            pclDriver->Stamp(&stStamp);
        }
    }

    // Draw the caption
    {
        DrawText_t stText;
        stText.usLeft = usX + GetLeft() + TEXT_X_OFFSET;
        stText.usTop = usY + GetTop();
        stText.uColor = m_uFontColor;
        stText.pstFont = m_pstFont;
        stText.pcString = m_szCaption;

        usTextWidth = pclDriver->TextWidth(&stText);
        pclDriver->Text(&stText);
    }
}

//---------------------------------------------------------------------------
GuiReturn_t CheckBoxControl::ProcessEvent(
  GuiEvent_t *pstEvent_ )
{
    K_USHORT usXOffset, usYOffset;

    GetControlOffset(&usXOffset, &usYOffset);

    GUI_DEBUG_PRINT("ButtonControl::ProcessEvent\n");

    switch (pstEvent_->ucEventType)
    {
        case EVENT_TYPE_KEYBOARD:
        {
            // If this is a space bar or an enter key, behave like a mouse click.
            if ((KEYCODE_SPACE == pstEvent_->stKey.ucKeyCode) ||
                (KEYCODE_RETURN == pstEvent_->stKey.ucKeyCode))
            {
                if (pstEvent_->stKey.bKeyState)
                {
                    m_bChecked = true;
                }
                else
                {
                    m_bChecked = false;
                }
                SetStale();
            }
        }
            break;
        case EVENT_TYPE_MOUSE:
        {
            // Is this control currently in the "active"/pressed state?
            if (m_bChecked)
            {
                // Check to see if the movement is out-of-bounds based on the coordinates.
                // If so, de-activate the control
                if (pstEvent_->stMouse.bLeftState)
                {
                    if ((pstEvent_->stMouse.usX >= GetLeft() + usXOffset) &&
                        (pstEvent_->stMouse.usX < GetLeft() + usXOffset +
GetWidth()-1) &&
                        (pstEvent_->stMouse.usY >= GetTop() + usYOffset) &&
                        (pstEvent_->stMouse.usY < GetTop() + usYOffset +
GetHeight() - 1))
                    {
                        m_bChecked = false;
                        SetStale();
                    }
                }
            }
            else if (!m_bChecked)
            {
                // If we registered a down-click in the bounding box, set the state of the
                // control to activated.
                if (pstEvent_->stMouse.bLeftState)
                {
                    if ((pstEvent_->stMouse.usX >= GetLeft() + usXOffset) &&
                        (pstEvent_->stMouse.usX < GetLeft() + usXOffset +
GetWidth()-1) &&
                        (pstEvent_->stMouse.usY >= GetTop() + usYOffset) &&
                        (pstEvent_->stMouse.usY < GetTop() + usYOffset +
GetHeight() - 1))
                    {
                        m_bChecked = true;
                        SetStale();
                    }
                }
            }

            if (!IsInFocus())
            {
                GetParentWindow()->SetFocus(this);
                SetStale();
            }
        }
            break;
    }
}
```

17.15 /home/mo/mark3-source/embedded/stage/src/control_checkbox.h File Reference

Checkbox Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"
```

Classes

- class CheckBoxControl

17.15.1 Detailed Description

Checkbox Control. A binary On/Off switch control

Definition in file control_checkbox.h.

17.16 control_checkbox.h

```
/*==========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__  |__ __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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==========================================================================*/
#ifndef __CONTROL_CHECKBOX_H__
#define __CONTROL_CHECKBOX_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"

class CheckBoxControl : public GuiControl
{
public:
    virtual void Init();
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ );
    virtual void Activate( bool bActivate_ )  { SetStale(); }

    void SetFont( Font_t *pstFont_ )          { m_pstFont    = pstFont_; }
    void SetCaption( const char *szCaption_ ) { m_szCaption = szCaption_; }
    void SetCheck( bool bChecked_ )              { m_bChecked   = bChecked_; }
    void SetFontColor( COLOR uFontColor_ )    { m_uFontColor = uFontColor_; }
    void SetBoxColor( COLOR uBoxColor_ )      { m_uBoxColor  = uBoxColor_; }
    void SetBackColor( COLOR uBackColor_ )      { m_uBackColor = uBackColor_; }
    bool IsChecked( void )                       { return m_bChecked; }

private:
    const char *m_szCaption;
    COLOR m_uBackColor;
    COLOR m_uBoxColor;
    COLOR m_uFontColor;
    Font_t *m_pstFont;
    bool m_bChecked;
};

#endif

```

17.17 /home/mo/mark3-source/embedded/stage/src/control_gamepanel.cpp File Reference

GUI Panel Control Implementation with joystick control and tick-based state machine updates.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "graphics.h"
#include "control_gamepanel.h"
```

17.17.1 Detailed Description

GUI Panel Control Implementation with joystick control and tick-based state machine updates.

Definition in file control_gamepanel.cpp.

17.18 control_gamepanel.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "graphics.h"
#include "control_gamepanel.h"

//---------------------------------------------------------------------------
void GamePanelControl::Draw()
{
    // Game state machine goes here.
}

//---------------------------------------------------------------------------
GuiReturn_t GamePanelControl::ProcessEvent(
GuiEvent_t *pstEvent_ )
{
     K_USHORT usXOffset, usYOffset;

     switch (pstEvent_->ucEventType)
     {
         case EVENT_TYPE_TIMER:
             // Every tick, call Draw().  This is used to kick the state
             // machine
             SetStale();
             break;
         case EVENT_TYPE_KEYBOARD:
             break;
         case EVENT_TYPE_MOUSE:
             break;
         case EVENT_TYPE_JOYSTICK:
             m_stLastJoy.usRawData = m_stCurrentJoy.usRawData;
             m_stCurrentJoy.usRawData = pstEvent_->stJoystick.
usRawData;
             break;
     }
     return GUI_EVENT_OK;
}
```

17.19 /home/mo/mark3-source/embedded/stage/src/control_gamepanel.h File Reference

GUI Game Panel Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
```

Classes

- class GamePanelControl

17.19.1 Detailed Description

GUI Game Panel Control. A game panel is a blank UI element whose dimensions define the dimensions of a gameplay surface. The element triggers a draw() call on every tick event (which can be used to kick a game's state machine). The control also responds to joystick events, which can then be used to control the game.

Definition in file control_gamepanel.h.

17.20 control_gamepanel.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __CONTROL_GAMEPANEL_H__
#define __CONTROL_GAMEPANEL_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"

class GamePanelControl : public GuiControl
{
public:
    virtual void Init() { SetAcceptFocus(false); m_stCurrentJoy.usRawData = 0; m_stLastJoy.usRawData = 0;}
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ );
    virtual void Activate( bool bActivate_ ) {}

private:
    JoystickEvent_t m_stLastJoy;
    JoystickEvent_t m_stCurrentJoy;

};

#endif
```

17.21 /home/mo/mark3-source/embedded/stage/src/control_groupbox.cpp File Reference

GUI GroupBox Control Implementation.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "graphics.h"
#include "control_groupbox.h"
```

Macros

- #define **BORDER_OFFSET** (4)
- #define **TEXT_X_OFFSET** (8)
- #define **TEXT_Y_OFFSET** (0)

17.21.1 Detailed Description

GUI GroupBox Control Implementation.

Definition in file control_groupbox.cpp.

17.22 control_groupbox.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "graphics.h"
#include "control_groupbox.h"

#define BORDER_OFFSET           (4)
#define TEXT_X_OFFSET           (8)
#define TEXT_Y_OFFSET           (0)

//---------------------------------------------------------------------------
void GroupBoxControl::Draw()
{
    GUI_DEBUG_PRINT( "GroupBoxControl::Draw()\n");
    GraphicsDriver *pclDriver = GetParentWindow()->
GetDriver();
    K_USHORT usX, usY;
    K_USHORT usTextWidth;

    GetControlOffset(&usX, &usY);

    // Draw the background panel
    {
        DrawRectangle_t stRectangle;
        stRectangle.usTop = GetTop() + usY;
        stRectangle.usBottom = stRectangle.usTop + GetHeight() -1;
        stRectangle.usLeft = GetLeft() + usX;
        stRectangle.usRight = stRectangle.usLeft + GetWidth() -1;
        stRectangle.bFill = true;
        stRectangle.uLineColor = m_uPanelColor;
        stRectangle.uFillColor = m_uPanelColor;

        pclDriver->Rectangle(&stRectangle);
    }

    // Draw the caption
    {
        DrawText_t stText;
        stText.usLeft = usX + TEXT_X_OFFSET;
        stText.usTop = usY + TEXT_Y_OFFSET;
        stText.uColor = m_uFontColor;
        stText.pstFont = m_pstFont;
        stText.pcString = m_pcCaption;

        usTextWidth = pclDriver->TextWidth(&stText);
        pclDriver->Text(&stText);
    }

    // Draw the lines surrounding the panel
    {
        DrawLine_t stLine;

        stLine.uColor = m_uLineColor;
        stLine.usY1 = GetTop() + usY + BORDER_OFFSET;
        stLine.usY2 = GetTop() + usY + GetHeight() - BORDER_OFFSET - 1;
        stLine.usX1 = usX + BORDER_OFFSET;
        stLine.usX2 = usX + BORDER_OFFSET;
        pclDriver->Line(&stLine);

        stLine.usY1 = GetTop() + usY + BORDER_OFFSET;
        stLine.usY2 = GetTop() + usY + GetHeight() - BORDER_OFFSET - 1;
        stLine.usX1 = usX + GetWidth() - BORDER_OFFSET - 1;
        stLine.usX2 = usX + GetWidth() - BORDER_OFFSET - 1;
        pclDriver->Line(&stLine);

        stLine.usY1 = GetTop() + usY + GetHeight() - BORDER_OFFSET - 1;
        stLine.usY2 = GetTop() + usY + GetHeight() - BORDER_OFFSET - 1;
        stLine.usX1 = usX + BORDER_OFFSET;
        stLine.usX2 = usX + GetWidth() - BORDER_OFFSET - 1;
        pclDriver->Line(&stLine);

        stLine.usY1 = GetTop() + BORDER_OFFSET - 1;
        stLine.usY2 = GetTop() + BORDER_OFFSET - 1;
        stLine.usX1 = usX + BORDER_OFFSET;
        stLine.usX2 = usX + TEXT_X_OFFSET - 2;
        pclDriver->Line(&stLine);

        stLine.usX1 = usX + TEXT_X_OFFSET + usTextWidth;
        stLine.usX2 = usX + GetWidth() - BORDER_OFFSET - 1;
        pclDriver->Line(&stLine);
    }


}
```

17.23 /home/mo/mark3-source/embedded/stage/src/control_groupbox.h File Reference

GUI Group Box Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
```

Classes

- class GroupBoxControl

17.23.1 Detailed Description

GUI Group Box Control. A groupbox control is essentially a panel with a text caption, and a lined border.

Definition in file control_groupbox.h.

17.24 control_groupbox.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \    ||     |    ||  |/ /    ||___   |
|     \/   | ||     \   ||     \    ||     \    ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||_____|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __CONTROL_GROUPBOX_H__
```

```
#define __CONTROL_GROUPBOX_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"

class GroupBoxControl : public GuiControl
{
public:
    virtual void Init() { m_uLineColor = COLOR_BLACK;
                          m_uFontColor = COLOR_GREY25;
                          m_uPanelColor = COLOR_GREY75;
                          SetAcceptFocus(false); }
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ ) {};
    virtual void Activate( bool bActivate_ ) {}

    void SetPanelColor( COLOR eColor_ ) { m_uPanelColor = eColor_; }
    void SetLineColor( COLOR eColor_ ) { m_uLineColor = eColor_; }
    void SetFontColor( COLOR eColor_ ) { m_uFontColor = eColor_; }
    void SetFont( Font_t *pstFont_ ) { m_pstFont = pstFont_; }
    void SetCaption( const K_CHAR *pcCaption_ ) { m_pcCaption = pcCaption_; }
private:
    COLOR m_uPanelColor;
    COLOR m_uLineColor;
    COLOR m_uFontColor;

    Font_t *m_pstFont;
    const K_CHAR *m_pcCaption;
};

#endif

```

17.25 /home/mo/mark3-source/embedded/stage/src/control_label.h File Reference

GUI Label Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"
```

Classes

- class LabelControl

17.25.1 Detailed Description

GUI Label Control. A label control is a static text eliment, specified by a font, a color, and a string to overlay at a given location.

Definition in file control_label.h.

17.26 control_label.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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```

```
===========================================================================*/
#ifndef __CONTROL_LABEL_H__
#define __CONTROL_LABEL_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"

class LabelControl : public GuiControl
{
public:
    virtual void Init() { m_uBackColor = COLOR_BLACK;
                         m_uFontColor = COLOR_WHITE;
                         m_pstFont = NULL;
                         m_pcCaption = "";
                         SetAcceptFocus(false); }
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ ) {}
    virtual void Activate( bool bActivate_ ) {}

    void SetBackColor( COLOR eColor_ )             { m_uBackColor = eColor_; }
    void SetFontColor( COLOR eColor_ )             { m_uFontColor = eColor_; }
    void SetFont( Font_t *pstFont_ )             { m_pstFont = pstFont_; }
    void SetCaption( const K_CHAR *pcData_ )     { m_pcCaption = pcData_; }

private:
    Font_t *m_pstFont;
    const K_CHAR *m_pcCaption;
    COLOR m_uBackColor;
    COLOR m_uFontColor;

};

#endif

```

17.27 /home/mo/mark3-source/embedded/stage/src/control_notification.cpp File Reference

Notification pop-up control.

```
#include "control_notification.h"
#include "kerneltypes.h"
```

17.27.1 Detailed Description

Notification pop-up control. A pop-up control that can be used to present the user with information about system state changes, events, etc.

Definition in file control_notification.cpp.

17.28 control_notification.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "control_notification.h"
#include "kerneltypes.h"

//---------------------------------------------------------------------------
```

```
void NotificationControl::Draw()
{
    if (!m_bVisible)
    {
        return;
    }

    DrawRectangle_t stRect;
    DrawLine_t stLine;
    DrawText_t stText;

    GraphicsDriver *pclDriver = GetParentWindow()->
GetDriver();

    K_USHORT usXOffset = 0;
    K_USHORT usHalfWidth = 0;
    K_USHORT usYOffset = 0;

    // Get the location of the control relative to elements higher in the heirarchy
    GetControlOffset(&usXOffset, &usYOffset);

    // Draw the rounded-off rectangle
    stLine.usX1 = GetLeft() + usXOffset + 1;
    stLine.usX2 = stLine.usX1 + GetWidth() - 3;
    stLine.usY1 = GetTop() + usYOffset;
    stLine.usY2 = stLine.usY1;
    stLine.uColor = COLOR_WHITE;
    pclDriver->Line(&stLine);

    stLine.usY1 = GetTop() + usYOffset + GetHeight() - 1;
    stLine.usY2 = stLine.usY1;
    pclDriver->Line(&stLine);

    // Draw the rounded-off rectangle
    stLine.usX1 = GetLeft() + usXOffset ;
    stLine.usX2 = stLine.usX1;

    stLine.usY1 = GetTop() + usYOffset + 1;
    stLine.usY2 = stLine.usY1 + GetHeight() - 3;
    pclDriver->Line(&stLine);

    // Draw the rounded-off rectangle
    stLine.usX1 = GetLeft() + usXOffset + GetWidth() - 1;
    stLine.usX2 = stLine.usX1;
    pclDriver->Line(&stLine);

    stRect.usTop = GetTop() + usYOffset + 1;
    stRect.usBottom = stRect.usTop + GetHeight() - 3;
    stRect.usLeft = GetLeft() + usXOffset + 1;
    stRect.usRight = stRect.usLeft + GetWidth() - 3;
    stRect.bFill = true;
    stRect.uFillColor = COLOR_BLACK;
    stRect.uLineColor = COLOR_BLACK;
    pclDriver->Rectangle(&stRect);

    // Draw the Text
    stText.pstFont = m_pstFont;
    stText.pcString = m_szCaption;
    stText.uColor = COLOR_WHITE;
    usHalfWidth = pclDriver->TextWidth(&stText);
    usHalfWidth >>= 1;
    stText.usLeft = GetLeft() + (GetWidth()>>1) - usHalfWidth + usXOffset;
    stText.usTop = GetTop() + usYOffset;
    pclDriver->Text(&stText);
}

//---------------------------------------------------------------------------
GuiReturn_t NotificationControl::ProcessEvent(
GuiEvent_t *pstEvent_ )
{

    switch (pstEvent_->ucEventType)
    {
        case EVENT_TYPE_TIMER:
        {
            if (m_bTrigger && m_usTimeout)
            {
                m_usTimeout--;

                if (!m_usTimeout)
                {
                    m_bVisible = false;
                    m_bTrigger = false;
                    SetStale();

                    K_USHORT usX, usY;
                    GetControlOffset(&usX, &usY);

                    GetParentWindow()->InvalidateRegion(
GetLeft() + usX, GetTop() + usY, GetWidth(), GetHeight());
                }
            }

            break;
        }
        default:
            break;
    }
}
```

17.29 /home/mo/mark3-source/embedded/stage/src/control_notification.h File Reference

Notification pop-up control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
```

Classes

- class NotificationControl

17.29.1 Detailed Description

Notification pop-up control. A pop-up control that can be used to present the user with information about system state changes, events, etc.

Definition in file control_notification.h.

17.30 control_notification.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __CONTROL_NOTIFICATION_H__
#define __CONTROL_NOTIFICATION_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"

class NotificationControl : public GuiControl
{
public:
    virtual void Init()
    {
        SetAcceptFocus(false);
        m_szCaption = "";
        m_pstFont = NULL;
        m_bVisible = true;
        m_bTrigger = false;
    }

    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ );
    virtual void Activate( bool bActivate_ ) {}

    void SetFont( Font_t *pstFont_ ) { m_pstFont = pstFont_; }
    void SetCaption( const K_CHAR *szCaption_ ) { m_szCaption = szCaption_; }

    void Trigger( K_USHORT usTimeout_ )
    {
        m_usTimeout = usTimeout_;
        m_bTrigger = true;
        m_bVisible = true;
        SetStale();
    }

private:
    const K_CHAR * m_szCaption;
    Font_t *m_pstFont;
    K_USHORT m_usTimeout;
    bool m_bTrigger;
    bool m_bVisible;
};

#endif

```

17.31 /home/mo/mark3-source/embedded/stage/src/control_panel.cpp File Reference

GUI Panel Control Implementation.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "graphics.h"
#include "control_panel.h"
```

17.31.1 Detailed Description

GUI Panel Control Implementation.

Definition in file control_panel.cpp.

17.32 control_panel.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "graphics.h"
#include "control_panel.h"

//---------------------------------------------------------------------------
void PanelControl::Draw()
{
    GUI_DEBUG_PRINT( "PanelControl::Draw()\n");
    GraphicsDriver *pclDriver = GetParentWindow()->
GetDriver();
    DrawRectangle_t stRectangle;
    K_USHORT usX, usY;

    GetControlOffset(&usX, &usY);

    stRectangle.usTop = GetTop() + usY;
    stRectangle.usBottom = stRectangle.usTop + GetHeight() -1;
    stRectangle.usLeft = GetLeft() + usX;
    stRectangle.usRight = stRectangle.usLeft + GetWidth() -1;
    stRectangle.bFill = true;
    stRectangle.uLineColor = m_uColor;
    stRectangle.uFillColor = m_uColor;

    pclDriver->Rectangle(&stRectangle);
}
```

17.33 /home/mo/mark3-source/embedded/stage/src/control_panel.h File Reference

GUI Panel Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
```

Classes

- class PanelControl

17.33.1 Detailed Description

GUI Panel Control. The "panel" is probably the simplest control that can be implemented in a GUI. It serves as a dock for other controls, and also as an example for implementing more complex controls.

A panel is essentially a flat rectangle, specified by a control's typical top/left/height/width parameters, and a color value.

Definition in file control_panel.h.

17.34 control_panel.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __CONTROL_PANEL_H__
#define __CONTROL_PANEL_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"

class PanelControl : public GuiControl
{
public:
    virtual void Init() { m_uColor = COLOR_BLACK; SetAcceptFocus(false); }
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ ) {};
    virtual void Activate( bool bActivate_ ) {}

    void SetColor( COLOR eColor_ ) { m_uColor = eColor_; }

private:
    COLOR m_uColor;
};

#endif

```

17.35 /home/mo/mark3-source/embedded/stage/src/control_progress.cpp File Reference

GUI Progress Bar Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "control_progress.h"
```

17.35.1 Detailed Description

GUI Progress Bar Control. A simple progress bar control using lines and rectangles to display the status of an operation from initialization to completion

Definition in file control_progress.cpp.

17.36 control_progress.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "control_progress.h"

//---------------------------------------------------------------------------
void ProgressControl::Init()
{
    m_uBackColor = COLOR_BLACK;
    m_uBorderColor = COLOR_GREY75;
    m_uProgressColor = COLOR_GREEN;
    SetAcceptFocus(false);
}

//---------------------------------------------------------------------------
void ProgressControl::Draw()
{
    GraphicsDriver *pclDriver = GetParentWindow()->
GetDriver();
    DrawRectangle_t stRect;
    DrawLine_t stLine;

    K_USHORT usX, usY;
    K_USHORT usProgressWidth;

    GetControlOffset(&usX, &usY);

    // Draw the outside of the progress bar region
    stLine.uColor = m_uBorderColor;
    stLine.usX1 = usX + GetLeft() + 1;
    stLine.usX2 = usX + GetLeft() + GetWidth() - 2;
    stLine.usY1 = usY + GetTop();
    stLine.usY2 = usY + GetTop();
    pclDriver->Line(&stLine);

    stLine.usY1 = usY + GetTop() + GetHeight() - 1;
    stLine.usY2 = usY + GetTop() + GetHeight() - 1;
    pclDriver->Line(&stLine);

    stLine.usY1 = usY + GetTop() + 1;
    stLine.usY2 = usY + GetTop() + GetHeight() - 2;
    stLine.usX1 = usX + GetLeft();
    stLine.usX2 = usX + GetLeft();
    pclDriver->Line(&stLine);

    stLine.usX1 = usX + GetLeft() + GetWidth() - 1;
    stLine.usX2 = usX + GetLeft() + GetWidth() - 1;
    pclDriver->Line(&stLine);

    // Draw the "completed" portion
    usProgressWidth = (K_USHORT)( ( ( ( (K_ULONG)m_ucProgress) * (GetWidth()-2) ) + 50 ) / 100);
    stRect.usTop = usY + GetTop() + 1;
    stRect.usBottom = usY + GetTop() + GetHeight() - 2;
    stRect.usLeft = usX + GetLeft() + 1;
    stRect.usRight = stRect.usLeft + usProgressWidth - 1;
    stRect.bFill = true;
    stRect.uLineColor = m_uProgressColor;
    stRect.uFillColor = m_uProgressColor;
    pclDriver->Rectangle(&stRect);

    // Draw the "incomplete" portion
    stRect.usLeft = stRect.usRight + 1;
    stRect.usRight = usX + GetLeft() + GetWidth() - 2;
    stRect.bFill = true;
    stRect.uLineColor = m_uBackColor;
    stRect.uFillColor = m_uBackColor;
    pclDriver->Rectangle(&stRect);

}

//---------------------------------------------------------------------------
void ProgressControl::SetProgress( K_UCHAR ucProgress_ )
{
    m_ucProgress = ucProgress_;
    if (m_ucProgress > 100)
    {
        m_ucProgress;
    }
    SetStale();
}

//---------------------------------------------------------------------------
GuiReturn_t ProgressControl::ProcessEvent( GuiEvent_t *pstEvent_)
{
    return GUI_EVENT_OK;
}
```

17.37 /home/mo/mark3-source/embedded/stage/src/control_progress.h File Reference

GUI Progress Bar Control.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"
```

Classes

- class ProgressControl

17.37.1 Detailed Description

GUI Progress Bar Control. A simple progress bar control using lines and rectangles to display the status of an operation from initialization to completion

Definition in file control_progress.h.

17.38 control_progress.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __CONTROL_PROGRESS_H__
#define __CONTROL_PROGRESS_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"

class ProgressControl : public GuiControl
{
public:
    virtual void Init();
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ );
    virtual void Activate( bool bActivate_ ) {}

    void SetBackColor( COLOR eColor_ )      { m_uBackColor = eColor_; }
    void SetProgressColor( COLOR eColor_ )  { m_uProgressColor = eColor_; }
    void SetBorderColor( COLOR eColor_ )    { m_uBorderColor = eColor_; }

    void SetProgress( K_UCHAR ucProgress_ );

private:
    COLOR m_uBackColor;
    COLOR m_uProgressColor;
    COLOR m_uBorderColor;
    K_UCHAR m_ucProgress;
};

#endif
```

17.39 /home/mo/mark3-source/embedded/stage/src/control_slickbutton.h File Reference

GUI Button Control, with a flare.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"
```

Classes

- class SlickButtonControl

Typedefs

- typedef void(∗ **ButtonCallback**)(void ∗pvData_)

17.39.1 Detailed Description

GUI Button Control, with a flare. Basic pushbutton control with an up/down state, and Mark3 visual style

Definition in file control_slickbutton.h.

17.40 control_slickbutton.h

```

/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __CONTROL_SLICKBUTTON_H__
#define __CONTROL_SLICKBUTTON_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"

typedef void (*ButtonCallback)( void *pvData_ );

class SlickButtonControl : public GuiControl
{
public:

    virtual void Init();
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ );
    virtual void Activate( bool bActivate_ );

    void SetFont( Font_t *pstFont_ )        { m_pstFont = pstFont_; }

    void SetCaption( const K_CHAR *szCaption_ )     { m_szCaption = szCaption_;}

    void SetCallback( ButtonCallback pfCallback_, void *pvData_ )
        { m_pfCallback = pfCallback_; m_pvCallbackData = pvData_; }
private:

    const K_CHAR *m_szCaption;
    Font_t *m_pstFont;
    bool    m_bState;
    K_UCHAR m_ucTimeout;

    void *m_pvCallbackData;
    ButtonCallback m_pfCallback;
};


#endif

```

17.41 /home/mo/mark3-source/embedded/stage/src/control_slickprogress.cpp File Reference

GUI Progress Bar Control, with flare.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "control_slickprogress.h"
```

17.41.1 Detailed Description

GUI Progress Bar Control, with flare. A simple progress bar control using lines and rectangles to display the status of an operation from initialization to completion

Definition in file control_slickprogress.cpp.

17.42 control_slickprogress.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "control_slickprogress.h"

//---------------------------------------------------------------------------
void SlickProgressControl::Init()
{
    SetAcceptFocus(false);
}

//---------------------------------------------------------------------------
void SlickProgressControl::Draw()
{
    GraphicsDriver *pclDriver = GetParentWindow()->
GetDriver();
    DrawRectangle_t stRect;
    DrawLine_t stLine;

    K_USHORT usX, usY;
    K_USHORT usProgressWidth;

    GetControlOffset(&usX, &usY);

    // Draw the outside of the progress bar region
    stLine.uColor = COLOR_GREY50;
    stLine.usX1 = usX + GetLeft() + 1;
    stLine.usX2 = usX + GetLeft() + GetWidth() - 2;
    stLine.usY1 = usY + GetTop();
    stLine.usY2 = usY + GetTop();
    pclDriver->Line(&stLine);

    stLine.usY1 = usY + GetTop() + GetHeight() - 1;
    stLine.usY2 = usY + GetTop() + GetHeight() - 1;
    pclDriver->Line(&stLine);

    stLine.usY1 = usY + GetTop() + 1;
    stLine.usY2 = usY + GetTop() + GetHeight() - 2;
    stLine.usX1 = usX + GetLeft();
    stLine.usX2 = usX + GetLeft();
    pclDriver->Line(&stLine);

    stLine.usX1 = usX + GetLeft() + GetWidth() - 1;
    stLine.usX2 = usX + GetLeft() + GetWidth() - 1;
    pclDriver->Line(&stLine);

    // Draw the "completed" portion
    usProgressWidth = (K_USHORT)( ( ( ( (K_ULONG)m_ucProgress) * (GetWidth()-2) ) + 50 ) / 100);
    stRect.usTop = usY + GetTop() + 1;
    stRect.usBottom = usY + GetTop() + ((GetHeight() - 1) / 2);
    stRect.usLeft = usX + GetLeft() + 1;
    stRect.usRight = stRect.usLeft + usProgressWidth - 1;
    stRect.bFill = true;
    stRect.uLineColor = RGB_COLOR( 0, (K_UCHAR)(MAX_GREEN * 0.85), (K_UCHAR)(MAX_BLUE * 0.25));
    stRect.uFillColor = stRect.uLineColor;
    pclDriver->Rectangle(&stRect);

    stRect.usTop = stRect.usBottom + 1;
    stRect.usBottom = usY + GetTop() + GetHeight() - 2;
    stRect.uLineColor = RGB_COLOR( 0, (K_ULONG)(MAX_GREEN * 0.75), (K_ULONG)(MAX_BLUE * 0.20));
    stRect.uFillColor = stRect.uLineColor;
    pclDriver->Rectangle(&stRect);

    // Draw the "incomplete" portion
    stRect.usTop = usY + GetTop() + 1;
    stRect.usBottom = usY + GetTop() + GetHeight() - 2;
    stRect.usLeft = stRect.usRight + 1;
    stRect.usRight = usX + GetLeft() + GetWidth() - 2;
    stRect.bFill = true;
    stRect.uLineColor = RGB_COLOR( (K_ULONG)(MAX_RED * 0.10), (K_ULONG)(MAX_GREEN * 0.10), (
      K_ULONG)(MAX_BLUE * 0.10));
    stRect.uFillColor = stRect.uLineColor;
    pclDriver->Rectangle(&stRect);

}

//---------------------------------------------------------------------------
void SlickProgressControl::SetProgress( K_UCHAR ucProgress_ )
{
    m_ucProgress = ucProgress_;
    if (m_ucProgress > 100)
    {
        m_ucProgress;
    }
    SetStale();
}

//---------------------------------------------------------------------------
GuiReturn_t SlickProgressControl::ProcessEvent(
GuiEvent_t *pstEvent_)
{
    return GUI_EVENT_OK;
}
```

17.43 /home/mo/mark3-source/embedded/stage/src/control_slickprogress.h File Reference

GUI Progress Bar Control, with flare.

```
#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"
```

Classes

- class SlickProgressControl

17.43.1 Detailed Description

GUI Progress Bar Control, with flare. A simple progress bar control using lines and rectangles to display the status of an operation from initialization to completion

Definition in file control_slickprogress.h.

17.44 control_slickprogress.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]--------------------------------------------------
```

```
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===========================================================================*/
#ifndef __CONTROL_SLICKPROGRESS_H__
#define __CONTROL_SLICKPROGRESS_H__

#include "gui.h"
#include "kerneltypes.h"
#include "draw.h"
#include "font.h"

class SlickProgressControl : public GuiControl
{
public:
    virtual void Init();
    virtual void Draw();
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ );
    virtual void Activate( bool bActivate_ ) {}

    void SetProgress( K_UCHAR ucProgress_ );

private:
    K_UCHAR m_ucProgress;
};

#endif
```

17.45 /home/mo/mark3-source/embedded/stage/src/dcpu.cpp File Reference

Portable DCPU-16 CPU emulator.

```
#include "dcpu.h"
#include "kerneltypes.h"
#include "ll.h"
```

Macros

- #define **CORE_DEBUG** 0
- #define **DBG_PRINT**(...)

Variables

- static const K_UCHAR aucBasicOpcodeCycles []

  Define the number of cycles that each "basic" opcode takes to execute.
- static const K_UCHAR aucExtendedOpcodeCycles []

  Define the number of cycles that each "extended" opcode takes to execute.

17.45.1 Detailed Description

Portable DCPU-16 CPU emulator. The DCPU-16 is the in-game CPU used in the upcoming game 0x10^c, from the creators of the wildly successful Minecraft. While the DCPU is supposed to be part of the game, it has serious potential for use in all sorts of embedded applications.

The fact that DCPU is a very lightweight VM to implement and contains built-in instructions for accessing hardware peripheras and handling external interrupts lends itself to being used on microcontrollers.

Unlike a lot of embedded CPUs, DCPU-16 assembly is extremely simple to learn, since it has a very limited number of opcodes (37), each of which provide the same register/memory addressing modes for all operands. There are also only 2 opcode formats which make interpreting opcodes very efficient.

The DCPU-16 is extended using a variable number of "external hardware devices" which communicate with the CPU core using interrupts. These devices are enumerated on startup, and since there is no defined format for how these devices work, we can hijack this interface to provide a way for the DCPU to access resources supplied by the OS (i.e Timers, Drivers), or the hardware directly. This also lends itself to inter-VM communications (multiple DCPUs communicating with eachother in different OS threads). There's an immense amount of flexibility here - applications from debugging to scripting to runtime-configuration are all easily supported by this machine.

But what is a platform without tools support? Fortunately, the hype around 0x10c is building - and a development community for this platform has grown immensely. There are a number of compilers, assemblers, and IDEs, many of which support virtualized hardware extensions. One of the compilers is a CLANG/LLVM backend, which should allow for very good C language support.

I had attempted to do something similar by creating a VM based on the 8051 (see the Funk51 project on source-forge), but that project was at least four times as large - and the tools support was very spotty. There were C compilers, but there was a lot of shimming required to produce output that was suitable for the VM. Also, the lack of a native host interface (interrupts, hardware bus enumerations, etc.) forced a non-standard approach to triggering native methods by writing commands to a reserved chunk of memory and writing to a special "trigger" address to invoke the native system. Using a DCPU-16 based simulator addresses this in a nice, clean way by providing modern tools, and a VM infrastruture tailored to be interfaced with a host.

Regarding this version of the DCPU emulator - it's very simple to use. Program binaries are loaded into buffers in the host CPU's RAM, with the host also providing a separate buffer for DCPU RAM. The size of the DCPU RAM buffer will contain both the RAM area, as well as the program stack, so care must be taken to ensure that the stack doesn't overflow. The DCPU specification allows for 64K words (128KB) of RAM and ROM each, but this implementation allows us to tailor the CPU for more efficient or minimal environments.

In the future, this emulator will be extended to provide a mechanism to allow programs to be run out of flash, EEPROM, or other interfaces via the Mark3 Drivers API.

Once the program has been loaded into the host's address space, the DCPU class can be initialized.

```
// Use 16-bit words for 16-bit emulator.
K_USHORT ausRAM[ RAM_SIZE ];
K_USHORT ausROM[ ROM_SIZE ];
{
    class DCPU clMyDCPU;

    // Read program code into ausROM buffer here

    // Initialize the DCPU emulator
    clMyDCPU.Init( ausROM, RAM_SIZE, ausROM, ROM_SIZE );
}
```

Once the emulator has been initialized, the VM can be run one opcode at a time, as in the following example.

```
while(1)
{
    clMyCPU.RunOpcode();
}
```

To inspect the contents of the VM's registers, call the GetRegisters() method. This is useful for printing the CPU state on a regular basis, or using the PC value to determine when to end execution, or to provide an offset for disassembling the current opcode.

```
DCPU_Registers *pstRegisters;
pstRegisters = clMyCPU.GetRegisters();
```

Definition in file dcpu.cpp.

17.46 dcpu.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]--------------------------------------------------

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===========================================================================*/
#include "dcpu.h"
#include "kerneltypes.h"
#include "ll.h"

#define CORE_DEBUG 0

//---------------------------------------------------------------------------
#if CORE_DEBUG

  #include <stdio.h>
  #include <string.h>
  #include <stdlib.h>

  #define DBG_PRINT(...)        printf(__VA_ARGS__)
#else
  #define DBG_PRINT(...)
#endif

//---------------------------------------------------------------------------
static const K_UCHAR aucBasicOpcodeCycles[] =
{
    0,        // OP_NON_BASIC = 0
    1,        // OP_SET
    2,        // OP_ADD
    2,        // OP_SUB
    2,        // OP_MUL
    2,        // OP_MLI
    3,        // OP_DIV
    3,        // OP_DVI,
    3,        // OP_MOD,
    3,        // OP_MDI,
    1,        // OP_AND,
    1,        // OP_BOR,
    1,        // OP_XOR,
    1,        // OP_SHR,
    1,        // OP_ASR,
    1,        // OP_SHL,
    2,        // OP_IFB,
    2,        // OP_IFC,
    2,        // OP_IFE,
    2,        // OP_IFN,
    2,        // OP_IFG,
    2,        // OP_IFA,
    2,        // OP_IFL,
    2,        // OP_IFU,
    0,        // OP_18,
    0,        // OP_19,
    3,        // OP_ADX,
    3,        // OP_SBX,
    0,        // OP_1C,
    0,        // OP_1D,
    2,        // OP_STI,
    2,        // OP_STD
};

//---------------------------------------------------------------------------
static const K_UCHAR aucExtendedOpcodeCycles[] =
{
    0,    // "RESERVED",
    3,    // "JSR",
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    4,    // "INT",
    1,    // "IAG",
    1,    // "IAS",
    3,    // "RFI",
    2,    // "IAQ",
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    2,    // "HWN",
    4,    // "HWQ",
    4,    // "HWI",
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,    // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
    0,     // "UNDEFINED"
};

//---------------------------------------------------------------------------
void DCPU::SET()
{
    DBG_PRINT("SET\n");
    *b = *a;
}

//---------------------------------------------------------------------------
void DCPU::ADD()
{
    K_ULONG ulTemp;
    DBG_PRINT("ADD\n");

    ulTemp = (K_ULONG)*a + (K_ULONG)*b;
    if (ulTemp >= 65536)
    {
        m_stRegisters.EX = 0x0001;
    }
    else
    {
        m_stRegisters.EX = 0;
    }

    *b = *b + *a;
}

//---------------------------------------------------------------------------
void DCPU::SUB()
{
    K_LONG lTemp;
    DBG_PRINT("SUB\n");

    lTemp = (K_LONG)*b - (K_LONG)*a;
    if (lTemp < 0)
    {
        m_stRegisters.EX = 0xFFFF;
    }
    else
    {
        m_stRegisters.EX = 0;
    }

    *b = *b - *a;
}

//---------------------------------------------------------------------------
void DCPU::MUL()
{
    K_ULONG ulTemp;

    DBG_PRINT("MUL\n");
    ulTemp = (((K_ULONG)*a * (K_ULONG)*b));
    m_stRegisters.EX = (K_USHORT)(ulTemp >> 16);
    *b = (K_USHORT)(ulTemp & 0x0000FFFF);
}

//---------------------------------------------------------------------------
void DCPU::MLI()
{
    K_LONG lTemp;

    DBG_PRINT("MLI\n");
    lTemp = ((K_LONG)(*(K_SHORT*)a) * (K_LONG)(*(K_SHORT*)b));
    m_stRegisters.EX = (K_USHORT)(lTemp >> 16);
    *b = (K_USHORT)(lTemp & 0x0000FFFF);
}

//---------------------------------------------------------------------------
void DCPU::DIV()
{
    K_USHORT usTemp;

    DBG_PRINT("DIV\n");
    if (*a == 0)
    {
        *b = 0;
        m_stRegisters.EX = 0;
    }
    else
    {
        usTemp = (K_USHORT)((((K_ULONG)*b) << 16) / (K_ULONG)*a);
        *b = *b / *a;
        m_stRegisters.EX = usTemp;
    }
}

//---------------------------------------------------------------------------
void DCPU::DVI()
{
    K_USHORT usTemp;

    DBG_PRINT("DVI\n");
    if (*a == 0)
    {
        *b = 0;
        m_stRegisters.EX = 0;
    }
    else
    {
        usTemp = (K_USHORT)((((K_LONG)*((K_SHORT*)b)) << 16) / (K_LONG)(*(K_SHORT*)
a));
        *b = (K_USHORT)(*(K_SHORT*)b / *(K_SHORT*)a);
        m_stRegisters.EX = usTemp;

    }
}

//---------------------------------------------------------------------------
void DCPU::MOD()
{
    DBG_PRINT("MOD\n");
    if (*a == 0)
    {
        *b = 0;
    }
    else
    {
        *b = *b % *a;
    }
}

//---------------------------------------------------------------------------
void DCPU::MDI()
{
    DBG_PRINT("MDI\n");
    if (*b == 0)
    {
        *a = 0;
    }
    else
    {
        *b = (K_USHORT)(*((K_SHORT*)b) % *((K_SHORT*)a));
    }
}

//---------------------------------------------------------------------------
void DCPU::AND()
{
    DBG_PRINT("AND\n");
    *b = *b & *a;
}

//---------------------------------------------------------------------------
void DCPU::BOR()
{
    DBG_PRINT("BOR\n");
    *b = *b | *a;
}

//---------------------------------------------------------------------------
void DCPU::XOR()
{
    DBG_PRINT("XOR\n");
    *b = *b ^ *a;
}

//---------------------------------------------------------------------------
void DCPU::SHR()
{
    K_USHORT usTemp = (K_USHORT)((((K_ULONG)*b) << 16) >> (K_ULONG)*a);

    DBG_PRINT("SHR\n");
    *b = *b >> *a;
    m_stRegisters.EX = usTemp;
}

//---------------------------------------------------------------------------
void DCPU::ASR()
{
    K_USHORT usTemp = (K_USHORT)((((K_LONG)*b) << 16) >> (K_LONG)*a);

    DBG_PRINT("ASR\n");
    *b = (K_USHORT)(*(K_SHORT*)b >> *(K_SHORT*)a);
    m_stRegisters.EX = usTemp;
}
//---------------------------------------------------------------------------
void DCPU::SHL()
{
    K_USHORT usTemp = (K_USHORT)((((K_ULONG)*b) << (K_ULONG)*a) >> 16);

    DBG_PRINT("SHL\n");
    *b = *b << *a;
    m_stRegisters.EX = usTemp;
}

//---------------------------------------------------------------------------
bool DCPU::IFB()
{
    DBG_PRINT("IFB\n");
    if ((*b & *a) != 0)
    {
        return true;
    }
    return false;
}

//---------------------------------------------------------------------------
bool DCPU::IFC()
{
    DBG_PRINT("IFC\n");
    if ((*b & *a) == 0)
    {
        return true;
    }
    return false;
}

//---------------------------------------------------------------------------
bool DCPU::IFE()
{
    DBG_PRINT("IFE\n");
    if (*b == *a)
    {
        return true;
    }
    return false;
}

//---------------------------------------------------------------------------
bool DCPU::IFN()
{
    DBG_PRINT("IFN\n");
    if (*b != *a)
    {
        return true;
    }
    return false;
}

//---------------------------------------------------------------------------
bool DCPU::IFG()
{
    DBG_PRINT("IFG\n");
    if (*b > *a)
    {
        return true;
    }
    return false;
}

//---------------------------------------------------------------------------
bool DCPU::IFA()
{
    DBG_PRINT("IFA\n");
    if (*((K_SHORT*)b) > *((K_SHORT*)a))
    {
        return true;
    }
    return false;
}
```

```

//---------------------------------------------------------------------------
bool DCPU::IFL()
{
    DBG_PRINT("IFL\n");
    if (*b < *a)
    {
        return true;
    }
    return false;
}

//---------------------------------------------------------------------------
bool DCPU::IFU()
{
    DBG_PRINT("IFU\n");
    if (*(K_SHORT*)b < *(K_SHORT*)a)
    {
        return true;
    }
    return false;
}

//---------------------------------------------------------------------------
void DCPU::ADX()
{
    K_ULONG ulTemp;
    DBG_PRINT("ADX\n");
    ulTemp = (K_ULONG)*b + (K_ULONG)*a + (K_ULONG)m_stRegisters.EX;
    if (ulTemp >= 0x10000)
    {
        m_stRegisters.EX = 1;
    }
    else
    {
        m_stRegisters.EX = 0;
    }

    *b = ((K_USHORT)(ulTemp & 0x0000FFFF));
}

//---------------------------------------------------------------------------
void DCPU::SBX()
{
    K_LONG lTemp;
    DBG_PRINT("SBX\n");
    lTemp = (K_LONG)*b - (K_LONG)*a + (K_LONG)m_stRegisters.EX;
    if (lTemp < 0 )
    {
        m_stRegisters.EX = 0xFFFF;
    }
    else
    {
        m_stRegisters.EX = 0;
    }

    *b = ((K_USHORT)(lTemp & 0x0000FFFF));
}

//---------------------------------------------------------------------------
void DCPU::STI()
{
    DBG_PRINT("STI\n");
    *b = *a;
    m_stRegisters.I++;
    m_stRegisters.J++;
}

//---------------------------------------------------------------------------
void DCPU::STD()
{
    DBG_PRINT("STD\n");
    *b = *a;
    m_stRegisters.I--;
    m_stRegisters.J--;
}

//---------------------------------------------------------------------------
void DCPU::JSR()
{
    DBG_PRINT("JSR 0x%04X\n", *a);
    m_pusRAM[ m_stRegisters.SP-- ] = m_stRegisters.PC;
    m_stRegisters.PC = *a;
}

//---------------------------------------------------------------------------
void DCPU::INT()
```

```
{
    DBG_PRINT("INT\n");

    if (m_stRegisters.IA == 0)
    {
        // If IA is not set, return out.
        return;
    }

    // Either acknowledge the interrupt immediately, or queue it.
    if (m_bInterruptQueueing == false)
    {
        m_pusRAM[ m_stRegisters.SP-- ] = m_stRegisters.PC;
        m_pusRAM[ m_stRegisters.SP-- ] = m_stRegisters.A;

        m_stRegisters.A = *a;
        m_stRegisters.PC = m_stRegisters.IA;
        m_bInterruptQueueing = true;
    }
    else
    {
        // Add interrupt message to the queue
        m_ausInterruptQueue[ ++m_ucQueueLevel ] = *
a;
    }
}

//---------------------------------------------------------------------------
void DCPU::ProcessInterruptQueue()
{
    // If there's an interrupt address specified, queueing is disabled, and
    // the queue isn't empty
    if (m_stRegisters.IA && !m_bInterruptQueueing &&
m_ucQueueLevel)
    {
        m_pusRAM[ m_stRegisters.SP-- ] = m_stRegisters.PC;
        m_pusRAM[ m_stRegisters.SP-- ] = m_stRegisters.A;

        m_stRegisters.A = m_ausInterruptQueue[
m_ucQueueLevel-- ];
        m_stRegisters.PC = m_stRegisters.IA;

        m_bInterruptQueueing = true;
    }
}


//---------------------------------------------------------------------------
void DCPU::IAG()
{
    DBG_PRINT("IAG\n");

    *a = m_stRegisters.IA;
}

//---------------------------------------------------------------------------
void DCPU::IAS()
{
    DBG_PRINT("IAS\n");

    m_stRegisters.IA = *a;
}

//---------------------------------------------------------------------------
void DCPU::RFI()
{
    DBG_PRINT("RFI\n");

    m_bInterruptQueueing = false;

    m_stRegisters.A  = m_pusRAM[ ++m_stRegisters.SP ];
    m_stRegisters.PC = m_pusRAM[ ++m_stRegisters.SP ];

}

//---------------------------------------------------------------------------
void DCPU::IAQ()
{
    DBG_PRINT("IAQ\n");

    if (*a)
    {
        m_bInterruptQueueing = true;
    }
    else
    {
        m_bInterruptQueueing = false;
    }
}

//---------------------------------------------------------------------------
void DCPU::HWN()
{
    LinkListNode *pclNode;

    DBG_PRINT("HWN\n");
    m_usTempA = 0;
    pclNode = m_clPluginList.GetHead();
    while (pclNode)
    {
        m_usTempA++;
        pclNode = pclNode->GetNext();
    }

    *a = m_usTempA;
}

//---------------------------------------------------------------------------
void DCPU::HWQ()
{
    DBG_PRINT("HWQ\n");
    DCPUPlugin *pclPlugin;
    pclPlugin = (DCPUPlugin*)m_clPluginList.GetHead();

    while (pclPlugin)
    {
        if (pclPlugin->GetDeviceNumber() == *a)
        {
            pclPlugin->Enumerate(&m_stRegisters);
            break;
        }
        pclPlugin = (DCPUPlugin*)pclPlugin->GetNext();
    }
}

//---------------------------------------------------------------------------
void DCPU::HWI()
{
    DBG_PRINT("HWI\n");

    DCPUPlugin *pclPlugin;
    pclPlugin = (DCPUPlugin*)m_clPluginList.GetHead();

    while (pclPlugin)
    {
        if (pclPlugin->GetDeviceNumber() == *a)
        {
            pclPlugin->Interrupt(this);
            break;
        }
        pclPlugin = (DCPUPlugin*)pclPlugin->GetNext();
    }
}

//---------------------------------------------------------------------------
void DCPU::Init(     K_USHORT *pusRAM_, K_USHORT usRAMSize_,
                     const K_USHORT *pusROM_, K_USHORT usROMSize_ )
{
    m_stRegisters.PC = 0;
    m_stRegisters.SP = usRAMSize_ ;
    m_stRegisters.A = 0;
    m_stRegisters.B = 0;
    m_stRegisters.C = 0;
    m_stRegisters.X = 0;
    m_stRegisters.Y = 0;
    m_stRegisters.Z = 0;
    m_stRegisters.I = 0;
    m_stRegisters.J = 0;
    m_stRegisters.EX = 0;
    m_stRegisters.IA = 0;
    m_ulCycleCount = 0;

    m_pusROM = (K_USHORT*)pusROM_;
    m_usROMSize = usROMSize_;

    m_pusRAM = pusRAM_;
    m_usRAMSize = usRAMSize_;
}

//---------------------------------------------------------------------------
K_UCHAR DCPU::GetOperand( K_UCHAR ucOpType_, K_USHORT **pusResult_ )
{
    K_UCHAR ucRetVal = 0;
    switch (ucOpType_)
    {
        case ARG_A:     case ARG_B:     case ARG_C:     case ARG_X:
        case ARG_Y:     case ARG_Z:     case ARG_I:     case ARG_J:
            *pusResult_ = &m_stRegisters.ausRegisters[ ucOpType_ - ARG_A ];
            break;

        case ARG_BRACKET_A:     case ARG_BRACKET_B:     case ARG_BRACKET_C:     case ARG_BRACKET_X:
        case ARG_BRACKET_Y:     case ARG_BRACKET_Z:     case ARG_BRACKET_I:     case ARG_BRACKET_J:
            *pusResult_ = &m_pusRAM[ m_stRegisters.ausRegisters[ ucOpType_ - ARG_BRACKET_A ] ];
            break;

        case ARG_WORD_A: case ARG_WORD_B: case ARG_WORD_C: case ARG_WORD_X:
        case ARG_WORD_Y: case ARG_WORD_Z: case ARG_WORD_I: case ARG_WORD_J:
        {
            K_USHORT usTemp = m_pusROM[ m_stRegisters.PC++ ];
            usTemp += m_stRegisters.ausRegisters[ ucOpType_ - ARG_WORD_A ];
            *pusResult_ = &m_pusRAM[ usTemp ];
            ucRetVal = 1;
        }
            break;
        case ARG_PUSH_POP_SP:
            if (*pusResult_ == a)
            {
                a = &m_pusRAM[ ++m_stRegisters.SP ];
            }
            else
            {
                b = &m_pusRAM[ m_stRegisters.SP-- ];
            }
            break;
        case ARG_PEEK_SP:
            *pusResult_ = &m_pusRAM[ m_stRegisters.SP ];
            break;
        case ARG_WORD_SP:
        {
            K_USHORT usTemp = m_pusROM[ ++m_stRegisters.PC ];
            usTemp += m_stRegisters.SP;
            *pusResult_ = &m_pusRAM[ usTemp ];
            ucRetVal++;
        }
            break;
        case ARG_SP:
            *pusResult_ = &(m_stRegisters.SP);
            break;
        case ARG_PC:
            *pusResult_ = &(m_stRegisters.PC);
            break;
        case ARG_EX:
            *pusResult_ = &(m_stRegisters.EX);
            break;
        case ARG_NEXT_WORD:
            *pusResult_ = &m_pusRAM[ m_pusROM[ m_stRegisters.PC++ ] ];
            ucRetVal++;
            break;
        case ARG_NEXT_LITERAL:
            *pusResult_ = &m_pusROM[ m_stRegisters.PC++ ];
            ucRetVal++;
            break;

        case ARG_LITERAL_0:
            *pusResult_ = &m_usTempA;
            m_usTempA = (K_USHORT)(-1);
            break;
        case ARG_LITERAL_1:     case ARG_LITERAL_2:     case ARG_LITERAL_3:     case ARG_LITERAL_4:
        case ARG_LITERAL_5:     case ARG_LITERAL_6: case ARG_LITERAL_7:     case ARG_LITERAL_8:
        case ARG_LITERAL_9:     case ARG_LITERAL_A:     case ARG_LITERAL_B:     case ARG_LITERAL_C:
        case ARG_LITERAL_D:     case ARG_LITERAL_E:     case ARG_LITERAL_F:     case ARG_LITERAL_10:
        case ARG_LITERAL_11: case ARG_LITERAL_12: case ARG_LITERAL_13: case ARG_LITERAL_14:
        case ARG_LITERAL_15: case ARG_LITERAL_16: case ARG_LITERAL_17: case ARG_LITERAL_18:
        case ARG_LITERAL_19: case ARG_LITERAL_1A: case ARG_LITERAL_1B: case ARG_LITERAL_1C:
        case ARG_LITERAL_1D: case ARG_LITERAL_1E: case ARG_LITERAL_1F:
            *pusResult_ = &m_usTempA;
            m_usTempA = (K_USHORT)(ucOpType_ - ARG_LITERAL_1);
            break;
        default:
            break;
    }
    return ucRetVal;
}

//---------------------------------------------------------------------------
void DCPU::RunOpcode()
{
    // Fetch the opcode @ the current program counter
    K_USHORT usWord = m_pusROM[ m_stRegisters.PC++ ];
    K_UCHAR ucOp = (K_UCHAR)DCPU_NORMAL_OPCODE_MASK(usWord);
    K_UCHAR ucA = (K_UCHAR)DCPU_A_MASK(usWord);
    K_UCHAR ucB = (K_UCHAR)DCPU_B_MASK(usWord);
    K_UCHAR ucSize = 1;

    DBG_PRINT("0x%04X: %04X\n", m_stRegisters.PC - 1, usWord );

    // Decode the opcode
    if (ucOp)
    {
        bool bRunNext = true;

        a = &m_usTempA;
        b = 0;

        // If this is a "basic" opcode, decode "a" and "b"
        ucSize += GetOperand( ucA , &a );
        ucSize += GetOperand( ucB, &b );

        // Add the cycles to the runtime clock
        m_ulCycleCount += (K_ULONG)aucBasicOpcodeCycles[ ucOp ];
        m_ulCycleCount += (ucSize - 1);

        // Execute the instruction once we've decoded the opcode and
        // processed the arguments.
        switch (DCPU_NORMAL_OPCODE_MASK(usWord))
        {
            case OP_SET:    SET();        break;
            case OP_ADD:    ADD();        break;
            case OP_SUB:    SUB();        break;

            case OP_MUL:    MUL();        break;
            case OP_MLI:    MLI();        break;
            case OP_DIV:    DIV();        break;
            case OP_DVI:    DVI();        break;
            case OP_MOD:    MOD();        break;
            case OP_MDI:    MDI();        break;
            case OP_AND:    AND();        break;
            case OP_BOR:    BOR();        break;
            case OP_XOR:    XOR();        break;
            case OP_SHR:    SHR();        break;
            case OP_ASR:    ASR();        break;
            case OP_SHL:    SHL();        break;
            case OP_IFB:    bRunNext = IFB();    break;
            case OP_IFC:    bRunNext = IFC();    break;
            case OP_IFE:    bRunNext = IFE();    break;
            case OP_IFN:    bRunNext = IFN();    break;
            case OP_IFG:    bRunNext = IFG();    break;
            case OP_IFA:    bRunNext = IFA();    break;
            case OP_IFL:    bRunNext = IFL();    break;
            case OP_IFU:    bRunNext = IFU();    break;
            case OP_ADX:    ADX();        break;
            case OP_SBX:    SBX();        break;
            case OP_STI:    STI();        break;
            case OP_STD:    STD();        break;
            default:    break;
        }

        // If we're not supposed to run the next instruction (i.e. skip it
        // due to failed condition), adjust the PC.
        if (!bRunNext)
        {
            // Skipped branches take an extra cycle
            m_ulCycleCount++;

            // Skip the next opcode
            usWord = m_pusROM[ m_stRegisters.PC++ ];
            if (DCPU_NORMAL_OPCODE_MASK(usWord))
            {
                DBG_PRINT( "Skipping Basic Opcode: %X\n", DCPU_NORMAL_OPCODE_MASK(usWord));
                // If this is a "basic" opcode, decode "a" and "b" - we do this to make sure our
                // PC gets adjusted properly.
                GetOperand( DCPU_A_MASK(usWord), &a );
                GetOperand( DCPU_B_MASK(usWord), &b );
            }
            else
            {
                DBG_PRINT( "Skipping Extended Opcode: %X\n", DCPU_EXTENDED_OPCODE_MASK(usWord));
                GetOperand( DCPU_A_MASK(usWord), &a );
            }
        }
    }
    else
    {
        // Extended opcode.  These only have a single argument, stored in the
        // "a" field.
        GetOperand( ucA, &a );
        m_ulCycleCount++;

        // Execute the "extended" instruction now that the opcode has been
        // decoded, and the arguments processed.
        switch (ucB)
        {
            case OP_EX_JSR:         JSR();    break;
            case OP_EX_INT:         INT();    break;
            case OP_EX_IAG:         IAG();    break;
            case OP_EX_IAS:         IAS();    break;
            case OP_EX_RFI:         RFI();    break;
            case OP_EX_IAQ:         IAQ();    break;
            case OP_EX_HWN:         HWN();    break;
            case OP_EX_HWQ:         HWQ();    break;
            case OP_EX_HWI:         HWI();    break;
            default:    break;
        }
    }

    // Process an interrupt from the queue (if there is one)
    ProcessInterruptQueue();
}

//---------------------------------------------------------------------------
void DCPU::SendInterrupt( K_USHORT usMessage_ )
{
    if (m_stRegisters.IA == 0)
    {
        // If IA is not set, return out.
        return;
    }

    // Either acknowledge the interrupt immediately, or queue it.
    if (m_bInterruptQueueing == false)
    {
        m_pusRAM[ m_stRegisters.SP-- ] = m_stRegisters.PC;
        m_pusRAM[ m_stRegisters.SP-- ] = m_stRegisters.A;

        m_stRegisters.A = usMessage_;
        m_stRegisters.PC = m_stRegisters.IA;
        m_bInterruptQueueing = true;
    }
    else
    {
        // Add interrupt message to the queue
        m_ausInterruptQueue[ ++m_ucQueueLevel ] = usMessage_;
    }
}

//---------------------------------------------------------------------------
void DCPU::AddPlugin( DCPUPlugin *pclPlugin_ )
{
    m_clPluginList.Add( (LinkListNode*)pclPlugin_ );
}
```

17.47 /home/mo/mark3-source/embedded/stage/src/dcpu.h File Reference

DCPU-16 emulator.

```
#include "kerneltypes.h"
#include "ll.h"
```

Classes

- struct DCPU_Registers

  Structure defining the DCPU hardware registers.
- class DCPUPlugin

  Class used to provide the hardware device abstraction between the DCPU-16 emulator/VM and the host system.
- class DCPU

  DCPU emulator, used for running code out of EEPROM, RAM, or other memory interfaces than FLASH.

Macros

- #define DCPU_NORMAL_OPCODE_MASK(x) ((K_USHORT)(x & 0x001F))

  DCPU v1.7 CPU emulator.
- #define **DCPU_EXTENDED_OPCODE_MASK**(x) ((K_USHORT)((x >> 5) & 0x001F))
- #define **DCPU_A_MASK**(x) ((K_USHORT)((x >> 10) & 0x003F))
- #define **DCPU_B_MASK**(x) ((K_USHORT)((x >> 5) & 0x001F))
- #define **DCPU_BUILD_NORMAL**(x, y, z) (((K_USHORT)(x) & 0x001F) | ((K_USHORT)(y) & 0x001F) << 5 | ((K_USHORT)(z) & 0x003F) << 10)
- #define **DCPU_BUILD_EXTENDED**(x, y) (((K_USHORT)(x & 0x001F) << 5) | ((K_USHORT)(y & 0x003F) << 10))

Typedefs

- typedef void(∗ DCPU_Callback)(DCPU ∗pclVM_)

  Callback function type used to implement HWI for VM->Host communications.

Enumerations

- enum DCPU_OpBasic {
  OP_NON_BASIC = 0, OP_SET, OP_ADD, OP_SUB,
  OP_MUL, OP_MLI, OP_DIV, OP_DVI,
  OP_MOD, OP_MDI, OP_AND, OP_BOR,
  OP_XOR, OP_SHR, OP_ASR, OP_SHL,
  OP_IFB, OP_IFC, OP_IFE, OP_IFN,
  OP_IFG, OP_IFA, OP_IFL, OP_IFU,
  OP_18, OP_19, OP_ADX, OP_SBX,
  OP_1C, OP_1D, OP_STI, OP_STD }

  DCPU Basic Opcodes.
- enum DCPU_OpExtended {
  OP_EX_RESERVED = 0, OP_EX_JSR, OP_EX_2, OP_EX_3,
  OP_EX_4, OP_EX_5, OP_EX_6, OP_EX_7,
  OP_EX_INT, OP_EX_IAG, OP_EX_IAS, OP_EX_RFI,
  OP_EX_IAQ, OP_EX_D, OP_EX_E, OP_EX_F,
  OP_EX_HWN, OP_EX_HWQ, OP_EX_HWI, OP_EX_13,
  OP_EX_14, OP_EX_15, OP_EX_16, OP_EX_17,
  OP_EX_18, OP_EX_19, OP_EX_1A, OP_EX_1B,
  OP_EX_1C, OP_EX_1D, OP_EX_1E, OP_EX_1F }

  DCPU Extended opcodes.
- enum DCPU_Argument {
  ARG_A = 0, **ARG_B**, **ARG_C**, **ARG_X**,
  ARG_Y, **ARG_Z**, **ARG_I**, **ARG_J**,
  ARG_BRACKET_A, **ARG_BRACKET_B**, **ARG_BRACKET_C**, **ARG_BRACKET_X**,
  ARG_BRACKET_Y, **ARG_BRACKET_Z**, **ARG_BRACKET_I**, **ARG_BRACKET_J**,
  ARG_WORD_A, **ARG_WORD_B**, **ARG_WORD_C**, **ARG_WORD_X**,
  ARG_WORD_Y, **ARG_WORD_Z**, **ARG_WORD_I**, **ARG_WORD_J**,
  ARG_PUSH_POP_SP, **ARG_PEEK_SP**, **ARG_WORD_SP**, **ARG_SP**,
  ARG_PC, **ARG_EX**, **ARG_NEXT_WORD**, **ARG_NEXT_LITERAL**,
  ARG_LITERAL_0, **ARG_LITERAL_1**, **ARG_LITERAL_2**, **ARG_LITERAL_3**,
  ARG_LITERAL_4, **ARG_LITERAL_5**, **ARG_LITERAL_6**, **ARG_LITERAL_7**,
  ARG_LITERAL_8, **ARG_LITERAL_9**, **ARG_LITERAL_A**, **ARG_LITERAL_B**,
  ARG_LITERAL_C, **ARG_LITERAL_D**, **ARG_LITERAL_E**, **ARG_LITERAL_F**,
  ARG_LITERAL_10, **ARG_LITERAL_11**, **ARG_LITERAL_12**, **ARG_LITERAL_13**,
  ARG_LITERAL_14, **ARG_LITERAL_15**, **ARG_LITERAL_16**, **ARG_LITERAL_17**,
  ARG_LITERAL_18, **ARG_LITERAL_19**, **ARG_LITERAL_1A**, **ARG_LITERAL_1B**,
  ARG_LITERAL_1C, **ARG_LITERAL_1D**, **ARG_LITERAL_1E**, **ARG_LITERAL_1F** }

Argument formats.

17.47.1 Detailed Description

DCPU-16 emulator.

Definition in file dcpu.h.

17.47.2 Macro Definition Documentation

17.47.2.1 #define DCPU_NORMAL_OPCODE_MASK(*x*) ((K_USHORT)(x & 0x001F))

DCPU v1.7 CPU emulator.

Basic opcode format: [aaaaaabbbbbooooo]

Where: - aaaaaa 6-bit source argument

- bbbbb 5-bit destination argument
- o is the opcode itself in a

If oooo = 0, then it's an "extended" opcode

Extended opcode format: [aaaaaaoooooxxxxx]

Where:

- xxxxx = all 0's - (basic opcode)
- ooooo = an extended opcode
- aaaaaa = the argument

Definition at line 48 of file dcpu.h.

17.47.3 Enumeration Type Documentation

17.47.3.1 enum DCPU_OpBasic

DCPU Basic Opcodes.

Enumerator

OP_NON_BASIC special instruction - see below

OP_SET b, a | sets b to a

OP_ADD b, a | sets b to b+a, sets EX to 0x0001 if there's an overflow, 0x0 otherwise

OP_SUB b, a | sets b to b-a, sets EX to 0xffff if there's an underflow, 0x0 otherwise

OP_MUL b, a | sets b to b∗a, sets EX to ((b∗a)>>16)&0xffff (treats b, a as unsigned)

OP_MLI b, a | like MUL, but treat b, a as signed

OP_DIV b, a | sets b to b/a, sets EX to ((b<<16)/a)&0xffff. if a==0, sets b and EX to 0 instead. (treats b, a as unsigned)

OP_DVI b, a | like DIV, but treat b, a as signed. Rounds towards 0

OP_MOD b, a | sets b to ba. if a==0, sets b to 0 instead.

OP_MDI b, a | like MOD, but treat b, a as signed. (MDI -7, 16 == -7)

OP_AND b, a | sets b to b&a

OP_BOR b, a | sets b to b|a

OP_XOR b, a | sets b to b^a

OP_SHR b, a | sets b to b>>>a, sets EX to ((b<<16)>>a)&0xffff (logical shift)

OP_ASR b, a | sets b to b>>a, sets EX to ((b<<16)>>>a)&0xffff (arithmetic shift) (treats b as signed)

OP_SHL b, a | sets b to b<<a, sets EX to ((b<<a)>>16)&0xffff

OP_IFB b, a | performs next instruction only if (b&a)!=0

OP_IFC b, a | performs next instruction only if (b&a)==0

OP_IFE b, a | performs next instruction only if b==a

OP_IFN b, a | performs next instruction only if b!=a

OP_IFG b, a | performs next instruction only if b>a

OP_IFA b, a | performs next instruction only if b>a (signed)

OP_IFL b, a | performs next instruction only if b<a

OP_IFU b, a | performs next instruction only if b<a (signed)

OP_18 **UNDEFINED**

OP_19 **UNDEFINED**

OP_ADX b, a | sets b to b+a+EX, sets EX to 0x0001 if there is an over-flow, 0x0 otherwise

OP_SBX b, a | sets b to b-a+EX, sets EX to 0xFFFF if there is an under-flow, 0x0 otherwise

OP_1C **UNDEFINED**

OP_1D **UNDEFINED**

OP_STI b, a | sets b to a, then increases I and J by 1

OP_STD b, a | sets b to a, then decreases I and J by 1

Definition at line 99 of file dcpu.h.

17.47.3.2 enum DCPU_OpExtended

DCPU Extended opcodes.

Enumerator

OP_EX_JSR a - pushes the address of the next instruction to the stack, then sets PC to a

OP_EX_2 **UNDEFINED**

OP_EX_3 **UNDEFINED**

OP_EX_4 **UNDEFINED**

OP_EX_5 **UNDEFINED**

OP_EX_6 **UNDEFINED**

OP_EX_7 **UNDEFINED**

OP_EX_INT Invoke software interrupt "a".

OP_EX_IAG Get interrupt address in "a".

OP_EX_IAS Set interrupt address from "a".

OP_EX_RFI Disables interrupt queueing, pops A from the stack, then pops PC from the stack.

OP_EX_IAQ if a is nonzero, interrupts will be added to the queue instead of triggered. if a is zero, interrupts will be triggered as normal again

OP_EX_D **UNDEFINED**

OP_EX_E **UNDEFINED**

OP_EX_F **UNDEFINED**

OP_EX_HWN Sets "a" to number of connected HW devices.

OP_EX_HWQ Set registers with information about hardware at index "a".

OP_EX_HWI Send an interrupt to hardware interface "a".

OP_EX_13 **UNDEFINED**

OP_EX_14 **UNDEFINED**

OP_EX_15 **UNDEFINED**

OP_EX_16 **UNDEFINED**

OP_EX_17 **UNDEFINED**

OP_EX_18 **UNDEFINED**

OP_EX_19 **UNDEFINED**

OP_EX_1A **UNDEFINED**

OP_EX_1B **UNDEFINED**

OP_EX_1C **UNDEFINED**

OP_EX_1D **UNDEFINED**

OP_EX_1E **UNDEFINED**

OP_EX_1F **UNDEFINED**

Definition at line 139 of file dcpu.h.

17.48 dcpu.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \    ||     |     ||  |/ /    ||___   |
|     \/   | ||     \   ||     \     ||     \    ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||_____|
    |_____|      |_____|     |_____|     |_____|

--[Mark3 Realtime Platform]--------------------------------------------------

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===========================================================================*/
#ifndef __DCPU_H__
#define __DCPU_H__

#include "kerneltypes.h"
#include "ll.h"

//---------------------------------------------------------------------------
//---------------------------------------------------------------------------
// Macros to access individual elements from within an opcode
#define DCPU_NORMAL_OPCODE_MASK( x ) \
        ((K_USHORT)(x & 0x001F))

#define DCPU_EXTENDED_OPCODE_MASK( x ) \
        ((K_USHORT)((x >> 5) & 0x001F))

#define DCPU_A_MASK( x ) \
        ((K_USHORT)((x >> 10) & 0x003F))

#define DCPU_B_MASK( x ) \
        ((K_USHORT)((x >> 5) & 0x001F))

//---------------------------------------------------------------------------
// Macros to emit opcodes in the normal/extended formats
#define DCPU_BUILD_NORMAL( x, y, z ) \
        ( ((K_USHORT)(x) & 0x001F) | ((K_USHORT)(y) & 0x001F) << 5 | ((K_USHORT)(z) & 0x003F) << 10 )

#define DCPU_BUILD_EXTENDED( x, y ) \
        ( ((K_USHORT)(x & 0x001F) << 5) | ((K_USHORT)(y & 0x003F) << 10) )

//---------------------------------------------------------------------------
typedef struct
{
    union
    {
        struct
        {
            K_USHORT A;
            K_USHORT B;
            K_USHORT C;
            K_USHORT X;
            K_USHORT Y;
            K_USHORT Z;
            K_USHORT I;
            K_USHORT J;
            K_USHORT PC;
            K_USHORT SP;
            K_USHORT EX;
            K_USHORT IA;
        };
        K_USHORT ausRegisters[12];
    };
} DCPU_Registers;

//---------------------------------------------------------------------------
typedef enum
{
    OP_NON_BASIC = 0,
    OP_SET,
    OP_ADD,
    OP_SUB,
    OP_MUL,
    OP_MLI,
    OP_DIV,
    OP_DVI,
    OP_MOD,
    OP_MDI,
    OP_AND,
    OP_BOR,
    OP_XOR,
    OP_SHR,
    OP_ASR,
    OP_SHL,
    OP_IFB,
    OP_IFC,
    OP_IFE,
    OP_IFN,
    OP_IFG,
    OP_IFA,
    OP_IFL,
    OP_IFU,
    OP_18,
    OP_19,
    OP_ADX,
    OP_SBX,
    OP_1C,
    OP_1D,
    OP_STI,
    OP_STD
} DCPU_OpBasic;

//---------------------------------------------------------------------------
typedef enum
{
    OP_EX_RESERVED = 0,
    OP_EX_JSR,
    OP_EX_2,
    OP_EX_3,
    OP_EX_4,
    OP_EX_5,
    OP_EX_6,
    OP_EX_7,
    OP_EX_INT,
    OP_EX_IAG,
    OP_EX_IAS,
    OP_EX_RFI,
    OP_EX_IAQ,
    OP_EX_D,
    OP_EX_E,
    OP_EX_F,
    OP_EX_HWN,
    OP_EX_HWQ,
    OP_EX_HWI,
    OP_EX_13,
    OP_EX_14,
    OP_EX_15,
    OP_EX_16,
    OP_EX_17,
    OP_EX_18,
    OP_EX_19,
    OP_EX_1A,
    OP_EX_1B,
    OP_EX_1C,
    OP_EX_1D,
    OP_EX_1E,
    OP_EX_1F
} DCPU_OpExtended;

//---------------------------------------------------------------------------
typedef enum
{
    ARG_A = 0,
    ARG_B,
    ARG_C,
    ARG_X,
    ARG_Y,
    ARG_Z,
    ARG_I,
    ARG_J,

    ARG_BRACKET_A,
    ARG_BRACKET_B,
    ARG_BRACKET_C,
    ARG_BRACKET_X,
    ARG_BRACKET_Y,
    ARG_BRACKET_Z,
    ARG_BRACKET_I,
    ARG_BRACKET_J,

    ARG_WORD_A,
    ARG_WORD_B,
    ARG_WORD_C,
    ARG_WORD_X,
    ARG_WORD_Y,
    ARG_WORD_Z,
    ARG_WORD_I,
    ARG_WORD_J,

    ARG_PUSH_POP_SP,
    ARG_PEEK_SP,
    ARG_WORD_SP,
    ARG_SP,
    ARG_PC,
    ARG_EX,
    ARG_NEXT_WORD,
    ARG_NEXT_LITERAL,

    ARG_LITERAL_0,
    ARG_LITERAL_1,
    ARG_LITERAL_2,
    ARG_LITERAL_3,
    ARG_LITERAL_4,
    ARG_LITERAL_5,
    ARG_LITERAL_6,
    ARG_LITERAL_7,
    ARG_LITERAL_8,
    ARG_LITERAL_9,
    ARG_LITERAL_A,
    ARG_LITERAL_B,
    ARG_LITERAL_C,
    ARG_LITERAL_D,
    ARG_LITERAL_E,
    ARG_LITERAL_F,
    ARG_LITERAL_10,
    ARG_LITERAL_11,
    ARG_LITERAL_12,
    ARG_LITERAL_13,
    ARG_LITERAL_14,
    ARG_LITERAL_15,
    ARG_LITERAL_16,
    ARG_LITERAL_17,
    ARG_LITERAL_18,
    ARG_LITERAL_19,
    ARG_LITERAL_1A,
    ARG_LITERAL_1B,
    ARG_LITERAL_1C,
    ARG_LITERAL_1D,
    ARG_LITERAL_1E,
    ARG_LITERAL_1F

} DCPU_Argument;

//---------------------------------------------------------------------------
class DCPU;    // Forward declaration - required by the plugin class

//---------------------------------------------------------------------------
typedef void (*DCPU_Callback)(DCPU *pclVM_);

//---------------------------------------------------------------------------
class DCPUPlugin : public LinkListNode
```

```
{
public:
    void Init(    K_USHORT usDeviceNumber_,
                K_ULONG ulHWID_,
                K_ULONG ulVID_,
                K_USHORT usVersion_,
                DCPU_Callback pfCallback_)
    {
        m_ulHWID = ulHWID_;
        m_ulVID = ulVID_;
        m_usDeviceNumber = usDeviceNumber_;
        m_usVersion = usVersion_;
        m_pfCallback = pfCallback_;
    }

    void Enumerate( DCPU_Registers *pstRegisters_ )
    {
        pstRegisters_->A = (K_USHORT)(m_ulHWID & 0x0000FFFF);
        pstRegisters_->B = (K_USHORT)((m_ulHWID >> 16) & 0x0000FFFF);
        pstRegisters_->C = m_usVersion;
        pstRegisters_->X = (K_USHORT)(m_ulVID & 0x0000FFFF);
        pstRegisters_->Y = (K_USHORT)((m_ulVID >> 16) & 0x0000FFFF);
    }

    void Interrupt( DCPU *pclCPU_ )
    {
        m_pfCallback(pclCPU_);
    }

    K_USHORT GetDeviceNumber()
    {
        return m_usDeviceNumber;
    }

    friend class DCPUPluginList;
private:
    K_USHORT      m_usDeviceNumber;
    K_ULONG       m_ulHWID;
    K_ULONG       m_ulVID;
    K_USHORT      m_usVersion;

    DCPU_Callback m_pfCallback;
};

//---------------------------------------------------------------------------
class DCPU
{
public:
    void Init( K_USHORT *pusRAM_, K_USHORT usRAMSize_, const K_USHORT *pusROM_, K_USHORT usROMSize_ );

    void RunOpcode();

    DCPU_Registers *GetRegisters() { return &
m_stRegisters; }

    void SendInterrupt( K_USHORT usMessage_ );

    void AddPlugin( DCPUPlugin *pclPlugin_ );

private:

    // Basic opcodes
    void SET();
    void ADD();
    void SUB();
    void MUL();
    void MLI();
    void DIV();
    void DVI();
    void MOD();
    void MDI();
    void AND();
    void BOR();
    void XOR();
    void SHR();
    void ASR();
    void SHL();
    bool IFB();
    bool IFC();
    bool IFE();
    bool IFN();
    bool IFG();
    bool IFA();
    bool IFL();
    bool IFU();
    void ADX();
    void SBX();
    void STI();
    void STD();

    // Extended opcodes
    void JSR();
    void INT();
    void IAG();
    void IAS();
    void RFI();
    void IAQ();
    void HWN();
    void HWQ();
    void HWI();

    K_UCHAR GetOperand( K_UCHAR ucOpType_, K_USHORT **pusResult_ );


    void ProcessInterruptQueue();

    DCPU_Registers m_stRegisters;

    K_USHORT *a;
    K_USHORT *b;

    K_USHORT m_usTempA;

    K_USHORT *m_pusRAM;
    K_USHORT m_usRAMSize;

    K_USHORT *m_pusROM;
    K_USHORT m_usROMSize;

    K_ULONG  m_ulCycleCount;

    K_BOOL   m_bInterruptQueueing;
    K_UCHAR  m_ucQueueLevel;
    K_USHORT m_ausInterruptQueue[ 8 ];

    DoubleLinkList m_clPluginList;
};

#endif
```

17.49 /home/mo/mark3-source/embedded/stage/src/debug_tokens.h File Reference

Hex codes/translation tables used for efficient string tokenization.

Macros

- #define BLOCKING_CPP 0x0001 /∗ SUBSTITUTE="blocking.cpp" ∗/

  Source file names start at 0x0000.
- #define **DRIVER_CPP** 0x0002 /∗ SUBSTITUTE="driver.cpp" ∗/
- #define **KERNEL_CPP** 0x0003 /∗ SUBSTITUTE="kernel.cpp" ∗/
- #define **LL_CPP** 0x0004 /∗ SUBSTITUTE="ll.cpp" ∗/
- #define **MESSAGE_CPP** 0x0005 /∗ SUBSTITUTE="message.cpp" ∗/
- #define **MUTEX_CPP** 0x0006 /∗ SUBSTITUTE="mutex.cpp" ∗/
- #define **PROFILE_CPP** 0x0007 /∗ SUBSTITUTE="profile.cpp" ∗/
- #define **QUANTUM_CPP** 0x0008 /∗ SUBSTITUTE="quantum.cpp" ∗/
- #define **SCHEDULER_CPP** 0x0009 /∗ SUBSTITUTE="scheduler.cpp" ∗/
- #define **SEMAPHORE_CPP** 0x000A /∗ SUBSTITUTE="semaphore.cpp" ∗/
- #define **THREAD_CPP** 0x000B /∗ SUBSTITUTE="thread.cpp" ∗/
- #define **THREADLIST_CPP** 0x000C /∗ SUBSTITUTE="threadlist.cpp" ∗/
- #define **TIMERLIST_CPP** 0x000D /∗ SUBSTITUTE="timerlist.cpp" ∗/
- #define **KERNELSWI_CPP** 0x000E /∗ SUBSTITUTE="kernelswi.cpp" ∗/
- #define **KERNELTIMER_CPP** 0x000F /∗ SUBSTITUTE="kerneltimer.cpp" ∗/
- #define **KPROFILE_CPP** 0x0010 /∗ SUBSTITUTE="kprofile.cpp" ∗/
- #define **THREADPORT_CPP** 0x0011 /∗ SUBSTITUTE="threadport.cpp" ∗/
- #define BLOCKING_H 0x1000 /∗ SUBSTITUTE="blocking.h" ∗/

Header file names start at 0x1000.

- #define **DRIVER_H** 0x1001 /∗ SUBSTITUTE="driver.h" ∗/
- #define **KERNEL_H** 0x1002 /∗ SUBSTITUTE="kernel.h" ∗/
- #define **KERNELTYPES_H** 0x1003 /∗ SUBSTITUTE="kerneltypes.h" ∗/
- #define **LL_H** 0x1004 /∗ SUBSTITUTE="ll.h" ∗/
- #define **MANUAL_H** 0x1005 /∗ SUBSTITUTE="manual.h" ∗/
- #define **MARK3CFG_H** 0x1006 /∗ SUBSTITUTE="mark3cfg.h" ∗/
- #define **MESSAGE_H** 0x1007 /∗ SUBSTITUTE="message.h" ∗/
- #define **MUTEX_H** 0x1008 /∗ SUBSTITUTE="mutex.h" ∗/
- #define **PROFILE_H** 0x1009 /∗ SUBSTITUTE="profile.h" ∗/
- #define **PROFILING_RESULTS_H** 0x100A /∗ SUBSTITUTE="profiling_results.h" ∗/
- #define **QUANTUM_H** 0x100B /∗ SUBSTITUTE="quantum.h" ∗/
- #define **SCHEDULER_H** 0x100C /∗ SUBSTITUTE="scheduler.h" ∗/
- #define **SEMAPHORE_H** 0x100D /∗ SUBSTITUTE="ksemaphore.h" ∗/
- #define **THREAD_H** 0x100E /∗ SUBSTITUTE="thread.h" ∗/
- #define **THREADLIST_H** 0x100F /∗ SUBSTITUTE="threadlist.h" ∗/
- #define **TIMERLIST_H** 0x1010 /∗ SUBSTITUTE="timerlist.h" ∗/
- #define **KERNELSWI_H** 0x1011 /∗ SUBSTITUTE="kernelswi.h ∗/
- #define **KERNELTIMER_H** 0x1012 /∗ SUBSTITUTE="kerneltimer.h ∗/
- #define **KPROFILE_H** 0x1013 /∗ SUBSTITUTE="kprofile.h" ∗/
- #define **THREADPORT_H** 0x1014 /∗ SUBSTITUTE="threadport.h" ∗/
- #define STR_PANIC 0x2000 /∗ SUBSTITUTE="!Panic!" ∗/

  Indexed strings start at 0x2000.

- #define **STR_MARK3_INIT** 0x2001 /∗ SUBSTITUTE="Initializing Kernel Objects" ∗/
- #define **STR_KERNEL_ENTER** 0x2002 /∗ SUBSTITUTE="Starting Kernel" ∗/
- #define **STR_THREAD_START** 0x2003 /∗ SUBSTITUTE="Switching to First Thread" ∗/
- #define **STR_START_ERROR** 0x2004 /∗ SUBSTITUTE="Error starting kernel - function should never return" ∗/
- #define **STR_THREAD_CREATE** 0x2005 /∗ SUBSTITUTE="Creating Thread" ∗/
- #define **STR_STACK_SIZE_1** 0x2006 /∗ SUBSTITUTE=" Stack Size: %1" ∗/
- #define **STR_PRIORITY_1** 0x2007 /∗ SUBSTITUTE=" Priority: %1" ∗/
- #define **STR_THREAD_ID_1** 0x2008 /∗ SUBSTITUTE=" Thread ID: %1" ∗/
- #define **STR_ENTRYPOINT_1** 0x2009 /∗ SUBSTITUTE=" EntryPoint: %1" ∗/
- #define **STR_CONTEXT_SWITCH_1** 0x200A /∗ SUBSTITUTE="Context Switch To Thread: %1" ∗/
- #define **STR_IDLING** 0x200B /∗ SUBSTITUTE="Idling CPU" ∗/
- #define **STR_WAKEUP** 0x200C /∗ SUBSTITUTE="Waking up" ∗/
- #define **STR_SEMAPHORE_PEND_1** 0x200D /∗ SUBSTITUTE="Semaphore Pend: %1" ∗/
- #define **STR_SEMAPHORE_POST_1** 0x200E /∗ SUBSTITUTE="Semaphore Post: %1" ∗/
- #define **STR_MUTEX_CLAIM_1** 0x200F /∗ SUBSTITUTE="Mutex Claim: %1" ∗/
- #define **STR_MUTEX_RELEASE_1** 0x2010 /∗ SUBSTITUTE="Mutex Release: %1" ∗/
- #define **STR_THREAD_BLOCK_1** 0x2011 /∗ SUBSTITUTE="Thread %1 Blocked" ∗/
- #define **STR_THREAD_UNBLOCK_1** 0x2012 /∗ SUBSTITUTE="Thread %1 Unblocked" ∗/
- #define **STR_ASSERT_FAILED** 0x2013 /∗ SUBSTITUTE="Assertion Failed" ∗/
- #define **STR_SCHEDULE_1** 0x2014 /∗ SUBSTITUTE="Scheduler chose %1" ∗/
- #define **STR_THREAD_START_1** 0x2015 /∗ SUBSTITUTE="Thread Start: %1" ∗/
- #define **STR_THREAD_EXIT_1** 0x2016 /∗ SUBSTITUTE="Thread Exit: %1" ∗/
- #define **STR_UNDEFINED** 0xFFFF /∗ SUBSTITUTE="UNDEFINED" ∗/

17.49.1 Detailed Description

Hex codes/translation tables used for efficient string tokenization. We use this for efficiently encoding strings used for kernel traces, debug prints, etc. The upside - this is really fast and efficient for encoding strings and data. Downside? The tools need to parse this header file in order to convert the enumerated data into actual strings, decoding them.

Definition in file debug_tokens.h.

17.50 debug_tokens.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __DEBUG_TOKENS_H__
#define __DEBUG_TOKENS_H__
//---------------------------------------------------------------------------
#define BLOCKING_CPP        0x0001        /* SUBSTITUTE="blocking.cpp" */
#define DRIVER_CPP          0x0002        /* SUBSTITUTE="driver.cpp" */
#define KERNEL_CPP          0x0003        /* SUBSTITUTE="kernel.cpp" */
#define LL_CPP              0x0004        /* SUBSTITUTE="ll.cpp" */
#define MESSAGE_CPP         0x0005        /* SUBSTITUTE="message.cpp" */
#define MUTEX_CPP           0x0006        /* SUBSTITUTE="mutex.cpp" */
#define PROFILE_CPP         0x0007        /* SUBSTITUTE="profile.cpp" */
#define QUANTUM_CPP         0x0008        /* SUBSTITUTE="quantum.cpp" */
#define SCHEDULER_CPP       0x0009        /* SUBSTITUTE="scheduler.cpp" */
#define SEMAPHORE_CPP       0x000A        /* SUBSTITUTE="semaphore.cpp" */
#define THREAD_CPP          0x000B        /* SUBSTITUTE="thread.cpp" */
#define THREADLIST_CPP      0x000C        /* SUBSTITUTE="threadlist.cpp" */
#define TIMERLIST_CPP       0x000D        /* SUBSTITUTE="timerlist.cpp" */
#define KERNELSWI_CPP       0x000E        /* SUBSTITUTE="kernelswi.cpp" */
#define KERNELTIMER_CPP     0x000F        /* SUBSTITUTE="kerneltimer.cpp" */
#define KPROFILE_CPP        0x0010        /* SUBSTITUTE="kprofile.cpp" */
#define THREADPORT_CPP      0x0011        /* SUBSTITUTE="threadport.cpp" */

//---------------------------------------------------------------------------
#define BLOCKING_H          0x1000        /* SUBSTITUTE="blocking.h" */
#define DRIVER_H            0x1001        /* SUBSTITUTE="driver.h" */
#define KERNEL_H            0x1002        /* SUBSTITUTE="kernel.h" */
#define KERNELTYPES_H       0x1003        /* SUBSTITUTE="kerneltypes.h" */
#define LL_H                0x1004        /* SUBSTITUTE="ll.h" */
#define MANUAL_H            0x1005        /* SUBSTITUTE="manual.h" */
#define MARK3CFG_H          0x1006        /* SUBSTITUTE="mark3cfg.h" */
#define MESSAGE_H           0x1007        /* SUBSTITUTE="message.h" */
#define MUTEX_H             0x1008        /* SUBSTITUTE="mutex.h" */
#define PROFILE_H           0x1009        /* SUBSTITUTE="profile.h" */
#define PROFILING_RESULTS_H 0x100A        /* SUBSTITUTE="profiling_results.h" */
#define QUANTUM_H           0x100B        /* SUBSTITUTE="quantum.h" */
#define SCHEDULER_H         0x100C        /* SUBSTITUTE="scheduler.h" */
#define SEMAPHORE_H         0x100D        /* SUBSTITUTE="ksemaphore.h" */
#define THREAD_H            0x100E        /* SUBSTITUTE="thread.h" */
#define THREADLIST_H        0x100F        /* SUBSTITUTE="threadlist.h" */
#define TIMERLIST_H         0x1010        /* SUBSTITUTE="timerlist.h" */
#define KERNELSWI_H         0x1011        /* SUBSTITUTE="kernelswi.h */
#define KERNELTIMER_H       0x1012        /* SUBSTITUTE="kerneltimer.h */
#define KPROFILE_H          0x1013        /* SUBSTITUTE="kprofile.h" */
#define THREADPORT_H        0x1014        /* SUBSTITUTE="threadport.h" */

//---------------------------------------------------------------------------
#define STR_PANIC            0x2000        /* SUBSTITUTE="!Panic!" */
#define STR_MARK3_INIT       0x2001        /* SUBSTITUTE="Initializing Kernel Objects" */
#define STR_KERNEL_ENTER     0x2002        /* SUBSTITUTE="Starting Kernel" */
#define STR_THREAD_START     0x2003        /* SUBSTITUTE="Switching to First Thread" */
#define STR_START_ERROR      0x2004        /* SUBSTITUTE="Error starting kernel - function should never
 return" */
#define STR_THREAD_CREATE    0x2005        /* SUBSTITUTE="Creating Thread" */
#define STR_STACK_SIZE_1     0x2006        /* SUBSTITUTE="  Stack Size: %1" */
#define STR_PRIORITY_1       0x2007        /* SUBSTITUTE="  Priority: %1" */
#define STR_THREAD_ID_1      0x2008        /* SUBSTITUTE="  Thread ID: %1" */
#define STR_ENTRYPOINT_1     0x2009        /* SUBSTITUTE="  EntryPoint: %1" */
#define STR_CONTEXT_SWITCH_1 0x200A        /* SUBSTITUTE="Context Switch To Thread: %1" */
#define STR_IDLING           0x200B        /* SUBSTITUTE="Idling CPU" */
#define STR_WAKEUP           0x200C        /* SUBSTITUTE="Waking up" */
#define STR_SEMAPHORE_PEND_1 0x200D        /* SUBSTITUTE="Semaphore Pend: %1" */
#define STR_SEMAPHORE_POST_1 0x200E        /* SUBSTITUTE="Semaphore Post: %1" */
#define STR_MUTEX_CLAIM_1    0x200F        /* SUBSTITUTE="Mutex Claim: %1" */
#define STR_MUTEX_RELEASE_1  0x2010        /* SUBSTITUTE="Mutex Release: %1" */
#define STR_THREAD_BLOCK_1   0x2011        /* SUBSTITUTE="Thread %1 Blocked" */
#define STR_THREAD_UNBLOCK_1 0x2012        /* SUBSTITUTE="Thread %1 Unblocked" */
#define STR_ASSERT_FAILED    0x2013        /* SUBSTITUTE="Assertion Failed" */
#define STR_SCHEDULE_1       0x2014        /* SUBSTITUTE="Scheduler chose %1" */
#define STR_THREAD_START_1   0x2015        /* SUBSTITUTE="Thread Start: %1" */
#define STR_THREAD_EXIT_1    0x2016        /* SUBSTITUTE="Thread Exit: %1" */

//---------------------------------------------------------------------------
```

```
00098 #define STR_UNDEFINED            0xFFFF       /* SUBSTITUTE="UNDEFINED" */
00099 #endif
```

17.51 /home/mo/mark3-source/embedded/stage/src/draw.h File Reference

Raster graphics APIs Description: Implements basic drawing functionality.

```
#include "kerneltypes.h"
#include "font.h"
#include "colorspace.h"
```

Classes

- struct DrawPoint_t

  Defines a pixel.
- struct DrawLine_t

  Defines a simple line.
- struct DrawRectangle_t

  Defines a rectangle.
- struct DrawCircle_t

  Defines a circle.
- struct DrawEllipse_t

  Defines a ellipse.
- struct DrawBitmap_t

  Defines a bitmap.
- struct DrawStamp_t

  Defines a 1-bit 2D bitmap of arbitrary resolution.
- struct DrawText_t

  Defines a bitmap-rendered string.
- struct TextFX_t
- struct DrawWindow_t

  Defines the active window - establishes boundaries for drawing on the current display.
- struct DrawMove_t

  Simple 2D copy/paste.
- struct DrawVector_t

  Specifies a single 2D point.
- struct DrawPoly_t

  Defines the structure of an arbitrary polygon.

Macros

- #define TEXTFX_FLAG_OPAQUE_BG (0x01)

  Use an opaque BG.
- #define TEXTFX_FLAG_ROTATE (0x02)

  Apply text rotation.
- #define TEXTFX_FLAG_SCALE_X (0x04)

  Scale the text horizontally.
- #define TEXTFX_FLAG_SCALE_Y (0x08)

  Scale the text vertically.

Enumerations

- enum **DisplayEvent_t** {
  DISPLAY_EVENT_SET_PIXEL = 0x00, **DISPLAY_EVENT_GET_PIXEL**, **DISPLAY_EVENT_CLEAR**, **DISPLAY_EVENT_LINE**,
  DISPLAY_EVENT_RECTANGLE, **DISPLAY_EVENT_CIRCLE**, **DISPLAY_EVENT_ELLIPSE**, **DISPLAY_EVENT_BITMAP**,
  DISPLAY_EVENT_STAMP, **DISPLAY_EVENT_TEXT**, **DISPLAY_EVENT_MOVE**, **DISPLAY_EVENT_POLY** }

17.51.1 Detailed Description

Raster graphics APIs Description: Implements basic drawing functionality. This forms a hardware abstraction layer which requires a backend for rendering.

Definition in file draw.h.

17.52 draw.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
//---------------------------------------------------------------------------

#ifndef __DRAW_H_
#define __DRAW_H_

#include "kerneltypes.h"
#include "font.h"
#include "colorspace.h"

//---------------------------------------------------------------------------
// Event definitions for 2D hardware accelerated graphics functions
typedef enum
{
    //--[Mandatory for a display driver]-------------------------------------
    DISPLAY_EVENT_SET_PIXEL = 0x00,
    DISPLAY_EVENT_GET_PIXEL,

    //--[Optional if supported in hardware]----------------------------------
    DISPLAY_EVENT_CLEAR,
    DISPLAY_EVENT_LINE,
    DISPLAY_EVENT_RECTANGLE,
    DISPLAY_EVENT_CIRCLE,
    DISPLAY_EVENT_ELLIPSE,
    DISPLAY_EVENT_BITMAP,
    DISPLAY_EVENT_STAMP,
    DISPLAY_EVENT_TEXT,
    DISPLAY_EVENT_MOVE,
    DISPLAY_EVENT_POLY
} DisplayEvent_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;
    COLOR uColor;
} DrawPoint_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX1;
    K_USHORT usX2;
    K_USHORT usY1;
    K_USHORT usY2;
    COLOR uColor;
} DrawLine_t;
//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usLeft;
    K_USHORT usTop;
    K_USHORT usRight;
    K_USHORT usBottom;
    COLOR uLineColor;
    K_BOOL bFill;
    COLOR uFillColor;
} DrawRectangle_t;
//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;
    K_USHORT usRadius;
    COLOR uLineColor;
    K_BOOL bFill;
    COLOR uFillColor;
} DrawCircle_t;
//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;
    K_USHORT usHeight;
    K_USHORT usWidth;
    COLOR uColor;
} DrawEllipse_t;
//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;
    K_USHORT usWidth;
    K_USHORT usHeight;
    K_UCHAR ucBPP;
    K_UCHAR *pucData;
} DrawBitmap_t;
//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;
    K_USHORT usWidth;
    K_USHORT usHeight;
    COLOR uColor;
    K_UCHAR *pucData;
} DrawStamp_t;    // monochrome stamp, bitpacked 8bpp

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usLeft;
    K_USHORT usTop;
    COLOR uColor;
    Font_t *pstFont;
    const K_CHAR *pcString;
} DrawText_t;

//---------------------------------------------------------------------------
#define TEXTFX_FLAG_OPAQUE_BG   (0x01)
#define TEXTFX_FLAG_ROTATE      (0x02)
#define TEXTFX_FLAG_SCALE_X     (0x04)
#define TEXTFX_FLAG_SCALE_Y     (0x08)

//---------------------------------------------------------------------------
typedef struct
{
    K_UCHAR ucFlags;
    COLOR uBGColor;
    K_USHORT usRotateDeg;
    K_USHORT usScaleX100;
    K_USHORT usScaleY100;
} TextFX_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usLeft;
    K_USHORT usRight;
    K_USHORT usTop;
    K_USHORT usBottom;
} DrawWindow_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usSrcX;
    K_USHORT usSrcY;
    K_USHORT usDstX;
    K_USHORT usDstY;
    K_USHORT usCopyHeight;
    K_USHORT usCopyWidth;
} DrawMove_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;
} DrawVector_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT     usNumPoints;
    COLOR        uColor;
    K_BOOL       bFill;
    DrawVector_t *pstVector;
} DrawPoly_t;

#endif //__DRAW_H__
```

17.53 /home/mo/mark3-source/embedded/stage/src/driver.cpp File Reference

Device driver/hardware abstraction layer.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"
#include "driver.h"
```

Classes

- class DevNull

    This class implements the "default" driver (/dev/null)

Macros

- #define **__FILE_ID__** DRIVER_CPP

Functions

- static K_UCHAR **DrvCmp** (const K_CHAR *szStr1_, const K_CHAR *szStr2_)

Variables

- static DevNull **clDevNull**

17.53.1 Detailed Description

Device driver/hardware abstraction layer.

Definition in file driver.cpp.

17.54 driver.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||      |      ||  |/ /      ||___   |
|     \/   | ||     \     ||      \      ||     \      ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"
#include "driver.h"

//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     DRIVER_CPP

//---------------------------------------------------------------------------
#if KERNEL_USE_DRIVER

DoubleLinkList DriverList::m_clDriverList;

class DevNull : public Driver
{
public:
    virtual void Init() { SetName("/dev/null"); };
    virtual K_UCHAR Open() { return 0; }
    virtual K_UCHAR Close() { return 0; }

    virtual K_USHORT Read( K_USHORT usBytes_, K_UCHAR *pucData_)
        { return usBytes_; }

    virtual K_USHORT Write( K_USHORT usBytes_, K_UCHAR *pucData_)
        { return usBytes_; }

    virtual K_USHORT Control( K_USHORT usEvent_, void *pvDataIn_, K_USHORT usSizeIn_, void *
pvDataOut_,  K_USHORT usSizeOut_ )
        { return 0; }

};

//---------------------------------------------------------------------------
static DevNull clDevNull;

//---------------------------------------------------------------------------
static K_UCHAR DrvCmp( const K_CHAR *szStr1_, const K_CHAR *szStr2_ )
{
    K_CHAR *szTmp1 = (K_CHAR*) szStr1_;
    K_CHAR *szTmp2 = (K_CHAR*) szStr2_;

    while (*szTmp1 && *szTmp2)
    {
        if (*szTmp1++ != *szTmp2++)
        {
            return 0;
        }
    }

    // Both terminate at the same length
    if (!(*szTmp1) && !(*szTmp2))
    {
        return 1;
    }

    return 0;
}

//---------------------------------------------------------------------------
void DriverList::Init()
{
    // Ensure we always have at least one entry - a default in case no match
    // is found (/dev/null)
    clDevNull.Init();
    Add(&clDevNull);
}

//---------------------------------------------------------------------------
```

```
Driver *DriverList::FindByPath( const K_CHAR *m_pcPath )
{
    KERNEL_ASSERT( m_pcPath );
    Driver *pclTemp = static_cast<Driver*>(m_clDriverList.
GetHead());

    while (pclTemp)
    {
        if(DrvCmp(m_pcPath, pclTemp->GetPath()))
        {
            return pclTemp;
        }
        pclTemp = static_cast<Driver*>(pclTemp->GetNext());
    }
    return &clDevNull;
}

#endif
```

17.55 /home/mo/mark3-source/embedded/stage/src/driver.h File Reference

Driver abstraction framework.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"
```

Classes

- class Driver

  Base device-driver class used in hardware abstraction.
- class DriverList

  List of Driver objects used to keep track of all device drivers in the system.

17.55.1 Detailed Description

Driver abstraction framework.

17.55.2 Intro

This is the basis of the driver framework. In the context of Mark3, drivers don't necessarily have to be based on physical hardware peripherals. They can be used to represent algorithms (such as random number generators), files, or protocol stacks. Unlike FunkOS, where driver IO is protected automatically by a mutex, we do not use this kind of protection - we leave it up to the driver implementor to do what's right in its own context. This also frees up the driver to implement all sorts of other neat stuff, like sending messages to threads associated with the driver. Drivers are implemented as character devices, with the standard array of posix-style accessor methods for reading, writing, and general driver control.

A global driver list is provided as a convenient and minimal "filesystem" structure, in which devices can be accessed by name.

17.55.3 Driver Design

A device driver needs to be able to perform the following operations: -Initialize a peripheral -Start/stop a peripheral -Handle I/O control operations -Perform various read/write operations

At the end of the day, that's pretty much all a device driver has to do, and all of the functionality that needs to be presented to the developer.

We abstract all device drivers using a base-class which implements the following methods: -Start/Open -Stop/Close -Control -Read -Write

A basic driver framework and API can thus be implemented in five function calls - that's it! You could even reduce that further by handling the initialize, start, and stop operations inside the "control" operation.

17.55.4 Driver API

In C++, we can implement this as a class to abstract these event handlers, with virtual void functions in the base class overridden by the inherited objects.

To add and remove device drivers from the global table, we use the following methods:

```
void DriverList::Add( Driver *pclDriver_ );
void DriverList::Remove( Driver *pclDriver_ );
```

DriverList::Add()/Remove() takes a single arguments the pointer to he object to operate on.

Once a driver has been added to the table, drivers are opened by NAME using DriverList::FindByName("/dev/name"). This function returns a pointer to the specified driver if successful, or to a built in /dev/null device if the path name is invalid. After a driver is open, that pointer is used for all other driver access functions.

This abstraction is incredibly useful any peripheral or service can be accessed through a consistent set of APIs, that make it easy to substitute implementations from one platform to another. Portability is ensured, the overhead is negligible, and it emphasizes the reuse of both driver and application code as separate entities.

Consider a system with drivers for I2C, SPI, and UART peripherals - under our driver framework, an application can initialize these peripherals and write a greeting to each using the same simple API functions for all drivers:

```
pclI2C  = DriverList::FindByName("/dev/i2c");
pclUART = DriverList::FindByName("/dev/tty0");
pclSPI  = DriverList::FindByName("/dev/spi");

pclI2C->Write(12,"Hello World!");
pclUART->Write(12, "Hello World!");
pclSPI->Write(12, "Hello World!");
```

Definition in file driver.h.

17.56 driver.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "ll.h"

#ifndef __DRIVER_H__
#define __DRIVER_H__

#if KERNEL_USE_DRIVER

class DriverList;
//---------------------------------------------------------------------------
class Driver : public LinkListNode
{
public:
    virtual void Init() = 0;

    virtual K_UCHAR Open() = 0;

    virtual K_UCHAR Close() = 0;

    virtual K_USHORT Read( K_USHORT usBytes_,
                           K_UCHAR *pucData_) = 0;

    virtual K_USHORT Write( K_USHORT usBytes_,
                            K_UCHAR *pucData_) = 0;

    virtual K_USHORT Control( K_USHORT usEvent_,
                              void *pvDataIn_,
                              K_USHORT usSizeIn_,
                              void *pvDataOut_,
                              K_USHORT usSizeOut_ ) = 0;

    void SetName( const K_CHAR *pcName_ ) { m_pcPath = pcName_; }

    const K_CHAR *GetPath() { return m_pcPath; }

private:

    const K_CHAR *m_pcPath;
};

//---------------------------------------------------------------------------
class DriverList
{
public:
    static void Init();

    static void Add( Driver *pclDriver_ ) { m_clDriverList.
Add(pclDriver_); }

    static void Remove( Driver *pclDriver_ ) { m_clDriverList.
Remove(pclDriver_); }

    static Driver *FindByPath( const K_CHAR *m_pcPath );

private:

    static DoubleLinkList m_clDriverList;
};

#endif //KERNEL_USE_DRIVER

#endif
```

17.57 /home/mo/mark3-source/embedded/stage/src/eventflag.cpp File Reference

Event Flag Blocking Object/IPC-Object implementation.

```
#include "mark3cfg.h"
#include "blocking.h"
#include "kernel.h"
#include "thread.h"
#include "eventflag.h"
#include "timerlist.h"
```

Macros

- #define **EVENT_TRANSACTION_WAIT** (0)
- #define **EVENT_TRANSACTION_SET** (1)
- #define **EVENT_TRANSACTION_CLEAR** (2)
- #define **EVENT_TRANSACTION_TIMEOUT** (3)

Functions

- void **TimedEventFlag_Callback** (Thread *pclOwner_, void *pvData_)

17.57.1 Detailed Description

Event Flag Blocking Object/IPC-Object implementation.

Definition in file eventflag.cpp.

17.58 eventflag.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  _____
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_____|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "mark3cfg.h"
#include "blocking.h"
#include "kernel.h"
#include "thread.h"
#include "eventflag.h"

#if KERNEL_USE_EVENTFLAG

//---------------------------------------------------------------------------
#define EVENT_TRANSACTION_WAIT      (0)
#define EVENT_TRANSACTION_SET       (1)
#define EVENT_TRANSACTION_CLEAR     (2)
#define EVENT_TRANSACTION_TIMEOUT   (3)

#if KERNEL_USE_TIMERS
#include "timerlist.h"
//---------------------------------------------------------------------------
void TimedEventFlag_Callback(Thread *pclOwner_, void *pvData_)
{
    EventFlag *pclEventFlag = static_cast<EventFlag*>(pvData_);

    // The blocking operation timed out before it occurred.  Allow the
    // object to unblock the thread.
    pclEventFlag->Timeout(pclOwner_);
}

//---------------------------------------------------------------------------
void EventFlag::Timeout(Thread *pclChosenOne_)
{
    // Take a lock on the object - if the object is already locked, it means
    // that another context is currently operating within the locked context.
    // In that case, queue an event in the kernel transaction queue, and
    // return out immediately.  The operation will be executed on the
    // thread currently holding the lock.
    K_BOOL bSchedState;
    if (LockAndQueue( EVENT_TRANSACTION_TIMEOUT, (void*)pclChosenOne_, &bSchedState))
    {
        return;
    }

    // Drain the FIFO - this will ensure that the operation above is executed,
    // as well as any other queued operations that occur as a reuslt of
    // processing through interrupts.
    if (ProcessQueue())
    {
        // If a new thread needs to be chosen, call yield
        Thread::Yield();
    }

    // Re-enable the scheduler to its previous state.
    Scheduler::SetScheduler(bSchedState);
}

//---------------------------------------------------------------------------
K_USHORT EventFlag::Wait(K_USHORT usMask_, EventFlagOperation_t eMode_)
{
    return Wait(usMask_, eMode_, 0);
}
K_USHORT EventFlag::Wait(K_USHORT usMask_, EventFlagOperation_t eMode_, K_ULONG ulTimeMS_)
#else
K_USHORT EventFlag::Wait(K_USHORT usMask_, EventFlagOperation_t eMode_)
```

```
#endif
{
    // Claim the lock (we know only one thread can hold the lock, only one thread can
    // execute at a time, and only threads can call wait)
    K_BOOL bSchedState;
    if (LockAndQueue(EVENT_TRANSACTION_WAIT, (void*)((K_ADDR)usMask_), &bSchedState))
    {
        // This should never be able to happen with the logic implemented above
        Kernel::Panic( PANIC_EVENT_LOCK_VIOLATION );
    }

    // Set data on the current thread that needs to be passed into the transaction
    // handler (and can't be queued in the simple key-value pair in the transaciton
    // object)
    Scheduler::GetCurrentThread()->SetEventFlagMode(eMode_);
#if KERNEL_USE_TIMERS
    Scheduler::GetCurrentThread()->GetTimer()->
SetIntervalTicks(ulTimeMS_);
    Scheduler::GetCurrentThread()->SetExpired(false);
#endif

    // Drain the FIFO of all queued events and trigger a context switch if necessary
    if (ProcessQueue())
    {
        Thread::Yield();
    }

    // Re-enable the scheduler
    Scheduler::SetScheduler(bSchedState);


#if KERNEL_USE_TIMERS
    if (ulTimeMS_)
    {
        Scheduler::GetCurrentThread()->GetTimer()->
Stop();
    }
#endif

    return Scheduler::GetCurrentThread()->
GetEventFlagMask();
}

//---------------------------------------------------------------------------
K_BOOL EventFlag::ProcessQueue()
{
    Transaction *pclTRX;
    K_BOOL bReschedule = false;

    do
    {
        pclTRX = m_clKTQ.Dequeue();
        KERNEL_ASSERT(pclTRX);

        switch (pclTRX->GetCode())
        {
            case EVENT_TRANSACTION_WAIT:
                WaitTransaction(pclTRX, &bReschedule);
                break;
            case EVENT_TRANSACTION_SET:
                SetTransaction(pclTRX, &bReschedule);
                break;
            case EVENT_TRANSACTION_CLEAR:
                ClearTransaction(pclTRX, &bReschedule);
                break;
#if KERNEL_USE_TIMERS
            case EVENT_TRANSACTION_TIMEOUT:
                TimeoutTransaction(pclTRX, &bReschedule);
                break;
#endif
            default:
                break;
        }
        m_clKTQ.Finish(pclTRX);
    } while (UnLock() > 1);

    return bReschedule;
}

//---------------------------------------------------------------------------
void EventFlag::WaitTransaction( Transaction *pclTRX_, K_BOOL *
pbReschedule_ )
{
    bool bMatch = false;
    Thread *pclThread = Scheduler::GetCurrentThread();
    K_USHORT usMask = (K_USHORT)((K_ADDR)pclTRX_->GetData());

```

```
#if KERNEL_USE_TIMERS
    Timer *pclTimer = pclThread->GetTimer();
    pclThread->SetExpired(false);
#endif

    // Check to see whether or not the current mask matches any of the
    // desired bits.

    EventFlagOperation_t eMode = pclThread->GetEventFlagMode();
    if ((eMode == EVENT_FLAG_ALL) || (eMode == EVENT_FLAG_ALL_CLEAR))
    {
        // Check to see if the flags in their current state match all of
        // the set flags in the event flag group, with this mask.
        if ((m_usSetMask & usMask) == usMask)
        {
            bMatch = true;
            pclThread->SetEventFlagMask(usMask);
        }
    }
    else if ((eMode == EVENT_FLAG_ANY) || (eMode == EVENT_FLAG_ANY_CLEAR))
    {
        // Check to see if the existing flags match any of the set flags in
        // the event flag group  with this mask
        if (m_usSetMask & usMask)
        {
            bMatch = true;
            pclThread->SetEventFlagMask(m_usSetMask & usMask);
        }
    }

    // We're unable to match this pattern as-is, so we must block.
    if (!bMatch)
    {
        // Reset the current thread's event flag mask & mode
        pclThread->SetEventFlagMask(usMask);
        pclThread->SetEventFlagMode(eMode);

#if KERNEL_USE_TIMERS
        K_ULONG ulTimeMS = pclTimer->GetInterval();
        if (ulTimeMS)
        {
            pclTimer->Start(0, ulTimeMS, TimedEventFlag_Callback, (void*)this);
        }
#endif

        // Add the thread to the object's block-list.
        Block(pclThread);

        *pbReschedule_ = true;
    }
}

//---------------------------------------------------------------------------
void EventFlag::SetTransaction( Transaction *pclTRX_, K_BOOL *
pbReschedule_ )
{
    Thread *pclPrev;
    Thread *pclCurrent;

    K_USHORT usNewMask;
    K_USHORT usMask = (K_USHORT)((K_ADDR)pclTRX_->GetData());
    // Walk through the whole block list, checking to see whether or not
    // the current flag set now matches any/all of the masks and modes of
    // the threads involved.

    m_usSetMask |= usMask;
    usNewMask = m_usSetMask;

    // Start at the head of the list, and iterate through until we hit the
    // "head" element in the list again.  Ensure that we handle the case where
    // we remove the first or last elements in the list, or if there's only
    // one element in the list.
    pclCurrent = static_cast<Thread*>(m_clBlockList.GetHead());

    // Do nothing when there are no objects blocking.
    if (pclCurrent)
    {
        // First loop - process every thread in the block-list and check to
        // see whether or not the current flags match the event-flag conditions
        // on the thread.
        do
        {
            pclPrev = pclCurrent;
            pclCurrent = static_cast<Thread*>(pclCurrent->GetNext());

            // Read the thread's event mask/mode
            K_USHORT usThreadMask = pclPrev->GetEventFlagMask();
            EventFlagOperation_t eThreadMode = pclPrev->GetEventFlagMode();

            // For the "any" mode - unblock the blocked threads if one or more bits
            // in the thread's bitmask match the object's bitmask
            if ((EVENT_FLAG_ANY == eThreadMode) || (EVENT_FLAG_ANY_CLEAR == eThreadMode))
            {
                if (usThreadMask & m_usSetMask)
                {
                    pclPrev->SetEventFlagMode(EVENT_FLAG_PENDING_UNBLOCK);
                    pclPrev->SetEventFlagMask(m_usSetMask & usThreadMask);
                    *pbReschedule_ = true;

                    // If the "clear" variant is set, then clear the bits in the mask
                    // that caused the thread to unblock.
                    if (EVENT_FLAG_ANY_CLEAR == eThreadMode)
                    {
                        usNewMask &=~ (usThreadMask & usMask);
                    }
                }
            }
            // For the "all" mode, every set bit in the thread's requested bitmask must
            // match the object's flag mask.
            else if ((EVENT_FLAG_ALL == eThreadMode) || (EVENT_FLAG_ALL_CLEAR == eThreadMode))
            {
                if ((usThreadMask & m_usSetMask) == usThreadMask)
                {
                    pclPrev->SetEventFlagMode(EVENT_FLAG_PENDING_UNBLOCK);
                    pclPrev->SetEventFlagMask(usThreadMask);
                    *pbReschedule_ = true;

                    // If the "clear" variant is set, then clear the bits in the mask
                    // that caused the thread to unblock.
                    if (EVENT_FLAG_ALL_CLEAR == eThreadMode)
                    {
                        usNewMask &=~ (usThreadMask & usMask);
                    }
                }
            }
        }
        // To keep looping, ensure that there's something in the list, and
        // that the next item isn't the head of the list.
        while (pclPrev != m_clBlockList.GetTail());

        // Second loop - go through and unblock all of the threads that
        // were tagged for unblocking.
        pclCurrent = static_cast<Thread*>(m_clBlockList.GetHead());
        bool bIsTail = false;
        do
        {
            pclPrev = pclCurrent;
            pclCurrent = static_cast<Thread*>(pclCurrent->GetNext());

            // Check to see if this is the condition to terminate the loop
            if (pclPrev == m_clBlockList.GetTail())
            {
                bIsTail = true;
            }

            // If the first pass indicated that this thread should be
            // unblocked, then unblock the thread
            if (pclPrev->GetEventFlagMode() == EVENT_FLAG_PENDING_UNBLOCK)
            {
                UnBlock(pclPrev);
            }
        }
        while (!bIsTail);
    }

    // Update the bitmask based on any "clear" operations performed along
    // the way
    m_usSetMask = usNewMask;
}

//---------------------------------------------------------------------------
void EventFlag::ClearTransaction( Transaction *pclTRX_, K_BOOL *pbReschedule_ )
{
    m_usSetMask &= ~((K_USHORT)((K_ADDR)pclTRX_->GetData()));
}

#if KERNEL_USE_TIMERS
//---------------------------------------------------------------------------
void EventFlag::TimeoutTransaction( Transaction *pclTRX_, K_BOOL *pbReschedule_ )
{
    Thread *pclChosenOne = static_cast<Thread*>(pclTRX_->GetData());
    UnBlock(pclChosenOne);

    pclChosenOne->SetExpired(true);
    pclChosenOne->SetEventFlagMask(0);

    if (pclChosenOne->GetPriority() > Scheduler::GetCurrentThread()->
GetPriority())
    {
        *pbReschedule_ = true;
    }
}
#endif

//---------------------------------------------------------------------------
void EventFlag::Set(K_USHORT usMask_)
{
    // This function follows the signature of Wait() and Timeout()
    K_BOOL bSchedState;
    if (LockAndQueue( EVENT_TRANSACTION_SET, (void*)((K_ADDR)usMask_), &bSchedState))
    {
        return;
    }

    if (ProcessQueue())
    {
        Thread::Yield();
    }

    Scheduler::SetScheduler(bSchedState);
}

//---------------------------------------------------------------------------
void EventFlag::Clear(K_USHORT usMask_)
{
    // This function follows the signature of Wait() and Timeout()
    K_BOOL bSchedState;
    if (LockAndQueue( EVENT_TRANSACTION_CLEAR, (void*)((K_ADDR)usMask_), &bSchedState))
    {
        return;
    }

    if (ProcessQueue())
    {
        Thread::Yield();
    }

    Scheduler::SetScheduler(bSchedState);
}

//---------------------------------------------------------------------------
K_USHORT EventFlag::GetMask()
{
    // Return the presently held event flag values in this object.  Ensure
    // we get this within a critical section to guarantee atomicity.
    K_USHORT usReturn;
    CS_ENTER();
    usReturn = m_usSetMask;
    CS_EXIT();
    return usReturn;
}

#endif // KERNEL_USE_EVENTFLAG
```

17.59 /home/mo/mark3-source/embedded/stage/src/eventflag.h File Reference

Event Flag Blocking Object/IPC-Object definition.

```
#include "mark3cfg.h"
#include "kernel.h"
#include "kerneltypes.h"
#include "blocking.h"
#include "thread.h"
#include "transaction.h"
```

Classes

- class EventFlag

  The EventFlag class is a blocking object, similar to a semaphore or mutex, commonly used for synchronizing thread execution based on events occurring within the system.

17.59.1 Detailed Description

Event Flag Blocking Object/IPC-Object definition.

Definition in file eventflag.h.

17.60 eventflag.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \    ||     |     ||  |/ /     ||___   |
|     \/   | ||     \   ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||_____|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __EVENTFLAG_H__
#define __EVENTFLAG_H__

#include "mark3cfg.h"
#include "kernel.h"
#include "kerneltypes.h"
#include "blocking.h"
#include "thread.h"
#include "transaction.h"

#if KERNEL_USE_EVENTFLAG

//---------------------------------------------------------------------------
class EventFlag : public BlockingObject
{
public:
    void Init() { m_usSetMask = 0; m_clBlockList.
Init(); }

    K_USHORT Wait(K_USHORT usMask_, EventFlagOperation_t eMode_);

#if KERNEL_USE_TIMERS

    K_USHORT Wait(K_USHORT usMask_, EventFlagOperation_t eMode_, K_ULONG ulTimeMS_);

    void Timeout(Thread *pclOwner_);

#endif

    void Set(K_USHORT usMask_);

    void Clear(K_USHORT usMask_);

    K_USHORT GetMask();

private:

    K_BOOL ProcessQueue();

    void WaitTransaction( Transaction *pclTRX_, K_BOOL *pbReschedule_ );

    void SetTransaction( Transaction *pclTRX_, K_BOOL *pbReschedule_ );

    void ClearTransaction( Transaction *pclTRX_, K_BOOL *pbReschedule_ );

#if KERNEL_USE_TIMERS

    void TimeoutTransaction( Transaction *pclTRX_, K_BOOL *pbReschedule_ );
#endif

```

```
    K_USHORT m_usSetMask;

};

#endif //KERNEL_USE_EVENTFLAG
#endif //__EVENTFLAG_H__

```

17.61 /home/mo/mark3-source/embedded/stage/src/fixed_heap.cpp File Reference

Fixed-block-size memory management.

```
#include "kerneltypes.h"
#include "fixed_heap.h"
#include "threadport.h"
```

17.61.1 Detailed Description

Fixed-block-size memory management. This allows a user to create heaps containing multiple lists, each list containing a linked-list of blocks that are each the same size. As a result of the linked-list format, these heaps are very fast - requiring only a linked list pop/push to allocated/free memory. Array traversal is required to allow for the optimal heap to be used. Blocks are chosen from the first heap with free blocks large enough to fulfill the request.

Only simple malloc/free functionlality is supported in this implementation, no complex vector-allocate or reallocation functions are supported.

Heaps are protected by critical section, and are thus thread-safe.

When creating a heap, a user supplies an array of heap configuration objects, which determines how many objects of what size are available.

The configuration objects are defined from smallest list to largest, the memory to back the heap is supplied as a pointer to a "blob" of memory which will be used to create the underlying heap objects that make up the heap internal data structures. This blob must be large enough to contain all of the requested heap objects, with all of the additional metadata required to manage the objects.

Multiple heaps can be created using this library (heaps are not singleton).

Definition in file fixed_heap.cpp.

17.62 fixed_heap.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "fixed_heap.h"
#include "threadport.h"

//---------------------------------------------------------------------------
void *BlockHeap::Create( void *pvHeap_, K_USHORT usSize_, K_USHORT usBlockSize_ )
{
    K_USHORT usNodeCount = usSize_ /
                            (usBlockSize_ + sizeof(LinkListNode) + sizeof(void*));
    K_ADDR adNode = (K_ADDR)pvHeap_;
    K_ADDR adMaxNode = (K_ADDR)((K_ADDR)pvHeap_ + (K_ADDR)usSize_);
    m_clList.Init();

    // Create a heap (linked-list nodes + byte pool) in the middle of
    // the data blob
    for (K_USHORT i = 0; i < usNodeCount; i++ )
    {
        // Create a pointer back to the source list.
        BlockHeap **pclTemp = (BlockHeap**)(adNode + sizeof(
LinkListNode));
        *pclTemp = (BlockHeap*)(this);

        // Add the node to the block list
        m_clList.Add( (LinkListNode*)adNode );

        // Move the pointer in the pool to point to the next block to allocate
        adNode += (usBlockSize_ + sizeof(LinkListNode) + sizeof(
BlockHeap*));

        // Bail if we would be going past the end of the allocated space...
        if ((K_ULONG)adNode >= (K_ULONG)adMaxNode)
        {
            break;
        }
    }
    m_usBlocksFree = usNodeCount;

    // Return pointer to end of heap (used for heap-chaining)
    return (void*)adNode;
}

//---------------------------------------------------------------------------
void *BlockHeap::Alloc()
{
    LinkListNode *pclNode = m_clList.GetHead();

    // Return the first node from the head of the list
    if (pclNode)
    {
        m_clList.Remove( pclNode );
        m_usBlocksFree--;

        // Account for block-management metadata
        return (void*)((K_ADDR)pclNode + sizeof(LinkListNode) + sizeof(void*));
    }

    // Or null, if the heap is empty.
    return 0;
}

//---------------------------------------------------------------------------
void BlockHeap::Free( void* pvData_ )
{
    // Compute the address of the original object (class metadata included)
    LinkListNode *pclNode = (LinkListNode*)((K_ADDR)pvData_ - sizeof(
LinkListNode) - sizeof(void*));

    // Add the object back to the block data pool
    m_clList.Add(pclNode);
    m_usBlocksFree++;
}

//---------------------------------------------------------------------------
void FixedHeap::Create( void *pvHeap_, HeapConfig *pclHeapConfig_ )
{
    K_USHORT i = 0;
    void *pvTemp = pvHeap_;
    while( pclHeapConfig_[i].m_usBlockSize != 0)
    {
        pvTemp = pclHeapConfig_[i].m_clHeap.Create
                    (pvTemp,
                     (pclHeapConfig_[i].m_usBlockSize +sizeof(LinkListNode) + sizeof(void*)) *
                     pclHeapConfig_[i].m_usBlockCount,
                     pclHeapConfig_[i].m_usBlockSize );
        i++;
    }
    m_paclHeaps = pclHeapConfig_;
}

//---------------------------------------------------------------------------
void *FixedHeap::Alloc( K_USHORT usSize_ )
{
    void *pvRet = 0;
    K_USHORT i = 0;

    // Go through all heaps, trying to find the smallest one that
    // has a free item to satisfy the allocation
    while (m_paclHeaps[i].m_usBlockSize != 0)
    {
        CS_ENTER();
        if ((m_paclHeaps[i].m_usBlockSize >= usSize_) && m_paclHeaps[i].m_clHeap.IsFree() )
        {
            // Found a match
            pvRet = m_paclHeaps[i].m_clHeap.Alloc();
        }
        CS_EXIT();

        // Return an object if found
        if (pvRet)
        {
            return pvRet;
        }
        i++;
    }

    // Or null on no-match
    return pvRet;
}

//---------------------------------------------------------------------------
void FixedHeap::Free( void *pvNode_ )
{
    // Compute the pointer to the block-heap this block belongs to, and
    // return it.
    CS_ENTER();
    BlockHeap **pclHeap = (BlockHeap**)((K_ADDR)pvNode_ - sizeof(BlockHeap*));
    (*pclHeap)->Free(pvNode_);
    CS_EXIT();
}


```

17.63 /home/mo/mark3-source/embedded/stage/src/fixed_heap.h File Reference

Fixed-block-size heaps.

```
#include "kerneltypes.h"
#include "ll.h"
```

Classes

- class BlockHeap

  Single-block-size heap.
- class HeapConfig

  Heap configuration object.
- class FixedHeap

  Fixed-size-block heap allocator with multiple block sizes.

17.63.1 Detailed Description

Fixed-block-size heaps.

Definition in file fixed_heap.h.

17.64 fixed_heap.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]--------------------------------------------------

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===========================================================================*/
#ifndef __FIXED_HEAP_H__
#define __FIXED_HEAP_H__

#include "kerneltypes.h"
#include "ll.h"

//---------------------------------------------------------------------------
class BlockHeap
{
public:
    void *Create( void *pvHeap_, K_USHORT usSize_, K_USHORT usBlockSize_ );

    void *Alloc();

    void Free( void* pvData_ );

    K_BOOL IsFree() { return m_usBlocksFree != 0; }

protected:
    K_USHORT m_usBlocksFree;

private:
    DoubleLinkList m_clList;
};


class FixedHeap;

//---------------------------------------------------------------------------
class HeapConfig
{
public:
    K_USHORT m_usBlockSize;
    K_USHORT m_usBlockCount;
    friend class FixedHeap;
protected:
    BlockHeap m_clHeap;
};

//---------------------------------------------------------------------------
class FixedHeap
{
public:
    void Create( void *pvHeap_, HeapConfig *pclHeapConfig_ );

    void *Alloc( K_USHORT usSize_ );

    static void Free( void *pvNode_ );

private:
    HeapConfig *m_paclHeaps;
};

#endif

```

17.65 /home/mo/mark3-source/embedded/stage/src/font.h File Reference

Font structure definitions.

```
#include "kerneltypes.h"
#include "fontport.h"
```

Classes

- struct Glyph_t
- struct Font_t

Macros

- #define GLYPH_SIZE(x) (((K_USHORT)((x->ucWidth + 7) >> 3) ∗ (K_USHORT)(x->ucHeight)) + sizeof(Glyph_t) - 1)

  The size of the glyph is the width∗height (in bytes), plus the overhead of the struct parameters.

17.65.1 Detailed Description

Font structure definitions.

Definition in file font.h.

17.66 font.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __FONT_H__
#define __FONT_H__

#include "kerneltypes.h"
#include "fontport.h"

//---------------------------------------------------------------------------
typedef struct
{
    K_UCHAR ucWidth;
    K_UCHAR ucHeight;
    K_UCHAR ucVOffset;
    K_UCHAR aucData[1];
} Glyph_t;

//---------------------------------------------------------------------------
#define GLYPH_SIZE(x) \
    (((K_USHORT)((x->ucWidth + 7) >> 3) * (K_USHORT)(x->ucHeight)) + sizeof(Glyph_t) - 1)

//---------------------------------------------------------------------------
typedef struct
{
    K_UCHAR ucSize;
    K_UCHAR ucFlags;
    K_UCHAR ucStartChar;
    K_UCHAR ucMaxChar;
    const K_CHAR *szName;
    const FONT_STORAGE_TYPE *pucFontData;
} Font_t;

#endif

```

17.67 /home/mo/mark3-source/embedded/stage/src/graphics.cpp File Reference

Generic graphics driver implementation.

```
#include "kerneltypes.h"
#include "graphics.h"
#include "draw.h"
#include "driver.h"
#include "colorspace.h"
#include "font.h"
#include <stdio.h>
```

17.67.1 Detailed Description

Generic graphics driver implementation.

Definition in file graphics.cpp.

17.68 graphics.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "graphics.h"
#include "draw.h"
#include "driver.h"
#include "colorspace.h"
#include "font.h"

#include <stdio.h>

//---------------------------------------------------------------------------
void GraphicsDriver::ClearScreen()
{
    DrawPoint_t stPoint;
    stPoint.uColor = COLOR_BLACK;

    for (stPoint.usX = 0; stPoint.usX < m_usResX; stPoint.usX++)
    {
        for (stPoint.usY = 0; stPoint.usY < m_usResY; stPoint.usY++)
        {
            // Pixel Write
            DrawPixel(&stPoint);
        }
    }
}
//---------------------------------------------------------------------------
void GraphicsDriver::Point(DrawPoint_t *pstPoint_)
{
    DrawPixel(pstPoint_);
}

//---------------------------------------------------------------------------
void GraphicsDriver::Line(DrawLine_t *pstLine_)
{
    // Bresenham Line drawing algorithm, adapted from:
    // www.cs.unc.edu/~mcmillan/comp136/Lecture6/Lines.html

    DrawPoint_t stPoint;
    K_SHORT sX1 = (K_SHORT)pstLine_->usX1;
    K_SHORT sX2 = (K_SHORT)pstLine_->usX2;
    K_SHORT sY1 = (K_SHORT)pstLine_->usY1;
    K_SHORT sY2 = (K_SHORT)pstLine_->usY2;
    K_SHORT sDeltaY = sY2 - sY1;
    K_SHORT sDeltaX = sX2 - sX1;
    K_CHAR cStepx, cStepy;
    stPoint.uColor = pstLine_->uColor;

    if (sDeltaY < 0)
    {
        sDeltaY = -sDeltaY;
        cStepy = -1;
    }
    else
    {
        cStepy = 1;
    }

    if (sDeltaX < 0)
    {
        sDeltaX = -sDeltaX;
        cStepx = -1;
    }
    else
    {
        cStepx = 1;
    }

    // Scale by a factor of 2 in each direction
    sDeltaY <<= 1;
    sDeltaX <<= 1;

    stPoint.usX = sX1;
    stPoint.usY = sY1;
    DrawPixel(&stPoint);

    if (sDeltaX > sDeltaY)
    {
        K_SHORT sFraction = sDeltaY - (sDeltaX >> 1);

        while (sX1 != sX2)
        {
            if (sFraction >= 0)
            {
                sY1 += cStepy;
                sFraction -= sDeltaX;
            }
            sX1 += cStepx;
            sFraction += sDeltaY;

            stPoint.usX = sX1;
            stPoint.usY = sY1;
            DrawPixel(&stPoint);
        }
    }
    else
    {
        K_SHORT sFraction = sDeltaX - (sDeltaY >> 1);
        while (sY1 != sY2)
        {
            if (sFraction >= 0)
            {
                sX1 += cStepx;
                sFraction -= sDeltaY;
            }
            sY1 += cStepy;
            sFraction += sDeltaX;

            stPoint.usX = sX1;
            stPoint.usY = sY1;
            DrawPixel(&stPoint);
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Rectangle(DrawRectangle_t *pstRectangle_)
{
    DrawPoint_t stPoint;

    // if drawing a background fill color (optional)
    if (pstRectangle_->bFill == true)
    {
        stPoint.uColor = pstRectangle_->uFillColor;
        for (stPoint.usX = pstRectangle_->usLeft; stPoint.usX <= pstRectangle_->
usRight; stPoint.usX++)
        {
            for (stPoint.usY = pstRectangle_->usTop; stPoint.usY <= pstRectangle_->
usBottom; stPoint.usY++)
            {
                DrawPixel(&stPoint);
            }
        }
    }

    // Draw four orthogonal lines...
    stPoint.uColor = pstRectangle_->uLineColor;
    stPoint.usY = pstRectangle_->usTop;
    for (stPoint.usX = pstRectangle_->usLeft; stPoint.usX <= pstRectangle_->usRight; stPoint.usX++)
    {
        DrawPixel(&stPoint);
    }

    stPoint.usY = pstRectangle_->usBottom;
    for (stPoint.usX = pstRectangle_->usLeft; stPoint.usX <= pstRectangle_->usRight; stPoint.usX++)
    {
        DrawPixel(&stPoint);
    }

    stPoint.usX = pstRectangle_->usLeft;
    for (stPoint.usY = pstRectangle_->usTop; stPoint.usY <= pstRectangle_->usBottom; stPoint.usY++)
    {
        DrawPixel(&stPoint);
    }

    stPoint.usX = pstRectangle_->usRight;
    for (stPoint.usY = pstRectangle_->usTop; stPoint.usY <= pstRectangle_->usBottom; stPoint.usY++)
    {
        DrawPixel(&stPoint);
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Circle(DrawCircle_t *pstCircle_)
{
    DrawPoint_t stPoint;
    K_SHORT sX;
    K_SHORT sY;
    K_ULONG ulRadSquare;

    K_ULONG ulXSquare;
    K_ULONG ulYSquare;

    // Get the radius squared value...
    ulRadSquare = (K_ULONG)pstCircle_->usRadius;
    ulRadSquare *= ulRadSquare;

    // Look at the upper-right quarter of the circle
    for (sX = 0; sX <= (K_SHORT)pstCircle_->usRadius; sX++)
    {
        ulXSquare = (K_ULONG)sX;
        ulXSquare *= ulXSquare;
        for (sY = 0; sY <= (K_SHORT)pstCircle_->usRadius; sY++)
        {
            ulYSquare = (K_ULONG)sY;
            ulYSquare *= ulYSquare;

            // if filled...
            if (pstCircle_->bFill == true)
            {
                stPoint.uColor = pstCircle_->uFillColor;
                if (ulXSquare + ulYSquare <= ulRadSquare)
                {
                    // Draw the fill color at the appropriate locations (quadrature...)
                    stPoint.usX = pstCircle_->usX + sX;
                    stPoint.usY = pstCircle_->usY + sY;
                    DrawPixel(&stPoint);
                    stPoint.usX = pstCircle_->usX - sX;
                    stPoint.usY = pstCircle_->usY + sY;
                    DrawPixel(&stPoint);
                    stPoint.usX = pstCircle_->usX + sX;
                    stPoint.usY = pstCircle_->usY - sY;
                    DrawPixel(&stPoint);
                    stPoint.usX = pstCircle_->usX - sX;
                    stPoint.usY = pstCircle_->usY - sY;
                    DrawPixel(&stPoint);
                }
            }
            // Check for edge...
            if (
                ((ulXSquare + ulYSquare) >= (ulRadSquare-pstCircle_->usRadius)) &&
                ((ulXSquare + ulYSquare) <= (ulRadSquare+pstCircle_->usRadius))
               )
            {
                stPoint.uColor = pstCircle_->uLineColor;

                // Draw the fill color at the appropriate locations (quadrature...)
                stPoint.usX = pstCircle_->usX + sX;
                stPoint.usY = pstCircle_->usY + sY;
                DrawPixel(&stPoint);
                stPoint.usX = pstCircle_->usX - sX;
                stPoint.usY = pstCircle_->usY + sY;
                DrawPixel(&stPoint);
                stPoint.usX = pstCircle_->usX + sX;
                stPoint.usY = pstCircle_->usY - sY;
                DrawPixel(&stPoint);
                stPoint.usX = pstCircle_->usX - sX;
                stPoint.usY = pstCircle_->usY - sY;
                DrawPixel(&stPoint);
            }
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Ellipse(DrawEllipse_t *pstEllipse_)
{
    DrawPoint_t stPoint;
    K_SHORT sX;
    K_SHORT sY;
    K_ULONG ulRadius;
    K_ULONG ulHSquare;
    K_ULONG ulVSquare;
    K_ULONG ulXSquare;
    K_ULONG ulYSquare;

    ulHSquare = (K_ULONG)pstEllipse_->usWidth;
    ulHSquare *= ulHSquare;

    ulVSquare = (K_ULONG)pstEllipse_->usHeight;
    ulVSquare *= ulVSquare;

    ulRadius = ulHSquare * ulVSquare;

    for (sX = 0; sX <= (K_SHORT)pstEllipse_->usWidth; sX++)
    {
        ulXSquare = (K_ULONG)sX;
        ulXSquare *= ulXSquare;
        ulXSquare *= ulHSquare;

        for (sY = 0; sY <= (K_SHORT)pstEllipse_->usHeight; sY++)
        {
            ulYSquare = (K_ULONG)sY;
            ulYSquare *= ulYSquare;
            ulYSquare *= ulVSquare;

            if ((ulXSquare + ulYSquare) <= ulRadius)
            {
                // Draw the fill color at the appropriate locations (quadrature...)
                stPoint.usX = pstEllipse_->usX + sX;
                stPoint.usY = pstEllipse_->usY + sY;
                DrawPixel(&stPoint);
                stPoint.usX = pstEllipse_->usX - sX;
                stPoint.usY = pstEllipse_->usY + sY;
                DrawPixel(&stPoint);
                stPoint.usX = pstEllipse_->usX + sX;
                stPoint.usY = pstEllipse_->usY - sY;
                DrawPixel(&stPoint);
                stPoint.usX = pstEllipse_->usX - sX;
                stPoint.usY = pstEllipse_->usY - sY;
                DrawPixel(&stPoint);
            }
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Bitmap(DrawBitmap_t *pstBitmap_)
{
    K_USHORT usRow;
    K_USHORT usCol;

    K_USHORT usIndex;

    K_UCHAR ucRed = 0;
    K_UCHAR ucBlue = 0;
    K_UCHAR ucGreen = 0;

    DrawPoint_t stPoint;

    usIndex = 0;
    for (usRow = pstBitmap_->usY; usRow < (pstBitmap_->usY + pstBitmap_->
usHeight); usRow++)
    {
        for (usCol = pstBitmap_->usX; usCol < (pstBitmap_->usX + pstBitmap_->
usWidth); usCol++)
        {

            stPoint.usX = usCol;
            stPoint.usY = usRow;

            // Build the color based on the bitmap value...  This algorithm
            // is slow, but it automatically converts any 8/16/24 bit bitmap into the
            // current colorspace defined...
            switch(pstBitmap_->ucBPP)
            {
                case 1:
                {
                    // 3:2:3, RGB
                    ucRed     = ((pstBitmap_->pucData[usIndex]) & 0xE0) << 1;
                    ucGreen   = ((pstBitmap_->pucData[usIndex]) & 0x18) << 3;
                    ucBlue    = ((pstBitmap_->pucData[usIndex]) & 0x07) << 5;
                }
                    break;
                case 2:
                {
                    K_USHORT usTemp;
                    usTemp = pstBitmap_->pucData[usIndex];
                    usTemp <<= 8;
                    usTemp |= pstBitmap_->pucData[usIndex + 1];

                    // 5:6:5, RGB
                    ucRed     = (K_UCHAR)((usTemp >> 11) & 0x001F) << 3;
                    ucGreen   = (K_UCHAR)((usTemp >> 5) & 0x003F)  << 2;
                    ucBlue    = (K_UCHAR)(usTemp & 0x001F) << 3;
                }
                    break;
                case 3:
                {
                    K_ULONG ulTemp;
                    ulTemp = pstBitmap_->pucData[usIndex];
                    ulTemp <<= 8;
                    ulTemp |= pstBitmap_->pucData[usIndex + 1];
                    ulTemp <<= 8;
                    ulTemp |= pstBitmap_->pucData[usIndex + 2];

                    // 8:8:8 RGB
                    ucRed    = (K_UCHAR)((ulTemp & 0x00FF0000) >> 16);
                    ucGreen  = (K_UCHAR)((ulTemp & 0x0000FF00) >> 8);
                    ucBlue   = (K_UCHAR)((ulTemp & 0x000000FF));
                }
                    break;
                default:
                    break;
            }

            // Convert the R,G,B values into the correct colorspace for display
#if DRAW_COLOR_2BIT
            //1-bit
            ucRed >>= 7;
            ucGreen >>= 7;
            ucBlue >>= 7;
#elif DRAW_COLOR_8BIT
            //3:2:3 R:G:B
            ucRed >>= 5;
            ucGreen >>= 6;
            ucBlue >>= 5;
#elif DRAW_COLOR_16BIT
            //5:6:5 R:G:B
            ucRed >>= 3;
            ucGreen >>= 2;
            ucBlue >>= 3;
#elif DRAW_COLOR_24BIT
            // No conversion required
#endif
            // Build the color.
            stPoint.uColor = RGB_COLOR(ucRed,ucGreen,ucBlue);

            // Draw the point.
            DrawPixel(&stPoint);

            // Stamps are opaque, don't fill in the BG
            usIndex += m_ucBPP / 8;
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Stamp(DrawStamp_t *pstStamp_)
{
    K_USHORT usRow;
    K_USHORT usCol;
    K_USHORT usShift;
    K_USHORT usIndex;
    DrawPoint_t stPoint;

    usIndex = 0;
    for (usRow = pstStamp_->usY; usRow < (pstStamp_->usY + pstStamp_->
usHeight); usRow++)
    {
        usShift = 0x80;
        for (usCol = pstStamp_->usX; usCol < (pstStamp_->usX + pstStamp_->
usWidth); usCol++)
        {
            // If the packed bit in the bitmap is a "1", draw the color.
            if (pstStamp_->pucData[usIndex] & usShift)
            {
                stPoint.usX = usCol;
                stPoint.usY = usRow;
                stPoint.uColor = pstStamp_->uColor;
                DrawPixel(&stPoint);
            }
            // Stamps are opaque, don't fill in the BG

            // Shift to the next bit in the field
            usShift >>= 1;

            // Rollover - next bit in the bitmap.
            // This obviously works best for stamps that are multiples of 8x8
            if (usShift == 0)
            {
                usShift = 0x80;
                usIndex++;
            }
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Move( DrawMove_t *pstMove_ )
{
    DrawPoint_t stPoint;
    K_LONG sX;
    K_LONG sY;
    K_LONG sXInc = 0;
    K_LONG sYInc = 0;

    K_BOOL bLeftToRight = false;
    K_BOOL bTopToBottom = false;

    if (pstMove_->usSrcX > pstMove_->usDstX)
    {
        bLeftToRight = true;
    }
    if (pstMove_->usSrcY > pstMove_->usDstY)
    {
        bTopToBottom = true;
    }

    if (bLeftToRight)
    {
        sXInc++;
    }
    else
    {
        sXInc--;
        pstMove_->usSrcX += pstMove_->usCopyWidth - 1;
        pstMove_->usDstX += pstMove_->usCopyWidth - 1;
    }

    if (bTopToBottom)
    {
        sYInc++;
    }
    else
    {
        sYInc--;
        pstMove_->usSrcY += pstMove_->usCopyHeight - 1;
        pstMove_->usDstY += pstMove_->usCopyHeight - 1;
    }

    // Hideously inefficient memory move...
    for (sX = 0; sX < pstMove_->usCopyWidth; sX++)
    {
        for (sY = 0; sY < pstMove_->usCopyHeight; sY++)
        {
            // Read from source (value read into the point struct)
            stPoint.usY = (K_USHORT)((K_LONG)pstMove_->usSrcY + ((K_LONG)sY * sYInc));
            stPoint.usX = (K_USHORT)((K_LONG)pstMove_->usSrcX + ((K_LONG)sX * sXInc));
            ReadPixel(&stPoint);

            // Copy to dest
            stPoint.usY = (K_USHORT)((K_LONG)pstMove_->usDstY + ((K_LONG)sY * sYInc));
            stPoint.usX = (K_USHORT)((K_LONG)pstMove_->usDstX + ((K_LONG)sX * sXInc));
            DrawPixel(&stPoint);
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Text(DrawText_t *pstText_)
{
    K_USHORT usX, usY;
    K_USHORT usStartX;
    K_USHORT usStartY;
    K_USHORT usCharOffsetX;
    K_USHORT usCharIndex = 0;
    K_UCHAR *pucData = (K_UCHAR*)pstText_->pstFont->pucFontData;
    DrawPoint_t stPoint;

    // set the color for this element.
    stPoint.uColor = pstText_->uColor;

    usCharOffsetX = 0;

    // Draw every character in the string, one at a time
    while (pstText_->pcString[usCharIndex] != 0)
    {
        K_USHORT usOffset = 0;

        K_UCHAR ucWidth;
        K_UCHAR ucHeight;
        K_UCHAR ucVOffset;
        K_UCHAR ucBitmask;

        // Read the glyphs from memory until we arrive at the one we wish to print
        for (usX = 0; usX < pstText_->pcString[usCharIndex]; usX++)
        {
            // Glyphs are variable-sized for efficiency - to look up a particular
            // glyph, we must traverse all preceding glyphs in the list
            ucWidth  = Font_ReadByte(usOffset, pucData);
            ucHeight = Font_ReadByte(usOffset + 1, pucData);

            // Adjust the offset to point to the next glyph
            usOffset += ((((K_USHORT)ucWidth + 7) >> 3) * (K_USHORT)ucHeight)
                        + (sizeof(Glyph_t) - 1);
        }

        // Header information:  glyph size and vertical offset
        ucWidth   = Font_ReadByte(usOffset++, pucData);
        ucHeight  = Font_ReadByte(usOffset++, pucData);
        ucVOffset = Font_ReadByte(usOffset++, pucData);

        usStartY = pstText_->usTop + (K_USHORT)ucVOffset;
        usStartX = pstText_->usLeft;

        // Draw the font from left->right, top->bottom
        for (   usY = usStartY;
                usY < usStartY + (K_USHORT)ucHeight;
                usY++ )
        {
            K_UCHAR ucTempChar = Font_ReadByte(usOffset, pucData);
            ucBitmask = 0x80;

            for (   usX = usCharOffsetX + usStartX;
                    usX < usCharOffsetX + usStartX + (K_USHORT)ucWidth;
                    usX++ )
            {
                if (!ucBitmask)
                {
                    ucBitmask = 0x80;
                    usOffset++;
                    ucTempChar = Font_ReadByte(usOffset, pucData);
                }

                if (ucTempChar & ucBitmask)
                {
                    // Update the location
                    stPoint.usX = usX;
                    stPoint.usY = usY;

                    // Draw the point.
                    DrawPixel(&stPoint);
                }

                ucBitmask >>= 1;
            }

            usOffset++;
        }

        // Next character
        usCharIndex++;
        usCharOffsetX += (K_USHORT)ucWidth + 1;
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::TextFX(DrawText_t *pstText_,
TextFX_t *pstFX_ )
{
    K_USHORT usX, usY;
    K_USHORT usPartialX = 0;
    K_USHORT usPartialY = 0;
    K_USHORT usStartX;
    K_USHORT usStartY;
    K_USHORT usCharOffsetX;
    K_USHORT usCharIndex = 0;
    K_UCHAR *pucData = (K_UCHAR*)pstText_->pstFont->pucFontData;
    DrawPoint_t stPoint;

    // set the color for this element.
    stPoint.uColor = pstText_->uColor;

    usCharOffsetX = 0;

    // Draw every character in the string, one at a time
    while (pstText_->pcString[usCharIndex] != 0)
    {
        K_USHORT usOffset = 0;

        K_UCHAR ucWidth;
        K_UCHAR ucHeight;
        K_UCHAR ucVOffset;
        K_UCHAR ucBitmask;

        // Read the glyphs from memory until we arrive at the one we wish to print
        for (usX = 0; usX < pstText_->pcString[usCharIndex]; usX++)
        {
            // Glyphs are variable-sized for efficiency - to look up a particular
            // glyph, we must traverse all preceding glyphs in the list
            ucWidth  = Font_ReadByte(usOffset, pucData);
            ucHeight = Font_ReadByte(usOffset + 1, pucData);

            // Adjust the offset to point to the next glyph
            usOffset += ((((K_USHORT)ucWidth + 7) >> 3) * (K_USHORT)ucHeight)
                        + (sizeof(Glyph_t) - 1);
        }

        // Header information:  glyph size and vertical offset
        ucWidth   = Font_ReadByte(usOffset++, pucData);
        ucHeight  = Font_ReadByte(usOffset++, pucData);
        ucVOffset = Font_ReadByte(usOffset++, pucData);

        usStartY = pstText_->usTop + (K_USHORT)ucVOffset;
        usStartX = pstText_->usLeft;

        // Draw the font from left->right, top->bottom
        for (   usY = usStartY;
                usY < usStartY + (K_USHORT)ucHeight;
                usY++ )
        {
            K_UCHAR ucTempChar = Font_ReadByte(usOffset, pucData);
            ucBitmask = 0x80;
            usPartialY = 0;
            usPartialX = 0;

            K_USHORT usTempPartialX = 0;

            for (   usX = usCharOffsetX + usStartX;
                    usX < usCharOffsetX + usStartX + (K_USHORT)ucWidth;
                    usX++ )
            {
                K_USHORT usTempPartialY = 0;
                usPartialY = 0;
                if (!ucBitmask)
                {
                    ucBitmask = 0x80;
                    usOffset++;
                    ucTempChar = Font_ReadByte(usOffset, pucData);
                }

                if ((ucTempChar & ucBitmask) || (pstFX_->ucFlags &
TEXTFX_FLAG_OPAQUE_BG))
                {
                    // usX and usY represent the untransformed data...
                    // we need usStartX, usStartY, usDeltaX, usDeltaY to proceed.
                    K_USHORT usDeltaX = (usX - pstText_->usLeft);
                    K_USHORT usDeltaY = (usY - pstText_->usTop);

                    // Compute "unadjusted" pixels for normal or scaled
                    K_USHORT usRawX, usRawY;

                    if (pstFX_->ucFlags & TEXTFX_FLAG_SCALE_X)
                    {
                        usRawX = usStartX + (((usDeltaX * pstFX_->usScaleX100))/100);
                        usTempPartialX = pstFX_->usScaleX100;
                    }
                    else
                    {
                        usRawX = usX;
                        usTempPartialX = 100;
                    }
                    usTempPartialX += usPartialX;

                    if (pstFX_->ucFlags & TEXTFX_FLAG_SCALE_Y)
                    {
                        usRawY = usStartY + (((usDeltaY * pstFX_->usScaleY100))/100);
                        usTempPartialY = pstFX_->usScaleY100;
                    }
                    else
                    {
                        usRawY = usY;
                        usTempPartialY = 100;
                    }
                    usTempPartialY += usPartialY;

                    K_USHORT usBLAH = usTempPartialX;

                    if (!(ucTempChar & ucBitmask))
                    {
                        stPoint.uColor = pstFX_->uBGColor;
                    }
                    else
                    {
                        stPoint.uColor = pstText_->uColor;
                    }


                    stPoint.usX = usRawX;
                    while (usTempPartialX >= 50)
                    {
                        stPoint.usY = usRawY;
                        usBLAH = usTempPartialY;
                        while (usBLAH >= 50)
                        {
                            DrawPixel(&stPoint);
                            stPoint.usY++;
                            if (usBLAH >= 100)
                            {
                                usBLAH -= 100;
                            }
                            else
                            {
                                usBLAH = 0;
                            }
                        }
                        stPoint.usX++;
                        if (usTempPartialX >= 100)
                        {
                            usTempPartialX -= 100;
                        }
                        else
                        {
                            usTempPartialX = 0;
                        }
                    }

                    usPartialX = (usTempPartialX % 100);
                    usPartialY = (usTempPartialY % 100);
                }

                ucBitmask >>= 1;
            }

            usOffset++;
        }

        // Next character
        usCharIndex++;
        usCharOffsetX += (K_USHORT)ucWidth + 1;
    }
}

//---------------------------------------------------------------------------
K_USHORT GraphicsDriver::TextWidth(DrawText_t *pstText_)
{
    K_USHORT usCharOffsetX;
    K_USHORT usCharIndex = 0;
    K_USHORT usX;
    K_UCHAR *pucData = (K_UCHAR*)pstText_->pstFont->pucFontData;

    usCharOffsetX = 0;

    // Draw every character in the string, one at a time
    while (pstText_->pcString[usCharIndex] != 0)
    {
        K_USHORT usOffset = 0;

        K_UCHAR ucWidth;
        K_UCHAR ucHeight;

        // Read the glyphs from memory until we arrive at the one we wish to print
        for (usX = 0; usX < pstText_->pcString[usCharIndex]; usX++)
        {
            // Glyphs are variable-sized for efficiency - to look up a particular
            // glyph, we must traverse all preceding glyphs in the list
            ucWidth  = Font_ReadByte(usOffset, pucData);
            ucHeight = Font_ReadByte(usOffset + 1, pucData);

            // Adjust the offset to point to the next glyph
            usOffset += ((((K_USHORT)ucWidth + 7) >> 3) * (K_USHORT)ucHeight)
                        + (sizeof(Glyph_t) - 1);
        }

        // Header information:  glyph size and vertical offset
        ucWidth   = Font_ReadByte(usOffset, pucData);
        usOffset += (sizeof(Glyph_t) - 1);

        // Next character
        usCharIndex++;
        usCharOffsetX += (K_USHORT)ucWidth + 1;
    }

    return usCharOffsetX;
}

//---------------------------------------------------------------------------
void GraphicsDriver::TriangleWire(DrawPoly_t *pstPoly_)
{
    DrawLine_t stLine;

    stLine.uColor = pstPoly_->uColor;

    stLine.usX1 = pstPoly_->pstVector[0].usX;
    stLine.usY1 = pstPoly_->pstVector[0].usY;
    stLine.usX2 = pstPoly_->pstVector[1].usX;
    stLine.usY2 = pstPoly_->pstVector[1].usY;
    Line(&stLine);

    stLine.usX1 = pstPoly_->pstVector[1].usX;
    stLine.usY1 = pstPoly_->pstVector[1].usY;
    stLine.usX2 = pstPoly_->pstVector[2].usX;
    stLine.usY2 = pstPoly_->pstVector[2].usY;
    Line(&stLine);

    stLine.usX1 = pstPoly_->pstVector[2].usX;
    stLine.usY1 = pstPoly_->pstVector[2].usY;
    stLine.usX2 = pstPoly_->pstVector[0].usX;
    stLine.usY2 = pstPoly_->pstVector[0].usY;
    Line(&stLine);
}
//---------------------------------------------------------------------------
void GraphicsDriver::TriangleFill(DrawPoly_t *pstPoly_)
{
    // Drawing a raster-filled triangle:
    K_UCHAR ucMaxEdge = 0;
    K_UCHAR ucMinEdge1 = 0, ucMinEdge2 = 0;
    K_SHORT sMax = 0;
    K_SHORT sTemp;

    K_SHORT sDeltaX1, sDeltaX2;
    K_SHORT sDeltaY1, sDeltaY2;
    K_CHAR cStepX1, cStepX2;
    K_CHAR cStepY;
    K_SHORT sX1, sX2, sX3, sY1, sY2, sY3;
    K_SHORT sTempX1, sTempY1, sTempX2, sTempY2;
    K_SHORT sFraction1;
    K_SHORT sFraction2;
    K_SHORT i;
    DrawPoint_t stPoint;

    // Figure out which line segment is the longest
    sTemp = (K_SHORT)pstPoly_->pstVector[0].usY - (K_SHORT)pstPoly_->
pstVector[1].usY;
    if( sTemp < 0 )    { sTemp = -sTemp; }
    if( sTemp > sMax ) { sMax  = sTemp; ucMaxEdge = 0; ucMinEdge1 = 1; ucMinEdge2 = 2;}

    sTemp = (K_SHORT)pstPoly_->pstVector[1].usY - (K_SHORT)pstPoly_->
pstVector[2].usY;
    if( sTemp < 0 )    { sTemp = -sTemp; }
    if( sTemp > sMax ) { sMax  = sTemp; ucMaxEdge = 1; ucMinEdge1 = 2; ucMinEdge2 = 0; }

    sTemp = (K_SHORT)pstPoly_->pstVector[2].usY - (K_SHORT)pstPoly_->
pstVector[0].usY;
    if( sTemp < 0 )    { sTemp = -sTemp; }
    if( sTemp > sMax ) { sMax  = sTemp; ucMaxEdge = 2; ucMinEdge1 = 0; ucMinEdge2 = 1;}

    // Label the vectors and copy into temporary signed buffers
    sX1 = (K_SHORT)pstPoly_->pstVector[ucMaxEdge].usX;
    sX2 = (K_SHORT)pstPoly_->pstVector[ucMinEdge1].usX;
    sX3 = (K_SHORT)pstPoly_->pstVector[ucMinEdge2].usX;

    sY1 = (K_SHORT)pstPoly_->pstVector[ucMaxEdge].usY;
    sY2 = (K_SHORT)pstPoly_->pstVector[ucMinEdge1].usY;
    sY3 = (K_SHORT)pstPoly_->pstVector[ucMinEdge2].usY;

    // Figure out whether or not we're drawing up-down or down-up
    sDeltaY1 = sY1 - sY2;
    if (sDeltaY1 < 0) { cStepY = -1; sDeltaY1 = -sDeltaY1; } else { cStepY = 1; }

    sDeltaX1 = sX1 - sX2;
    if (sDeltaX1 < 0) { cStepX1 = -1; sDeltaX1 = -sDeltaX1; } else { cStepX1 = 1; }

    sDeltaY2 = sY1 - sY3;
    if (sDeltaY2 < 0) { cStepY = -1; sDeltaY2 = -sDeltaY2; } else { cStepY = 1; }

    sDeltaX2 = sX1 - sX3;
    if (sDeltaX2 < 0) { cStepX2 = -1; sDeltaX2 = -sDeltaX2; } else { cStepX2 = 1; }

    sDeltaX1 <<=1;
    sDeltaX2 <<=1;
    sDeltaY1 <<=1;
    sDeltaY2 <<=1;

    sFraction1 = sDeltaX1;// - (sDeltaY1 >> 1);
    sFraction2 = sDeltaX2;// - (sDeltaY2 >> 1);

    sTempY1 = sY1;
    sTempY2 = sY1;
    sTempX1 = sX1;
    sTempX2 = sX1;

    stPoint.uColor = pstPoly_->uColor;

    if( sDeltaY2 != 0 )
    {
        while (sTempY2 != sY3)
        {
            stPoint.usY = sTempY2;
            if( sTempX1 < sTempX2 ) {
                for( i = sTempX1; i <= sTempX2; i++) {
                    stPoint.usX = i;
                    Point(&stPoint);
                }
            } else {
                for( i = sTempX2; i <= sTempX1; i++ ) {
                    stPoint.usX = i;
                    Point(&stPoint);
                }
            }

            while (sFraction2 >= sDeltaY2)
            {
                sTempX2 -= cStepX2;
                sFraction2 -= sDeltaY2;
            }
            sTempY2 -= cStepY;
            sFraction2 += sDeltaX2;

            while (sFraction1 >= sDeltaY1)
            {
                sTempX1 -= cStepX1;
                sFraction1 -= sDeltaY1;
            }
            sTempY1 -= cStepY;
            sFraction1 += sDeltaX1;
        }
    }

    sDeltaY2 = sY3 - sY2;
    sDeltaX2 = sX3 - sX2;

    if (sDeltaX2 < 0) { cStepX2 = -1; sDeltaX2 = -sDeltaX2; } else { cStepX2 = 1; }
    if (sDeltaY2 < 0) { cStepY = -1;  sDeltaY2 = -sDeltaY2; } else { cStepY  = 1; }

    sDeltaX2 <<=1;
    sDeltaY2 <<=1;

    sFraction2 = sDeltaX2; // - (sDeltaY2 >> 1);

    sTempY2 = sY3;
    sTempX2 = sX3;

    if( sDeltaY2 != 0)
    {
        while (sTempY2 != sY2)
        {
            stPoint.usY = sTempY2;
            if( sTempX1 < sTempX2 ) {
                for( i = sTempX1; i <= sTempX2; i++) {
                    stPoint.usX = i;
                    Point(&stPoint);
                }
            } else {
                for( i = sTempX2; i <= sTempX1; i++ ) {
                    stPoint.usX = i;
                    Point(&stPoint);
                }
            }

            while (sFraction2 >= sDeltaY2)
            {
                sTempX2 -= cStepX2;
                sFraction2 -= sDeltaY2;
            }
            sTempY2 -= cStepY;
            sFraction2 += sDeltaX2;

            while (sFraction1 >= sDeltaY1)
            {
                sTempX1 -= cStepX1;
                sFraction1 -= sDeltaY1;
            }
            sTempY1 -= cStepY;
            sFraction1 += sDeltaX1;
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::Polygon(DrawPoly_t *pstPoly_)
{
    K_USHORT i,j,k;
    K_BOOL bState = false;

    DrawPoly_t   stTempPoly;
    DrawVector_t astTempVec[3];

    if (pstPoly_->usNumPoints < 3)
    {
        return;
    }

    stTempPoly.uColor = pstPoly_->uColor;
    stTempPoly.bFill = pstPoly_->bFill;
    stTempPoly.pstVector = astTempVec;
    stTempPoly.usNumPoints = 3;

    astTempVec[0].usX = pstPoly_->pstVector[0].usX;
    astTempVec[1].usX = pstPoly_->pstVector[1].usX;
    astTempVec[0].usY = pstPoly_->pstVector[0].usY;
    astTempVec[1].usY = pstPoly_->pstVector[1].usY;

    j = 2;
    astTempVec[2].usX = pstPoly_->pstVector[pstPoly_->usNumPoints - 1].usX;
    astTempVec[2].usY = pstPoly_->pstVector[pstPoly_->usNumPoints - 1].usY;

    k = pstPoly_->usNumPoints - 2;

    if( pstPoly_->bFill )
    {
        TriangleFill(&stTempPoly);
    }
    else
    {
        TriangleWire(&stTempPoly);
    }

    // Filled polygon/wireframe polygon using triangle decomp.
    for(i = 0; i < pstPoly_->usNumPoints - 3; i++)
    {
        astTempVec[0].usX = astTempVec[1].usX;
        astTempVec[1].usX = astTempVec[2].usX;
        astTempVec[0].usY = astTempVec[1].usY;
        astTempVec[1].usY = astTempVec[2].usY;

        if( !bState )
        {
            bState = true;
            astTempVec[2].usX = pstPoly_->pstVector[j].usX;
            astTempVec[2].usY = pstPoly_->pstVector[j].usY;
            j++;
        }
        else
        {
            bState = false;
            astTempVec[2].usX = pstPoly_->pstVector[k].usX;
            astTempVec[2].usY = pstPoly_->pstVector[k].usY;
            k--;
        }
        if( pstPoly_->bFill )
        {
            TriangleFill(&stTempPoly);
        }
        else
        {
            TriangleWire(&stTempPoly);
        }
    }
}

//---------------------------------------------------------------------------
void GraphicsDriver::SetWindow(DrawWindow_t *pstWindow_)
{
    if ((pstWindow_->usLeft <= pstWindow_->usRight) &&
        (pstWindow_->usRight < m_usResX) &&
        (pstWindow_->usLeft < m_usResX))
    {
        m_usLeft = pstWindow_->usLeft;
        m_usRight = pstWindow_->usRight;
    }

    if ((pstWindow_->usTop <= pstWindow_->usBottom) &&
        (pstWindow_->usTop < m_usTop)  &&
        (pstWindow_->usBottom < m_usBottom))
    {
        m_usTop = pstWindow_->usTop;
        m_usBottom = pstWindow_->usBottom;
    }

}

//---------------------------------------------------------------------------
void GraphicsDriver::ClearWindow()
{
    m_usLeft = 0;
    m_usTop = 0;
    m_usRight = m_usResX - 1;
    m_usBottom = m_usResY - 1;
}
```

17.69 /home/mo/mark3-source/embedded/stage/src/graphics.h File Reference

Graphics driver class declaration.

```
#include "driver.h"
#include "draw.h"
```

Classes

- class GraphicsDriver

  Defines the base graphics driver class, which is inherited by all other graphics drivers.

17.69.1 Detailed Description

Graphics driver class declaration.

Definition in file graphics.h.

17.70 graphics.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||_____|\__\  __||__|\__\  __||__|\__\  __||_____|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __GRAPHICSX_H__
#define __GRAPHICSX_H__

#include "driver.h"
#include "draw.h"

//---------------------------------------------------------------------------
class GraphicsDriver : public Driver
{
public:
//---------------------------------------------------------------------------
/*
    The base graphics driver does not implement the set of
    virtual methods inherited from the Driver class.  This
    is left to the actual hardware implementation.
*/
//---------------------------------------------------------------------------

    virtual void DrawPixel(DrawPoint_t *pstPoint_) {};

    virtual void ReadPixel(DrawPoint_t *pstPoint_) {};

//---------------------------------------------------------------------------
/*
    Raster operations defined using per-pixel rendering.
    Can be overridden in inheriting classes.
*/
//---------------------------------------------------------------------------
    virtual void ClearScreen();

    virtual void Point(DrawPoint_t *pstPoint_);

    virtual void Line(DrawLine_t *pstLine_);

    virtual void Rectangle(DrawRectangle_t *pstRectangle_);

    virtual void Circle(DrawCircle_t *pstCircle_);

    virtual void Ellipse(DrawEllipse_t *pstEllipse_);

    virtual void Bitmap(DrawBitmap_t *pstBitmap_);

    virtual void Stamp(DrawStamp_t *pstStamp_);

    virtual void Move(DrawMove_t *pstMove_ );

    virtual void TriangleWire(DrawPoly_t *pstPoly_);

    virtual void TriangleFill(DrawPoly_t *pstPoly_);

    virtual void Polygon(DrawPoly_t *pstPoly_);

    virtual void Text(DrawText_t *pstText_);

    void TextFX(DrawText_t *pstText_, TextFX_t *pstFX_);

    virtual K_USHORT TextWidth(DrawText_t *pstText_);

    void SetWindow( DrawWindow_t *pstWindow_ );

    void ClearWindow();
protected:

    K_USHORT m_usResX;
    K_USHORT m_usResY;

    K_USHORT m_usLeft;
    K_USHORT m_usTop;
    K_USHORT m_usRight;
    K_USHORT m_usBottom;

    K_UCHAR m_ucBPP;
};

#endif

```

17.71 /home/mo/mark3-source/embedded/stage/src/gui.cpp File Reference

Graphical User Interface classes and data structure definitions.

```
#include "message.h"
#include "kerneltypes.h"
#include "gui.h"
#include "system_heap.h"
#include "fixed_heap.h"
#include "memutil.h"
```

17.71.1 Detailed Description

Graphical User Interface classes and data structure definitions.

Definition in file gui.cpp.

17.72 gui.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "message.h"
#include "kerneltypes.h"
#include "gui.h"
#include "system_heap.h"
#include "fixed_heap.h"
#include "memutil.h"

//---------------------------------------------------------------------------
void GuiWindow::AddControl( GuiControl *pclControl_,
GuiControl *pclParent_ )
{
    GUI_DEBUG_PRINT("GuiWindow::AddControl\n");

    m_clControlList.Add(static_cast<LinkListNode*>(pclControl_));
    m_pclInFocus = pclControl_;
    m_ucControlCount++;

    pclControl_->SetParentWindow(this);
    pclControl_->SetParentControl(pclParent_);
}

//---------------------------------------------------------------------------
void GuiWindow::RemoveControl( GuiControl *pclControl_ )
{
    GUI_DEBUG_PRINT("GuiWindow::RemoveControl\n");

    if (pclControl_->GetPrev())
    {
        m_pclInFocus = static_cast<GuiControl*>(pclControl_->GetPrev());
    }
    else if (pclControl_->GetNext())
    {
        m_pclInFocus = static_cast<GuiControl*>(pclControl_->GetNext());
    }
    else
    {
        m_pclInFocus = NULL;
    }
    m_clControlList.Remove(static_cast<LinkListNode*>(pclControl_));
    m_ucControlCount--;
}

//---------------------------------------------------------------------------
K_UCHAR GuiWindow::GetMaxZOrder()
{
    GUI_DEBUG_PRINT("GuiWindow::GetMaxZOrder\n");

    LinkListNode *pclTempNode;
    K_UCHAR ucZ = 0;
    K_UCHAR ucTempZ;

    pclTempNode = m_clControlList.GetHead();

    while (pclTempNode)
    {
        ucTempZ = (static_cast<GuiControl*>(pclTempNode))->GetZOrder();
        if (ucTempZ > ucZ)
        {
            ucZ = ucTempZ;
        }
        pclTempNode = pclTempNode->GetNext();
    }

    return ucZ;
}

//---------------------------------------------------------------------------
void GuiWindow::Redraw( K_BOOL bRedrawAll_ )
{
    GUI_DEBUG_PRINT("GuiWindow::Redraw\n");

    K_UCHAR ucControlsLeft = m_ucControlCount;
    K_UCHAR ucCurrentZ = 0;
    K_UCHAR ucMaxZ;

    ucMaxZ = GetMaxZOrder();

    // While there are still controls left to process (and we're less than
    // the maximum Z-order, just a sanity check.), redraw each object that
    // has its stale flag set, or all controls if the bRedrawAll_ parameter
    // is true.
    while (ucControlsLeft && (ucCurrentZ <= ucMaxZ))
    {
        LinkListNode *pclTempNode;

        pclTempNode = m_clControlList.GetHead();
        while (pclTempNode)
        {
            GuiControl* pclTempControl = static_cast<GuiControl*>(pclTempNode);
            if (pclTempControl->GetZOrder() == ucCurrentZ)
            {
                if ((bRedrawAll_) || (pclTempControl->IsStale()))
                {
                    pclTempControl->Draw();
                    pclTempControl->ClearStale();
                }

                ucControlsLeft--;
            }

            pclTempNode = pclTempNode->GetNext();
        }
        ucCurrentZ++;
    }
    GUI_DEBUG_PRINT("  Current Z: %d\n", ucCurrentZ);
    GUI_DEBUG_PRINT("  Controls Left: %d\n", ucControlsLeft);
}

//---------------------------------------------------------------------------
void GuiWindow::InvalidateRegion( K_USHORT usLeft_, K_USHORT usTop_, K_USHORT usWidth_, K_USHORT usHeight_ )
{
    LinkListNode *pclTempNode;
    K_USHORT usLeft1, usLeft2, usRight1, usRight2, usTop1, usTop2, usBottom1, usBottom2;

    pclTempNode = m_clControlList.GetHead();

    usLeft1 = usLeft_;
    usRight1 = usLeft_ + usWidth_ - 1;
    usTop1 = usTop_;
    usBottom1 = usTop_ + usHeight_ - 1;

    while (pclTempNode)
    {
        GuiControl *pclControl = static_cast<GuiControl*>(pclTempNode);
        K_USHORT usX, usY;

        bool bMatch = false;

        // Get the absolute display coordinates
        pclControl->GetControlOffset(&usX, &usY);


        usLeft2 = pclControl->GetLeft() + usX;
        usRight2 = usLeft2 + pclControl->GetWidth() - 1;
        usTop2 = pclControl->GetTop() + usY;
        usBottom2 = usTop2 + pclControl->GetHeight() - 1;

        // If the control has any pixels in the bounding box.
        if (
                (
                    (
                        (usLeft1 >= usLeft2) &&
                        (usLeft1 <= usRight2)
                    ) ||
                    (
                        (usRight1 >= usLeft2) &&
                        (usRight1 <= usRight2)
                    ) ||
                    ((usLeft1 <= usLeft2) && (usRight1 >= usRight2))
                ) &&
                (
                    (
                        (usTop1 >= usTop2) &&
                        (usTop1 <= usBottom2)
                    ) ||
                    (
                        (usBottom1 >= usTop2) &&
                        (usBottom1 <= usBottom2)
                    ) ||
                    ((usTop1 <= usTop2) && (usBottom1 >= usBottom2))
                )
            )
        {
            bMatch = true;
        }
        else if(
                (
                    (
                        (usLeft2 >= usLeft1) &&
                        (usLeft2 <= usRight1)
                    ) ||
                    (
                        (usRight2 >= usLeft1) &&
                        (usRight2 <= usRight1)
                    ) ||
                    ((usLeft2 <= usLeft1) && (usRight2 >= usRight1))
                ) &&
                (
                    (
                        (usTop2 >= usTop1) &&
                        (usTop2 <= usBottom1)
                    ) ||
                    (
                        (usBottom2 >= usTop1) &&
                        (usBottom2 <= usBottom1)
                    ) ||
                    ((usTop2 <= usTop1) && (usBottom2 >= usBottom1))
                )
            )
        {
            bMatch = true;
        }


        if (bMatch)
        {
            pclControl->SetStale();

            // Invalidate all child controls as well (since redrawing a parent could cause them to
 disappear)
            GuiControl *pclChild = static_cast<GuiControl*>(
m_clControlList.GetHead());

            // Go through all controls and check for parental ancestry
            while (pclChild)
            {
                GuiControl *pclParent = static_cast<GuiControl*>(pclChild->
GetParentControl());

                // If this control is a descendant of the current control at some level
                while (pclParent)
                {
                    if (pclParent == pclControl)
                    {
                        // Set the control as stale
                        pclChild->SetStale();
                        break;
                    }
                    pclParent = pclParent->GetParentControl();
                }

                pclChild = static_cast<GuiControl*>((static_cast<
LinkListNode*>(pclChild))->GetNext());
            }
        }

        pclTempNode = pclTempNode->GetNext();
    }
}

//---------------------------------------------------------------------------
void GuiWindow::ProcessEvent( GuiEvent_t *pstEvent_ )
{
    GUI_DEBUG_PRINT("GuiWindow::ProcessEvent\n");

    // If the event is for broadcast - send it to all controls,
    // without regard to order.
    if ((TARGET_ID_BROADCAST == pstEvent_->ucTargetID)
        || (TARGET_ID_BROADCAST_Z == pstEvent_->ucTargetID))
    {
        GUI_DEBUG_PRINT("  TARGET_ID_BROADCAST(_Z)\n");

        LinkListNode *pclTempNode;
        pclTempNode = m_clControlList.GetHead();

        while (pclTempNode)
        {
            GuiReturn_t eRet;
            eRet = (static_cast<GuiControl*>(pclTempNode))->ProcessEvent(pstEvent_);
            if (GUI_EVENT_CONSUMED == eRet)
            {
                break;
            }
            pclTempNode = pclTempNode->GetNext();
        }
    }
    // Send the event only to the currently-selected object.
    else if (TARGET_ID_FOCUS == pstEvent_->ucTargetID)
    {
        GUI_DEBUG_PRINT("  TARGET_ID_FOCUS\n");
        GuiReturn_t eReturn = GUI_EVENT_OK;

        // Try to let the control process the event on its own
        if (m_pclInFocus)
        {
            eReturn = m_pclInFocus->ProcessEvent(pstEvent_);
        }

        // If the event was not consumed, use default logic to process the event
        if (GUI_EVENT_CONSUMED != eReturn)
        {
            if (EVENT_TYPE_KEYBOARD == pstEvent_->ucEventType)
            {
                if (KEYCODE_TAB == pstEvent_->stKey.ucKeyCode)
                {
                    if (pstEvent_->stKey.bKeyState)
                    {
                        CycleFocus(true);
                    }
                }
            }
            else if (EVENT_TYPE_JOYSTICK == pstEvent_->ucEventType)
            {
                if (pstEvent_->stJoystick.bUp || pstEvent_->stJoystick.bLeft)
                {
                    // Cycle focus *backwards*
                    CycleFocus(false);
                }
                else if (pstEvent_->stJoystick.bRight || pstEvent_->stJoystick.bDown)
                {
                    // Cycle focus *forewards*
                    CycleFocus(true);
                }
            }
        }
    }
    else if (TARGET_ID_HIGH_Z == pstEvent_->ucTargetID)
    {
        GUI_DEBUG_PRINT("  TARGET_ID_HIGH_Z\n");

        K_USHORT usTargetX, usTargetY;
        K_USHORT usOffsetX, usOffsetY;
        K_UCHAR ucMaxZ = 0;

        LinkListNode *pclTempNode;
        pclTempNode = m_clControlList.GetHead();

        switch (pstEvent_->ucEventType)
        {
            case EVENT_TYPE_MOUSE:
            case EVENT_TYPE_TOUCH:
            {
                GuiControl *pclTargetControl = NULL;

                // Read the target X/Y coordinates out of the event struct
                if (EVENT_TYPE_TOUCH == pstEvent_->ucEventType)
                {
                    usTargetX = pstEvent_->stTouch.usX;
                    usTargetY = pstEvent_->stTouch.usY;
                }
                else
                {
                    usTargetX = pstEvent_->stMouse.usX;
                    usTargetY = pstEvent_->stMouse.usY;
                }

                // Go through every control on the window, checking to see if the
                // event falls within the bounding box
                   while (pclTempNode)
                {
                    GuiControl *pclControl = (static_cast<GuiControl*>(pclTempNode));

                    pclControl->GetControlOffset(&usOffsetX, &usOffsetY);

                    // Compare event coordinates to bounding box (with offsets)
                    if ( ((usTargetX >= (usOffsetX + pclControl->GetLeft()) &&
                          (usTargetX <= (usOffsetX + pclControl->GetLeft() + pclControl->GetWidth() - 1))) &&
                         ((usTargetY >= (usOffsetY + pclControl->GetTop()) &&
                          (usTargetY <= (usOffsetY + pclControl->GetTop() + pclControl->GetHeight() - 1)))) )
                    {
                        // If this control is higher in Z-Order, set this as the newest
                        // candidate control to accept the event
                        if (pclControl->GetZOrder() >= ucMaxZ)
                        {
                            pclTargetControl = pclControl;
                            ucMaxZ = pclControl->GetZOrder();
                        }
                    }

                    pclTempNode = pclTempNode->GetNext();
                }

                // If a suitable control was found on the event surface, pass the event off
                // for processing.
                if (pclTargetControl)
                {
                    // If the selected control is different from the current in-focus
                    // control, then deactive that control.
                    if (m_pclInFocus && (m_pclInFocus != pclTargetControl))
                    {
                        m_pclInFocus->Activate(false);
                        m_pclInFocus = NULL;
                    }
                    (static_cast<GuiControl*>(pclTargetControl))->ProcessEvent(pstEvent_);
                }
            }
                break;
            default:
                break;
        }
    }
}
//---------------------------------------------------------------------------
void GuiWindow::SetFocus( GuiControl *pclControl_ )
{
    GUI_DEBUG_PRINT("GuiWindow::SetFocus\n");

    m_pclInFocus = pclControl_;
}

//---------------------------------------------------------------------------
void GuiWindow::CycleFocus( bool bForward_ )
{
    GUI_DEBUG_PRINT("GuiWindow::CycleFocus\n");

    // Set starting point and cached copy of current nodes
    LinkListNode *pclTempNode = static_cast<GuiControl*>(
m_clControlList.GetHead());
    LinkListNode *pclStartNode = m_pclInFocus;

    if (bForward_)
    {
        // If there isn't a current focus node, set the focus to the beginning
        // of the list
        if (!m_pclInFocus)
        {
            m_pclInFocus = static_cast<GuiControl*>(pclTempNode);
            if (!m_pclInFocus)
            {
                return;
            }
            pclTempNode = static_cast<GuiControl*>(m_pclInFocus);
            pclStartNode = NULL;
        }
        else
        {
            // Deactivate the control that's losing focus
            static_cast<GuiControl*>(m_pclInFocus)->Activate(false);

            // Otherwise start with the next node
            pclStartNode = pclStartNode->GetNext();
        }

        // Go through the whole control list and find the next one to accept
        // the focus
        while (pclTempNode && pclTempNode != pclStartNode)
        {
            if (static_cast<GuiControl*>(pclTempNode)->AcceptsFocus())
            {
                m_pclInFocus = static_cast<GuiControl*>(pclTempNode);
                m_pclInFocus->Activate(true);
                SetFocus(m_pclInFocus);
                return;
            }
            pclTempNode = pclTempNode->GetNext();
        }

        pclTempNode = static_cast<GuiControl*>(m_clControlList.
GetHead());
        while (pclTempNode && pclTempNode != pclStartNode)
        {
            if (static_cast<GuiControl*>(pclTempNode)->AcceptsFocus())
            {
                m_pclInFocus = static_cast<GuiControl*>(pclTempNode);
                m_pclInFocus->Activate(true);
                SetFocus(m_pclInFocus);
                return;
            }
            pclTempNode = pclTempNode->GetNext();
        }
    }
    else
    {
        pclTempNode = static_cast<GuiControl*>(m_clControlList.
GetTail());
        pclStartNode = m_pclInFocus;

        // If there isn't a current focus node, set the focus to the end
        // of the list
        if (!m_pclInFocus)
        {
            m_pclInFocus = static_cast<GuiControl*>(pclTempNode);
            if (!m_pclInFocus)
            {
                return;
            }
            pclTempNode = static_cast<GuiControl*>(m_pclInFocus);
            pclStartNode = NULL;
        }
        else
        {
            // Deactivate the control that's losing focus
            static_cast<GuiControl*>(m_pclInFocus)->Activate(false);

            // Otherwise start with the previous node
            pclStartNode = pclStartNode->GetPrev();
        }

        // Go through the whole control list and find the next one to accept
        // the focus
        while (pclTempNode && pclTempNode != pclStartNode)
        {
            if (static_cast<GuiControl*>(pclTempNode)->AcceptsFocus())
            {
                m_pclInFocus = static_cast<GuiControl*>(pclTempNode);
                m_pclInFocus->Activate(true);
                SetFocus(m_pclInFocus);
                return;
            }
            pclTempNode = pclTempNode->GetPrev();
        }

        pclTempNode = static_cast<GuiControl*>(m_clControlList.
GetTail());
        while (pclTempNode && pclTempNode != pclStartNode)
        {
            if (static_cast<GuiControl*>(pclTempNode)->AcceptsFocus())
            {
                m_pclInFocus = static_cast<GuiControl*>(pclTempNode);
                m_pclInFocus->Activate(true);
                SetFocus(m_pclInFocus);
                return;
            }
            pclTempNode = pclTempNode->GetPrev();
        }
    }
}
//---------------------------------------------------------------------------
GuiWindow *GuiEventSurface::FindWindowByName( const K_CHAR *
szName_ )
{
    LinkListNode *pclTempNode = static_cast<LinkListNode*>(
m_clWindowList.GetHead());

    while (pclTempNode)
    {
        if (MemUtil::CompareStrings(szName_, static_cast<GuiWindow*>(pclTempNode)->
GetName()))
        {
             return static_cast<GuiWindow*>(pclTempNode);
        }
        pclTempNode = pclTempNode->GetNext();
    }

    return NULL;
}

//---------------------------------------------------------------------------
void GuiEventSurface::AddWindow( GuiWindow *pclWindow_ )
{
    GUI_DEBUG_PRINT("GuiEventSurface::AddWindow\n");

    m_clWindowList.Add(static_cast<LinkListNode*>(pclWindow_));
}

//---------------------------------------------------------------------------
void GuiEventSurface::RemoveWindow( GuiWindow *pclWindow_ )
{
    GUI_DEBUG_PRINT("GuiEventSurface::RemoveWindow\n");

    m_clWindowList.Remove(static_cast<LinkListNode*>(pclWindow_));
}

//---------------------------------------------------------------------------
K_BOOL GuiEventSurface::SendEvent( GuiEvent_t *pstEvent_ )
{
    GUI_DEBUG_PRINT("GuiEventSurface::SendEvent\n");

    // Allocate a message from the global message pool
    Message *pclMessage = GlobalMessagePool::Pop();

    // No messages available? Return a failure
    if (!pclMessage)
    {
        return false;
    }

    // Allocate a copy of the event from the heap
    GuiEvent_t *pstEventCopy = static_cast<GuiEvent_t*>(
SystemHeap::Alloc(sizeof(GuiEvent_t)));

    // If the allocation fails, push the message back to the global pool and bail
    if (!pstEventCopy)
    {
        GlobalMessagePool::Push(pclMessage);
        return false;
    }

    // Copy the source event into the destination event buffer
    CopyEvent(pstEventCopy, pstEvent_);

    // Set the new event as the message payload
    pclMessage->SetData(static_cast<void*>(pstEventCopy));

    // Send the event to the message queue
    m_clMessageQueue.Send(pclMessage);

    return true;
}

//---------------------------------------------------------------------------
K_BOOL GuiEventSurface::ProcessEvent()
{
    GUI_DEBUG_PRINT("GuiEventSurface::ProcessEvent\n");

    // read the event from the queue (blocking call)
    Message *pclMessage = m_clMessageQueue.Receive();
    GuiEvent_t stLocalEvent;

    // If we failed to get something from the queue,
    // bail out
    if (!pclMessage)
    {
        return false;
    }

    // Copy the event data from the message into a local copy
    CopyEvent(&stLocalEvent,
        static_cast<GuiEvent_t*>(pclMessage->GetData()));

    // Free the message and event as soon as possible, since
    // they are shared system resources
    SystemHeap::Free(pclMessage->GetData());
    GlobalMessagePool::Push(pclMessage);

    // Special case check - target ID is the highest Z-ordered window(s) ONLY.
    if (stLocalEvent.ucTargetID == TARGET_ID_BROADCAST_Z)
    {
        LinkListNode* pclTempNode = m_clWindowList.
GetHead();
        K_UCHAR ucMaxZ = 0;

        while (pclTempNode)
        {
            if (ucMaxZ < (static_cast<GuiWindow*>(pclTempNode))->GetZOrder() )
            {
                ucMaxZ = static_cast<GuiWindow*>(pclTempNode)->GetZOrder();
            }
            pclTempNode = pclTempNode->GetNext();
        }

        // Iterate through all windows again - may have multiple windows
        // at the same z-order.
        pclTempNode = m_clWindowList.GetHead();
        while (pclTempNode)
        {
            if (ucMaxZ == (static_cast<GuiWindow*>(pclTempNode))->GetZOrder())
            {
                (static_cast<GuiWindow*>(pclTempNode))->ProcessEvent(&stLocalEvent);
            }
            pclTempNode = pclTempNode->GetNext();
        }
    }
    // Broadcast the event - sending it to *all* windows.  Let the individual
    // windows figure out what to do with the events.
    else
    {
        LinkListNode* pclTempNode = m_clWindowList.
GetHead();
        while (pclTempNode)
        {
            (static_cast<GuiWindow*>(pclTempNode))->ProcessEvent(&stLocalEvent);
            pclTempNode = pclTempNode->GetNext();
        }
    }

    // Return out
    return true;
}

//---------------------------------------------------------------------------
void GuiEventSurface::CopyEvent( GuiEvent_t *pstDst_,
GuiEvent_t *pstSrc_ )
{
    GUI_DEBUG_PRINT("GuiEventSurface::CopyEvent\n");
    K_UCHAR *pucDst_ = (K_UCHAR*)pstDst_;
    K_UCHAR *pucSrc_ = (K_UCHAR*)pstSrc_;
    K_UCHAR i;
    for (i = 0; i < sizeof(GuiEvent_t); i++)
    {
        *pucDst_++ = *pucSrc_++;
    }
}

//---------------------------------------------------------------------------
void GuiEventSurface::InvalidateRegion( K_USHORT usLeft_, K_USHORT usTop_,
 K_USHORT usWidth_, K_USHORT usHeight_ )
{
    LinkListNode* pclTempNode = m_clWindowList.GetHead();
    while (pclTempNode)
    {
        (static_cast<GuiWindow*>(pclTempNode))->InvalidateRegion(usLeft_, usTop_, usWidth_,
usWidth_);
        pclTempNode = pclTempNode->GetNext();
    }
}

//---------------------------------------------------------------------------
void GuiControl::GetControlOffset( K_USHORT *pusX_, K_USHORT *pusY_ )
{
    GUI_DEBUG_PRINT("GuiControl::GetControlOffset\n");
    GuiControl *pclTempControl = m_pclParentControl;
    *pusX_ = 0;
    *pusY_ = 0;
    while (pclTempControl)
    {
        *pusX_ += pclTempControl->GetLeft();
        *pusY_ += pclTempControl->GetTop();
        pclTempControl = pclTempControl->GetParentControl();
    }

    if (m_pclParentWindow)
    {
        *pusX_ += m_pclParentWindow->GetLeft();
        *pusY_ += m_pclParentWindow->GetTop();
    }
}
```

17.73 /home/mo/mark3-source/embedded/stage/src/gui.h File Reference

Graphical User Interface classes and data structure declarations.

```
#include "kerneltypes.h"
#include "ll.h"
#include "driver.h"
#include "graphics.h"
#include "message.h"
#include "keycodes.h"
```

Classes

- struct KeyEvent_t

  Keyboard UI event structure definition.
- struct MouseEvent_t

  Mouse UI event structure.
- struct TouchEvent_t

  Touch UI event structure.
- struct JoystickEvent_t

  Joystick UI event structure.
- struct TimerEvent_t

  Timer UI event structure.
- struct GuiEvent_t

  Composite UI event structure.
- class GuiWindow

  Basic Window Class.
- class GuiEventSurface

  GUI Event Surface Object.
- class GuiControl

  GUI Control Base Class.
- class StubControl

  Stub control class, used for testing out the GUI framework where certain controls have not yet been implemented.

Macros

- #define **GUI_DEBUG** (0)
- #define **GUI_DEBUG_PRINT**(...)
- #define EVENT_STATE_UP (0)

  Event state defintions, used for determining whether or not a button or key is in the "up" or "down" contact state.
- #define **EVENT_STATE_DOWN** (1)
- #define MAX_WINDOW_CONTROLS (251)

  Maximum number of controls per window.
- #define TARGET_ID_BROADCAST_Z (252)

  Broadcast event to all controls in the topmost window.
- #define TARGET_ID_BROADCAST (253)

  Send event to all controls in all windows.
- #define TARGET_ID_FOCUS (254)

  Send event to the in-focus control.
- #define TARGET_ID_HIGH_Z (255)

  Send event to the highest Z-order control.

Enumerations

- enum GuiEventType_t {
  EVENT_TYPE_KEYBOARD, EVENT_TYPE_MOUSE, EVENT_TYPE_TOUCH, EVENT_TYPE_JOYSTICK,
  EVENT_TYPE_TIMER, EVENT_TYPE_COUNT }

  Enumeration defining the various UI event codes.
- enum GuiReturn_t {
  GUI_EVENT_OK = 0, GUI_EVENT_CONSUMED, GUI_EVENT_CANCEL, GUI_EVENT_RETRY,
  GUI_EVENT_COUNT }

17.73.1 Detailed Description

Graphical User Interface classes and data structure declarations.

Definition in file gui.h.

17.73.2 Enumeration Type Documentation

17.73.2.1 enum GuiEventType_t

Enumeration defining the various UI event codes.

Enumerator

EVENT_TYPE_KEYBOARD	Keypress event.
EVENT_TYPE_MOUSE	Mouse movement or click event.
EVENT_TYPE_TOUCH	Touchscreen movement event.
EVENT_TYPE_JOYSTICK	Joystick event.
EVENT_TYPE_TIMER	Timer event.
EVENT_TYPE_COUNT	Count of different event types supported.

Definition at line 65 of file gui.h.

17.73.2.2 enum GuiReturn_t

Enumerator

GUI_EVENT_OK	No problem.
GUI_EVENT_CONSUMED	Event was consumed.
GUI_EVENT_CANCEL	Event processing canceled.
GUI_EVENT_RETRY	Retry processing the event.

Definition at line 203 of file gui.h.

17.74 gui.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]------------------------------------------------

```

```
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===========================================================================*/
#ifndef __GUI_H__
#define __GUI_H__

#include "kerneltypes.h"
#include "ll.h"
#include "driver.h"
#include "graphics.h"

#include "message.h"

#include "keycodes.h"

#define GUI_DEBUG            (0)

#if GUI_DEBUG
    #include <stdio.h>
    #include <stdlib.h>
    #include <string.h>

    #define GUI_DEBUG_PRINT        printf
#else
#define GUI_DEBUG_PRINT(...)
#endif


//---------------------------------------------------------------------------
#define EVENT_STATE_UP            (0)
#define EVENT_STATE_DOWN        (1)

//---------------------------------------------------------------------------
#define MAX_WINDOW_CONTROLS        (251)

#define TARGET_ID_BROADCAST_Z    (252)
#define TARGET_ID_BROADCAST        (253)
#define TARGET_ID_FOCUS            (254)
#define TARGET_ID_HIGH_Z        (255)


//---------------------------------------------------------------------------
typedef enum
{
    EVENT_TYPE_KEYBOARD,
    EVENT_TYPE_MOUSE,
    EVENT_TYPE_TOUCH,
    EVENT_TYPE_JOYSTICK,
    EVENT_TYPE_TIMER,
//---
    EVENT_TYPE_COUNT
} GuiEventType_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_UCHAR ucKeyCode;
    union
    {
        K_UCHAR ucFlags;
        struct
        {
            unsigned int bKeyState:1;
            unsigned int bShiftState:1;
            unsigned int bCtrlState:1;
            unsigned int bAltState:1;
            unsigned int bWinState:1;
            unsigned int bFnState:1;
        };
    };
} KeyEvent_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;

    union
    {
        K_UCHAR ucFlags;
        struct
        {
            unsigned int bLeftState:1;
            unsigned int bRightState:1;
            unsigned int bMiddleState:1;
            unsigned int bScrollUp:1;
            unsigned int bScrollDown:1;
        };
    };
} MouseEvent_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usX;
    K_USHORT usY;

    union
    {
        K_USHORT ucFlags;
        struct
        {
            unsigned int bTouch:1;
        };
    };
} TouchEvent_t;

//---------------------------------------------------------------------------
typedef struct
{
    union
    {
        K_USHORT usRawData;
        struct
        {
            unsigned int bUp:1;
            unsigned int bDown:1;
            unsigned int bLeft:1;
            unsigned int bRight:1;

            unsigned int bButton1:1;
            unsigned int bButton2:1;
            unsigned int bButton3:1;
            unsigned int bButton4:1;
            unsigned int bButton5:1;
            unsigned int bButton6:1;
            unsigned int bButton7:1;
            unsigned int bButton8:1;
            unsigned int bButton9:1;
            unsigned int bButton10:1;

            unsigned int bSelect:1;
            unsigned int bStart:1;
        };
    };
} JoystickEvent_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT usTicks;
} TimerEvent_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_UCHAR ucEventType;
    K_UCHAR ucTargetID;
    union
    {
        KeyEvent_t        stKey;
        MouseEvent_t    stMouse;
        TouchEvent_t    stTouch;
        JoystickEvent_t stJoystick;
        TimerEvent_t    stTimer;
    };

} GuiEvent_t;

//---------------------------------------------------------------------------
typedef enum
{
    GUI_EVENT_OK = 0,
    GUI_EVENT_CONSUMED,
    GUI_EVENT_CANCEL,
    GUI_EVENT_RETRY,
//---
    GUI_EVENT_COUNT
} GuiReturn_t;

class GuiControl;

//---------------------------------------------------------------------------
```

```
class GuiWindow : public LinkListNode
{

public:
    void Init()
    {
        m_ucControlCount = 0;
        m_pclDriver = NULL;
        m_szName = "";
    }

    void SetDriver( GraphicsDriver *pclDriver_ ) {
m_pclDriver = pclDriver_; }

    GraphicsDriver *GetDriver() { return m_pclDriver; }

    void AddControl( GuiControl *pclControl_, GuiControl *pclParent_ );

    void RemoveControl( GuiControl *pclControl_ );

    K_UCHAR GetMaxZOrder();

    void Redraw( K_BOOL bRedrawAll_ );

    void ProcessEvent( GuiEvent_t *pstEvent_ );

    void SetFocus( GuiControl *pclControl_ );

    K_BOOL IsInFocus( GuiControl *pclControl_ )
    {
        if (m_pclInFocus == pclControl_)
        {
            return true;
        }
        return false;
    }

    void SetTop( K_USHORT usTop_ )          { m_usTop = usTop_; }

    void SetLeft( K_USHORT usLeft_ )       { m_usLeft = usLeft_; }

    void SetHeight( K_USHORT usHeight_ ) { m_usHeight = usHeight_; }

    void SetWidth( K_USHORT usWidth_ )     { m_usWidth = usWidth_; }

    K_USHORT GetTop()              { return m_usTop; }

    K_USHORT GetLeft()              { return m_usLeft; }

    K_USHORT GetHeight()          { return m_usHeight; }

    K_USHORT GetWidth()          { return m_usWidth; }

    K_UCHAR GetZOrder()          { return m_ucZ; }

    void SetZOrder( K_UCHAR ucZ_ ) { m_ucZ = ucZ_; }

    void CycleFocus( bool bForward_ );

    void SetName( const K_CHAR *szName_ ) { m_szName = szName_; }

    const K_CHAR *GetName() { return m_szName; }

    void InvalidateRegion( K_USHORT usLeft_, K_USHORT usTop_, K_USHORT usWidth_, K_USHORT
usHeight_ );

private:
    K_USHORT m_usTop;
    K_USHORT m_usLeft;
    K_USHORT m_usHeight;
    K_USHORT m_usWidth;

    K_UCHAR  m_ucZ;
    const K_CHAR  *m_szName;

    DoubleLinkList m_clControlList;
    GuiControl *m_pclInFocus;
    K_UCHAR m_ucControlCount;
    GraphicsDriver *m_pclDriver;
};

//---------------------------------------------------------------------------
class GuiEventSurface
{
public:
    void Init() { m_clMessageQueue.Init(); }

    void AddWindow( GuiWindow *pclWindow_ );

    void RemoveWindow( GuiWindow *pclWindow_ );

    K_BOOL SendEvent( GuiEvent_t *pstEvent_ );

    K_BOOL ProcessEvent();

    K_UCHAR GetEventCount() { return m_clMessageQueue.GetCount(); }

    GuiWindow *FindWindowByName( const K_CHAR *szName_ );

    void InvalidateRegion( K_USHORT usLeft_, K_USHORT usTop_, K_USHORT usWidth_, K_USHORT usHeight_ );

private:
    void CopyEvent( GuiEvent_t *pstDst_, GuiEvent_t *pstSrc_ );

private:
    DoubleLinkList m_clWindowList;

    MessageQueue   m_clMessageQueue;
};

//---------------------------------------------------------------------------
class GuiControl : public LinkListNode
{
public:
    virtual void Init() = 0;

    virtual void Draw() = 0;

    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ ) = 0;

    void SetTop( K_USHORT usTop_ )          { m_usTop = usTop_; }

    void SetLeft( K_USHORT usLeft_ )      { m_usLeft = usLeft_; }

    void SetHeight( K_USHORT usHeight_ ) { m_usHeight = usHeight_; }

    void SetWidth( K_USHORT usWidth_ )      { m_usWidth = usWidth_; }

    void SetZOrder( K_UCHAR ucZ_ )          { m_ucZOrder = ucZ_; }

    void SetControlIndex( K_UCHAR ucIdx_ ) { m_ucControlIndex = ucIdx_; }

    K_USHORT GetTop()             { return m_usTop; }

    K_USHORT GetLeft()             { return m_usLeft; }

    K_USHORT GetHeight()         { return m_usHeight; }

    K_USHORT GetWidth()         { return m_usWidth; }

    K_UCHAR  GetZOrder()        { return m_ucZOrder; }

    K_UCHAR  GetControlIndex()     { return m_ucControlIndex; }

    K_BOOL     IsStale()            { return m_bStale; }

    void GetControlOffset( K_USHORT *pusX_, K_USHORT *pusY_ );

    K_BOOL  IsInFocus()
    {
        return m_pclParentWindow->IsInFocus(this);
    }

    virtual void Activate( bool bActivate_ ) = 0;

protected:
    friend class GuiWindow;
    friend class GuiEventSurface;

    void SetParentControl( GuiControl *pclParent_ ) { m_pclParentControl = pclParent_; }

    void SetParentWindow( GuiWindow *pclWindow_ )    { m_pclParentWindow  = pclWindow_; }

    GuiControl *GetParentControl()                      { return m_pclParentControl; }

    GuiWindow *GetParentWindow()                      { return m_pclParentWindow; }

    void ClearStale()                                 { m_bStale = false; }
    void SetStale()                              { m_bStale = true; }

    void SetAcceptFocus( bool bFocus_ )          {
m_bAcceptsFocus = bFocus_; }

    bool AcceptsFocus()                          { return
m_bAcceptsFocus; }
private:
    K_BOOL     m_bStale;

    K_BOOL   m_bAcceptsFocus;

    K_UCHAR  m_ucZOrder;

    K_UCHAR  m_ucControlIndex;

    K_USHORT m_usTop;

    K_USHORT m_usLeft;

    K_USHORT m_usWidth;

    K_USHORT m_usHeight;

    GuiControl *m_pclParentControl;

    GuiWindow  *m_pclParentWindow;
};

//---------------------------------------------------------------------------
class StubControl : public GuiControl
{
public:
    virtual void Init() {  }
    virtual void Draw() {  }
    virtual GuiReturn_t ProcessEvent( GuiEvent_t *pstEvent_ ) { return
GUI_EVENT_OK; }
    virtual void Activate( bool bActivate_ ) { }
};

#endif

```

17.75 /home/mo/mark3-source/embedded/stage/src/kernel.cpp File Reference

Kernel initialization and startup code.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel.h"
#include "scheduler.h"
#include "thread.h"
#include "threadport.h"
#include "timerlist.h"
#include "message.h"
#include "driver.h"
#include "profile.h"
#include "kprofile.h"
#include "tracebuffer.h"
#include "kernel_debug.h"
#include "transaction.h"
```

Macros

- #define **__FILE_ID__** KERNEL_CPP

17.75.1 Detailed Description

Kernel initialization and startup code.

Definition in file kernel.cpp.

17.76 kernel.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "kernel.h"
#include "scheduler.h"
#include "thread.h"
#include "threadport.h"
#include "timerlist.h"
#include "message.h"
#include "driver.h"
#include "profile.h"
#include "kprofile.h"
#include "tracebuffer.h"
#include "kernel_debug.h"
#include "transaction.h"

bool Kernel::m_bIsStarted;
bool Kernel::m_bIsPanic;
panic_func_t Kernel::m_pfPanic;

//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     KERNEL_CPP

//---------------------------------------------------------------------------
void Kernel::Init(void)
{
    m_bIsStarted = false;
    m_bIsPanic = false;
    m_pfPanic = 0;

#if KERNEL_USE_DEBUG
    TraceBuffer::Init();
#endif
    KERNEL_TRACE( STR_MARK3_INIT );

    // Initialize the global kernel data - scheduler, timer-scheduler, and
    // the global message pool.
    Scheduler::Init();
#if KERNEL_USE_DRIVER
    DriverList::Init();
#endif
#if KERNEL_USE_TIMERS
    TimerScheduler::Init();
#endif
#if KERNEL_USE_MESSAGE
    GlobalMessagePool::Init();
#endif
#if KERNEL_USE_PROFILER
    Profiler::Init();
#endif
    TransactionQueue::GlobalQueueInit();
}

//---------------------------------------------------------------------------
void Kernel::Start(void)
{
    KERNEL_TRACE( STR_THREAD_START );
    m_bIsStarted = true;
    ThreadPort::StartThreads();
    KERNEL_TRACE( STR_START_ERROR );

}

//---------------------------------------------------------------------------
void Kernel::Panic(K_USHORT usCause_)
{
    m_bIsPanic = true;
    if (m_pfPanic)
    {
        m_pfPanic(usCause_);
    }
    else
    {
        while(1);
    }
}
```

17.77 /home/mo/mark3-source/embedded/stage/src/kernel.h File Reference

Kernel initialization and startup class.

```
#include "kerneltypes.h"
#include "panic_codes.h"
```

Classes

- class Kernel

    Class that encapsulates all of the kernel startup functions.

17.77.1 Detailed Description

Kernel initialization and startup class. The Kernel namespace provides functions related to initializing and starting up the kernel.

The Kernel::Init() function must be called before any of the other functions in the kernel can be used.

Once the initial kernel configuration has been completed (i.e. first threads have been added to the scheduler), the Kernel::Start() function can then be called, which will transition code execution from the "main()" context to the threads in the scheduler.

Definition in file kernel.h.

17.78 kernel.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __KERNEL_H__
#define __KERNEL_H__

#include "kerneltypes.h"
#include "panic_codes.h"

//---------------------------------------------------------------------------
class Kernel
```

```
{
public:
    static void Init(void);

    static void Start(void);

    static bool IsStarted()    {   return m_bIsStarted;    }

    static void SetPanic( panic_func_t pfPanic_ ) { m_pfPanic = pfPanic_; }

    static bool IsPanic()      {   return m_bIsPanic;   }

    static void Panic(K_USHORT usCause_);

private:
    static bool m_bIsStarted;
    static bool m_bIsPanic;
    static panic_func_t m_pfPanic;
};

#endif

```

17.79 /home/mo/mark3-source/embedded/stage/src/kernel_debug.h File Reference

Macros and functions used for assertions, kernel traces, etc.

```
#include "debug_tokens.h"
#include "mark3cfg.h"
#include "tracebuffer.h"
#include "kernel.h"
```

Macros

- #define **__FILE_ID__** 0
- #define **KERNEL_TRACE**(x)
- #define **KERNEL_TRACE_1**(x, arg1)
- #define **KERNEL_TRACE_2**(x, arg1, arg2)
- #define **KERNEL_ASSERT**(x)

17.79.1 Detailed Description

Macros and functions used for assertions, kernel traces, etc.

Definition in file kernel_debug.h.

17.80 kernel_debug.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __KERNEL_DEBUG_H__
#define __KERNEL_DEBUG_H__

#include "debug_tokens.h"
#include "mark3cfg.h"
```

```
#include "tracebuffer.h"
#include "kernel.h"

//---------------------------------------------------------------------------
#if KERNEL_USE_DEBUG

//---------------------------------------------------------------------------
#define __FILE_ID__            STR_UNDEFINED

//---------------------------------------------------------------------------
#define KERNEL_TRACE( x )     \
{      \
    K_USHORT ausMsg__[5]; \
    ausMsg__[0] = 0xACDC;  \
    ausMsg__[1] = __FILE_ID__; \
    ausMsg__[2] = __LINE__; \
    ausMsg__[3] = TraceBuffer::Increment() ; \
    ausMsg__[4] = (K_USHORT)(x) ; \
    TraceBuffer::Write(ausMsg__, 5); \
};

//---------------------------------------------------------------------------
#define KERNEL_TRACE_1( x, arg1 ) \
{      \
    K_USHORT ausMsg__[6]; \
    ausMsg__[0] = 0xACDC;  \
    ausMsg__[1] = __FILE_ID__; \
    ausMsg__[2] = __LINE__; \
    ausMsg__[3] = TraceBuffer::Increment(); \
    ausMsg__[4] = (K_USHORT)(x); \
    ausMsg__[5] = arg1; \
    TraceBuffer::Write(ausMsg__, 6); \
}

//---------------------------------------------------------------------------
#define KERNEL_TRACE_2( x, arg1, arg2 ) \
{      \
    K_USHORT ausMsg__[7]; \
    ausMsg__[0] = 0xACDC;  \
    ausMsg__[1] = __FILE_ID__; \
    ausMsg__[2] = __LINE__; \
    ausMsg__[3] = TraceBuffer::Increment(); \
    ausMsg__[4] = (K_USHORT)(x); \
    ausMsg__[5] = arg1; \
    ausMsg__[6] = arg2; \
    TraceBuffer::Write(ausMsg__, 7); \
}

//---------------------------------------------------------------------------
#define KERNEL_ASSERT( x ) \
{          \
    if( ( x ) == false ) \
    {    \
        K_USHORT ausMsg__[5];    \
        ausMsg__[0] = 0xACDC;    \
        ausMsg__[1] = __FILE_ID__;    \
        ausMsg__[2] = __LINE__; \
        ausMsg__[3] = TraceBuffer::Increment(); \
        ausMsg__[4] = STR_ASSERT_FAILED;    \
        TraceBuffer::Write(ausMsg__, 5); \
        Kernel::Panic(PANIC_ASSERT_FAILED); \
    }    \
}

#else
//---------------------------------------------------------------------------
#define __FILE_ID__            0
//---------------------------------------------------------------------------
#define KERNEL_TRACE( x )
//---------------------------------------------------------------------------
#define KERNEL_TRACE_1( x, arg1 )
//---------------------------------------------------------------------------
#define KERNEL_TRACE_2( x, arg1, arg2 )
//---------------------------------------------------------------------------
#define KERNEL_ASSERT( x )

#endif // KERNEL_USE_DEBUG

#endif
```

17.81 /home/mo/mark3-source/embedded/stage/src/kernelswi.cpp File Reference

Kernel Software interrupt implementation for ATMega328p.

```
#include "kerneltypes.h"
#include "kernelswi.h"
#include <avr/io.h>
#include <avr/interrupt.h>
```

17.81.1 Detailed Description

Kernel Software interrupt implementation for ATMega328p.

Definition in file kernelswi.cpp.

17.82 kernelswi.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \    ||     |     ||  |/ /     ||___   |
|     \/   | ||     \   ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "kernelswi.h"

#include <avr/io.h>
#include <avr/interrupt.h>

//---------------------------------------------------------------------------
void KernelSWI::Config(void)
{
    PORTD &= ~0x04; // Clear INT0
    DDRD |= 0x04;    // Set PortD, bit 2 (INT0) As Output
    EICRA |= (1 << ISC00) | (1 << ISC01);    // Rising edge on INT0
}

//---------------------------------------------------------------------------
void KernelSWI::Start(void)
{
    EIFR &= ~(1 << INTF0);    // Clear any pending interrupts on INT0
    EIMSK |= (1 << INT0);    // Enable INT0 interrupt (as K_LONG as I-bit is set)
}

//---------------------------------------------------------------------------
void KernelSWI::Stop(void)
{
    EIMSK &= ~(1 << INT0);    // Disable INT0 interrupts
}

//---------------------------------------------------------------------------
K_UCHAR KernelSWI::DI()
{
    K_UCHAR bEnabled = ((EIMSK & (1 << INT0)) != 0);
    EIMSK &= ~(1 << INT0);
    return bEnabled;
}

//---------------------------------------------------------------------------
void KernelSWI::RI(K_UCHAR bEnable_)
{
    if (bEnable_)
    {
        EIMSK |= (1 << INT0);
    }
    else
    {
        EIMSK &= ~(1 << INT0);
    }
}

//---------------------------------------------------------------------------
void KernelSWI::Clear(void)
```

```
{
    EIFR &= ~(1 << INTF0);     // Clear the interrupt flag for INT0
}

//---------------------------------------------------------------------------
void KernelSWI::Trigger(void)
{
    //if(Thread_IsSchedulerEnabled())
    {
        PORTD &= ~0x04;
        PORTD |= 0x04;
    }
}
```

17.83 /home/mo/mark3-source/embedded/stage/src/kernelswi.h File Reference

Kernel Software interrupt declarations.

```
#include "kerneltypes.h"
```

Classes

- class KernelSWI

  Class providing the software-interrupt required for context-switching in the kernel.

17.83.1 Detailed Description

Kernel Software interrupt declarations.

Definition in file kernelswi.h.

17.84 kernelswi.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \    ||     |     ||  |/ /    ||___   |
|     \/   | ||     \   ||     \     ||     \    ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#ifndef __KERNELSWI_H_
#define __KERNELSWI_H_

//---------------------------------------------------------------------------
class KernelSWI
{
public:
    static void Config(void);

    static void Start(void);

    static void Stop(void);

    static void Clear(void);

    static void Trigger(void);

    static K_UCHAR DI();

    static void RI(K_UCHAR bEnable_);
};

```

```

#endif // __KERNELSIW_H_
```

17.85 /home/mo/mark3-source/embedded/stage/src/kerneltimer.cpp File Reference

Kernel Timer Implementation for ATMega328p.

```
#include "kerneltypes.h"
#include "kerneltimer.h"
#include "mark3cfg.h"
#include <avr/io.h>
#include <avr/interrupt.h>
```

Macros

- #define **TCCR1B_INIT** ((1 << WGM12) | (1 << CS12))
- #define **TIMER_IMSK** (1 << OCIE1A)
- #define **TIMER_IFR** (1 << OCF1A)

17.85.1 Detailed Description

Kernel Timer Implementation for ATMega328p.

Definition in file kerneltimer.cpp.

17.86 kerneltimer.cpp

```
/*============================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_     |__ __|__    |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___    |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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============================================================================*/
#include "kerneltypes.h"
#include "kerneltimer.h"
#include "mark3cfg.h"

#include <avr/io.h>
#include <avr/interrupt.h>

#define TCCR1B_INIT        ((1 << WGM12) | (1 << CS12))
#define TIMER_IMSK        (1 << OCIE1A)
#define TIMER_IFR        (1 << OCF1A)

//----------------------------------------------------------------------------
void KernelTimer::Config(void)
{
    TCCR1B = TCCR1B_INIT;
}

//----------------------------------------------------------------------------
void KernelTimer::Start(void)
{
#if !KERNEL_TIMERS_TICKLESS
    TCCR1B = ((1 << WGM12) | (1 << CS11) | (1 << CS10));
    OCR1A = ((SYSTEM_FREQ / 1000) / 64);
#else
    TCCR1B |= (1 << CS12);
#endif

```

```
    TCNT1 = 0;
    TIFR1 &= ~TIMER_IFR;
    TIMSK1 |= TIMER_IMSK;
}

//---------------------------------------------------------------------------
void KernelTimer::Stop(void)
{
#if KERNEL_TIMERS_TICKLESS
    TIFR1 &= ~TIMER_IFR;
    TIMSK1 &= ~TIMER_IMSK;
    TCCR1B &= ~(1 << CS12);      // Disable count...
    TCNT1 = 0;
    OCR1A = 0;
#endif
}

//---------------------------------------------------------------------------
K_USHORT KernelTimer::Read(void)
{
#if KERNEL_TIMERS_TICKLESS
    volatile K_USHORT usRead1;
    volatile K_USHORT usRead2;

    do {
        usRead1 = TCNT1;
        usRead2 = TCNT1;
    } while (usRead1 != usRead2);

    return usRead1;
#else
    return 0;
#endif
}

//---------------------------------------------------------------------------
K_ULONG KernelTimer::SubtractExpiry(K_ULONG ulInterval_)
{
#if KERNEL_TIMERS_TICKLESS
    OCR1A -= (K_USHORT)ulInterval_;
    return (K_ULONG)OCR1A;
#else
    return 0;
#endif
}

//---------------------------------------------------------------------------
K_ULONG KernelTimer::TimeToExpiry(void)
{
#if KERNEL_TIMERS_TICKLESS
    K_USHORT usRead = KernelTimer::Read();
    K_USHORT usOCR1A = OCR1A;

    if (usRead >= usOCR1A)
    {
        return 0;
    }
    else
    {
        return (K_ULONG)(usOCR1A - usRead);
    }
#else
    return 0;
#endif
}

//---------------------------------------------------------------------------
K_ULONG KernelTimer::GetOvertime(void)
{
    return KernelTimer::Read();
}

//---------------------------------------------------------------------------
K_ULONG KernelTimer::SetExpiry(K_ULONG ulInterval_)
{
#if KERNEL_TIMERS_TICKLESS
    K_USHORT usSetInterval;
    if (ulInterval_ > 65535)
    {
        usSetInterval = 65535;
    }
    else
    {
        usSetInterval = (K_USHORT)ulInterval_ ;
    }
    OCR1A = usSetInterval;
    return (K_ULONG)usSetInterval;
```

```
#else
    return 0;
#endif
}

//---------------------------------------------------------------------------
void KernelTimer::ClearExpiry(void)
{
#if KERNEL_TIMERS_TICKLESS
    OCR1A = 65535;                    // Clear the compare value
#endif
}

//---------------------------------------------------------------------------
K_UCHAR KernelTimer::DI(void)
{
#if KERNEL_TIMERS_TICKLESS
    K_UCHAR bEnabled = ((TIMSK1 & (TIMER_IMSK)) != 0);
    TIFR1 &= ~TIMER_IFR;       // Clear interrupt flags
    TIMSK1 &= ~TIMER_IMSK;     // Disable interrupt
    return bEnabled;
#else
    return 0;
#endif
}

//---------------------------------------------------------------------------
void KernelTimer::EI(void)
{
    KernelTimer::RI(0);
}

//---------------------------------------------------------------------------
void KernelTimer::RI(K_UCHAR bEnable_)
{
#if KERNEL_TIMERS_TICKLESS
    if (bEnable_)
    {
        TIMSK1 |= (1 << OCIE1A);    // Enable interrupt
    }
    else
    {
        TIMSK1 &= ~(1 << OCIE1A);
    }
#endif
}
```

17.87 /home/mo/mark3-source/embedded/stage/src/kerneltimer.h File Reference

Kernel Timer Class declaration.

```
#include "kerneltypes.h"
```

Classes

- class KernelTimer

  Hardware timer interface, used by all scheduling/timer subsystems.

Macros

- #define **SYSTEM_FREQ** ((K_ULONG)16000000)
- #define **TIMER_FREQ** ((K_ULONG)(SYSTEM_FREQ / 256))

17.87.1 Detailed Description

Kernel Timer Class declaration.

Definition in file kerneltimer.h.

17.88 kerneltimer.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#ifndef __KERNELTIMER_H_
#define __KERNELTIMER_H_

//---------------------------------------------------------------------------
#define SYSTEM_FREQ        ((K_ULONG)16000000)
#define TIMER_FREQ        ((K_ULONG)(SYSTEM_FREQ / 256)) // Timer ticks per second...

//---------------------------------------------------------------------------
class KernelTimer
{
public:
    static void Config(void);

    static void Start(void);

    static void Stop(void);

    static K_UCHAR DI(void);

    static void RI(K_UCHAR bEnable_);

    static void EI(void);

    static K_ULONG SubtractExpiry(K_ULONG ulInterval_);

    static K_ULONG TimeToExpiry(void);

    static K_ULONG SetExpiry(K_ULONG ulInterval_);

    static K_ULONG GetOvertime(void);

    static void ClearExpiry(void);

private:
    static K_USHORT Read(void);

};

#endif //__KERNELTIMER_H_
```

17.89 /home/mo/mark3-source/embedded/stage/src/kerneltypes.h File Reference

Basic data type primatives used throughout the OS.

```
#include <stdint.h>
```

Macros

- #define **K_BOOL** uint8_t
- #define **K_CHAR** char
- #define **K_UCHAR** uint8_t
- #define **K_USHORT** uint16_t
- #define **K_SHORT** int16_t
- #define **K_ULONG** uint32_t
- #define **K_LONG** int32_t
- #define **K_ADDR** uint32_t
- #define **K_WORD** uint32_t

Typedefs

- typedef void(∗ **panic_func_t**)(K_USHORT usPanicCode_)

Enumerations

- enum **EventFlagOperation_t** {
EVENT_FLAG_ALL, **EVENT_FLAG_ANY**, **EVENT_FLAG_ALL_CLEAR**, **EVENT_FLAG_ANY_CLEAR**, **EVENT_FLAG_MODES**, **EVENT_FLAG_PENDING_UNBLOCK** }

17.89.1 Detailed Description

Basic data type primatives used throughout the OS.

Definition in file kerneltypes.h.

17.90 kerneltypes.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include <stdint.h>

#ifndef __KERNELTYPES_H__
#define __KERNELTYPES_H__

#if defined(bool)
    #define K_BOOL            bool
#else
    #define K_BOOL            uint8_t
#endif

#define K_CHAR            char
#define K_UCHAR            uint8_t
#define K_USHORT        uint16_t
#define K_SHORT            int16_t
#define K_ULONG            uint32_t
#define K_LONG            int32_t

#if !defined(K_ADDR)
    #define K_ADDR      uint32_t
#endif
#if !defined(K_WORD)
    #define K_WORD      uint32_t
#endif

//---------------------------------------------------------------------------
typedef void (*panic_func_t)( K_USHORT usPanicCode_ );

//---------------------------------------------------------------------------
typedef enum
{
    EVENT_FLAG_ALL,
    EVENT_FLAG_ANY,
    EVENT_FLAG_ALL_CLEAR,
    EVENT_FLAG_ANY_CLEAR,
    EVENT_FLAG_MODES,
    EVENT_FLAG_PENDING_UNBLOCK
} EventFlagOperation_t;


#endif
```

17.91 /home/mo/mark3-source/embedded/stage/src/keycodes.h File Reference

Standard ASCII keyboard codes.

`#include "kerneltypes.h"`

Enumerations

- enum **KEYCODE** {
  KEYCODE_LBUTTON = 0x01, **KEYCODE_RBUTTON**, **KEYCODE_CANCEL**, **KEYCODE_MBUTTON**,
  KEYCODE_BACK = 0x08, **KEYCODE_TAB**, **KEYCODE_CLEAR** = 0x0C, **KEYCODE_RETURN**,
  KEYCODE_SHIFT = 0x10, **KEYCODE_CONTROL**, **KEYCODE_MENU**, **KEYCODE_PAUSE**,
  KEYCODE_CAPITAL, **KEYCODE_ESCAPE** = 0x1B, **KEYCODE_SPACE**, **KEYCODE_PRIOR**,
  KEYCODE_NEXT, **KEYCODE_END**, **KEYCODE_HOME**, **KEYCODE_LEFT**,
  KEYCODE_UP, **KEYCODE_RIGHT**, **KEYCODE_DOWN**, **KEYCODE_SELECT**,
  KEYCODE_PRINT, **KEYCODE_EXECUTE**, **KEYCODE_SNAPSHOT**, **KEYCODE_INSERT**,
  KEYCODE_DELETE, **KEYCODE_HELP** = 0x2F, **KEYCODE_0**, **KEYCODE_1**,
  KEYCODE_2, **KEYCODE_3**, **KEYCODE_4**, **KEYCODE_5**,
  KEYCODE_6, **KEYCODE_7**, **KEYCODE_8**, **KEYCODE_9**,
  KEYCODE_A, **KEYCODE_B**, **KEYCODE_C**, **KEYCODE_D**,
  KEYCODE_E, **KEYCODE_F**, **KEYCODE_G**, **KEYCODE_H**,
  KEYCODE_I, **KEYCODE_J**, **KEYCODE_K**, **KEYCODE_L**,
  KEYCODE_M, **KEYCODE_N**, **KEYCODE_O**, **KEYCODE_P**,
  KEYCODE_Q, **KEYCODE_R**, **KEYCODE_S**, **KEYCODE_T**,
  KEYCODE_U, **KEYCODE_V**, **KEYCODE_W**, **KEYCODE_X**,
  KEYCODE_Y, **KEYCODE_Z**, **KEYCODE_NUMPAD0** = 0x60, **KEYCODE_NUMPAD1**,
  KEYCODE_NUMPAD2, **KEYCODE_NUMPAD3**, **KEYCODE_NUMPAD4**, **KEYCODE_NUMPAD5**,
  KEYCODE_NUMPAD6, **KEYCODE_NUMPAD7**, **KEYCODE_NUMPAD8**, **KEYCODE_NUMPAD9**,
  KEYCODE_SEPARATOR = 0x6C, **KEYCODE_SUBTRACT**, **KEYCODE_DECIMAL**, **KEYCODE_DIVIDE**,
  KEYCODE_F1, **KEYCODE_F2**, **KEYCODE_F3**, **KEYCODE_F4**,
  KEYCODE_F5, **KEYCODE_F6**, **KEYCODE_F7**, **KEYCODE_F8**,
  KEYCODE_F9, **KEYCODE_F10**, **KEYCODE_F11**, **KEYCODE_F12**,
  KEYCODE_F13, **KEYCODE_F14**, **KEYCODE_F15**, **KEYCODE_F16**,
  KEYCODE_F17, **KEYCODE_F18**, **KEYCODE_F19**, **KEYCODE_F20**,
  KEYCODE_F21, **KEYCODE_F22**, **KEYCODE_F23**, **KEYCODE_F24**,
  KEYCODE_NUMLOCK = 0x90, **KEYCODE_SCROLL**, **KEYCODE_LSHIFT** = 0xA0, **KEYCODE_RSHIFT**,
  KEYCODE_LCONTROL, **KEYCODE_RCONTROL**, **KEYCODE_LMENU**, **KEYCODE_RMENU**,
  KEYCODE_PLAY = 0xFA, **KEYCODE_ZOOM** }

17.91.1 Detailed Description

Standard ASCII keyboard codes.

Definition in file keycodes.h.

17.92 keycodes.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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```

```
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===============================================================================*/
#ifndef __KEYCODES_H_
#define __KEYCODES_H_

#include "kerneltypes.h"

typedef enum
{
    KEYCODE_LBUTTON = 0x01,
    KEYCODE_RBUTTON,
    KEYCODE_CANCEL,
    KEYCODE_MBUTTON,
    KEYCODE_BACK = 0x08,
    KEYCODE_TAB,
    KEYCODE_CLEAR = 0x0C,
    KEYCODE_RETURN,
    KEYCODE_SHIFT = 0x10,
    KEYCODE_CONTROL,
    KEYCODE_MENU,
    KEYCODE_PAUSE,
    KEYCODE_CAPITAL,
    KEYCODE_ESCAPE = 0x1B,
    KEYCODE_SPACE,
    KEYCODE_PRIOR,
    KEYCODE_NEXT,
    KEYCODE_END,
    KEYCODE_HOME,
    KEYCODE_LEFT,
    KEYCODE_UP,
    KEYCODE_RIGHT,
    KEYCODE_DOWN,
    KEYCODE_SELECT,
    KEYCODE_PRINT,
    KEYCODE_EXECUTE,
    KEYCODE_SNAPSHOT,
    KEYCODE_INSERT,
    KEYCODE_DELETE,
    KEYCODE_HELP = 0x2F,
    KEYCODE_0,
    KEYCODE_1,
    KEYCODE_2,
    KEYCODE_3,
    KEYCODE_4,
    KEYCODE_5,
    KEYCODE_6,
    KEYCODE_7,
    KEYCODE_8,
    KEYCODE_9,
    KEYCODE_A,
    KEYCODE_B,
    KEYCODE_C,
    KEYCODE_D,
    KEYCODE_E,
    KEYCODE_F,
    KEYCODE_G,
    KEYCODE_H,
    KEYCODE_I,
    KEYCODE_J,
    KEYCODE_K,
    KEYCODE_L,
    KEYCODE_M,
    KEYCODE_N,
    KEYCODE_O,
    KEYCODE_P,
    KEYCODE_Q,
    KEYCODE_R,
    KEYCODE_S,
    KEYCODE_T,
    KEYCODE_U,
    KEYCODE_V,
    KEYCODE_W,
    KEYCODE_X,
    KEYCODE_Y,
    KEYCODE_Z,
    KEYCODE_NUMPAD0 = 0x60,
    KEYCODE_NUMPAD1,
    KEYCODE_NUMPAD2,
    KEYCODE_NUMPAD3,
    KEYCODE_NUMPAD4,
    KEYCODE_NUMPAD5,
    KEYCODE_NUMPAD6,
    KEYCODE_NUMPAD7,
    KEYCODE_NUMPAD8,
    KEYCODE_NUMPAD9,
    KEYCODE_SEPARATOR = 0x6C,
    KEYCODE_SUBTRACT,
    KEYCODE_DECIMAL,
    KEYCODE_DIVIDE,
    KEYCODE_F1,
    KEYCODE_F2,
    KEYCODE_F3,
    KEYCODE_F4,
    KEYCODE_F5,
    KEYCODE_F6,
    KEYCODE_F7,
    KEYCODE_F8,
    KEYCODE_F9,
    KEYCODE_F10,
    KEYCODE_F11,
    KEYCODE_F12,
    KEYCODE_F13,
    KEYCODE_F14,
    KEYCODE_F15,
    KEYCODE_F16,
    KEYCODE_F17,
    KEYCODE_F18,
    KEYCODE_F19,
    KEYCODE_F20,
    KEYCODE_F21,
    KEYCODE_F22,
    KEYCODE_F23,
    KEYCODE_F24,
    KEYCODE_NUMLOCK = 0x90,
    KEYCODE_SCROLL,
    KEYCODE_LSHIFT = 0xA0,
    KEYCODE_RSHIFT,
    KEYCODE_LCONTROL,
    KEYCODE_RCONTROL,
    KEYCODE_LMENU,
    KEYCODE_RMENU,
    KEYCODE_PLAY = 0xFA,
    KEYCODE_ZOOM
} KEYCODE;

#endif //__KEYCODES_H_
```

17.93 /home/mo/mark3-source/embedded/stage/src/kprofile.cpp File Reference

ATMega328p Profiling timer implementation.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "profile.h"
#include "kprofile.h"
#include "threadport.h"
#include <avr/io.h>
#include <avr/interrupt.h>
```

Functions

- **ISR** (TIMER0_OVF_vect)

17.93.1 Detailed Description

ATMega328p Profiling timer implementation.

Definition in file kprofile.cpp.

17.94 kprofile.cpp

```
/*===========================================================================
       _____        _____        _____        _____
 ___|    _|__   __|_    |__  __|__   |__  __| __  |__  ______
```

```
|    \  /  | ||    \      ||      |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "profile.h"
#include "kprofile.h"
#include "threadport.h"
#include <avr/io.h>
#include <avr/interrupt.h>

#if KERNEL_USE_PROFILER
K_ULONG Profiler::m_ulEpoch;

//---------------------------------------------------------------------------
void Profiler::Init()
{
    TCCR0A = 0;
    TCCR0B = 0;
    TIFR0 = 0;
    TIMSK0 = 0;
    m_ulEpoch = 0;
}

//---------------------------------------------------------------------------
void Profiler::Start()
{
    TIFR0 = 0;
    TCNT0 = 0;
    TCCR0B |= (1 << CS01);
    TIMSK0 |= (1 << TOIE0);
}

//---------------------------------------------------------------------------
void Profiler::Stop()
{
    TIFR0 = 0;
    TCCR0B &= ~(1 << CS01);
    TIMSK0 &= ~(1 << TOIE0);
}
//---------------------------------------------------------------------------
K_USHORT Profiler::Read()
{
    K_USHORT usRet;
    CS_ENTER();
    TCCR0B &= ~(1 << CS01);
    usRet = TCNT0;
    TCCR0B |= (1 << CS01);
    CS_EXIT();
    return usRet;
}

//---------------------------------------------------------------------------
void Profiler::Process()
{
    CS_ENTER();
    m_ulEpoch++;
    CS_EXIT();
}

//---------------------------------------------------------------------------
ISR(TIMER0_OVF_vect)
{
    Profiler::Process();
}

#endif
```

17.95 /home/mo/mark3-source/embedded/stage/src/kprofile.h File Reference

Profiling timer hardware interface.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"
```

Classes

- class Profiler

  System profiling timer interface.

Macros

- #define **TICKS_PER_OVERFLOW** (256)
- #define **CLOCK_DIVIDE** (8)

17.95.1 Detailed Description

Profiling timer hardware interface.

Definition in file kprofile.h.

17.96 kprofile.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"

#ifndef __KPROFILE_H__
#define __KPROFILE_H__

#if KERNEL_USE_PROFILER

//---------------------------------------------------------------------------
#define TICKS_PER_OVERFLOW              (256)
#define CLOCK_DIVIDE                    (8)

//---------------------------------------------------------------------------
class Profiler
{
public:
    static void Init();

    static void Start();

    static void Stop();

    static K_USHORT Read();

    static void Process();

    static K_ULONG GetEpoch(){ return m_ulEpoch; }
private:

    static K_ULONG m_ulEpoch;
};

#endif //KERNEL_USE_PROFILER
```

```

#endif

```

17.97 /home/mo/mark3-source/embedded/stage/src/ksemaphore.cpp File Reference

Semaphore Blocking-Object Implemenation.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel.h"
#include "ksemaphore.h"
#include "blocking.h"
#include "kernel_debug.h"
#include "scheduler.h"
#include "transaction.h"
#include "timerlist.h"
```

Macros

- #define **__FILE_ID__** SEMAPHORE_CPP
- #define **SEMAPHORE_TRANSACTION_POST** (0)
- #define **SEMAPHORE_TRANSACTION_PEND** (1)
- #define **SEMAPHORE_TRANSACTION_UNBLOCK** (2)

Functions

- void **TimedSemaphore_Callback** (Thread ∗pclOwner_, void ∗pvData_)

17.97.1 Detailed Description

Semaphore Blocking-Object Implemenation.

Definition in file ksemaphore.cpp.

17.98 ksemaphore.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__    |__  __| __  |__  ______
|    \  /  | ||    \      ||     |      ||  |/ /    ||___   |
|     \/   | ||     \     ||     \      ||     \    ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "kernel.h"
#include "ksemaphore.h"
#include "blocking.h"
#include "kernel_debug.h"
#include "scheduler.h"
#include "transaction.h"
//---------------------------------------------------------------------------
#if defined __FILE_ID__
```

```
    #undef __FILE_ID__
#endif
#define __FILE_ID__     SEMAPHORE_CPP

#if KERNEL_USE_SEMAPHORE

//---------------------------------------------------------------------------
#define SEMAPHORE_TRANSACTION_POST      (0)
#define SEMAPHORE_TRANSACTION_PEND      (1)
#define SEMAPHORE_TRANSACTION_UNBLOCK   (2)

#if KERNEL_USE_TIMERS
#include "timerlist.h"

//---------------------------------------------------------------------------
void TimedSemaphore_Callback(Thread *pclOwner_, void *pvData_)
{
    Semaphore *pclSemaphore = static_cast<Semaphore*>(pvData_);

    // Indicate that the semaphore has expired on the thread
    pclOwner_->SetExpired(true);

    // Wake up the thread that was blocked on this semaphore.
    pclSemaphore->Timeout(pclOwner_);
}

//---------------------------------------------------------------------------
void Semaphore::Timeout(Thread *pclChosenOne_)
{
    K_BOOL bSchedState;
    if (LockAndQueue(SEMAPHORE_TRANSACTION_UNBLOCK, pclChosenOne_, &bSchedState))
    {
        return;
    }

    if (ProcessQueue()) {
        Thread::Yield();
    }

    Scheduler::SetScheduler(bSchedState);
}

#endif // KERNEL_USE_TIMERS

//---------------------------------------------------------------------------
K_BOOL Semaphore::ProcessQueue()
{
    Transaction *pclTRX;
    K_BOOL bReschedule = false;

    do
    {
        pclTRX = m_clKTQ.Dequeue();
        KERNEL_ASSERT(pclTRX);

        switch (pclTRX->GetCode())
        {
            case SEMAPHORE_TRANSACTION_POST:
                PostTransaction(pclTRX, &bReschedule);
                break;
            case SEMAPHORE_TRANSACTION_PEND:
                PendTransaction(pclTRX, &bReschedule);
                break;
            case SEMAPHORE_TRANSACTION_UNBLOCK:
                TimeoutTransaction(pclTRX, &bReschedule);
                break;
            default:
                break;
        }
        m_clKTQ.Finish(pclTRX);
    } while (UnLock() > 1);

    return bReschedule;
}

//---------------------------------------------------------------------------
void Semaphore::PostTransaction(Transaction *pclTRX_, K_BOOL *
pbReschedule_)
{
    // If nothing is waiting for the semaphore
    if (m_clBlockList.GetHead() == NULL)
    {
        // Check so see if we've reached the maximum value in the semaphore
        if (m_usValue < m_usMaxValue)
        {
            // Increment the count value
            m_usValue++;
        }
    }
    else
    {
        // Otherwise, there are threads waiting for the semaphore to be
        // posted, so wake the next one (highest priority goes first).
        *pbReschedule_ = WakeNext();
    }
}

//---------------------------------------------------------------------------
void Semaphore::PendTransaction(Transaction *pclTRX_, K_BOOL * pbReschedule_)
{
    // Decrement-and-set the semaphore value
    if (0 == m_usValue)
    {
        // The semaphore count is zero - we need to block the current thread
        // and wait until the semaphore is posted from elsewhere.
        *pbReschedule_ = true;

        // Get the current thread pointer.
        Thread *pclThread = static_cast<Thread*>(pclTRX_->GetData());

#if KERNEL_USE_TIMERS
        Timer *pclSemTimer = pclThread->GetTimer();
        pclThread->SetExpired(false);
        K_ULONG ulWaitTimeMS = pclSemTimer->GetInterval();

        if (ulWaitTimeMS)
        {
            pclSemTimer->Start(0, ulWaitTimeMS, TimedSemaphore_Callback, (void*)this);
        }
#endif
        Block(pclThread);
    }
    else
    {
        m_usValue--;
    }
}

//---------------------------------------------------------------------------
void Semaphore::TimeoutTransaction(Transaction *pclTRX_, K_BOOL * pbReschedule_)
{
    Thread *pclChosenOne = static_cast<Thread*>(pclTRX_->GetData());

    UnBlock(pclChosenOne);

    // Call a task switch only if higher priority thread
    if (pclChosenOne->GetPriority() > Scheduler::GetCurrentThread()->GetPriority())
    {
        *pbReschedule_ = true;
    }
}

//---------------------------------------------------------------------------
K_BOOL Semaphore::WakeNext()
{
    Thread *pclChosenOne;

    pclChosenOne = m_clBlockList.HighestWaiter();

    // Remove from the semaphore waitlist and back to its ready list.
    UnBlock(pclChosenOne);

    // Call a task switch only if higher priority thread
    if (pclChosenOne->GetPriority() > Scheduler::GetCurrentThread()->GetPriority())
    {
        return true;
    }

    return false;
}

//---------------------------------------------------------------------------
void Semaphore::Init(K_USHORT usInitVal_, K_USHORT usMaxVal_)
{
    // Copy the paramters into the object - set the maximum value for this
    // semaphore to implement either binary or counting semaphores, and set
    // the initial count.  Clear the wait list for this object.
    m_usValue = usInitVal_;
    m_usMaxValue = usMaxVal_;

    m_clBlockList.Init();
}

//---------------------------------------------------------------------------
void Semaphore::Post()
{
    KERNEL_TRACE_1( STR_SEMAPHORE_POST_1, (K_USHORT)Scheduler::GetCurrentThread(
)->GetID() );

    K_BOOL bSchedState;
    if (LockAndQueue(SEMAPHORE_TRANSACTION_POST, 0, &bSchedState))
    {
        return;
    }

    if (ProcessQueue()) {
        Thread::Yield();
    }

    Scheduler::SetScheduler(bSchedState);

    return;
}

#if !KERNEL_USE_TIMERS
//---------------------------------------------------------------------------
    // No timers, no timed pend
    void Semaphore::Pend()
#else
//---------------------------------------------------------------------------
    // Redirect the untimed pend API to the timed pend, with a null timeout.
    void Semaphore::Pend()
    {
        Pend(0);
    }
//---------------------------------------------------------------------------
    bool Semaphore::Pend( K_ULONG ulWaitTimeMS_ )
#endif
{
    KERNEL_TRACE_1( STR_SEMAPHORE_PEND_1, (K_USHORT)Scheduler::GetCurrentThread(
)->GetID() );

    // By locking the queue, we ensure that any post/unblock operations on this
    // semaphore that interrupt our normal execution wind up being queued flushed
    // before we exit.

    K_BOOL bSchedState;
    if (LockAndQueue(SEMAPHORE_TRANSACTION_PEND, (void*)
Scheduler::GetCurrentThread(), &bSchedState))
    {
        // This should never happen - kernel panic if we do.
        Kernel::Panic( PANIC_PEND_LOCK_VIOLATION );
    }

    // Set data on the current thread that needs to be passed into the transaction
    // handler (and can't be queued in the simple key-value pair in the transaciton
    // object)

#if KERNEL_USE_TIMERS
    // Pre-set the interval, since we can't cache it in the transaction
    Scheduler::GetCurrentThread()->GetTimer()->
SetIntervalTicks(ulWaitTimeMS_);
    Scheduler::GetCurrentThread()->SetExpired(false);
#endif

    if (ProcessQueue())
    {
        // Switch Threads immediately
        Thread::Yield();
    }

    Scheduler::SetScheduler(bSchedState);

#if KERNEL_USE_TIMERS
    if (ulWaitTimeMS_)
    {
        Scheduler::GetCurrentThread()->GetTimer()->
Stop();
    }
    K_BOOL retVal = (Scheduler::GetCurrentThread()->GetExpired() == false);

    return retVal;
#endif
}

//---------------------------------------------------------------------------
K_USHORT Semaphore::GetCount()
```

```
{
    K_USHORT usRet;
    CS_ENTER();
    usRet = m_usValue;
    CS_EXIT();
    return usRet;
}

#endif
```

17.99 /home/mo/mark3-source/embedded/stage/src/ksemaphore.h File Reference

Semaphore Blocking Object class declarations.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "blocking.h"
#include "threadlist.h"
#include "transaction.h"
#include "atomic.h"
```

Classes

- class Semaphore

  Counting semaphore, based on BlockingObject base class.

17.99.1 Detailed Description

Semaphore Blocking Object class declarations.

Definition in file ksemaphore.h.

17.100 ksemaphore.h

```
/*==========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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==========================================================================*/
#ifndef __KSEMAPHORE_H__
#define __KSEMAPHORE_H__

#include "kerneltypes.h"
#include "mark3cfg.h"

#include "blocking.h"
#include "threadlist.h"
#include "transaction.h"
#include "atomic.h"

#if KERNEL_USE_SEMAPHORE

//--------------------------------------------------------------------------
class Semaphore : public BlockingObject
{
public:
    void Init(K_USHORT usInitVal_, K_USHORT usMaxVal_);

    void Post();
    void Pend();

    K_USHORT GetCount();

#if KERNEL_USE_TIMERS

    bool Pend( K_ULONG ulWaitTimeMS_);

    void Timeout(Thread *pclChosenOne_);

#endif

private:

    K_UCHAR WakeNext();

    K_BOOL ProcessQueue();

    void PostTransaction(Transaction *pclTRX_, K_BOOL *pbReschedule_);

    void PendTransaction(Transaction *pclTRX_, K_BOOL *pbReschedule_);

    void TimeoutTransaction(Transaction *pclTRX_, K_BOOL *pbReschedule_);

    K_USHORT m_usValue;
    K_USHORT m_usMaxValue;
};

#endif //KERNEL_USE_SEMAPHORE

#endif
```

17.101 /home/mo/mark3-source/embedded/stage/src/ll.cpp File Reference

Core Linked-List implementation, from which all kernel objects are derived.

```
#include "kerneltypes.h"
#include "kernel.h"
#include "ll.h"
#include "kernel_debug.h"
```

Macros

- #define **__FILE_ID__** LL_CPP

17.101.1 Detailed Description

Core Linked-List implementation, from which all kernel objects are derived.

Definition in file ll.cpp.

17.102 ll.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
```

```
#include "kernel.h"
#include "ll.h"
#include "kernel_debug.h"

//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     LL_CPP

//---------------------------------------------------------------------------
void LinkListNode::ClearNode()
{
    next = NULL;
    prev = NULL;
}

//---------------------------------------------------------------------------
void DoubleLinkList::Add(LinkListNode *node_)
{
    KERNEL_ASSERT( node_ );

    // Add a node to the end of the linked list.
    if (!m_pstHead)
    {
        // If the list is empty, initilize the nodes
        m_pstHead = node_;
        m_pstTail = node_;

        m_pstHead->prev = NULL;
        m_pstTail->next = NULL;
        return;
    }

    // Move the tail node, and assign it to the new node just passed in
    m_pstTail->next = node_;
    node_->prev = m_pstTail;
    node_->next = NULL;
    m_pstTail = node_;
}

//---------------------------------------------------------------------------
void DoubleLinkList::Remove(LinkListNode *node_)
{
    KERNEL_ASSERT( node_ );

    if (node_->prev)
    {
#if SAFE_UNLINK
        if (node_->prev->next != node_)
        {
            Kernel::Panic(PANIC_LIST_UNLINK_FAILED);
        }
#endif
        node_->prev->next = node_->next;
    }
    if (node_->next)
    {
#if SAFE_UNLINK
        if (node_->next->prev != node_)
        {
            Kernel::Panic(PANIC_LIST_UNLINK_FAILED);
        }
#endif
        node_->next->prev = node_->prev;
    }
    if (node_ == m_pstHead)
    {
        m_pstHead = node_->next;
    }
    if (node_ == m_pstTail)
    {
        m_pstTail = node_->prev;
    }

    node_->ClearNode();
}

//---------------------------------------------------------------------------
void CircularLinkList::Add(LinkListNode *node_)
{
    KERNEL_ASSERT( node_ );

    // Add a node to the end of the linked list.
    if (!m_pstHead)
    {
        // If the list is empty, initilize the nodes
        m_pstHead = node_;
        m_pstTail = node_;

        m_pstHead->prev = m_pstHead;
        m_pstHead->next = m_pstHead;
        return;
    }

    // Move the tail node, and assign it to the new node just passed in
    m_pstTail->next = node_;
    node_->prev = m_pstTail;
    node_->next = m_pstHead;
    m_pstTail = node_;
    m_pstHead->prev = node_;
}

//---------------------------------------------------------------------------
void CircularLinkList::Remove(LinkListNode *node_)
{
    KERNEL_ASSERT( node_ );

    // Check to see if this is the head of the list...
    if ((node_ == m_pstHead) && (m_pstHead == m_pstTail))
    {
        // Clear the head and tail pointers - nothing else left.
        m_pstHead = NULL;
        m_pstTail = NULL;
        return;
    }

#if SAFE_UNLINK
    // Verify that all nodes are properly connected
    if ((node_->prev->next != node_) || (node_->next->prev != node_))
    {
        Kernel::Panic(PANIC_LIST_UNLINK_FAILED);
    }
#endif

    // This is a circularly linked list - no need to check for connection,
    // just remove the node.
    node_->next->prev = node_->prev;
    node_->prev->next = node_->next;

    if (node_ == m_pstHead)
    {
        m_pstHead = m_pstHead->next;
    }
    if (node_ == m_pstTail)
    {
        m_pstTail = m_pstTail->prev;
    }
    node_->ClearNode();
}

//---------------------------------------------------------------------------
void CircularLinkList::PivotForward()
{
    if (m_pstHead)
    {
        m_pstHead = m_pstHead->next;
        m_pstTail = m_pstTail->next;
    }
}

//---------------------------------------------------------------------------
void CircularLinkList::PivotBackward()
{
    if (m_pstHead)
    {
        m_pstHead = m_pstHead->prev;
        m_pstTail = m_pstTail->prev;
    }
}
```

17.103 /home/mo/mark3-source/embedded/stage/src/ll.h File Reference

Core linked-list declarations, used by all kernel list types.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
```

Classes

- class LinkListNode

  Basic linked-list node data structure.
- class LinkList

  Abstract-data-type from which all other linked-lists are derived.
- class DoubleLinkList

  Doubly-linked-list data type, inherited from the base LinkList type.
- class CircularLinkList

  Circular-linked-list data type, inherited from the base LinkList type.

Macros

- #define **NULL** (0)

17.103.1 Detailed Description

Core linked-list declarations, used by all kernel list types. At the heart of RTOS data structures are linked lists. Having a robust and efficient set of linked-list types that we can use as a foundation for building the rest of our kernel types allows us to keep our RTOS code efficient and logically-separated.

So what data types rely on these linked-list classes?

-Threads -ThreadLists -The Scheduler -Timers, -The Timer Scheduler -Blocking objects (Semaphores, Mutexes, etc...)

Pretty much everything in the kernel uses these linked lists. By having objects inherit from the base linked-list node type, we're able to leverage the double and circular linked-list classes to manager virtually every object type in the system without duplicating code. These functions are very efficient as well, allowing for very deterministic behavior in our code.

Definition in file ll.h.

17.104 ll.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __LL_H__
#define __LL_H__

#include "kerneltypes.h"
#include "mark3cfg.h"

//---------------------------------------------------------------------------
#ifndef NULL
#define NULL        (0)
#endif

//---------------------------------------------------------------------------
class LinkList;
class DoubleLinkList;
class CircularLinkList;

//---------------------------------------------------------------------------
class LinkListNode
```

```
{
protected:

    LinkListNode *next;
    LinkListNode *prev;

    LinkListNode() { ClearNode(); }

    void ClearNode();

public:
    LinkListNode *GetNext(void) { return next; }

    LinkListNode *GetPrev(void) { return prev; }

    friend class LinkList;
    friend class DoubleLinkList;
    friend class CircularLinkList;
};

//---------------------------------------------------------------------------
class LinkList
{
protected:
    LinkListNode *m_pstHead;
    LinkListNode *m_pstTail;

public:
    void Init(){ m_pstHead = NULL; m_pstTail = NULL; }

    virtual void Add(LinkListNode *node_) = 0;

    virtual void Remove(LinkListNode *node_) = 0;

    LinkListNode *GetHead() { return m_pstHead; }

    LinkListNode *GetTail() { return m_pstTail; }
};

//---------------------------------------------------------------------------
class DoubleLinkList : public LinkList
{
public:
    DoubleLinkList() { m_pstHead = NULL; m_pstTail = NULL; }

    virtual void Add(LinkListNode *node_);

    virtual void Remove(LinkListNode *node_);
};

//---------------------------------------------------------------------------
class CircularLinkList : public LinkList
{
public:
    CircularLinkList() { m_pstHead = NULL; m_pstTail = NULL; }

    virtual void Add(LinkListNode *node_);

    virtual void Remove(LinkListNode *node_);

    void PivotForward();

    void PivotBackward();
};

#endif
```

17.105 /home/mo/mark3-source/embedded/stage/src/manual.h File Reference

Ascii-format documentation, used by doxygen to create various printable and viewable forms.

17.105.1 Detailed Description

Ascii-format documentation, used by doxygen to create various printable and viewable forms.

Definition in file manual.h.

17.106 manual.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/


```

17.107 /home/mo/mark3-source/embedded/stage/src/mark3cfg.h File Reference

Mark3 Kernel Configuration.

Macros

- #define KERNEL_USE_TIMERS (1)

  The following options is related to all kernel time-tracking.
- #define KERNEL_TIMERS_TICKLESS (1)

  If you've opted to use the kernel timers module, you have an option as to which timer implementation to use: Tick-based or Tick-less.
- #define KERNEL_USE_QUANTUM (1)

  Do you want to enable time quanta? This is useful when you want to have tasks in the same priority group share time in a controlled way.
- #define THREAD_QUANTUM_DEFAULT (4)

  This value defines the default thread quantum when KERNEL_USE_QUANTUM is enabled.
- #define KERNEL_USE_SEMAPHORE (1)

  Do you want the ability to use counting/binary semaphores for thread synchronization? Enabling this features provides fully-blocking semaphores and enables all API functions declared in semaphore.h.
- #define KERNEL_USE_MUTEX (1)

  Do you want the ability to use mutual exclusion semaphores (mutex) for resource/block protection? Enabling this feature provides mutexes, with priority inheritence, as declared in mutex.h.
- #define KERNEL_USE_EVENTFLAG (1)

  Provides additional event-flag based blocking.
- #define KERNEL_USE_MESSAGE (1)

  Enable inter-thread messaging using message queues.
- #define GLOBAL_MESSAGE_POOL_SIZE (8)

  If Messages are enabled, define the size of the default kernel message pool.
- #define KERNEL_USE_SLEEP (1)

  Do you want to be able to set threads to sleep for a specified time? This enables the Thread::Sleep() API.
- #define KERNEL_USE_DRIVER (1)

  Enabling device drivers provides a posix-like filesystem interface for peripheral device drivers.
- #define KERNEL_USE_THREADNAME (1)

  Provide Thread method to allow the user to set a name for each thread in the system.
- #define KERNEL_USE_DYNAMIC_THREADS (1)

  Provide extra Thread methods to allow the application to create (and more importantly destroy) threads at runtime.
- #define KERNEL_USE_PROFILER (1)

  Provides extra classes for profiling the performance of code.

- #define KERNEL_USE_DEBUG (0)

    Provides extra logic for kernel debugging, and instruments the kernel with extra asserts, and kernel trace functionality.
- #define KERNEL_USE_ATOMIC (1)

    Provides support for atomic operations, including addition, subtraction, set, and test-and-set.
- #define SAFE_UNLINK (1)

    "Safe unlinking" performs extra checks on data to make sure that there are no consistencies when performing operations on linked lists.
- #define TRANSACTION_QUEUE_SIZE (3)

    Defines the size of the kernel transaction queue.

17.107.1 Detailed Description

Mark3 Kernel Configuration. This file is used to configure the kernel for your specific application in order to provide the optimal set of features for a given use case.

Since you only pay the price (code space/RAM) for the features you use, you can usually find a sweet spot between features and resource usage by picking and choosing features a-la-carte. This config file is written in an "interactive" way, in order to minimize confusion about what each option provides, and to make dependencies obvious.

Definition in file mark3cfg.h.

17.107.2 Macro Definition Documentation

17.107.2.1 #define GLOBAL_MESSAGE_POOL_SIZE (8)

If Messages are enabled, define the size of the default kernel message pool.

Messages can be manually added to the message pool, but this mechansims is more convenient and automatic. All message queues share their message objects from this global pool to maximize efficiency and simplify data management.

Definition at line 127 of file mark3cfg.h.

17.107.2.2 #define KERNEL_TIMERS_TICKLESS (1)

If you've opted to use the kernel timers module, you have an option as to which timer implementation to use: Tick-based or Tick-less.

Tick-based timers provide a "traditional" RTOS timer implementation based on a fixed-frequency timer interrupt. While this provides very accurate, reliable timing, it also means that the CPU is being interrupted far more often than may be necessary (as not all timer ticks result in "real work" being done).

Tick-less timers still rely on a hardware timer interrupt, but uses a dynamic expiry interval to ensure that the interrupt is only called when the next timer expires. This increases the complexity of the timer interrupt handler, but reduces the number and frequency.

Note that the CPU port (kerneltimer.cpp) must be implemented for the particular timer variant desired.

Definition at line 62 of file mark3cfg.h.

17.107.2.3 #define KERNEL_USE_ATOMIC (1)

Provides support for atomic operations, including addition, subtraction, set, and test-and-set.

Add/Sub/Set contain 8, 16, and 32-bit variants.

Definition at line 177 of file mark3cfg.h.

17.107.2.4 #define KERNEL_USE_DYNAMIC_THREADS (1)

Provide extra Thread methods to allow the application to create (and more importantly destroy) threads at runtime.

Useful for designs implementing worker threads, or threads that can be restarted after encountering error conditions.

Definition at line 159 of file mark3cfg.h.

17.107.2.5 #define KERNEL_USE_EVENTFLAG (1)

Provides additional event-flag based blocking.

This relies on an additional per-thread flag-mask to be allocated, which adds 2 bytes to the size of each thread object.

Definition at line 106 of file mark3cfg.h.

17.107.2.6 #define KERNEL_USE_MESSAGE (1)

Enable inter-thread messaging using message queues.

This is the preferred mechanism for IPC for serious multi-threaded communications; generally anywhere a semaphore or event-flag is insufficient.

Definition at line 114 of file mark3cfg.h.

17.107.2.7 #define KERNEL_USE_PROFILER (1)

Provides extra classes for profiling the performance of code.

Useful for debugging and development, but uses an additional hardware timer.

Definition at line 165 of file mark3cfg.h.

17.107.2.8 #define KERNEL_USE_QUANTUM (1)

Do you want to enable time quanta? This is useful when you want to have tasks in the same priority group share time in a controlled way.

This allows equal tasks to use unequal amounts of the CPU, which is a great way to set up CPU budgets per thread in a round-robin scheduling system. If enabled, you can specify a number of ticks that serves as the default time period (quantum). Unless otherwise specified, every thread in a priority will get the default quantum.

Definition at line 75 of file mark3cfg.h.

17.107.2.9 #define KERNEL_USE_SEMAPHORE (1)

Do you want the ability to use counting/binary semaphores for thread synchronization? Enabling this features provides fully-blocking semaphores and enables all API functions declared in semaphore.h.

If you have to pick one blocking mechanism, this is the one to choose.

Definition at line 92 of file mark3cfg.h.

17.107.2.10 #define KERNEL_USE_THREADNAME (1)

Provide Thread method to allow the user to set a name for each thread in the system.

Adds a const K_CHAR∗ pointer to the size of the thread object.

Definition at line 151 of file mark3cfg.h.

17.107.2.11 #define KERNEL_USE_TIMERS (1)

The following options is related to all kernel time-tracking.

-timers provide a way for events to be periodically triggered in a lightweight manner. These can be periodic, or one-shot.

-Thread Quantum (used for round-robin scheduling) is dependent on this module, as is Thread Sleep functionality.

Definition at line 41 of file mark3cfg.h.

17.107.2.12 #define SAFE_UNLINK (1)

"Safe unlinking" performs extra checks on data to make sure that there are no consistencies when performing operations on linked lists.

This goes beyond pointer checks, adding a layer of structural and metadata validation to help detect system corruption early.

Definition at line 185 of file mark3cfg.h.

17.107.2.13 #define THREAD_QUANTUM_DEFAULT (4)

This value defines the default thread quantum when KERNEL_USE_QUANTUM is enabled.

The thread quantum value is in milliseconds

Definition at line 84 of file mark3cfg.h.

17.107.2.14 #define TRANSACTION_QUEUE_SIZE (3)

Defines the size of the kernel transaction queue.

This defines the maximum number of queued operations that can be simultaneously pending on all blocking objects at any given time. Given that only unblocking operations from an interrupt context can necessitate a value larger than 1, this value really doesn't need to be that large.

Definition at line 194 of file mark3cfg.h.

17.108 mark3cfg.h

```
00001 /*===========================================================================
00002      _____       _____       _____       _____
00003  ___|   _|__  __|_     |__  __|__    |__  __| __  |__  ______
00004 |    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
00005 |     \/   | ||     \    ||     \     ||     \     ||___   |
00006 |__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
00007     |_____|      |_____|      |_____|      |_____|
00008 
00009 --[Mark3 Realtime Platform]-------------------------------------------------
00010 
00011 Copyright (c) 2012 Funkenstein Software Consulting, all rights reserved.
00012 See license.txt for more information
00013 ===========================================================================*/
00029 #ifndef __MARK3CFG_H__
00030 #define __MARK3CFG_H__
00031 
00041 #define KERNEL_USE_TIMERS                (1)
00042 
00061 #if KERNEL_USE_TIMERS
00062     #define KERNEL_TIMERS_TICKLESS       (1)
00063 #endif
00064 
00074 #if KERNEL_USE_TIMERS
00075     #define KERNEL_USE_QUANTUM           (1)
00076 #else
00077     #define KERNEL_USE_QUANTUM           (0)
00078 #endif
```

```
#define THREAD_QUANTUM_DEFAULT           (4)

#define KERNEL_USE_SEMAPHORE             (1)

#define KERNEL_USE_MUTEX                 (1)

#define KERNEL_USE_EVENTFLAG             (1)

#if KERNEL_USE_SEMAPHORE
    #define KERNEL_USE_MESSAGE           (1)
#else
    #define KERNEL_USE_MESSAGE           (0)
#endif

#if KERNEL_USE_MESSAGE
    #define GLOBAL_MESSAGE_POOL_SIZE     (8)
#endif

#if KERNEL_USE_TIMERS && KERNEL_USE_SEMAPHORE
    #define KERNEL_USE_SLEEP             (1)
#else
    #define KERNEL_USE_SLEEP             (0)
#endif

#define KERNEL_USE_DRIVER                (1)

#define KERNEL_USE_THREADNAME            (1)

#define KERNEL_USE_DYNAMIC_THREADS       (1)

#define KERNEL_USE_PROFILER              (1)

#define KERNEL_USE_DEBUG                 (0)

#define KERNEL_USE_ATOMIC                (1)

#define SAFE_UNLINK                      (1)

#define TRANSACTION_QUEUE_SIZE           (3)

#endif
```

17.109 /home/mo/mark3-source/embedded/stage/src/memutil.cpp File Reference

Implementation of memory, string, and conversion routines.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"
#include "memutil.h"
```

17.109.1 Detailed Description

Implementation of memory, string, and conversion routines.

Definition in file memutil.cpp.

17.110 memutil.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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```

```
===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"
#include "memutil.h"

//---------------------------------------------------------------------------
void MemUtil::DecimalToHex( K_UCHAR ucData_, char *szText_ )
{
    K_UCHAR ucTmp = ucData_;
    K_UCHAR ucMax;

    KERNEL_ASSERT( szText_ );

    if (ucTmp >= 0x10)
    {
        ucMax = 2;
    }
    else
    {
        ucMax = 1;
    }

    ucTmp = ucData_;
    szText_[ucMax] = 0;
    while (ucMax--)
    {
        if ((ucTmp & 0x0F) <= 9)
        {
            szText_[ucMax] = '0' + (ucTmp & 0x0F);
        }
        else
        {
            szText_[ucMax] = 'A' + ((ucTmp & 0x0F) - 10);
        }
        ucTmp>>=4;
    }
}

//---------------------------------------------------------------------------
void MemUtil::DecimalToHex( K_USHORT usData_, char *szText_ )
{
    K_USHORT usTmp = usData_;
    K_USHORT usMax = 1;
    K_USHORT usCompare = 0x0010;

    KERNEL_ASSERT( szText_ );

    while (usData_ > usCompare && usMax < 4)
    {
        usMax++;
        usCompare <<= 4;
    }

    usTmp = usData_;
    szText_[usMax] = 0;
    while (usMax--)
    {
        if ((usTmp & 0x0F) <= 9)
        {
            szText_[usMax] = '0' + (usTmp & 0x0F);
        }
        else
        {
            szText_[usMax] = 'A' + ((usTmp & 0x0F) - 10);
        }
        usTmp>>=4;
    }
}

//---------------------------------------------------------------------------
void MemUtil::DecimalToHex( K_ULONG ulData_, char *szText_ )
{
    K_ULONG ulTmp = ulData_;
    K_ULONG ulMax = 1;
    K_ULONG ulCompare = 0x0010;

    KERNEL_ASSERT( szText_ );

    while (ulData_ > ulCompare && ulMax < 8)
    {
        ulMax++;
        ulCompare <<= 4;
    }

    ulTmp = ulData_;
    szText_[ulMax] = 0;
    while (ulMax--)
    {
        if ((ulTmp & 0x0F) <= 9)
        {
            szText_[ulMax] = '0' + (ulTmp & 0x0F);
        }
        else
        {
            szText_[ulMax] = 'A' + ((ulTmp & 0x0F) - 10);
        }
        ulTmp>>=4;
    }
}
//---------------------------------------------------------------------------
void MemUtil::DecimalToString( K_UCHAR ucData_, char *szText_ )
{
    K_UCHAR ucTmp = ucData_;
    K_UCHAR ucMax;

    KERNEL_ASSERT(szText_);

    // Find max index to print...
    if (ucData_ >= 100)
    {
        ucMax = 3;
    }
    else if (ucData_ >= 10)
    {
        ucMax = 2;
    }
    else
    {
        ucMax = 1;
    }

    szText_[ucMax] = 0;
    while (ucMax--)
    {
        szText_[ucMax] = '0' + (ucTmp % 10);
        ucTmp/=10;
    }
}

//---------------------------------------------------------------------------
void MemUtil::DecimalToString( K_USHORT usData_, char *szText_ )
{
    K_USHORT usTmp = usData_;
    K_USHORT usMax = 1;
    K_USHORT usCompare = 10;

    KERNEL_ASSERT(szText_);

    while (usData_ >= usCompare && usMax < 5)
    {
        usCompare *= 10;
        usMax++;
    }

    szText_[usMax] = 0;
    while (usMax--)
    {
        szText_[usMax] = '0' + (usTmp % 10);
        usTmp/=10;
    }
}

//---------------------------------------------------------------------------
void MemUtil::DecimalToString( K_ULONG ulData_, char *szText_ )
{
    K_ULONG ulTmp = ulData_;
    K_ULONG ulMax = 1;
    K_ULONG ulCompare = 10;

    KERNEL_ASSERT(szText_);

    while (ulData_ >= ulCompare && ulMax < 12)
    {
        ulCompare *= 10;
        ulMax++;
    }

    szText_[ulMax] = 0;
    while (ulMax--)
    {
        szText_[ulMax] = '0' + (ulTmp % 10);
        ulTmp/=10;
    }
```

```
}

//---------------------------------------------------------------------------
// Basic checksum routines
K_UCHAR  MemUtil::Checksum8( const void *pvSrc_, K_USHORT usLen_ )
{
    K_UCHAR ucRet = 0;
    K_UCHAR *pcData = (K_UCHAR*)pvSrc_;

    KERNEL_ASSERT(pvSrc_);

    // 8-bit CRC, computed byte at a time
    while (usLen_--)
    {
        ucRet += *pcData++;
    }
    return ucRet;
}

//---------------------------------------------------------------------------
K_USHORT MemUtil::Checksum16( const void *pvSrc_, K_USHORT usLen_ )
{
    K_USHORT usRet = 0;
    K_UCHAR *pcData = (K_UCHAR*)pvSrc_;

    KERNEL_ASSERT(pvSrc_);

    // 16-bit CRC, computed byte at a time
    while (usLen_--)
    {
        usRet += *pcData++;
    }
    return usRet;
}

//---------------------------------------------------------------------------
// Basic string routines
K_USHORT MemUtil::StringLength( const char *szStr_ )
{
    K_UCHAR *pcData = (K_UCHAR*)szStr_;
    K_USHORT usLen = 0;

    KERNEL_ASSERT(szStr_);

    while (*pcData++)
    {
        usLen++;
    }
    return usLen;
}

//---------------------------------------------------------------------------
bool   MemUtil::CompareStrings( const char *szStr1_, const char *szStr2_ )
{
    char *szTmp1 = (char*) szStr1_;
    char *szTmp2 = (char*) szStr2_;

    KERNEL_ASSERT(szStr1_);
    KERNEL_ASSERT(szStr2_);

    while (*szTmp1 && *szTmp2)
    {
        if (*szTmp1++ != *szTmp2++)
        {
            return false;
        }
    }

    // Both terminate at the same length
    if (!(*szTmp1) && !(*szTmp2))
    {
        return true;
    }

    return false;
}

//---------------------------------------------------------------------------
void MemUtil::CopyMemory( void *pvDst_, const void *pvSrc_, K_USHORT usLen_ )
{
    char *szDst = (char*) pvDst_;
    char *szSrc = (char*) pvSrc_;

    KERNEL_ASSERT(pvDst_);
    KERNEL_ASSERT(pvSrc_);

    // Run through the strings verifying that each character matches
    // and the lengths are the same.
    while (usLen_--)
    {
        *szDst++ = *szSrc++;
    }
}

//---------------------------------------------------------------------------
void MemUtil::CopyString( char *szDst_, const char *szSrc_ )
{
    char *szDst = (char*) szDst_;
    char *szSrc = (char*) szSrc_;

    KERNEL_ASSERT(szDst_);
    KERNEL_ASSERT(szSrc_);

    // Run through the strings verifying that each character matches
    // and the lengths are the same.
    while (*szSrc)
    {
        *szDst++ = *szSrc++;
    }
}

//---------------------------------------------------------------------------
K_SHORT MemUtil::StringSearch( const char *szBuffer_, const char *szPattern_ )
{
    char *szTmpPat = (char*)szPattern_;
    K_SHORT i16Idx = 0;
    K_SHORT i16Start;
    KERNEL_ASSERT( szBuffer_ );
    KERNEL_ASSERT( szPattern_ );

    // Run through the big buffer looking for a match of the pattern
    while (szBuffer_[i16Idx])
    {
        // Reload the pattern
        i16Start = i16Idx;
        szTmpPat = (char*)szPattern_;
        while (*szTmpPat && szBuffer_[i16Idx])
        {
            if (*szTmpPat != szBuffer_[i16Idx])
            {
                break;
            }
            szTmpPat++;
            i16Idx++;
        }
        // Made it to the end of the pattern, it's a match.
        if (*szTmpPat == '\0')
        {
            return i16Start;
        }
        i16Idx++;
    }

    return -1;
}

//---------------------------------------------------------------------------
bool MemUtil::CompareMemory( const void *pvMem1_, const void *pvMem2_, K_USHORT
usLen_ )
{
    char *szTmp1 = (char*) pvMem1_;
    char *szTmp2 = (char*) pvMem2_;

    KERNEL_ASSERT(pvMem1_);
    KERNEL_ASSERT(pvMem2_);

    // Run through the strings verifying that each character matches
    // and the lengths are the same.
    while (usLen_--)
    {
        if (*szTmp1++ != *szTmp2++)
        {
            return false;
        }
    }
    return true;
}

//---------------------------------------------------------------------------
void MemUtil::SetMemory( void *pvDst_, K_UCHAR ucVal_, K_USHORT usLen_ )
{
    char *szDst = (char*)pvDst_;

    KERNEL_ASSERT(pvDst_);

    while (usLen_--)
    {
        *szDst++ = ucVal_;
    }
}

//---------------------------------------------------------------------------
K_UCHAR MemUtil::Tokenize( const K_CHAR *szBuffer_, Token_t *pastTokens_, K_UCHAR
ucMaxTokens_)
{
    K_UCHAR ucCurrArg = 0;
    K_UCHAR ucLastArg = 0;
    K_UCHAR i = 0;

    K_UCHAR bEscape = false;

    KERNEL_ASSERT(szBuffer_);
    KERNEL_ASSERT(pastTokens_);

    while (szBuffer_[i])
    {
        //-- Handle unescaped quotes
        if (szBuffer_[i] == '\"')
        {
            if (bEscape)
            {
                bEscape = false;
            }
            else
            {
                bEscape = true;
            }
            i++;
            continue;
        }

        //-- Handle all escaped chars - by ignoring them
        if (szBuffer_[i] == '\\')
        {
            i++;
            if (szBuffer_[i])
            {
               i++;
            }
            continue;
        }

        //-- Process chars based on current escape characters
        if (bEscape)
        {
            // Everything within the quote is treated as literal, but escaped chars are still treated the
 same
            i++;
            continue;
        }

        //-- Non-escaped case
        if (szBuffer_[i] != ' ' )
        {
            i++;
            continue;
        }

        pastTokens_[ucCurrArg].pcToken = &(szBuffer_[ucLastArg]);
        pastTokens_[ucCurrArg].ucLen = i - ucLastArg;
        ucCurrArg++;
        if (ucCurrArg >= ucMaxTokens_)
        {
            return ucMaxTokens_;
        }

        i++;
        while (szBuffer_[i] && szBuffer_[i] == ' ')
        {
            i++;
        }

        ucLastArg = i;
    }
    if (i && !szBuffer_[i] && (i - ucLastArg))
    {
        pastTokens_[ucCurrArg].pcToken = &(szBuffer_[ucLastArg]);
        pastTokens_[ucCurrArg].ucLen = i - ucLastArg;
        ucCurrArg++;
    }
    return ucCurrArg;
```

```
}


```

17.111 /home/mo/mark3-source/embedded/stage/src/memutil.h File Reference

Utility class containing memory, string, and conversion routines.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"
```

Classes

- struct Token_t

    Token descriptor struct format.
- class MemUtil

    String and Memory manipulation class.

17.111.1 Detailed Description

Utility class containing memory, string, and conversion routines.

Definition in file memutil.h.

17.112 memutil.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __MEMUTIL_H__
#define __MEMUTIL_H__

#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel_debug.h"

//---------------------------------------------------------------------------
typedef struct
{
    const K_CHAR *pcToken;
    K_UCHAR ucLen;
} Token_t;

//---------------------------------------------------------------------------
class MemUtil
{

public:

    //-----------------------------------------------------------------------
    static void DecimalToHex( K_UCHAR ucData_, char *szText_ );
    static void DecimalToHex( K_USHORT usData_, char *szText_ );
    static void DecimalToHex( K_ULONG ulData_, char *szText_ );

    //-----------------------------------------------------------------------
    static void DecimalToString( K_UCHAR ucData_, char *szText_ );
    static void DecimalToString( K_USHORT usData_, char *szText_ );
    static void DecimalToString( K_ULONG ulData_, char *szText_ );

    //-----------------------------------------------------------------------
    static K_UCHAR  Checksum8( const void *pvSrc_, K_USHORT usLen_ );

    //-----------------------------------------------------------------------
    static K_USHORT Checksum16( const void *pvSrc_, K_USHORT usLen_ );

    //-----------------------------------------------------------------------
    static K_USHORT StringLength( const char *szStr_ );

    //-----------------------------------------------------------------------
    static bool CompareStrings( const char *szStr1_, const char *szStr2_ );

    //-----------------------------------------------------------------------
    static void CopyMemory( void *pvDst_, const void *pvSrc_, K_USHORT usLen_ );

    //-----------------------------------------------------------------------
    static void CopyString( char *szDst_, const char *szSrc_ );

    //-----------------------------------------------------------------------
    static K_SHORT StringSearch( const char *szBuffer_, const char *szPattern_ );

    //-----------------------------------------------------------------------
    static bool CompareMemory( const void *pvMem1_, const void *pvMem2_, K_USHORT usLen_ );

    //-----------------------------------------------------------------------
    static void SetMemory( void *pvDst_, K_UCHAR ucVal_, K_USHORT usLen_ );

    //-----------------------------------------------------------------------
    static K_UCHAR Tokenize( const char *szBuffer_, Token_t *pastTokens_, K_UCHAR
ucMaxTokens_);
};


#endif //__MEMUTIL_H__




```

17.113 /home/mo/mark3-source/embedded/stage/src/message.cpp File Reference

Inter-thread communications via message passing.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "message.h"
#include "threadport.h"
#include "kernel_debug.h"
#include "timerlist.h"
```

Macros

- #define **__FILE_ID__** MESSAGE_CPP

17.113.1 Detailed Description

Inter-thread communications via message passing.

Definition in file message.cpp.

17.114 message.cpp

```
/*===========================================================================
     _____         _____         _____         _____
```

```
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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=============================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "message.h"
#include "threadport.h"
#include "kernel_debug.h"

//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     MESSAGE_CPP


#if KERNEL_USE_MESSAGE

#if KERNEL_USE_TIMERS
    #include "timerlist.h"
#endif

Message GlobalMessagePool::m_aclMessagePool[8];
DoubleLinkList GlobalMessagePool::m_clList;

//---------------------------------------------------------------------------
void GlobalMessagePool::Init()
{
    K_UCHAR i;
    for (i = 0; i < GLOBAL_MESSAGE_POOL_SIZE; i++)
    {
        GlobalMessagePool::m_aclMessagePool[i].Init();
        GlobalMessagePool::m_clList.Add(&(GlobalMessagePool::m_aclMessagePool[i]));
    }
}

//---------------------------------------------------------------------------
void GlobalMessagePool::Push( Message *pclMessage_ )
{
    KERNEL_ASSERT( pclMessage_ );

    CS_ENTER();

    GlobalMessagePool::m_clList.Add(pclMessage_);

    CS_EXIT();
}

//---------------------------------------------------------------------------
Message *GlobalMessagePool::Pop()
{
    Message *pclRet;
    CS_ENTER();

    pclRet = static_cast<Message*>( GlobalMessagePool::m_clList.GetHead() );
    if (0 != pclRet)
    {
        GlobalMessagePool::m_clList.Remove( static_cast<LinkListNode*>( pclRet ) );
    }

    CS_EXIT();
    return pclRet;
}

//---------------------------------------------------------------------------
void MessageQueue::Init()
{
    m_clSemaphore.Init(0, GLOBAL_MESSAGE_POOL_SIZE);
}

//---------------------------------------------------------------------------
Message *MessageQueue::Receive()
{
    Message *pclRet;

    // Block the current thread on the counting semaphore
    m_clSemaphore.Pend();

    CS_ENTER();

    // Pop the head of the message queue and return it
    pclRet = static_cast<Message*>( m_clLinkList.GetHead() );
    m_clLinkList.Remove(static_cast<Message*>(pclRet));

    CS_EXIT();

    return pclRet;
}

#if KERNEL_USE_TIMERS
//---------------------------------------------------------------------------
Message *MessageQueue::Receive( K_ULONG ulTimeWaitMS_ )
{
    Message *pclRet;

    // Block the current thread on the counting semaphore
    if (!m_clSemaphore.Pend(ulTimeWaitMS_))
    {
        return NULL;
    }

    CS_ENTER();

    // Pop the head of the message queue and return it
    pclRet = static_cast<Message*>( m_clLinkList.GetHead() );
    m_clLinkList.Remove(static_cast<Message*>(pclRet));

    CS_EXIT();

    return pclRet;
}
#endif
//---------------------------------------------------------------------------
void MessageQueue::Send( Message *pclSrc_ )
{
    KERNEL_ASSERT( pclSrc_ );

    CS_ENTER();

    // Add the message to the head of the linked list
    m_clLinkList.Add( pclSrc_ );

    // Post the semaphore, waking the blocking thread for the queue.
    m_clSemaphore.Post();

    CS_EXIT();
}

//---------------------------------------------------------------------------
K_USHORT MessageQueue::GetCount()
{
    return m_clSemaphore.GetCount();
}
#endif //KERNEL_USE_MESSAGE
```

17.115 /home/mo/mark3-source/embedded/stage/src/message.h File Reference

Inter-thread communication via message-passing.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"
#include "ksemaphore.h"
#include "timerlist.h"
```

Classes

- class Message

  Class to provide message-based IPC services in the kernel.
- class GlobalMessagePool

  Implements a list of message objects shared between all threads.

- class MessageQueue

    List of messages, used as the channel for sending and receiving messages between threads.

17.115.1 Detailed Description

Inter-thread communication via message-passing. Embedded systems guru Jack Ganssle once said that without a robust form of interprocess communications (IPC), an RTOS is just a toy. Mark3 implements a form of IPC to provide safe and flexible messaging between threads.

Using kernel-managed IPC offers significant benefits over other forms of data sharing (i.e. Global variables) in that it avoids synchronization issues and race conditions common to the practice. Using IPC also enforces a more disciplined coding style that keeps threads decoupled from one another and minimizes global data preventing careless and hard-to-debug errors.

17.115.2 Using Messages, Queues, and the Global Message Pool

```
// Declare a message queue shared between two threads
MessageQueue my_queue;

int main()
{
    ...
    // Initialize the message queue
    my_queue.init();
    ...
}

void Thread1()
{
    // Example TX thread - sends a message every 10ms
    while(1)
    {
        // Grab a message from the global message pool
        Message *tx_message = GlobalMessagePool::Pop();

        // Set the message data/parameters
        tx_message->SetCode( 1234 );
        tx_message->SetData( NULL );

        // Send the message on the queue.
        my_queue.Send( tx_message );
        Thread::Sleep(10);
    }
}

void Thread2()
{
    while()
    {
        // Blocking receive - wait until we have messages to process
        Message *rx_message = my_queue.Recv();

        // Do something with the message data...

        // Return back into the pool when done
        GlobalMessagePool::Push(rx_message);
    }
}
```

Definition in file message.h.

17.116 message.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]--------------------------------------------------
```

```

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===========================================================================*/
#ifndef __MESSAGE_H__
#define __MESSAGE_H__

#include "kerneltypes.h"
#include "mark3cfg.h"

#include "ll.h"
#include "ksemaphore.h"

#if KERNEL_USE_MESSAGE

#if KERNEL_USE_TIMERS
    #include "timerlist.h"
#endif

//---------------------------------------------------------------------------
class Message : public LinkListNode
{
public:
    void Init() { m_pvData = NULL; m_usCode = 0; }

    void SetData( void *pvData_ ) { m_pvData = pvData_; }

    void *GetData() { return m_pvData; }

    void SetCode( K_USHORT usCode_ ) { m_usCode = usCode_; }

    K_USHORT GetCode() { return m_usCode; }
private:

    void *m_pvData;

    K_USHORT m_usCode;
};

//---------------------------------------------------------------------------
class GlobalMessagePool
{
public:
    static void Init();

    static void Push( Message *pclMessage_ );

    static Message *Pop();

private:
    static Message m_aclMessagePool[GLOBAL_MESSAGE_POOL_SIZE];

    static DoubleLinkList m_clList;
};

//---------------------------------------------------------------------------
class MessageQueue
{
public:
    void Init();

    Message *Receive();

#if KERNEL_USE_TIMERS

    Message *Receive( K_ULONG ulTimeWaitMS_ );
#endif

    void Send( Message *pclSrc_ );


    K_USHORT GetCount();
private:

    Semaphore m_clSemaphore;

    DoubleLinkList m_clLinkList;
};

#endif //KERNEL_USE_MESSAGE

#endif
```

17.117 /home/mo/mark3-source/embedded/stage/src/mutex.cpp File Reference

Mutual-exclusion object.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "kernel.h"
#include "blocking.h"
#include "mutex.h"
#include "kernel_debug.h"
#include "transaction.h"
```

Macros

- #define **__FILE_ID__** MUTEX_CPP
- #define **MUTEX_TRANSACTION_CLAIM** (0)
- #define **MUTEX_TRANSACTION_RELEASE** (1)
- #define **MUTEX_TRANSACTION_TIMEOUT** (2)

Functions

- void **TimedMutex_Calback** (Thread ∗pclOwner_, void ∗pvData_)

17.117.1 Detailed Description

Mutual-exclusion object.

Definition in file mutex.cpp.

17.118 mutex.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "kernel.h"
#include "blocking.h"
#include "mutex.h"
#include "kernel_debug.h"
#include "transaction.h"

//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     MUTEX_CPP


#if KERNEL_USE_MUTEX

//---------------------------------------------------------------------------
#define MUTEX_TRANSACTION_CLAIM     (0)
#define MUTEX_TRANSACTION_RELEASE   (1)
```

```
#define MUTEX_TRANSACTION_TIMEOUT   (2)

#if KERNEL_USE_TIMERS

//---------------------------------------------------------------------------
void TimedMutex_Calback(Thread *pclOwner_, void *pvData_)
{
    Mutex *pclMutex = static_cast<Mutex*>(pvData_);

    // Wake up the thread that was blocked on this semaphore.
    pclMutex->Timeout(pclOwner_);
}

//---------------------------------------------------------------------------
void Mutex::Timeout(Thread *pclOwner_)
{
    // Take a lock on the object - if the object is already locked, it means
    // that another context is currently operating within the locked context.
    // In that case, queue an event in the kernel transaction queue, and
    // return out immediately.  The operation will be executed on the
    // thread currently holding the lock.

    K_BOOL bSchedState;
    if (LockAndQueue( MUTEX_TRANSACTION_TIMEOUT, (void*)pclOwner_, &bSchedState))
    {
        return;
    }

    // Drain the FIFO - this will ensure that the operation above is executed,
    // as well as any other queued operations that occur as a reuslt of
    // processing through interrupts.
    if (ProcessQueue()) {
        Thread::Yield();
    }

    // Re-enable the scheduler to its previous state.
    Scheduler::SetScheduler(bSchedState);
}

#endif

//---------------------------------------------------------------------------
K_BOOL Mutex::ProcessQueue()
{
    Transaction *pclTRX;
    K_BOOL bReschedule = false;

    do
    {
        pclTRX = m_clKTQ.Dequeue();
        KERNEL_ASSERT(pclTRX);

        switch (pclTRX->GetCode())
        {
            case MUTEX_TRANSACTION_CLAIM:
                ClaimTransaction(pclTRX, &bReschedule);
                break;
            case MUTEX_TRANSACTION_RELEASE:
                ReleaseTransaction(pclTRX, &bReschedule);
                break;
#if KERNEL_USE_TIMERS
            case MUTEX_TRANSACTION_TIMEOUT:
                TimeoutTransaction(pclTRX, &bReschedule);
                break;
#endif
            default:
            break;
        }
        m_clKTQ.Finish(pclTRX);
    } while (UnLock() > 1);

    return bReschedule;
}
//---------------------------------------------------------------------------
void Mutex::ClaimTransaction(Transaction *pclTRX_, K_BOOL *pbReschedule_)
{
    Thread *pclThread = static_cast<Thread*>(pclTRX_->GetData());

    // Check to see if the mutex is claimed or not
    if (m_bReady != 0)
    {
        // Mutex isn't claimed, claim it.
        m_bReady = 0;
        m_ucRecurse = 0;
        m_ucMaxPri = pclThread->GetPriority();
        m_pclOwner = pclThread;
    }
    else
    {
        // If the mutex is already claimed, check to see if this is the owner thread,
        // since we allow the mutex to be claimed recursively.
        if (pclThread == m_pclOwner)
        {
            // Ensure that we haven't exceeded the maximum recursive-lock count
            KERNEL_ASSERT( (m_ucRecurse < 255) );
            m_ucRecurse++;
            return;
        }

        // The mutex is claimed already - we have to block now.  Move the
        // current thread to the list of threads waiting on the mutex.
#if KERNEL_USE_TIMERS
        K_ULONG ulWaitTimeMS = pclThread->GetTimer()->GetInterval();
        pclThread->SetExpired(false);
        if (ulWaitTimeMS)
        {
            pclThread->GetTimer()->Start(0, ulWaitTimeMS, (TimerCallback_t)TimedMutex_Calback,
 (void*)this);
        }
#endif

        Block(pclThread);

        // Check if priority inheritence is necessary.  We do this in order
        // to ensure that we don't end up with priority inversions in case
        // multiple threads are waiting on the same resource.

        // We can get away with doing this outside of a critical section, as all
        // transactions are serialized by the transaction queue, and the scheduler
        // is disabled.

        if(m_ucMaxPri <= pclThread->GetPriority())
        {
            m_ucMaxPri = pclThread->GetPriority();

            {
                Thread *pclTemp = static_cast<Thread*>(m_clBlockList.
GetHead());
                while(pclTemp)
                {
                    pclTemp->InheritPriority(m_ucMaxPri);
                    if(pclTemp == static_cast<Thread*>(m_clBlockList.
GetTail()) )
                    {
                        break;
                    }
                    pclTemp = static_cast<Thread*>(pclTemp->GetNext());
                }
                m_pclOwner->InheritPriority(m_ucMaxPri);
            }
        }

        *pbReschedule_ = true;
    }
}

//---------------------------------------------------------------------------
void Mutex::ReleaseTransaction(Transaction *pclTRX_, K_BOOL *
pbReschedule_)
{
    Thread *pclThread;

    // Disable the scheduler while we deal with internal data structures.
    pclThread = Scheduler::GetCurrentThread();

    // This thread had better be the one that owns the mutex currently...
    KERNEL_ASSERT((pclThread == m_pclOwner));

    // If the owner had claimed the lock multiple times, decrease the lock
    // count and return immediately.
    if (m_ucRecurse)
    {
        m_ucRecurse--;
        return;
    }

    // Restore the thread's original priority
    if (pclThread->GetCurPriority() != pclThread->GetPriority())
    {
        pclThread->SetPriority(pclThread->GetPriority());

        // In this case, we want to reschedule
        *pbReschedule_ = true;
    }

    // No threads are waiting on this semaphore?
    if (m_clBlockList.GetHead() == NULL)
    {
        // Re-initialize the mutex to its default values
        m_bReady = 1;
        m_ucMaxPri = 0;
        m_pclOwner = NULL;
    }
    else
    {
        // Wake the highest priority Thread pending on the mutex
        if(WakeNext())
        {
            // Switch threads if it’s higher or equal priority than the current thread
            *pbReschedule_ = true;
        }
    }
}

#if KERNEL_USE_TIMERS
//---------------------------------------------------------------------------
void Mutex::TimeoutTransaction(Transaction *pclTRX_, K_BOOL *
pbReschedule_)
{
    Thread *pclChosenOne = static_cast<Thread*>(pclTRX_->GetData());

    UnBlock(pclChosenOne);

    pclChosenOne->SetExpired(true);

    if (pclChosenOne->GetPriority() > Scheduler::GetCurrentThread()->
GetPriority())
    {
        *pbReschedule_ = true;
    }
}
#endif

//---------------------------------------------------------------------------
K_UCHAR Mutex::WakeNext()
{
    Thread *pclChosenOne = NULL;

    // Get the highest priority waiter thread
    pclChosenOne = m_clBlockList.HighestWaiter();

    // Unblock the thread
    UnBlock(pclChosenOne);

    // The chosen one now owns the mutex
    m_pclOwner = pclChosenOne;

    // Signal a context switch if it’s a greater than or equal to the current priority
    if (pclChosenOne->GetPriority() >= Scheduler::GetCurrentThread()
->GetPriority())
    {
        return 1;
    }
    return 0;
}

//---------------------------------------------------------------------------
void Mutex::Init()
{
    // Reset the data in the mutex
    m_bReady = 1;             // The mutex is free.
    m_ucMaxPri = 0;           // Set the maximum priority inheritence state
    m_pclOwner = NULL;        // Clear the mutex owner
    m_ucRecurse = 0;          // Reset recurse count
}

//---------------------------------------------------------------------------
#if KERNEL_USE_TIMERS
    void Mutex::Claim()
    {
        Claim(0);
    }
    bool Mutex::Claim(K_ULONG ulWaitTimeMS_)
#else
    void Mutex::Claim()
#endif
{
    KERNEL_TRACE_1( STR_MUTEX_CLAIM_1, (K_USHORT)Scheduler::GetCurrentThread()->
GetID() );

    // Claim the lock (we know only one thread can hold the lock, only one thread can
    // execute at a time, and only threads can call wait)
    K_BOOL bSchedState;
    if (LockAndQueue( MUTEX_TRANSACTION_CLAIM, (void*)
Scheduler::GetCurrentThread(), &bSchedState))
    {
        Kernel::Panic( PANIC_MUTEX_LOCK_VIOLATION );
    }

    // Set data on the current thread that needs to be passed into the transaction
    // handler (and can't be queued in the simple key-value pair in the transaciton
    // object)
#if KERNEL_USE_TIMERS
    Scheduler::GetCurrentThread()->GetTimer()->
SetIntervalTicks(ulWaitTimeMS_);
    Scheduler::GetCurrentThread()->SetExpired(false);
#endif

    if (ProcessQueue()) {
        Thread::Yield();
    }

    Scheduler::SetScheduler(bSchedState);

#if KERNEL_USE_TIMERS
    if (ulWaitTimeMS_)
    {
        Scheduler::GetCurrentThread()->GetTimer()->
Stop();
    }
    return (Scheduler::GetCurrentThread()->GetExpired() == false);
#endif
}

//---------------------------------------------------------------------------
void Mutex::Release()
{
    KERNEL_TRACE_1( STR_MUTEX_RELEASE_1, (K_USHORT)Scheduler::GetCurrentThread()
->GetID() );

    K_BOOL bSchedState;
    if (LockAndQueue( MUTEX_TRANSACTION_RELEASE, (void*)
Scheduler::GetCurrentThread(), &bSchedState))
    {
        return;
    }

    if (ProcessQueue()) {
        Thread::Yield();
    }

    Scheduler::SetScheduler(bSchedState);
}

#endif //KERNEL_USE_MUTEX
```

17.119 /home/mo/mark3-source/embedded/stage/src/mutex.h File Reference

Mutual exclusion class declaration.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "blocking.h"
#include "transaction.h"
#include "timerlist.h"
```

Classes

- class Mutex

  Mutual-exclusion locks, based on BlockingObject.

17.119.1 Detailed Description

Mutual exclusion class declaration. Resource locks are implemented using mutual exclusion semaphores (Mutex-_t). Protected blocks can be placed around any resource that may only be accessed by one thread at a time. If additional threads attempt to access the protected resource, they will be placed in a wait queue until the resource becomes available. When the resource becomes available, the thread with the highest original priority claims the resource and is activated. Priority inheritance is included in the implementation to prevent priority inversion. Always ensure that you claim and release your mutex objects consistently, otherwise you may end up with a deadlock scenario that's hard to debug.

17.119.2 Initializing

Initializing a mutex object by calling:

```
clMutex.Init();
```

17.119.3 Resource protection example

```
clMutex.Claim();
...
<resource protected block>
...
clMutex.Release();
```

Definition in file mutex.h.

17.120 mutex.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]--------------------------------------------------

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===========================================================================*/
#ifndef __MUTEX_H_
#define __MUTEX_H_

#include "kerneltypes.h"
#include "mark3cfg.h"

#include "blocking.h"
#include "transaction.h"

#if KERNEL_USE_MUTEX

#if KERNEL_USE_TIMERS
#include "timerlist.h"
#endif

//---------------------------------------------------------------------------
class Mutex : public BlockingObject
{
public:
    void Init();

    void Claim();

#if KERNEL_USE_TIMERS

    bool Claim(K_ULONG ulWaitTimeMS_);

    void Timeout( Thread *pclOwner_ );

#endif

    void Release();

private:

    K_UCHAR WakeNext();

    K_BOOL ProcessQueue();

    void ClaimTransaction(Transaction *pclTRX_, K_BOOL *pbReschedule_);

    void ReleaseTransaction(Transaction *pclTRX_, K_BOOL *pbReschedule_);

#if KERNEL_USE_TIMERS

    void TimeoutTransaction(Transaction *pclTRX_, K_BOOL *pbReschedule_);
#endif

    K_UCHAR m_ucRecurse;
    K_UCHAR m_bReady;
    K_UCHAR m_ucMaxPri;
    Thread *m_pclOwner;

};

#endif //KERNEL_USE_MUTEX

#endif //__MUTEX_H_

```

17.121 /home/mo/mark3-source/embedded/stage/src/nlfs.cpp File Reference

Nice Little Filesystem (NLFS) implementation for Mark3.

```
#include "kerneltypes.h"
#include "nlfs.h"
#include "nlfs_file.h"
#include "memutil.h"
#include "nlfs_config.h"
```

17.121.1 Detailed Description

Nice Little Filesystem (NLFS) implementation for Mark3.

Definition in file nlfs.cpp.

17.122 nlfs.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \    ||     |    ||  |/ /    ||___   |
|     \/   | ||     \   ||     \    ||     \    ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||______|
    |_____|      |_____|     |_____|     |_____|

--[Mark3 Realtime Platform]--------------------------------------------------

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===========================================================================*/
#include "kerneltypes.h"
#include "nlfs.h"
#include "nlfs_file.h"
#include "memutil.h"
#include "nlfs_config.h"

//---------------------------------------------------------------------------
K_CHAR NLFS::Find_Last_Slash( const char *szPath_ )
{
    K_UCHAR ucLastSlash = 0;
    K_UCHAR i = 0;
    while (szPath_[i])
    {
        if (szPath_[i] == '/')
        {
            ucLastSlash = i;
        }
        i++;
    }
    return ucLastSlash;
}

//---------------------------------------------------------------------------
K_BOOL NLFS::File_Names_Match( const K_CHAR *szPath_, NLFS_Node_t *pstNode_)
{
    K_UCHAR ucLastSlash = Find_Last_Slash( szPath_ );
    K_UCHAR i;

    ucLastSlash++;
    for (i = 0; i < FILE_NAME_LENGTH; i++)
    {
        if (!szPath_[ucLastSlash+i] || !pstNode_->stFileNode.acFileName[i])
        {
            break;
        }
        if (szPath_[ucLastSlash+i] != pstNode_->stFileNode.acFileName[i])
        {
            return false;
        }
    }

    if (szPath_[ucLastSlash+i] != pstNode_->stFileNode.acFileName[i])
    {
        return false;
    }
    return true;
}

//---------------------------------------------------------------------------
void NLFS::Print_File_Details( K_USHORT usNode_ )
{
    NLFS_Node_t stFileNode;
    Read_Node(usNode_, &stFileNode);

    DEBUG_PRINT(" Name       : %16s\n" , stFileNode.stFileNode.acFileName);
    DEBUG_PRINT(" Next Peer  : %d\n"   , stFileNode.stFileNode.usNextPeer);
    DEBUG_PRINT(" Prev Peer  : %d\n"   , stFileNode.stFileNode.usPrevPeer);
    DEBUG_PRINT(" User|Group : %d|%d\n", stFileNode.stFileNode.ucUser,
                                         stFileNode.stFileNode.ucGroup);

    DEBUG_PRINT(" Permissions: %04X\n" , stFileNode.stFileNode.usPerms);
    DEBUG_PRINT(" Parent     : %d\n"   , stFileNode.stFileNode.usParent);
    DEBUG_PRINT(" First Child: %d\n"   , stFileNode.stFileNode.usChild);
    DEBUG_PRINT(" Alloc Size : %d\n"   , stFileNode.stFileNode.ulAllocSize);
    DEBUG_PRINT(" File  Size : %d\n"   , stFileNode.stFileNode.ulFileSize);

    DEBUG_PRINT(" First Block: %d\n"   , stFileNode.stFileNode.ulFirstBlock);
    DEBUG_PRINT(" Last Block : %d\n"   , stFileNode.stFileNode.ulLastBlock);
}

//---------------------------------------------------------------------------
void NLFS::Print_Dir_Details( K_USHORT usNode_ )
{
    NLFS_Node_t stFileNode;
    Read_Node(usNode_, &stFileNode);

    DEBUG_PRINT(" Name       : %16s\n" , stFileNode.stFileNode.acFileName);
    DEBUG_PRINT(" Next Peer  : %d\n"   , stFileNode.stFileNode.usNextPeer);
    DEBUG_PRINT(" Prev Peer  : %d\n"   , stFileNode.stFileNode.usPrevPeer);
    DEBUG_PRINT(" User|Group : %d|%d\n", stFileNode.stFileNode.ucUser,
                                   stFileNode.stFileNode.ucGroup);
    DEBUG_PRINT(" Permissions: %04X\n"  , stFileNode.stFileNode.usPerms);
    DEBUG_PRINT(" Parent     : %d\n"   , stFileNode.stFileNode.usParent);
    DEBUG_PRINT(" First Child: %d\n"   , stFileNode.stFileNode.usChild);
}

//---------------------------------------------------------------------------
void NLFS::Print_Free_Details( K_USHORT usNode_ )
{
    NLFS_Node_t stFileNode;
    Read_Node(usNode_, &stFileNode);

    DEBUG_PRINT(" Next Free  : %d\n"    , stFileNode.stFileNode.usNextPeer );
}

//---------------------------------------------------------------------------
void NLFS::Print_Node_Details( K_USHORT usNode_ )
{
    NLFS_Node_t stTempNode;
    Read_Node(usNode_, &stTempNode);

    DEBUG_PRINT("\nNode: %d\n"
           " Node Type: ", usNode_);
    switch (stTempNode.eBlockType)
    {
        case NLFS_NODE_FREE:
            DEBUG_PRINT( "Free\n" );
            Print_Free_Details(usNode_);
            break;
        case NLFS_NODE_ROOT:
            DEBUG_PRINT( "Root Block\n" );
            break;
        case NLFS_NODE_FILE:
            DEBUG_PRINT( "File\n" );
            Print_File_Details(usNode_);
            break;
        case NLFS_NODE_DIR:
            DEBUG_PRINT( "Directory\n" );
            Print_Dir_Details(usNode_);
            break;
        default:
            break;
    }
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Pop_Free_Node(void)
{
    K_USHORT usRetVal = m_stLocalRoot.usNextFreeNode;
    NLFS_Node_t stFileNode;

    if (INVALID_NODE == usRetVal)
    {
        return 0;
    }

    // Update Claimed node
    Read_Node(usRetVal, &stFileNode);
    m_stLocalRoot.usNextFreeNode = stFileNode.stFileNode.usNextPeer;
    stFileNode.stFileNode.usNextPeer = INVALID_NODE;
    DEBUG_PRINT("Node %d allocated, next free %d\n", usRetVal, m_stLocalRoot.usNextFreeNode);
    Write_Node(usRetVal, &stFileNode);

    //Update root node
    Read_Node(FS_CONFIG_BLOCK , &stFileNode);
    stFileNode.stRootNode.usNextFreeNode = m_stLocalRoot.usNextFreeNode;
    stFileNode.stRootNode.usNumFilesFree--;
    Write_Node(FS_CONFIG_BLOCK, &stFileNode);

    return usRetVal;
}

//---------------------------------------------------------------------------
void NLFS::Push_Free_Node(K_USHORT usNode_)
{
    NLFS_Node_t stFileNode;

    Read_Node(usNode_, &stFileNode);
    stFileNode.stFileNode.usNextPeer = m_stLocalRoot.usNextFreeNode;
    m_stLocalRoot.usNextFreeNode = usNode_;

    Write_Node(usNode_, &stFileNode);

    DEBUG_PRINT("Node %d freed\n", usNode_);

    //Update root node
    Read_Node(FS_CONFIG_BLOCK , &stFileNode);
    stFileNode.stRootNode.usNextFreeNode = m_stLocalRoot.usNextFreeNode;
    stFileNode.stRootNode.usNumFilesFree++;
    Write_Node(FS_CONFIG_BLOCK , &stFileNode);
}

//---------------------------------------------------------------------------
K_ULONG NLFS::Pop_Free_Block(void)
{
    K_ULONG ulRetVal = m_stLocalRoot.ulNextFreeBlock;
    NLFS_Block_t stFileBlock;
    NLFS_Node_t  stFileNode;

    if ((INVALID_BLOCK == ulRetVal) || (0 == m_stLocalRoot.ulNumBlocksFree))
    {
        DEBUG_PRINT("Out of data blocks\n");
        return 0;
    }

    Read_Block_Header(ulRetVal, &stFileBlock);

    m_stLocalRoot.ulNextFreeBlock = stFileBlock.ulNextBlock;
    m_stLocalRoot.ulNumBlocksFree--;
    stFileBlock.ulNextBlock = INVALID_BLOCK;

    Write_Block_Header(ulRetVal, &stFileBlock);

    Read_Node(FS_CONFIG_BLOCK , &stFileNode);

    stFileNode.stRootNode.ulNextFreeBlock = m_stLocalRoot.ulNextFreeBlock;
    stFileNode.stRootNode.ulNumBlocksFree--;

    Write_Node(FS_CONFIG_BLOCK , &stFileNode);

    DEBUG_PRINT("Allocated block %d, next free %d\n", ulRetVal, m_stLocalRoot.ulNextFreeBlock);
    return ulRetVal;
}

//---------------------------------------------------------------------------
void NLFS::Push_Free_Block(K_ULONG ulBlock_ )
{
    NLFS_Block_t stFileBlock;
    NLFS_Node_t  stFileNode;

    Read_Block_Header(ulBlock_, &stFileBlock);

    stFileBlock.ulNextBlock = m_stLocalRoot.ulNextFreeBlock;
    m_stLocalRoot.ulNextFreeBlock = ulBlock_;

    Write_Block_Header(ulBlock_, &stFileBlock);

    Read_Node(FS_CONFIG_BLOCK , &stFileNode);
    stFileNode.stRootNode.ulNextFreeBlock = m_stLocalRoot.ulNextFreeBlock;
    stFileNode.stRootNode.ulNumBlocksFree++;
    Write_Node(FS_CONFIG_BLOCK , &stFileNode);

    DEBUG_PRINT("Block %d freed\n", ulBlock_);
}

//---------------------------------------------------------------------------
K_ULONG NLFS::Append_Block_To_Node(NLFS_Node_t *pstFile_ )
{
    K_ULONG ulBlock;
    NLFS_Block_t stFileBlock;

    // Allocate a new block
    ulBlock = Pop_Free_Block();
    if (ulBlock == INVALID_BLOCK)
    {
        return -1;
    }

    // Initialize the block
    DEBUG_PRINT("reading block header\n");
    Read_Block_Header(ulBlock, &stFileBlock);
    stFileBlock.ulNextBlock = INVALID_BLOCK;
    stFileBlock.uAllocated  = 1;

    DEBUG_PRINT("writing block header\n");
    Write_Block_Header(ulBlock, &stFileBlock);

    // Update the previous last-block links (if there is one)
    DEBUG_PRINT("updating previous block %d\n", pstFile_->stFileNode.ulLastBlock);
    if (pstFile_->stFileNode.ulLastBlock != INVALID_BLOCK)
    {
        Read_Block_Header(pstFile_->stFileNode.ulLastBlock, &stFileBlock);
        stFileBlock.ulNextBlock = ulBlock;
        Write_Block_Header(pstFile_->stFileNode.ulLastBlock, &stFileBlock);
    }
    else
    {
        DEBUG_PRINT("  previous block is invalid, setting as first\n");
        pstFile_->stFileNode.ulFirstBlock = ulBlock;
    }

    pstFile_->stFileNode.ulLastBlock = ulBlock;
    pstFile_->stFileNode.ulAllocSize += m_stLocalRoot.ulBlockSize;

    RootSync();

    return ulBlock;
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Find_Parent_Dir(const K_CHAR *szPath_)
{
    int i, j;
    K_UCHAR ucLastSlash = 0;
    K_USHORT usRetVal;
    K_CHAR szTempName[FILE_NAME_LENGTH];
    NLFS_Node_t stFileNode;
    K_USHORT usTempPeer;

    Read_Node(FS_ROOT_BLOCK, &stFileNode );

    usRetVal = FS_ROOT_BLOCK;

    if (szPath_[0] != '/')
    {
        DEBUG_PRINT("Only fully-qualified paths are supported.  Bailing\n");
        return -1;
    }

    // Starting from the root fs_block (which is the mount point...)
    ucLastSlash = Find_Last_Slash(szPath_);

    // a) Search for each "/" if we've got more than one...
    if (0 == ucLastSlash)
    {
        return usRetVal;
    }

    usTempPeer = stFileNode.stFileNode.usChild;
    Read_Node(usTempPeer, &stFileNode );

    i = 1;
    while (szPath_[i] && i < ucLastSlash)
    {
        NLFS_Node_t stTempNode;
        K_BOOL bMatch = false;

        j = 0;
        MemUtil::SetMemory(szTempName, 0, FILE_NAME_LENGTH);

        while (szPath_[i] && (szPath_[i] != '/') && j < FILE_NAME_LENGTH)
        {
            szTempName[j] = szPath_[i];
            i++;
            j++;
        }
        DEBUG_PRINT("Checking %s\n", szTempName );
        if (j == FILE_NAME_LENGTH && szPath_[i] != '/')
        {
            DEBUG_PRINT("Directory name too long, invalid\n");
            return -1;
        }
        else if (szPath_[i] != '/')
        {
            i++;
            continue;
        }

        // Check to see if there's a valid peer with this name...
        while (INVALID_NODE != usTempPeer)
        {
            Read_Node(usTempPeer, &stTempNode);
            if (NLFS_NODE_DIR == stTempNode.eBlockType)
            {
                if (true == MemUtil::CompareStrings(stTempNode.
stFileNode.acFileName, szTempName))
                {
                    bMatch = true;
                    break;
                }
            }
            usTempPeer = stTempNode.stFileNode.usNextPeer;
        }

        // Matched the folder name descend into the folder
        if (bMatch)
        {
            DEBUG_PRINT("Matched folder: %s, node %d\n", szTempName, usTempPeer);

            usRetVal = usTempPeer;

            usTempPeer = stTempNode.stFileNode.usChild;
            if (INVALID_NODE != usTempPeer)
            {
                DEBUG_PRINT("Entering subdirectory %d\n", usTempPeer);
                Read_Node(usTempPeer, &stFileNode);
            }
            else
            {
                break;
            }
        }
        // Failed to match the folder name, bail
        else
        {
            DEBUG_PRINT("Could not match folder name, bailing\n");
            usRetVal = -1;
            break;
        }

        if (i >= ucLastSlash)
        {
            break;
        }
        i++;
    }

    if (i == ucLastSlash)
    {
        // No more folders to traverse - we're successful.
        DEBUG_PRINT("Found root path for %s\n with node %d\n", szPath_, usRetVal);
        return usRetVal;
    }
    return INVALID_NODE;
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Find_File(const K_CHAR *szPath_)
{
    NLFS_Node_t stTempNode;
    NLFS_Node_t stTempDir;

    K_USHORT usTempNode;

    K_USHORT usParentDir = Find_Parent_Dir(szPath_);

    if (INVALID_NODE == usParentDir)
    {
        DEBUG_PRINT("invalid root dir\n");
        return INVALID_NODE;
    }

    Read_Node(usParentDir, &stTempDir);

    if (INVALID_NODE == stTempDir.stFileNode.usChild)
    {
        return INVALID_NODE;
    }

    usTempNode = stTempDir.stFileNode.usChild;

    // See if there are matching child nodes
    while (INVALID_NODE != usTempNode)
    {
        Read_Node(usTempNode, &stTempNode);

        if (true == File_Names_Match(szPath_,&stTempNode ))
        {
            DEBUG_PRINT("matched file: %16s, node %d\n",
                   stTempNode.stFileNode.acFileName, usTempNode);
            return usTempNode;
        }

        usTempNode = stTempNode.stFileNode.usNextPeer;
    }
    DEBUG_PRINT("couldn't match file: %s\n", szPath_);
    return INVALID_NODE;
}

//---------------------------------------------------------------------------
void NLFS::Print(void)
{
    K_USHORT i;
    for (i = 0; i < m_stLocalRoot.usNumFiles; i++)
    {
        Print_Node_Details(i);
    }
}

//---------------------------------------------------------------------------
void NLFS::Set_Node_Name( NLFS_Node_t *pstFileNode_, const char *szPath_ )
{
    K_UCHAR i,j;
    K_UCHAR ucLastSlash = 0;

    // Search for the last "/", that's where we stop looking.
    i = 0;
    while (szPath_[i])
    {
        if (szPath_[i] == '/')
        {
            ucLastSlash = i;
        }
        i++;
    }

    // Parse out filename
    i = ucLastSlash + 1;
    j = 0;
    while (szPath_[i] && j < FILE_NAME_LENGTH)
    {
        pstFileNode_->stFileNode.acFileName[j] = szPath_[i];
        j++;
        i++;
    }
    if (!szPath_[i]) // if no extension, we're done.
    {
        return;
    }
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Create_File_i(const K_CHAR *szPath_,
NLFS_Type_t eType_ )
{
    K_USHORT usNode;
    K_USHORT usRootNodes;

    NLFS_Node_t stFileNode;
    NLFS_Node_t stParentNode;
    NLFS_Node_t stPeerNode;

    // Tricky part - directory traversal
    usRootNodes = Find_Parent_Dir(szPath_);

    if (INVALID_NODE == usRootNodes)
    {
        DEBUG_PRINT("Unable to find path - bailing\n");
        return INVALID_NODE;
    }

    usNode = Pop_Free_Node();
    if (!usNode)
    {
        DEBUG_PRINT("Unable to allocate node.  Failing\n");
        return INVALID_NODE;
    }
    DEBUG_PRINT("New file using node %d\n", usNode);

    // File node allocated, do something with it...
    // Set the file’s name and extension

    Read_Node(usNode, &stFileNode);

    // Set the file path
    Set_Node_Name(&stFileNode, szPath_);

    // Set block as in-use as a file
    stFileNode.eBlockType = eType_;

    // Zero-out the file
    stFileNode.stFileNode.ulFileSize = 0;

    // Set the default user and group, as well as perms
    stFileNode.stFileNode.ucUser   = 0;
    stFileNode.stFileNode.ucGroup  = 0;
    stFileNode.stFileNode.usPerms  = PERM_U_ALL | PERM_G_ALL | PERM_O_ALL;

    stFileNode.stFileNode.usChild  = INVALID_NODE;
    stFileNode.stFileNode.usParent = usRootNodes;

    // Update the parent node.
    Read_Node(usRootNodes, &stParentNode);

    DEBUG_PRINT( "Parent’s root child: %d\n", stParentNode.stFileNode.
usChild );
    // Insert node at the beginning of the peer list
    if (INVALID_NODE != stParentNode.stFileNode.usChild)
    {
        stFileNode.stFileNode.usNextPeer = stParentNode.
stFileNode.usChild;
        stFileNode.stFileNode.usPrevPeer = INVALID_NODE;

        // Update the peer node.
        Read_Node(stFileNode.stFileNode.usNextPeer , &stPeerNode);

        stPeerNode.stFileNode.usPrevPeer = usNode;
        stParentNode.stFileNode.usChild = usNode;

        DEBUG_PRINT("updating peer’s prev: %d\n", stPeerNode.stFileNode.
usPrevPeer);
        Write_Node(stFileNode.stFileNode.usNextPeer, &stPeerNode);
    }
    else
    {
        stParentNode.stFileNode.usChild = usNode;
        stFileNode.stFileNode.usNextPeer = INVALID_NODE;
        stFileNode.stFileNode.usPrevPeer = INVALID_NODE;
    }

    Write_Node(usNode, &stFileNode);
    Write_Node(usRootNodes, &stParentNode);

    RootSync();

    return usNode;
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Create_File( const K_CHAR *szPath_ )
{

    if (INVALID_NODE != Find_File(szPath_))
    {
        DEBUG_PRINT("Create_File: File already exists\n");
        return INVALID_NODE;
    }

    return Create_File_i( szPath_, NLFS_NODE_FILE );
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Create_Dir( const K_CHAR *szPath_ )
{
    if (INVALID_NODE != Find_File(szPath_))
    {
        DEBUG_PRINT("Create_Dir: Dir already exists!\n");
        return INVALID_NODE;
    }

    return Create_File_i(szPath_, NLFS_NODE_DIR );
}

//---------------------------------------------------------------------------
void NLFS::Cleanup_Node_Links(K_USHORT usNode_,
NLFS_Node_t *pstNode_)
{
    DEBUG_PRINT("Cleanup_Node_Links: Entering\n");

    if (INVALID_NODE != pstNode_->stFileNode.usParent)
    {
        NLFS_Node_t stParent;
        DEBUG_PRINT("Cleanup_Node_Links: Parent Node: %d\n", pstNode_->stFileNode.usParent);
        Read_Node(pstNode_->stFileNode.usParent, &stParent);

        DEBUG_PRINT("0\n");
        if (stParent.stFileNode.usChild == usNode_)
        {
            DEBUG_PRINT("1\n");
            stParent.stFileNode.usChild = pstNode_->stFileNode.usNextPeer;
            Write_Node(pstNode_->stFileNode.usParent, &stParent);
            DEBUG_PRINT("2\n");
        }
    }

    DEBUG_PRINT("a\n");
    if ( (INVALID_NODE != pstNode_->stFileNode.usNextPeer) ||
         (INVALID_NODE != pstNode_->stFileNode.usPrevPeer) )
    {
        NLFS_Node_t stNextPeer;
        NLFS_Node_t stPrevPeer;

        DEBUG_PRINT("b\n");
        if (INVALID_NODE != pstNode_->stFileNode.usNextPeer)
        {
            DEBUG_PRINT("c\n");
            Read_Node(pstNode_->stFileNode.usNextPeer, &stNextPeer);
            DEBUG_PRINT("d\n");
        }

        if (INVALID_NODE != pstNode_->stFileNode.usPrevPeer)
        {
            DEBUG_PRINT("e\n");
            Read_Node(pstNode_->stFileNode.usPrevPeer, &stPrevPeer);
            DEBUG_PRINT("f\n");
        }

        if (INVALID_NODE != pstNode_->stFileNode.usNextPeer)
        {
            DEBUG_PRINT("g\n");
            stNextPeer.stFileNode.usPrevPeer = pstNode_->stFileNode.usPrevPeer;
            Write_Node(pstNode_->stFileNode.usNextPeer, &stNextPeer);
            DEBUG_PRINT("h\n");
        }

        if (INVALID_NODE != pstNode_->stFileNode.usPrevPeer)
        {
            DEBUG_PRINT("i\n");
            stPrevPeer.stFileNode.usNextPeer = pstNode_->stFileNode.usNextPeer;
            Write_Node(pstNode_->stFileNode.usPrevPeer, &stPrevPeer);
            DEBUG_PRINT("j\n");
        }
    }
    pstNode_->stFileNode.usParent = INVALID_NODE;
    pstNode_->stFileNode.usPrevPeer = INVALID_NODE;
    pstNode_->stFileNode.usNextPeer = INVALID_NODE;
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Delete_Folder(const K_CHAR *szPath_)
{
    K_USHORT usNode = Find_File(szPath_);
    NLFS_Node_t stNode;

    if (INVALID_NODE == usNode)
    {
        DEBUG_PRINT("Delete_Folder: File not found!\n");
        return INVALID_NODE;
    }
    if (FS_ROOT_BLOCK == usNode || FS_CONFIG_BLOCK == usNode)
    {
        DEBUG_PRINT("Delete_Folder: Cannot delete root!\n");
        return INVALID_NODE;
    }

    Read_Node(usNode, &stNode);

    if (NLFS_NODE_FILE == stNode.eBlockType)
    {
        DEBUG_PRINT("Delete_Folder: Path is not a Folder (is it a file?)");
        return INVALID_NODE;
    }

    if (INVALID_NODE != stNode.stFileNode.usChild)
    {
        DEBUG_PRINT("Delete_Folder: Folder is not empty!");
        return INVALID_NODE;
    }

    Cleanup_Node_Links(usNode, &stNode);

    stNode.eBlockType = NLFS_NODE_FREE;

    Write_Node(usNode, &stNode);
    Push_Free_Node(usNode);

    RootSync();

    return usNode;
}

//---------------------------------------------------------------------------
K_USHORT NLFS::Delete_File( const K_CHAR *szPath_)
{
    K_USHORT usNode = Find_File(szPath_);
    K_ULONG ulCurr;
    K_ULONG ulPrev;
    NLFS_Node_t stNode;
    NLFS_Block_t stBlock;

    if (INVALID_NODE == usNode)
    {
        DEBUG_PRINT("Delete_File: File not found!\n");
        return INVALID_NODE;
    }
    if (FS_ROOT_BLOCK == usNode || FS_CONFIG_BLOCK == usNode)
    {
        DEBUG_PRINT("Delete_File: Cannot delete root!\n");
        return INVALID_NODE;
    }

    Read_Node(usNode, &stNode);

    if (NLFS_NODE_DIR == stNode.eBlockType)
    {
        DEBUG_PRINT("Delete_File: Path is not a file (is it a directory?)");
        return INVALID_NODE;
    }

    Cleanup_Node_Links(usNode, &stNode);
    ulCurr = stNode.stFileNode.ulFirstBlock;

    while (INVALID_BLOCK != ulCurr)
    {
        Read_Block_Header(ulCurr, &stBlock);

        ulPrev = ulCurr;
        ulCurr = stBlock.ulNextBlock;

        Push_Free_Block(ulPrev);
    }

    stNode.eBlockType = NLFS_NODE_FREE;

    Write_Node(usNode, &stNode);
    Push_Free_Node(usNode);

    RootSync();

    return usNode;
}

//---------------------------------------------------------------------------
void NLFS::Format(NLFS_Host_t *puHost_, K_ULONG ulTotalSize_, K_USHORT usNumFiles_,
K_USHORT usDataBlockSize_)
{
    K_ULONG i;
    K_ULONG ulNumBlocks;

    NLFS_Node_t  stFileNode;
    NLFS_Block_t stFileBlock;

    // Compute number of data blocks (based on FS Size and the number of file blocks)
    ulTotalSize_ -= ((K_ULONG)usNumFiles_) * sizeof(stFileNode);
    ulNumBlocks = ulTotalSize_ / ((((K_ULONG)usDataBlockSize_) + (sizeof(stFileBlock) - 1) + 3 ) & ~3);

    DEBUG_PRINT("Number of blocks %d\n", ulNumBlocks);
    // Set up the local_pointer -> this is used for the low-level, platform-specific
    // bits, allowing the FS to be used on RAM buffers, EEPROM's, networks, etc.
    m_puHost = puHost_;

    // Set the local copies of the data block byte-offset, as well as the data-block size
    m_stLocalRoot.usNumFiles        = usNumFiles_;
    m_stLocalRoot.usNumFilesFree    = m_stLocalRoot.usNumFiles - 2;
    m_stLocalRoot.usNextFreeNode    = 2;

    m_stLocalRoot.ulNumBlocks       = ulNumBlocks;
    m_stLocalRoot.ulNumBlocksFree   = ulNumBlocks;
    m_stLocalRoot.ulNextFreeBlock   = 0;

    m_stLocalRoot.ulBlockSize       = ((((K_ULONG)usDataBlockSize_) + 3 ) & ~3 );
    m_stLocalRoot.ulBlockOffset     = (((K_ULONG)usNumFiles_) * sizeof(NLFS_Node_t));
    m_stLocalRoot.ulDataOffset      = m_stLocalRoot.ulBlockOffset
                                        + (((K_ULONG)ulNumBlocks) * sizeof(NLFS_Block_t));

    // Create root data block node
    MemUtil::CopyMemory(&(stFileNode.stRootNode), &m_stLocalRoot, sizeof(m_stLocalRoot));
    stFileNode.eBlockType = NLFS_NODE_ROOT;

    DEBUG_PRINT("Writing root node\n");
    Write_Node(0, &stFileNode);
    DEBUG_PRINT("Done\n");

    // Create root mount point (directory)
    MemUtil::SetMemory(&stFileNode, 0, sizeof(stFileNode));
    stFileNode.eBlockType = NLFS_NODE_DIR;

    stFileNode.stFileNode.acFileName[0] = '/';

    stFileNode.stFileNode.usNextPeer   = INVALID_NODE;
    stFileNode.stFileNode.usPrevPeer   = INVALID_NODE;
    stFileNode.stFileNode.ucGroup      = 0;
    stFileNode.stFileNode.ucUser       = 0;
    stFileNode.stFileNode.usPerms      = PERM_U_ALL | PERM_G_ALL | PERM_O_ALL;

    stFileNode.stFileNode.usParent     = INVALID_NODE;
    stFileNode.stFileNode.usChild      = INVALID_NODE;

    stFileNode.stFileNode.ulAllocSize  = 0;
    stFileNode.stFileNode.ulFileSize   = 0;

    stFileNode.stFileNode.ulFirstBlock = INVALID_BLOCK;
    stFileNode.stFileNode.ulLastBlock  = INVALID_BLOCK;

    DEBUG_PRINT("Writing mount point\n");
    Write_Node(1, &stFileNode);
    DEBUG_PRINT("Done\n");

    stFileNode.stFileNode.acFileName[0] = 0;
    // Format nodes
    for (i = 2; i < usNumFiles_; i++)
    {
        stFileNode.eBlockType = NLFS_NODE_FREE;
        if (i != usNumFiles_ - 1)
        {
            stFileNode.stFileNode.usNextPeer = (K_USHORT)(i + 1);
        }
        else
        {
            stFileNode.stFileNode.usNextPeer = INVALID_NODE;
        }

        Write_Node(i, &stFileNode);
    }
    DEBUG_PRINT("File nodes formatted\n");

    // Format file blocks
    MemUtil::SetMemory(&stFileBlock, 0, sizeof(stFileBlock));

    DEBUG_PRINT("Writing file blocks\n");
    for (i = 0; i < ulNumBlocks; i++)
    {
        if (i == ulNumBlocks - 1)
        {
            stFileBlock.ulNextBlock = INVALID_BLOCK;
        }
        else
        {
            stFileBlock.ulNextBlock = i + 1;
        }

        Write_Block_Header(i, &stFileBlock);
    }
}

//---------------------------------------------------------------------------
void NLFS::Mount(NLFS_Host_t *puHost_)
{
    NLFS_Node_t stRootNode;

    m_puHost = puHost_;
    DEBUG_PRINT("Remounting FS %X - reading config node\n", puHost_);

    // Reload the root block into the local cache
    Read_Node(FS_CONFIG_BLOCK, &stRootNode);

    DEBUG_PRINT("Copying config node\n");
    MemUtil::CopyMemory(&m_stLocalRoot, &(stRootNode.
stRootNode), sizeof(m_stLocalRoot));

    DEBUG_PRINT("Block Size", m_stLocalRoot.ulBlockSize );
    DEBUG_PRINT("Data Offset", m_stLocalRoot.ulDataOffset );
    DEBUG_PRINT("Block Offset", m_stLocalRoot.ulBlockOffset );
}

//---------------------------------------------------------------------------
void NLFS::RootSync()
{
    NLFS_Node_t stRootNode;

    MemUtil::CopyMemory(&(stRootNode.stRootNode), &
m_stLocalRoot, sizeof(m_stLocalRoot));
    stRootNode.eBlockType = NLFS_NODE_ROOT;
    Write_Node(FS_CONFIG_BLOCK, &stRootNode);
}


//---------------------------------------------------------------------------
K_USHORT NLFS::GetFirstChild( K_USHORT usNode_ )
{
    NLFS_Node_t stTemp;
    if (!usNode_ || INVALID_NODE == usNode_)
    {
        return INVALID_NODE;
    }
    Read_Node(usNode_, &stTemp);

    if (stTemp.eBlockType != NLFS_NODE_DIR)
    {
        return INVALID_NODE;
    }

    return stTemp.stFileNode.usChild;
}

//---------------------------------------------------------------------------
K_USHORT NLFS::GetNextPeer( K_USHORT usNode_ )
{
    NLFS_Node_t stTemp;
    if (!usNode_ || INVALID_NODE == usNode_)
    {
        return INVALID_NODE;
    }
    Read_Node(usNode_, &stTemp);
    return stTemp.stFileNode.usNextPeer;
}

//---------------------------------------------------------------------------
K_BOOL NLFS::GetStat( K_USHORT usNode_, NLFS_File_Stat_t *pstStat_)
{
    NLFS_Node_t stTemp;
    if (!usNode_ || INVALID_NODE == usNode_)
    {
        return false;
    }
    Read_Node(usNode_, &stTemp);
    pstStat_->ulAllocSize = stTemp.stFileNode.ulAllocSize;
    pstStat_->ulFileSize = stTemp.stFileNode.ulFileSize;
    pstStat_->ucGroup = stTemp.stFileNode.ucGroup;
    pstStat_->ucUser = stTemp.stFileNode.ucUser;
    pstStat_->usPerms = stTemp.stFileNode.usPerms;
    MemUtil::CopyMemory(pstStat_->acFileName, stTemp.
stFileNode.acFileName, 16);
    return true;
}
```

```
00936
```

17.123 /home/mo/mark3-source/embedded/stage/src/nlfs.h File Reference

Nice Little Filesystem (NLFS) - a simple, embeddable filesystem.

```
#include "kerneltypes.h"
#include <stdint.h>
```

Classes

- struct NLFS_File_Node_t

  Data structure for the "file" FS-node type.
- struct NLFS_Root_Node_t

  Data structure for the Root-configuration FS-node type.
- struct NLFS_Node_t

  Filesystem node data structure.
- struct NLFS_Block_t

  Block data structure.
- union NLFS_Host_t

  Union used for managing host-specific pointers/data-types.
- struct NLFS_File_Stat_t

  Structure used to report the status of a given file.
- class NLFS

  Nice Little File System class.

Macros

- #define PERM_UX (0x0001)

  Permission bit definitions.
- #define **PERM_UW** (0x0002)
- #define **PERM_UR** (0x0004)
- #define **PERM_U_ALL** (PERM_UX | PERM_UW | PERM_UR)
- #define **PERM_GX** (0x0008)
- #define **PERM_GW** (0x0010)
- #define **PERM_GR** (0x0020)
- #define **PERM_G_ALL** (PERM_GX | PERM_GW | PERM_GR)
- #define **PERM_OX** (0x0040)
- #define **PERM_OW** (0x0080)
- #define **PERM_OR** (0x0100)
- #define **PERM_O_ALL** (PERM_OX | PERM_OW | PERM_OR)
- #define **INVALID_BLOCK** (0xFFFFFFFF)
- #define **INVALID_NODE** (0xFFFF)
- #define **FILE_NAME_LENGTH** (16)
- #define **FS_CONFIG_BLOCK** (0)
- #define **FS_ROOT_BLOCK** (1)

Enumerations

- enum NLFS_Type_t {
  NLFS_NODE_FREE, NLFS_NODE_ROOT, NLFS_NODE_FILE, NLFS_NODE_DIR,
  FILE_BLOCK_COUNTS }

  Enumeration describing the various types of filesystem nodes used by NLFS.

17.123.1 Detailed Description

Nice Little Filesystem (NLFS) - a simple, embeddable filesystem. Introduction to the Nice-Little-Filesystem (NLFS)

NLFS is yet-another filesystem intended for use in embedded applications.

It is intended to be portable, lightweight, and flexible in terms of supporting different types of physical storage media. In order to ensure that it's easily embeddable, there are no external library dependencies, aside from library code provided elsewhere in Mark3 (namely the MemUtil utility class). Balancing code-size with features and functionality is also a tradeoff - NLFS supports basic operations (create file, create directory, read, write, seek, and delete), without a lot of other bells and whistles. One other feature built into the filesystem is posix-style user-group permissions. While the APIs in the NLFS classes do not enforce permissions explicitly, application-specific implementations of NLFS can enforce permissions based on facilities based on the security mechanisms built into the host OS.

The original purpose of this filesystem was to provide a flexible way of packaging files for read-only use within Mark3 (such as scripts and compiled DCPU-16 objects). However, there are all sorts of purposes for this type of filesystem - essentially, any application where a built-in file manifest or resource container format.

NLFS is a block-based filesystem, composed of three separate regions of data structures within a linearly-addressed blob of storage. These regions are represented on the physical storage in the following order:

[File Nodes][Data Block Headers][Block Data]

The individual regions are as follows:

1) File Nodes

This region is composed of a linear array of equally-sized file-node (NLFS_Node_t) structures, starting at byte offset 0 in the underlying media.

Each node defines a particular file or directory within the filesystem. Because of the linear layout of the filesystem, the file nodes are all pre-allocated during the time of filesystem creation. As a result, care should be taken to ensure enough file nodes are allocated to meet the needs of your application, without wasting space in the filesystem for nodes that will never be needed.

The first two nodes (node 0 and node 1) are special in the NLFS implementation.

Node 0 is also known as the root filesystem node. This block contains a different internal data strucure from other file nodes, and stores the configuration information for the particular filesystem, such as the number of file nodes, file blocks, block sizes, as well as indexes of the first free file and block nodes in the filesystem. With this information, it is possible to re-mount a filesystem created once in another location.

Node 1 is the mount-point for the filesystem, and is the root directory under which all other files and directories are found. By default Node 1 is simply named "/".

2) Block Headers

The block header region of the system comes after the file node region, and consists of a linear array of block node data structures. All storage in a filesystem not allocated towards file nodes is automatically allocated towards data blocks, and for each data block allocated, there is a block node data structure allocated within the block node region.

The NLFS_Block_t data structure contains a link to the next node in a block chain. If the block is free, the link points to the index of the next free block in the filesystem. If allocated, the link points to the index of the next block in the file. This structure also contains flags which indicate whether or not a block is free or allocated, and other flags used for filesystem continuity checks.

3) Block Data

The block data region is the last linear range in the filesystem, and consists of equally-sized blocks in the filesystem. Each block consists of a region of raw physical storage, without any additional metadata.

The contents of any files read or written to the filesystem is stored within the blocks in this region.

The NLFS Class has a number of virtual methods, which require that a user provides an implementaiton appropriate for the underlying physical storage medium from within a class inheriting NLFS.s

An example implemention for a RAM-based filesystem is provided in the NLFS_RAM class located within nlfs_ram.-cpp.

Definition in file nlfs.h.

17.123.2 Enumeration Type Documentation

17.123.2.1 enum **NLFS_Type_t**

Enumeration describing the various types of filesystem nodes used by NLFS.

A fileysstem node is a fixed-sized data structure consisting of a type specifier, and a union of the data structures representing each possible block type.

Enumerator

NLFS_NODE_FREE	File node is free.
NLFS_NODE_ROOT	Root filesystem descriptor.
NLFS_NODE_FILE	File node.
NLFS_NODE_DIR	Directory node.

Definition at line 152 of file nlfs.h.

17.124 nlfs.h

```
/*===========================================================================
     _____       _____       _____       _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __NLFS_H__
#define __NLFS_H__

#include "kerneltypes.h"
#include <stdint.h>

class NLFS_File;

//---------------------------------------------------------------------------
#define PERM_UX      (0x0001)
#define PERM_UW      (0x0002)
#define PERM_UR      (0x0004)
#define PERM_U_ALL   ( PERM_UX | PERM_UW | PERM_UR )

#define PERM_GX      (0x0008)
#define PERM_GW      (0x0010)
#define PERM_GR      (0x0020)
#define PERM_G_ALL   ( PERM_GX | PERM_GW | PERM_GR )

#define PERM_OX      (0x0040)
#define PERM_OW      (0x0080)
#define PERM_OR      (0x0100)
#define PERM_O_ALL   ( PERM_OX | PERM_OW | PERM_OR )

//---------------------------------------------------------------------------
```

```
#define INVALID_BLOCK   (0xFFFFFFFF)
#define INVALID_NODE    (0xFFFF)

//---------------------------------------------------------------------------
#define FILE_NAME_LENGTH    (16)

#define FS_CONFIG_BLOCK     (0)
#define FS_ROOT_BLOCK       (1)

//---------------------------------------------------------------------------
typedef enum
{
    NLFS_NODE_FREE,
    NLFS_NODE_ROOT,
    NLFS_NODE_FILE,
    NLFS_NODE_DIR,
// --
    FILE_BLOCK_COUNTS
} NLFS_Type_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_CHAR      acFileName[16];

    K_USHORT    usNextPeer;
    K_USHORT    usPrevPeer;

    K_UCHAR     ucGroup;
    K_UCHAR     ucUser;
    K_USHORT    usPerms;

    K_USHORT    usParent;
    K_USHORT    usChild;

//-- File-specific
    K_ULONG     ulAllocSize;
    K_ULONG     ulFileSize;

    K_ULONG     ulFirstBlock;
    K_ULONG     ulLastBlock;
} NLFS_File_Node_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_USHORT    usNumFiles;
    K_USHORT    usNumFilesFree;
    K_USHORT    usNextFreeNode;

    K_ULONG     ulNumBlocks;
    K_ULONG     ulNumBlocksFree;
    K_ULONG     ulNextFreeBlock;

    K_ULONG     ulBlockSize;
    K_ULONG     ulBlockOffset;
    K_ULONG     ulDataOffset;
} NLFS_Root_Node_t;

//---------------------------------------------------------------------------
typedef struct
{
    NLFS_Type_t     eBlockType;

    union   // Depending on the block type, we use one of the following
    {
        NLFS_Root_Node_t        stRootNode;
        NLFS_File_Node_t        stFileNode;
    };
} NLFS_Node_t;

//---------------------------------------------------------------------------
typedef struct
{
    K_ULONG     ulNextBlock;
    union
    {
        K_UCHAR     ucFlags;
        struct
        {
            unsigned int    uAllocated;
            unsigned int    uCheckBit;
        };
    };
} NLFS_Block_t;


```

```
//---------------------------------------------------------------------------
typedef union
{
    void *pvData;
    uint32_t u32Data;
    uint64_t u64Data;
    K_ADDR kaData;
} NLFS_Host_t;


//----------------------------------------------------------------------------
typedef struct
{
    K_ULONG   ulAllocSize;
    K_ULONG   ulFileSize;
    K_USHORT  usPerms;
    K_UCHAR   ucUser;
    K_UCHAR   ucGroup;
    K_CHAR    acFileName[16];
} NLFS_File_Stat_t;

//---------------------------------------------------------------------------
class NLFS
{
friend class NLFS_File;
public:

    void Format(NLFS_Host_t *puHost_, K_ULONG ulTotalSize_, K_USHORT usNumFiles_, K_USHORT
 usDataBlockSize_);

    void Mount(NLFS_Host_t *puHost_);

    K_USHORT Create_File(const K_CHAR *szPath_);

    K_USHORT Create_Dir(const K_CHAR *szPath_);

    K_USHORT Delete_File(const K_CHAR *szPath_);

    K_USHORT Delete_Folder(const K_CHAR *szPath_);

    void Cleanup_Node_Links(K_USHORT usNode_, NLFS_Node_t *pstNode_);

    K_USHORT Find_Parent_Dir(const K_CHAR *szPath_);

    K_USHORT Find_File(const K_CHAR *szPath_);

    void Print(void);

    K_ULONG GetBlockSize(void) { return m_stLocalRoot.
ulBlockSize; }

    K_ULONG GetNumBlocks(void) { return m_stLocalRoot.
ulNumBlocks; }

    K_ULONG GetNumBlocksFree(void) { return m_stLocalRoot.
ulNumBlocksFree; }

    K_ULONG GetNumFiles(void)  { return m_stLocalRoot.
usNumFiles; }

    K_USHORT GetNumFilesFree(void) { return m_stLocalRoot.
usNumFilesFree; }


    K_USHORT GetFirstChild( K_USHORT usNode_ );

    K_USHORT GetNextPeer( K_USHORT usNode_ );

    K_BOOL GetStat( K_USHORT usNode_, NLFS_File_Stat_t *pstStat_);

protected:

    K_CHAR Find_Last_Slash(const K_CHAR *szPath_);

    K_BOOL File_Names_Match(const K_CHAR *szPath_, NLFS_Node_t *pstNode_);

    virtual void Read_Node(K_USHORT usNode_, NLFS_Node_t *pstNode_) = 0;

    virtual void Write_Node(K_USHORT usNode_, NLFS_Node_t *pstNode_) = 0;

    virtual void Read_Block_Header(K_ULONG ulBlock_,
NLFS_Block_t *pstBlock_) = 0;

    virtual void Write_Block_Header(K_ULONG ulBlock_,
NLFS_Block_t *pstFileBlock_) = 0;

    virtual void Read_Block(K_ULONG ulBlock_, K_ULONG ulOffset_, void *pvData_, K_ULONG ulLen_) =
    0;

    virtual void Write_Block(K_ULONG ulBlock_, K_ULONG ulOffset_, void *pvData_, K_ULONG ulLen_)
    = 0;

    void RootSync();

    void Repair() {}

    void Print_Free_Details( K_USHORT usNode_);


    void Print_File_Details(K_USHORT usNode_);

    void Print_Dir_Details(K_USHORT usNode_);

    void Print_Node_Details(K_USHORT usNode_);

    void Push_Free_Node(K_USHORT usNode_);

    K_USHORT Pop_Free_Node(void);

    void Push_Free_Block(K_ULONG ulBlock_);

    K_ULONG Pop_Free_Block(void);

    K_ULONG Append_Block_To_Node(NLFS_Node_t *pstFile_);

    K_USHORT Create_File_i(const K_CHAR *szPath_, NLFS_Type_t eType_);

    void Set_Node_Name( NLFS_Node_t *pstFileNode_, const K_CHAR *szPath_ );

    NLFS_Host_t *m_puHost;
    NLFS_Root_Node_t m_stLocalRoot;
};

#endif
```

17.125 /home/mo/mark3-source/embedded/stage/src/nlfs_config.h File Reference

NLFS configuration parameters.

Macros

- #define **DEBUG** 0
- #define **DEBUG_PRINT**(...)

17.125.1 Detailed Description

NLFS configuration parameters.

Definition in file nlfs_config.h.

17.126 nlfs_config.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __NLFS_CONFIG_H
#define __NLFS_CONFIG_H

```

```
#define DEBUG       0

#if DEBUG
 #include <stdio.h>
 #include <stdlib.h>
 #define DEBUG_PRINT     printf
#else
 #define DEBUG_PRINT(...)
#endif


#endif // NLFS_CONFIG_H
```

17.127 /home/mo/mark3-source/embedded/stage/src/nlfs_file.cpp File Reference

Nice Little Filesystem - File Access Class.

```
#include "kerneltypes.h"
#include "memutil.h"
#include "nlfs_file.h"
#include "nlfs.h"
#include "nlfs_config.h"
```

17.127.1 Detailed Description

Nice Little Filesystem - File Access Class.

Definition in file nlfs_file.cpp.

17.128 nlfs_file.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "memutil.h"
#include "nlfs_file.h"
#include "nlfs.h"
#include "nlfs_config.h"

//----------------------------------------------------------------------------
int NLFS_File::Open(NLFS *pclFS_, const K_CHAR *szPath_, NLFS_File_Mode_t eMode_)
{
    K_USHORT usNode;
    usNode = pclFS_->Find_File(szPath_);

    if (INVALID_NODE == usNode)
    {
        DEBUG_PRINT("file does not exist in path\n");
        if (eMode_ & NLFS_FILE_CREATE)
        {
            DEBUG_PRINT("Attempt to create\n");
            usNode = pclFS_->Create_File(szPath_);
            if (INVALID_NODE == usNode)
            {
                DEBUG_PRINT("unable to create node in path\n");
                return -1;
            }
        }
        else
        {
            return -1;
        }
    }

    DEBUG_PRINT("Current Node: %d\n", usNode);

    m_pclFileSystem = pclFS_;
    m_pclFileSystem->Read_Node(usNode, &m_stNode);

    m_usFile = usNode;

    if (eMode_ & NLFS_FILE_APPEND)
    {
        if (!(eMode_ & NLFS_FILE_WRITE))
        {
            DEBUG_PRINT("Open file for append in read-only mode?  Why!\n");
            return -1;
        }
        if (-1 == Seek(m_stNode.stFileNode.ulFileSize))
        {
            DEBUG_PRINT("file open failed - error seeking to EOF for append\n");
            return -1;
        }

    }
    else if (eMode_ & NLFS_FILE_TRUNCATE)
    {
        if (!(eMode_ & NLFS_FILE_WRITE))
        {
            DEBUG_PRINT("Truncate file in read-only mode?  Why!\n");
            return -1;
        }

        K_ULONG ulCurr = m_stNode.stFileNode.ulFirstBlock;
        K_ULONG ulPrev = ulCurr;

        // Go through and clear all blocks allocated to the file
        while (INVALID_BLOCK != ulCurr)
        {
            NLFS_Block_t stBlock;
            pclFS_->Read_Block_Header(ulCurr, &stBlock);

            ulPrev = ulCurr;
            ulCurr = stBlock.ulNextBlock;

            pclFS_->Push_Free_Block(ulPrev);
        }

        m_ulOffset = 0;
        m_ulCurrentBlock = m_stNode.stFileNode.ulFirstBlock;
    }
    else
    {
        // Open file to beginning of file, regardless of mode.
        m_ulOffset = 0;
        m_ulCurrentBlock = m_stNode.stFileNode.ulFirstBlock;
    }

    m_ucFlags = eMode_;

    DEBUG_PRINT("Current Block: %d\n", m_ulCurrentBlock);
    DEBUG_PRINT("file open OK\n");
    return 0;
}

//---------------------------------------------------------------------------
int NLFS_File::Seek(K_ULONG ulOffset_)
{
    NLFS_Block_t stBlock;
    m_ulCurrentBlock = m_stNode.stFileNode.ulFirstBlock;
    m_ulOffset = ulOffset_;

    if (INVALID_NODE == m_usFile)
    {
        DEBUG_PRINT("Error - invalid file");
        return -1;
    }

    if (INVALID_BLOCK == m_ulCurrentBlock)
    {
        DEBUG_PRINT("Invalid block\n");
        m_ulOffset = 0;
        return -1;
    }

    m_pclFileSystem->Read_Block_Header(
m_ulCurrentBlock, &stBlock);

    while (ulOffset_ >= m_pclFileSystem->GetBlockSize())
    {
        ulOffset_ -= m_pclFileSystem->GetBlockSize();
        m_ulCurrentBlock = stBlock.ulNextBlock;
        if ((ulOffset_) && (INVALID_BLOCK == m_ulCurrentBlock))
        {
            m_ulCurrentBlock = m_stNode.stFileNode.
ulFirstBlock;
            m_ulOffset = 0;
            return -1;
        }
        m_pclFileSystem->Read_Block_Header(
m_ulCurrentBlock, &stBlock);
    }

    m_ulOffset = ulOffset_;
    return 0;
}

//---------------------------------------------------------------------------
int NLFS_File::Read(void *pvBuf_, K_ULONG ulLen_)
{
    K_ULONG ulBytesLeft;
    K_ULONG ulOffset;
    K_ULONG ulRead = 0;
    K_BOOL bBail = false;

    K_CHAR *szCharBuf = (K_CHAR*)pvBuf_;

    if (INVALID_NODE == m_usFile)
    {
        DEBUG_PRINT("Error - invalid file");
        return -1;
    }

    if (!(NLFS_FILE_READ & m_ucFlags))
    {
        DEBUG_PRINT("Error - file not open for read\n");
        return -1;
    }

    DEBUG_PRINT("Reading: %d bytes from file\n", ulLen_);
    while (ulLen_ && !bBail)
    {
        ulOffset = m_ulOffset & (m_pclFileSystem->
GetBlockSize() - 1);
        ulBytesLeft = m_pclFileSystem->GetBlockSize() - ulOffset;
        if (ulBytesLeft > ulLen_)
        {
            ulBytesLeft = ulLen_;
        }
        if (m_ulOffset + ulBytesLeft >= m_stNode.stFileNode.
ulFileSize)
        {
            ulBytesLeft = m_stNode.stFileNode.ulFileSize -
m_ulOffset;
            bBail = true;
        }

        DEBUG_PRINT( "%d bytes left in block, %d len, %x block\n", ulBytesLeft, ulLen_,
m_ulCurrentBlock);
        if (ulBytesLeft && ulLen_ && (INVALID_BLOCK != m_ulCurrentBlock))
        {
            m_pclFileSystem->Read_Block(
m_ulCurrentBlock, ulOffset, (void*)szCharBuf, ulBytesLeft );

            ulRead += ulBytesLeft;
            ulLen_ -= ulBytesLeft;
            szCharBuf += ulBytesLeft;
            m_ulOffset += ulBytesLeft;
            DEBUG_PRINT( "%d bytes to go\n", ulLen_);
        }
        if (ulLen_)
        {
            DEBUG_PRINT("reading next node\n");
            NLFS_Block_t stBlock;
            m_pclFileSystem->Read_Block_Header(
m_ulCurrentBlock, &stBlock);
            m_ulCurrentBlock = stBlock.ulNextBlock;
        }

        if (INVALID_BLOCK == m_ulCurrentBlock)
        {
            break;
        }

    }
    DEBUG_PRINT("Return :%d bytes read\n", ulRead);
    return ulRead;
}

//---------------------------------------------------------------------------
int NLFS_File::Write(void *pvBuf_, K_ULONG ulLen_)
{
    K_ULONG ulBytesLeft;
    K_ULONG ulOffset;
    K_ULONG ulWritten = 0;
    K_CHAR *szCharBuf = (K_CHAR*)pvBuf_;

    if (INVALID_NODE == m_usFile)
    {
        DEBUG_PRINT("Error - invalid file");
        return -1;
    }

    if (!(NLFS_FILE_WRITE & m_ucFlags))
    {
        DEBUG_PRINT("Error - file not open for write\n");
        return -1;
    }

    DEBUG_PRINT("writing: %d bytes to file\n", ulLen_);
    while (ulLen_)
    {
        ulOffset = m_ulOffset & (m_pclFileSystem->
GetBlockSize() - 1);
        ulBytesLeft = m_pclFileSystem->GetBlockSize() - ulOffset;
        if (ulBytesLeft > ulLen_)
        {
            ulBytesLeft = ulLen_;
        }
        if (ulBytesLeft && ulLen_ && (INVALID_BLOCK != m_ulCurrentBlock))
        {
            m_pclFileSystem->Write_Block(
m_ulCurrentBlock, ulOffset, (void*)szCharBuf, ulBytesLeft );
            ulWritten += ulBytesLeft;
            ulLen_ -= ulBytesLeft;
            szCharBuf += ulBytesLeft;
            m_stNode.stFileNode.ulFileSize += ulBytesLeft;
            m_ulOffset += ulBytesLeft;
            DEBUG_PRINT( "%d bytes to go\n", ulLen_);
        }
        if (!ulLen_)
        {
            m_pclFileSystem->Write_Node(m_usFile, &
m_stNode);
        }
        else
        {
            DEBUG_PRINT("appending\n");
            m_ulCurrentBlock = m_pclFileSystem->
Append_Block_To_Node(&m_stNode);
        }

        DEBUG_PRINT("writing node to file\n");
        m_pclFileSystem->Write_Node(m_usFile, &
m_stNode);
    }
    return ulWritten;
}

//---------------------------------------------------------------------------
int NLFS_File::Close(void)
{
    m_usFile = INVALID_NODE;
    m_ulCurrentBlock = INVALID_BLOCK;
    m_ulOffset = 0;
    m_ucFlags = 0;
    return 0;
}
```

17.129 /home/mo/mark3-source/embedded/stage/src/nlfs_file.h File Reference

NLFS file access class.

```
#include "kerneltypes.h"
#include "nlfs.h"
#include "nlfs_config.h"
```

Classes

- class NLFS_File

  The NLFS_File class.

Typedefs

- typedef K_UCHAR **NLFS_File_Mode_t**

Enumerations

- enum NLFS_File_Mode {
  NLFS_FILE_CREATE = 0x01, NLFS_FILE_APPEND = 0x02, NLFS_FILE_TRUNCATE = 0x04, NLFS_FIL-E_READ = 0x08,
  NLFS_FILE_WRITE = 0x10 }

17.129.1 Detailed Description

NLFS file access class.

Definition in file nlfs_file.h.

17.129.2 Enumeration Type Documentation

17.129.2.1 enum NLFS_File_Mode

Enumerator

NLFS_FILE_CREATE	Create the file if it does not exist.
NLFS_FILE_APPEND	Open to end of file.
NLFS_FILE_TRUNCATE	Truncate file size to 0-bytes.
NLFS_FILE_READ	Open file for read.
NLFS_FILE_WRITE	Open file for write.

Definition at line 27 of file nlfs_file.h.

17.130 nlfs_file.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
```

```
#ifndef __NLFS_FILE_H
#define __NLFS_FILE_H

#include "kerneltypes.h"
#include "nlfs.h"
#include "nlfs_config.h"

//---------------------------------------------------------------------------
typedef enum
{
    NLFS_FILE_CREATE = 0x01,
    NLFS_FILE_APPEND = 0x02,
    NLFS_FILE_TRUNCATE = 0x04,
    NLFS_FILE_READ = 0x08,
    NLFS_FILE_WRITE = 0x10
} NLFS_File_Mode;
typedef K_UCHAR NLFS_File_Mode_t;

//---------------------------------------------------------------------------
class NLFS_File
{

public:
    int     Open(NLFS *pclFS_, const K_CHAR *szPath_, NLFS_File_Mode_t eMode_);

    int     Read(void *pvBuf_, K_ULONG ulLen_);

    int     Write(void *pvBuf_, K_ULONG ulLen_);

    int     Seek(K_ULONG ulOffset_);

    int     Close(void);

private:
    NLFS                *m_pclFileSystem;
    K_ULONG             m_ulOffset;
    K_ULONG             m_ulCurrentBlock;
    K_USHORT            m_usFile;
    NLFS_File_Mode_t    m_ucFlags;
    NLFS_Node_t m_stNode;
};

#endif // __NLFS_FILE_H
```

17.131 /home/mo/mark3-source/embedded/stage/src/nlfs_ram.cpp File Reference

RAM-based Nice Little Filesystem (NLFS) driver.

```
#include "nlfs.h"
#include "nlfs_ram.h"
#include "memutil.h"
#include "nlfs_config.h"
```

17.131.1 Detailed Description

RAM-based Nice Little Filesystem (NLFS) driver.

Definition in file nlfs_ram.cpp.

17.132 nlfs_ram.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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```

```
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=============================================================================*/
#include "nlfs.h"
#include "nlfs_ram.h"
#include "memutil.h"
#include "nlfs_config.h"

//---------------------------------------------------------------------------
void NLFS_RAM::Read_Node( K_USHORT usNode_, NLFS_Node_t *pstFileNode_)
{
    NLFS_Node_t *pstFileNode =  (NLFS_Node_t*)(m_puHost->kaData
                                                      + (usNode_ * sizeof(
NLFS_Node_t)));

    MemUtil::CopyMemory(pstFileNode_, pstFileNode, sizeof(
NLFS_Node_t));
}

//---------------------------------------------------------------------------
void NLFS_RAM::Write_Node(K_USHORT usNode_, NLFS_Node_t *pstFileNode_)
{
    NLFS_Node_t *pstFileNode =  (NLFS_Node_t*)(m_puHost->kaData
                                                      + (usNode_ * sizeof(
NLFS_Node_t)));

    MemUtil::CopyMemory(pstFileNode, pstFileNode_, sizeof(
NLFS_Node_t));
}

//---------------------------------------------------------------------------
void NLFS_RAM::Read_Block_Header(K_ULONG ulBlock_,
NLFS_Block_t *pstFileBlock_)
{
    NLFS_Block_t *pstFileBlock =  (NLFS_Block_t*)(
m_puHost->kaData
                                                      + m_stLocalRoot.
ulBlockOffset
                                                      + (ulBlock_ * sizeof(
NLFS_Block_t)));

    MemUtil::CopyMemory(pstFileBlock_, pstFileBlock, sizeof(
NLFS_Block_t));
}

//---------------------------------------------------------------------------
void NLFS_RAM::Write_Block_Header(K_ULONG ulBlock_,
NLFS_Block_t *pstFileBlock_)
{
    NLFS_Block_t *pstFileBlock =  (NLFS_Block_t*)(
m_puHost->kaData
                                                      + m_stLocalRoot.
ulBlockOffset
                                                      + (ulBlock_ * sizeof(
NLFS_Block_t)));

    MemUtil::CopyMemory(pstFileBlock, pstFileBlock_, sizeof(
NLFS_Block_t));
}

//---------------------------------------------------------------------------
void NLFS_RAM::Read_Block(K_ULONG ulBlock_, K_ULONG ulOffset_, void *pvData_, K_ULONG
ulLen_)
{
    void *pvSrc_ = (void*)( m_puHost->kaData
                          + m_stLocalRoot.ulDataOffset
                          + ulOffset_
                          + (ulBlock_ * m_stLocalRoot.ulBlockSize) );
    MemUtil::CopyMemory(pvData_, pvSrc_, (K_USHORT)ulLen_);
}

//---------------------------------------------------------------------------
void NLFS_RAM::Write_Block(K_ULONG ulBlock_, K_ULONG ulOffset_, void *pvData_, K_ULONG
 ulLen_)
{
    void *pvDst_ = (void*)( m_puHost->kaData
                          + m_stLocalRoot.ulDataOffset
                          + ulOffset_
                          + (ulBlock_ * m_stLocalRoot.ulBlockSize) );
    MemUtil::CopyMemory(pvDst_, pvData_, (K_USHORT)ulLen_);
}
```

17.133 /home/mo/mark3-source/embedded/stage/src/nlfs_ram.h File Reference

RAM-based Nice Little Filesystem (NLFS) driver.

```
#include "nlfs.h"
```

Classes

- class NLFS_RAM

  The NLFS_RAM class.

17.133.1 Detailed Description

RAM-based Nice Little Filesystem (NLFS) driver.

Definition in file nlfs_ram.h.

17.134 nlfs_ram.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __NLFS_RAM_H
#define __NLFS_RAM_H

#include "nlfs.h"

class NLFS_RAM : public NLFS
{
private:

    virtual void Read_Node(K_USHORT usNode_, NLFS_Node_t *pstNode_);

    virtual void Write_Node(K_USHORT usNode_, NLFS_Node_t *pstNode_);

    virtual void Read_Block_Header(K_ULONG ulBlock_,
NLFS_Block_t *pstBlock_);

    virtual void Write_Block_Header(K_ULONG ulBlock_,
NLFS_Block_t *pstFileBlock_);

    virtual void Read_Block(K_ULONG ulBlock_, K_ULONG ulOffset_, void *pvData_, K_ULONG ulLen_);

    void Write_Block(K_ULONG ulBlock_, K_ULONG ulOffset_, void *pvData_, K_ULONG ulLen_);

};

#endif // NLFS_RAM_H
```

17.135 /home/mo/mark3-source/embedded/stage/src/panic_codes.h File Reference

Define and enumerate the possible causes of a kernel panic.

Macros

- #define **PANIC_ASSERT_FAILED** (1)
- #define **PANIC_LIST_UNLINK_FAILED** (2)
- #define **PANIC_STACK_SLACK_VIOLATED** (3)
- #define **PANIC_PEND_LOCK_VIOLATION** (4)
- #define **PANIC_EVENT_LOCK_VIOLATION** (5)
- #define **PANIC_MUTEX_LOCK_VIOLATION** (6)

17.135.1 Detailed Description

Define and enumerate the possible causes of a kernel panic.

Definition in file panic_codes.h.

17.136 panic_codes.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||  |  \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#ifndef __PANIC_CODES_H
#define __PANIC_CODES_H

#define PANIC_ASSERT_FAILED          (1)
#define PANIC_LIST_UNLINK_FAILED     (2)
#define PANIC_STACK_SLACK_VIOLATED   (3)
#define PANIC_PEND_LOCK_VIOLATION    (4)
#define PANIC_EVENT_LOCK_VIOLATION   (5)
#define PANIC_MUTEX_LOCK_VIOLATION   (6)

#endif // __PANIC_CODES_H

```

17.137 /home/mo/mark3-source/embedded/stage/src/profile.cpp File Reference

Code profiling utilities.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "profile.h"
#include "kprofile.h"
#include "threadport.h"
#include "kernel_debug.h"
```

Macros

- #define **__FILE_ID__** PROFILE_CPP

17.137.1 Detailed Description

Code profiling utilities.

Definition in file profile.cpp.

17.138 profile.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||  \      ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_____|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "profile.h"
#include "kprofile.h"
#include "threadport.h"
#include "kernel_debug.h"
//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     PROFILE_CPP


#if KERNEL_USE_PROFILER

//---------------------------------------------------------------------------
void ProfileTimer::Init()
{
    m_ulCumulative = 0;
    m_ulCurrentIteration = 0;
    m_usIterations = 0;
    m_bActive = 0;
}

//---------------------------------------------------------------------------
void ProfileTimer::Start()
{
    if (!m_bActive)
    {
        CS_ENTER();
        m_ulCurrentIteration = 0;
        m_ulInitialEpoch = Profiler::GetEpoch();
        m_usInitial = Profiler::Read();
        CS_EXIT();
        m_bActive = 1;
    }
}

//---------------------------------------------------------------------------
void ProfileTimer::Stop()
{
    if (m_bActive)
    {
        K_USHORT usFinal;
        K_ULONG ulEpoch;
        CS_ENTER();
        usFinal = Profiler::Read();
        ulEpoch = Profiler::GetEpoch();
        // Compute total for current iteration...
        m_ulCurrentIteration = ComputeCurrentTicks(usFinal, ulEpoch)
;
        m_ulCumulative += m_ulCurrentIteration;
        m_usIterations++;
        CS_EXIT();
        m_bActive = 0;
    }
}

//---------------------------------------------------------------------------
K_ULONG ProfileTimer::GetAverage()
{
    if (m_usIterations)
    {
        return m_ulCumulative / (K_ULONG)m_usIterations;
    }
    return 0;
}

//---------------------------------------------------------------------------
K_ULONG ProfileTimer::GetCurrent()
{

    if (m_bActive)
    {
        K_USHORT usCurrent;
        K_ULONG ulEpoch;
        CS_ENTER();
        usCurrent = Profiler::Read();
        ulEpoch = Profiler::GetEpoch();
        CS_EXIT();
        return ComputeCurrentTicks(usCurrent, ulEpoch);
    }
    return m_ulCurrentIteration;
}

//---------------------------------------------------------------------------
K_ULONG ProfileTimer::ComputeCurrentTicks(K_USHORT usCurrent_, K_ULONG
ulEpoch_)
{
    K_ULONG ulTotal;
    K_ULONG ulOverflows;

    ulOverflows = ulEpoch_ - m_ulInitialEpoch;

    // More than one overflow...
    if (ulOverflows > 1)
    {
        ulTotal = ((K_ULONG)(ulOverflows-1) * TICKS_PER_OVERFLOW)
                + (K_ULONG)(TICKS_PER_OVERFLOW - m_usInitial) +
                (K_ULONG)usCurrent_;
    }
    // Only one overflow, or one overflow that has yet to be processed
    else if (ulOverflows || (usCurrent_ < m_usInitial))
    {
        ulTotal = (K_ULONG)(TICKS_PER_OVERFLOW - m_usInitial) +
                (K_ULONG)usCurrent_;
    }
    // No overflows, none pending.
    else
    {
        ulTotal = (K_ULONG)(usCurrent_ - m_usInitial);
    }

    return ulTotal;
}

#endif
```

17.139 /home/mo/mark3-source/embedded/stage/src/profile.h File Reference

High-precision profiling timers.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"
```

Classes

- class ProfileTimer

  Profiling timer.

17.139.1 Detailed Description

High-precision profiling timers. Enables the profiling and instrumentation of performance-critical code. Multiple timers can be used simultaneously to enable system-wide performance metrics to be computed in a lightweight manner.

Usage:

```
ProfileTimer clMyTimer;
int i;

clMyTimer.Init();

// Profile the same block of code ten times
for (i = 0; i < 10; i++)
{
    clMyTimer.Start();
    ...
    //Block of code to profile
    ...
    clMyTimer.Stop();
}

// Get the average execution time of all iterations
ulAverageTimer = clMyTimer.GetAverage();

// Get the execution time from the last iteration
ulLastTimer = clMyTimer.GetCurrent();
```

Definition in file profile.h.

17.140 profile.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __PROFILE_H__
#define __PROFILE_H__

#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"

#if KERNEL_USE_PROFILER

class ProfileTimer
{

public:
    void Init();

    void Start();

    void Stop();

    K_ULONG GetAverage();

    K_ULONG GetCurrent();

private:

    K_ULONG ComputeCurrentTicks(K_USHORT usCount_, K_ULONG ulEpoch_);

    K_ULONG m_ulCumulative;
    K_ULONG m_ulCurrentIteration;
    K_USHORT m_usInitial;
    K_ULONG m_ulInitialEpoch;
    K_USHORT m_usIterations;
    K_UCHAR m_bActive;
};

#endif // KERNEL_USE_PROFILE

#endif
```

17.141 /home/mo/mark3-source/embedded/stage/src/quantum.cpp File Reference

Thread Quantum Implementation for Round-Robin Scheduling.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "timerlist.h"
#include "thread.h"
#include "quantum.h"
#include "kernel_debug.h"
```

Macros

- #define **__FILE_ID__** QUANTUM_CPP

Functions

- static void **QuantumCallback** (Thread ∗pclThread_, void ∗pvData_)

Variables

- static volatile K_BOOL **bAddQuantumTimer**

17.141.1 Detailed Description

Thread Quantum Implementation for Round-Robin Scheduling.

Definition in file quantum.cpp.

17.142 quantum.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__ ______
|    \  /  | ||    \    ||     |    ||  |/ /    ||___   |
|     \/   | ||     \   ||     \    ||     \    ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "timerlist.h"
#include "thread.h"
#include "quantum.h"
#include "kernel_debug.h"
//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
```

```
#define __FILE_ID__     QUANTUM_CPP

#if KERNEL_USE_QUANTUM

//---------------------------------------------------------------------------
static volatile K_BOOL bAddQuantumTimer;    // Indicates that a timer add is pending

//---------------------------------------------------------------------------
Timer Quantum::m_clQuantumTimer;    // The global timernodelist_t object
K_UCHAR Quantum::m_bActive;
//---------------------------------------------------------------------------
static void QuantumCallback(Thread *pclThread_, void *pvData_)
{
    // Validate thread pointer, check that source/destination match (it's
    // in its real priority list).  Also check that this thread was part of
    // the highest-running priority level.
    if (pclThread_->GetPriority() >= Scheduler::GetCurrentThread()->
GetPriority())
    {
        if (pclThread_->GetCurrent()->GetHead() != pclThread_->
GetCurrent()->GetTail() )
        {
            bAddQuantumTimer = true;
            pclThread_->GetCurrent()->PivotForward();
        }
    }
}

//---------------------------------------------------------------------------
void Quantum::SetTimer(Thread *pclThread_)
{
    m_clQuantumTimer.SetIntervalMSeconds(pclThread_->
GetQuantum());
    m_clQuantumTimer.SetFlags(TIMERLIST_FLAG_ONE_SHOT);
    m_clQuantumTimer.SetData(NULL);
    m_clQuantumTimer.SetCallback((TimerCallback_t)QuantumCallback);
    m_clQuantumTimer.SetOwner(pclThread_);
}

//---------------------------------------------------------------------------
void Quantum::AddThread(Thread *pclThread_)
{
    if (m_bActive)
    {
        return;
    }
    // If this isn't the only thread in the list.
    if ( pclThread_->GetCurrent()->GetHead() !=
           pclThread_->GetCurrent()->GetTail() )
    {
        Quantum::SetTimer(pclThread_);
        TimerScheduler::Add(&m_clQuantumTimer);
        m_bActive = 1;
    }
}

//---------------------------------------------------------------------------
void Quantum::RemoveThread(void)
{
    if (!m_bActive)
    {
        return;
    }

    // Cancel the current timer
    TimerScheduler::Remove(&m_clQuantumTimer);
    m_bActive = 0;
}

//---------------------------------------------------------------------------
void Quantum::UpdateTimer(void)
{
    // If we have to re-add the quantum timer (more than 2 threads at the
    // high-priority level...)
    if (bAddQuantumTimer)
    {
        // Trigger a thread yield - this will also re-schedule the
        // thread *and* reset the round-robin scheduler.
        Thread::Yield();
        bAddQuantumTimer = false;
    }
}

#endif //KERNEL_USE_QUANTUM
```

17.143 /home/mo/mark3-source/embedded/stage/src/quantum.h File Reference

Thread Quantum declarations for Round-Robin Scheduling.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "thread.h"
#include "timerlist.h"
```

Classes

- class Quantum

  Static-class used to implement Thread quantum functionality, which is a key part of round-robin scheduling.

17.143.1 Detailed Description

Thread Quantum declarations for Round-Robin Scheduling.

Definition in file quantum.h.

17.144 quantum.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __KQUANTUM_H__
#define __KQUANTUM_H__

#include "kerneltypes.h"
#include "mark3cfg.h"

#include "thread.h"
#include "timerlist.h"

#if KERNEL_USE_QUANTUM
class Timer;

class Quantum
{
public:
    static void UpdateTimer();

    static void AddThread( Thread *pclThread_ );

    static void RemoveThread();

private:
    static void SetTimer( Thread *pclThread_ );

    static Timer m_clQuantumTimer;
    static K_UCHAR m_bActive;
};

#endif //KERNEL_USE_QUANTUM

#endif
```

17.145 /home/mo/mark3-source/embedded/stage/src/scheduler.cpp File Reference

Strict-Priority + Round-Robin thread scheduler implementation.

```
#include "kerneltypes.h"
#include "ll.h"
#include "scheduler.h"
#include "thread.h"
#include "threadport.h"
#include "kernel_debug.h"
```

Macros

- #define **__FILE_ID__** SCHEDULER_CPP

Variables

- Thread ∗ **g_pstNext**
- Thread ∗ **g_pstCurrent**
- K_UCHAR **g_ucFlag**
- static const K_UCHAR **aucCLZ** [16] ={255,0,1,1,2,2,2,2,3,3,3,3,3,3,3,3}

17.145.1 Detailed Description

Strict-Priority + Round-Robin thread scheduler implementation.

Definition in file scheduler.cpp.

17.146 scheduler.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__    |__ __| __   |__ ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___    |
|     \/   | ||     \    ||     \     ||     \     ||___    |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "ll.h"
#include "scheduler.h"
#include "thread.h"
#include "threadport.h"
#include "kernel_debug.h"
//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     SCHEDULER_CPP

//---------------------------------------------------------------------------
Thread *g_pstNext;
Thread *g_pstCurrent;

//---------------------------------------------------------------------------
K_BOOL Scheduler::m_bEnabled;
K_BOOL Scheduler::m_bQueuedSchedule;

ThreadList Scheduler::m_clStopList;
ThreadList Scheduler::m_aclPriorities[NUM_PRIORITIES];
```

```
K_UCHAR Scheduler::m_ucPriFlag;

K_UCHAR g_ucFlag;
//---------------------------------------------------------------------------
static const K_UCHAR aucCLZ[16] ={255,0,1,1,2,2,2,2,3,3,3,3,3,3,3,3};

//---------------------------------------------------------------------------
void Scheduler::Init()
{
    m_ucPriFlag = 0;
    for (int i = 0; i < NUM_PRIORITIES; i++)
    {
        m_aclPriorities[i].SetPriority(i);
        m_aclPriorities[i].SetFlagPointer(&m_ucPriFlag);
    }
    g_ucFlag = m_ucPriFlag;
    m_bQueuedSchedule = false;
}

//---------------------------------------------------------------------------
void Scheduler::Schedule()
{
    K_UCHAR ucPri = 0;

    // Figure out what priority level has ready tasks (8 priorities max)
    ucPri = aucCLZ[m_ucPriFlag >> 4 ];
    if (ucPri == 0xFF) { ucPri = aucCLZ[m_ucPriFlag & 0x0F]; }
    else { ucPri += 4; }

    // Get the thread node at this priority.
    g_pstNext = (Thread*)( m_aclPriorities[ucPri].GetHead() );
    g_ucFlag = m_ucPriFlag;

    KERNEL_TRACE_1( STR_SCHEDULE_1, (K_USHORT)g_pstNext->GetID() );
}

//---------------------------------------------------------------------------
void Scheduler::Add(Thread *pclThread_)
{
    m_aclPriorities[pclThread_->GetPriority()].Add(pclThread_);
    g_ucFlag = m_ucPriFlag;
}

//---------------------------------------------------------------------------
void Scheduler::Remove(Thread *pclThread_)
{
    m_aclPriorities[pclThread_->GetPriority()].Remove(pclThread_);
    g_ucFlag = m_ucPriFlag;
}

//---------------------------------------------------------------------------
K_BOOL Scheduler::SetScheduler(K_BOOL bEnable_)
{
    K_BOOL bRet ;
    CS_ENTER();
    bRet = m_bEnabled;
    m_bEnabled = bEnable_;
    // If there was a queued scheduler evevent, dequeue and trigger an
    // immediate Yield
    if (m_bEnabled && m_bQueuedSchedule)
    {
        m_bQueuedSchedule = false;
        Thread::Yield();
    }
    CS_EXIT();
    return bRet;
}
```

17.147 /home/mo/mark3-source/embedded/stage/src/scheduler.h File Reference

Thread scheduler function declarations.

```
#include "kerneltypes.h"
#include "thread.h"
#include "threadport.h"
```

Classes

- class Scheduler

  Priority-based round-robin Thread scheduling, using ThreadLists for housekeeping.

Macros

- #define **NUM_PRIORITIES** (8)

Variables

- Thread ∗ **g_pstNext**
- Thread ∗ **g_pstCurrent**

17.147.1 Detailed Description

Thread scheduler function declarations. This scheduler implements a very flexible type of scheduling, which has become the defacto industry standard when it comes to real-time operating systems. This scheduling mechanism is referred to as priority round- robin.

From the name, there are two concepts involved here:

1) Priority scheduling:

Threads are each assigned a priority, and the thread with the highest priority which is ready to run gets to execute.

2) Round-robin scheduling:

Where there are multiple ready threads at the highest-priority level, each thread in that group gets to share time, ensuring that progress is made.

The scheduler uses an array of ThreadList objects to provide the necessary housekeeping required to keep track of threads at the various priorities. As s result, the scheduler contains one ThreadList per priority, with an additional list to manage the storage of threads which are in the "stopped" state (either have been stopped, or have not been started yet).

Definition in file scheduler.h.

17.148 scheduler.h

```
/*=============================================================================
        _____       _____        _____       _____
 ___|      _|__ __|_    |__ __|__   |__ __| __   |__  ______
|      \  /  | ||    \      ||    |     ||  |/ /     ||___   |
|       \/   | ||     \     ||    \     ||     \    ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
       |_____|     |_____|      |_____|     |_____|

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=============================================================================*/
#ifndef __SCHEDULER_H__
#define __SCHEDULER_H__

#include "kerneltypes.h"
#include "thread.h"
#include "threadport.h"

extern Thread *g_pstNext;
extern Thread *g_pstCurrent;

#define NUM_PRIORITIES               (8)
//-----------------------------------------------------------------------------
class Scheduler
```

```
{
public:
    static void Init();

    static void Schedule();

    static void Add(Thread *pclThread_);

    static void Remove(Thread *pclThread_);

    static K_BOOL SetScheduler(K_BOOL bEnable_);

    static Thread *GetCurrentThread(){ return g_pstCurrent; }

    static Thread *GetNextThread(){ return g_pstNext; }

    static ThreadList *GetThreadList(K_UCHAR ucPriority_){ return &
m_aclPriorities[ucPriority_]; }

    static ThreadList *GetStopList(){ return &m_clStopList; }

    static K_UCHAR IsEnabled(){ return m_bEnabled; }

    static void QueueScheduler() { m_bQueuedSchedule = true; }

private:
    static K_BOOL m_bEnabled;

    static K_BOOL m_bQueuedSchedule;

    static ThreadList m_clStopList;

    static ThreadList m_aclPriorities[NUM_PRIORITIES];

    static K_UCHAR m_ucPriFlag;
};
#endif

```

17.149 /home/mo/mark3-source/embedded/stage/src/screen.cpp File Reference

Higher level window management framework.

```
#include "kerneltypes.h"
#include "screen.h"
#include "gui.h"
#include "memutil.h"
```

17.149.1 Detailed Description

Higher level window management framework.

Definition in file screen.cpp.

17.150 screen.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||  |  \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "screen.h"
#include "gui.h"
```

```
#include "memutil.h"

//---------------------------------------------------------------------------
void Screen::SetManager( ScreenManager *pclScreenManager_ )
{
    m_pclScreenManager = pclScreenManager_;
}

//---------------------------------------------------------------------------
void Screen::SetWindowAffinity( const K_CHAR *szWindowName_ )
{
    m_pclWindow = m_pclScreenManager->FindWindowByName( szWindowName_ );
}

//---------------------------------------------------------------------------
GuiWindow *ScreenManager::FindWindowByName( const K_CHAR *m_szName_
 )
{
    return m_pclSurface->FindWindowByName( m_szName_ );
}

//---------------------------------------------------------------------------
Screen *ScreenManager::FindScreenByName( const K_CHAR *szName_ )
{
    LinkListNode *pclTempNode = static_cast<LinkListNode*>(
m_clScreenList.GetHead());

    while (pclTempNode)
    {
        if (MemUtil::CompareStrings(szName_, static_cast<Screen*>(pclTempNode)->
GetName()))
        {
            return static_cast<Screen*>(pclTempNode);
        }
        pclTempNode = pclTempNode->GetNext();
    }

    return NULL;
}

```

17.151 /home/mo/mark3-source/embedded/stage/src/screen.h File Reference

Higher level window management framework.

```
#include "kerneltypes.h"
#include "gui.h"
#include "ll.h"
```

Classes

- class Screen
- class ScreenList
- class ScreenManager

17.151.1 Detailed Description

Higher level window management framework.

Definition in file screen.h.

17.152 screen.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __SCREEN_H__
#define __SCREEN_H__

#include "kerneltypes.h"
#include "gui.h"
#include "ll.h"

//---------------------------------------------------------------------------
class ScreenList;
class ScreenManager;

//---------------------------------------------------------------------------
class Screen : public LinkListNode
{
public:
    void Activate()             { Create(); }

    void Deactivate()           { Destroy(); }

    void SetWindowAffinity( const K_CHAR *szWindowName_ );

    void SetName( const K_CHAR *szName_ )           { m_szName = szName_; }

    const K_CHAR *GetName()                         { return m_szName; }

protected:
    friend class ScreenManager;

    void SetManager( ScreenManager *pclScreenManager_ );

    const K_CHAR    *m_szName;
    ScreenManager   *m_pclScreenManager;
    GuiWindow       *m_pclWindow;

private:

    virtual void Create() = 0;
    virtual void Destroy() = 0;

};

//---------------------------------------------------------------------------
class ScreenList
{
public:
    ScreenList()                        { m_clList.Init(); }

    void Add( Screen *pclScreen_ )      { m_clList.Add(pclScreen_); }

    void Remove( Screen *pclScreen_)    { m_clList.Remove(pclScreen_); }

    Screen *GetHead()                   { return static_cast<Screen*>(
m_clList.GetHead()); }

private:
    DoubleLinkList  m_clList;
};

//---------------------------------------------------------------------------
class ScreenManager
{
public:

    ScreenManager() { m_pclSurface = NULL; }

    void AddScreen( Screen *pclScreen_ )        { m_clScreenList.
Add(pclScreen_);
                                                  pclScreen_->SetManager(this); }

    void RemoveScreen( Screen *pclScreen_)      {
m_clScreenList.Remove(pclScreen_);
                                                  pclScreen_->SetManager(NULL); }

    void SetEventSurface( GuiEventSurface *pclSurface_ ) {
m_pclSurface = pclSurface_; }

    GuiWindow *FindWindowByName( const K_CHAR *m_szName_ );

    Screen *FindScreenByName( const K_CHAR *m_szName_ );

private:

    ScreenList m_clScreenList;
    GuiEventSurface *m_pclSurface;
};

#endif
```

17.153 /home/mo/mark3-source/embedded/stage/src/shell_support.cpp File Reference

Support functions & data structures useful in implementing a shell.

```
#include "kerneltypes.h"
#include "memutil.h"
#include "shell_support.h"
```

17.153.1 Detailed Description

Support functions & data structures useful in implementing a shell.

Definition in file shell_support.cpp.

17.154 shell_support.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "memutil.h"
#include "shell_support.h"

//---------------------------------------------------------------------------
K_CHAR ShellSupport::RunCommand( CommandLine_t *pstCommand_, const ShellCommand_t *pastShellCommands_ )
{
    K_UCHAR i = 0;
    K_UCHAR tmp_len;
    while (pastShellCommands_[i].szCommand)
    {
        tmp_len = MIN(pstCommand_->pstCommand->ucLen, MemUtil::StringLength(pastShellCommands_[i].szCommand));

        if (true == MemUtil::CompareMemory( (const void*)pastShellCommands_[i].szCommand,
                                            (const void*)(pstCommand_->pstCommand->pcToken),
                                           tmp_len ) )
        {
            pastShellCommands_[i].pfHandler( pstCommand_ );
            return 1;
        }
        i++;
    }
    return 0;
}

//---------------------------------------------------------------------------
void ShellSupport::UnescapeToken( Token_t *pstToken_, K_CHAR *szDest_ )
{
    const K_CHAR *szSrc = pstToken_->pcToken;
    int i;
    int j = 0;
    for (i = 0; i < pstToken_->ucLen; i++)
    {
        //-- Escape characters
        if ('\\' == szSrc[i])
        {
            i++;
            if (i >= pstToken_->ucLen)
            {
                break;
            }
            switch (szSrc[i])
            {
            case 't':
                szDest_[j++] = '\t';
                break;
            case 'r':
                szDest_[j++] = '\r';
                break;
            case 'n':
                szDest_[j++] = '\n';
                break;
            case ' ':
                szDest_[j++] = ' ';
                break;
            case '\\':
                szDest_[j++] = '\\';
                break;
            case '\"':
                szDest_[j++] = '\"';
                break;
            default:
                break;
            }
        }
        //-- Unescaped quotes
        else if ('\"' == szSrc[i])
        {
            continue;
        }
        //-- Everything else
        else
        {
            szDest_[j++] = szSrc[i];
        }
    }
    //-- Null-terminate the string
    szDest_[j] = '\0';
}

//---------------------------------------------------------------------------
Option_t *ShellSupport::CheckForOption(
CommandLine_t *pstCommand_, const K_CHAR *szOption_ )
{
    K_CHAR i;
    K_UCHAR tmp_len;
    for (i = 0; i < pstCommand_->ucNumOptions; i++)
    {
        tmp_len = MIN(MemUtil::StringLength(szOption_), pstCommand_->
astOptions[i].pstStart->ucLen);

        if (true == MemUtil::CompareMemory( (const void*)szOption_,
                                            (const void*)(pstCommand_->astOptions[i].
pstStart->pcToken),
                                             tmp_len ) )
        {
            return &(pstCommand_->astOptions[i]);
        }
    }
    return 0;
}

//---------------------------------------------------------------------------
K_CHAR ShellSupport::TokensToCommandLine(
Token_t *pastTokens_, K_UCHAR ucTokens_, CommandLine_t *pstCommand_)
{
    K_CHAR count = 0;
    K_CHAR token = 0;
    K_CHAR option = 0;
    pstCommand_->ucNumOptions = 0;

    if (!ucTokens_)
    {
        return -1;
    }

    // Command is a single token...
    pstCommand_->pstCommand = &pastTokens_[0];

    // Parse out options
    token = 1;
    while (token < ucTokens_ && option < 12)
    {
        pstCommand_->astOptions[option].pstStart = &pastTokens_[token];
        count = 1;
        token++;
        while (token < ucTokens_ && pastTokens_[token].pcToken[0] != '-')
        {
            token++;
            count++;
        }
        pstCommand_->astOptions[option].ucCount = count;
        option++;
    }

    pstCommand_->ucNumOptions = option;
    pstCommand_->ucTokenCount = ucTokens_;
    pstCommand_->pastTokenList = pastTokens_;
    return option;
}
```

17.155 /home/mo/mark3-source/embedded/stage/src/shell_support.h File Reference

Support functions & data structures useful in implementing a shell.

```
#include "kerneltypes.h"
#include "memutil.h"
```

Classes

- struct Option_t

    Structure used to represent a command-line option with its arguments.
- struct CommandLine_t

    Structure containing multiple representations for command-line data.
- struct ShellCommand_t

    Data structure defining a lookup table correlating a command name to its handler function.
- class ShellSupport

    The ShellSupport class features utility functions which handle token processing, option/parameter lookup, and functions making it generally trivial to implement a lightweight custom shell.

Macros

- #define MIN(x, y) (((x) < (y)) ? (x) : (y))

    Utility macro used to return the lesser of two values/objects.
- #define MAX(x, y) (((x) > (y)) ? (x) : (y))

    Utility macro used to return the greater of two values/objects.

Typedefs

- typedef K_CHAR(∗ fp_internal_command)(CommandLine_t ∗pstCommandLine_)

    Function pointer type used to represent shell commands, as implemented by users of this infrastructure.

17.155.1 Detailed Description

Support functions & data structures useful in implementing a shell.

Definition in file shell_support.h.

17.155.2 Typedef Documentation

17.155.2.1 typedef K_CHAR(∗ fp_internal_command)(CommandLine_t ∗pstCommandLine_)

Function pointer type used to represent shell commands, as implemented by users of this infrastructure.

Commands return a signed 8-bit result, and take a command-line argument structure as the first and only argument.

Definition at line 110 of file shell_support.h.

17.156 shell_support.h

```
00001 /*===========================================================================
00002      _____        _____        _____        _____
00003  ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
00004 |    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
00005 |     \/   | ||     \     ||     \     ||     \     ||___   |
00006 |__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
00007     |_____|      |_____|      |_____|      |_____|
00008
00009 --[Mark3 Realtime Platform]--------------------------------------------------
00010
00011 Copyright (c) 2012 Funkenstein Software Consulting, all rights reserved.
00012 See license.txt for more information
00013 ===========================================================================*/
00023 #ifndef __SHELL_SUPPORT_H__
00024 #define __SHELL_SUPPORT_H__
00025
00026 //---------------------------------------------------------------------------
00027 #include "kerneltypes.h"
00028 #include "memutil.h"
00029
00030 //---------------------------------------------------------------------------
00031 #ifndef MIN
00032
00035     #define MIN(x,y)        ( ( (x) < (y) ) ? (x) : (y) )
00036 #endif
00037 #ifndef MAX
00038
00041     #define MAX(x,y)        ( ( (x) > (y) ) ? (x) : (y) )
00042 #endif
00043
00044 //---------------------------------------------------------------------------
00083 typedef struct
00084 {
00085     Token_t *pstStart;
00086     K_UCHAR ucCount;
00087 } Option_t;
00088
00089 //---------------------------------------------------------------------------
00093 typedef struct
00094 {
00095     Token_t *pastTokenList;
00096     K_UCHAR ucTokenCount;
00097
00098     Token_t *pstCommand;
00099
00100     Option_t astOptions[12];
00101     K_UCHAR ucNumOptions;
00102 } CommandLine_t;
00103
00104 //---------------------------------------------------------------------------
00110 typedef K_CHAR (*fp_internal_command)( CommandLine_t *pstCommandLine_ );
00111
00112 //---------------------------------------------------------------------------
00117 typedef struct
00118 {
00119     const K_CHAR *szCommand;
00120     fp_internal_command pfHandler;
00121 } ShellCommand_t;
00122
00123 //---------------------------------------------------------------------------
00129 class ShellSupport
00130 {
00131 public:
00132
00133     //---------------------------------------------------------------------------
00142     static K_CHAR RunCommand( CommandLine_t *pstCommand_, const
      ShellCommand_t *pastShellCommands_ );
00143
00144     //---------------------------------------------------------------------------
```

```
    static void UnescapeToken( Token_t *pstToken_, K_CHAR *szDest_ );

    //---------------------------------------------------------------------------
    static Option_t *CheckForOption( CommandLine_t *pstCommand_, const
K_CHAR *szOption_ );

    //---------------------------------------------------------------------------
    static K_CHAR TokensToCommandLine(Token_t *pastTokens_, K_UCHAR ucTokens_,
CommandLine_t *pstCommand_);

};



#endif // SHELL_SUPPORT_H
```

17.157 /home/mo/mark3-source/embedded/stage/src/slip.cpp File Reference

Serial Line IP framing code.

```
#include "kerneltypes.h"
#include "slip.h"
#include "driver.h"
```

Macros

- #define FRAMING_BYTE (192)

  Byte indicating end-of-frame.
- #define FRAMING_ENC_BYTE (219)

  Byte used to indicate substitution.
- #define FRAMING_SUB_BYTE (220)

  Byte to substitute for framing byte.
- #define FRAMING_SUB_ENC_BYTE (221)

  Byte to substitute for the substitute-byte.
- #define ACchar (69)

  Acknowledgement character.
- #define NACchar (96)

  Non-acknowledgement character.

17.157.1 Detailed Description

Serial Line IP framing code.

Definition in file slip.cpp.

17.158 slip.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||  \      ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
```

```
#include "slip.h"
#include "driver.h"

//---------------------------------------------------------------------------
#define FRAMING_BYTE            (192)
#define FRAMING_ENC_BYTE        (219)
#define FRAMING_SUB_BYTE        (220)
#define FRAMING_SUB_ENC_BYTE    (221)

//---------------------------------------------------------------------------
#define ACchar                 (69)
#define NACchar                (96)

//---------------------------------------------------------------------------
K_USHORT Slip::EncodeByte( K_UCHAR ucChar_, K_UCHAR *aucBuf_ )
{
    K_USHORT usLen = 1;
    switch (ucChar_)
    {
        case FRAMING_BYTE:
            aucBuf_[0] = FRAMING_ENC_BYTE;
            aucBuf_[1] = FRAMING_SUB_BYTE;
            usLen = 2;
            break;
        case FRAMING_ENC_BYTE:
            aucBuf_[0] = FRAMING_ENC_BYTE;
            aucBuf_[1] = FRAMING_SUB_ENC_BYTE;
            usLen = 2;
            break;
        default:
            aucBuf_[0] = ucChar_;
    }
    return usLen;
}

//---------------------------------------------------------------------------
K_USHORT Slip::DecodeByte( K_UCHAR *ucChar_, const K_UCHAR *aucBuf_ )
{
    K_USHORT usLen = 1;

    if (aucBuf_[0] == FRAMING_ENC_BYTE)
    {
        if(aucBuf_[1] == FRAMING_SUB_BYTE)
        {
            *ucChar_ = FRAMING_BYTE;
            usLen = 2;
        }
        else if(aucBuf_[1] == FRAMING_SUB_ENC_BYTE)
        {
            *ucChar_ = FRAMING_ENC_BYTE;
            usLen = 2;
        }
        else
        {
            *ucChar_ = 0;
            usLen = 0;
        }
    }
    else if (aucBuf_[0] == FRAMING_BYTE)
    {
        usLen = 0;
        *ucChar_ = 0;
    }
    else
    {
        *ucChar_ = aucBuf_[0];
    }
    return usLen;
}

//---------------------------------------------------------------------------
void Slip::WriteByte( K_UCHAR ucData_)
{
    K_USHORT usSize = 0;
    K_USHORT usIdx = 0;
    K_UCHAR aucBuf[2];
    usSize = EncodeByte(ucData_, aucBuf);
    while (usIdx < usSize)
    {
        usIdx += m_pclDriver->Write(usSize, &aucBuf[usIdx]);
    }
}

//---------------------------------------------------------------------------
K_USHORT Slip::ReadData(K_UCHAR *pucChannel_, K_CHAR *aucBuf_, K_USHORT usLen_)
{
    K_USHORT usReadCount;
    K_UCHAR ucTempCount;
    K_USHORT usValid = 0;
    K_USHORT usCRC;
    K_USHORT usCRC_Calc = 0;
    K_USHORT usLen;
    K_UCHAR *pucSrc = (K_UCHAR*)aucBuf_;
    K_UCHAR *pucDst = (K_UCHAR*)aucBuf_;

    usReadCount = m_pclDriver->Read(usLen_, (K_UCHAR*)aucBuf_);

    while (usReadCount)
    {
        K_UCHAR ucRead;
        ucTempCount = DecodeByte(&ucRead, pucSrc);

        *pucDst = ucRead;

        // Encountered a FRAMING_BYTE - end of message
        if (!ucTempCount)
        {
            break;
        }

        // Add to the CRC
        usCRC_Calc += ucRead;

        // Adjust iterators, source, and destination pointers.
        usReadCount -= ucTempCount;
        pucSrc += ucTempCount;
        pucDst++;
        usValid++;
    }

    // Ensure we have enough data to try a match.
    if (usValid < 5) {
        return 0;
    }

    usCRC_Calc -= aucBuf_[usValid-2];
    usCRC_Calc -= aucBuf_[usValid-1];

    usLen = ((K_USHORT)aucBuf_[1]) << 8;
    usLen += ((K_USHORT)aucBuf_[2]);
    usCRC = ((K_USHORT)aucBuf_[usValid-2]) << 8;
    usCRC += ((K_USHORT)aucBuf_[usValid-1]);

    if (usCRC != usCRC_Calc)
    {
        return 0;
    }

    *pucChannel_ = aucBuf_[0];

    return usLen;
}

//---------------------------------------------------------------------------
void Slip::WriteData(K_UCHAR ucChannel_, const K_CHAR *aucBuf_, K_USHORT usLen_)
{
    K_UCHAR aucTmp[2];
    K_USHORT usCRC = 0;

    // Lightweight protocol built on-top of SLIP.
    // 1) Channel ID (8-bit)
    // 2) Data Size (16-bit)
    // 3) Data blob
    // 4) CRC16 (16-bit)
    aucTmp[0] = FRAMING_BYTE;
    while( !m_pclDriver->Write(1, aucTmp) ) {}

    if (!usLen_)     // Read to end-of-line (\0)
    {
        K_UCHAR *pucBuf = (K_UCHAR*)aucBuf_;
        while (*pucBuf != '\0')
        {
            usLen_++;
            pucBuf++;
        }
    }

    WriteByte(ucChannel_);
    usCRC = ucChannel_;

    WriteByte((K_UCHAR)(usLen_ >> 8));
    usCRC += (usLen_ >> 8);

    WriteByte((K_UCHAR)(usLen_ & 0x00FF));
    usCRC += (usLen_ & 0x00FF);

    while (usLen_--)
    {
        WriteByte(*aucBuf_);
        usCRC += (K_USHORT)*aucBuf_;
        aucBuf_++;
    }

    WriteByte((K_UCHAR)(usCRC >> 8));
    WriteByte((K_UCHAR)(usCRC & 0x00FF));

    aucTmp[0] = FRAMING_BYTE;
    while( !m_pclDriver->Write(1, aucTmp) ) {}
}

//---------------------------------------------------------------------------
void Slip::SendAck()
{
    WriteByte(ACchar);
}

//---------------------------------------------------------------------------
void Slip::SendNack()
{
    WriteByte(NACchar);
}

//---------------------------------------------------------------------------
void Slip::WriteVector(K_UCHAR ucChannel_, SlipDataVector *astData_,
K_USHORT usLen_)
{
    K_UCHAR aucTmp[2];
    K_USHORT usCRC = 0;
    K_UCHAR i, j;
    K_USHORT usTotalLen = 0;

    // Calculate the total length of all message fragments
    for (i = 0; i < usLen_; i++)
    {
        usTotalLen += astData_[i].ucSize;
    }

    // Send a FRAMING_BYTE to start framing a message
    aucTmp[0] = FRAMING_BYTE;
    while( !m_pclDriver->Write(1, aucTmp) ) {}

    // Write a the channel
    WriteByte(ucChannel_);
    usCRC = ucChannel_;

    // Write the length
    WriteByte((K_UCHAR)(usTotalLen >> 8));
    usCRC += (usTotalLen >> 8);

    WriteByte((K_UCHAR)(usTotalLen & 0x00FF));
    usCRC += (usTotalLen & 0x00FF);

    // Write the message fragments
    for (i = 0; i < usLen_; i++)
    {
        K_UCHAR *aucBuf = astData_[i].pucData;
        for (j = 0; j < astData_[i].ucSize; j++ )
        {
            WriteByte(*aucBuf);
            usCRC += (K_USHORT)*aucBuf;
            aucBuf++;
        }
    }

    // Write the CRC
    WriteByte((K_UCHAR)(usCRC >> 8));
    WriteByte((K_UCHAR)(usCRC & 0x00FF));

    // Write the end-of-message
    aucTmp[0] = FRAMING_BYTE;
    while( !m_pclDriver->Write(1, aucTmp) ) {}
}
```

17.159 /home/mo/mark3-source/embedded/stage/src/slip.h File Reference

Serial Line IP framing code.

```
#include "kerneltypes.h"
#include "driver.h"
```

Classes

- struct SlipDataVector

  Data structure used for vector-based SLIP data transmission.
- class Slip

  Object used to frame communications over an abstract device using the serial-line internet protocol (SLIP).

Enumerations

- enum SlipChannel {
  SLIP_CHANNEL_TERMINAL = 0, SLIP_CHANNEL_UNISCOPE, SLIP_CHANNEL_NVM, SLIP_CHANNEL-_RESET,
  SLIP_CHANNEL_GRAPHICS, SLIP_CHANNEL_HID, **SLIP_CHANNEL_COUNT** }

17.159.1 Detailed Description

Serial Line IP framing code. Also includes code to frame data in FunkenSlip format for use with SlipTerm on a host PC.

FunkenSlip uses SLIP-framed messages with a pre-defined packet format as follows:

[Channel][Size][Data Buffer][CRC8]

Channel is 1 byte, indicating the type of data carried in the message

Size is 2 bytes, indicating the length of the binary blob that follows

Data Buffer is n bytes, and contains the raw packet data.

CRC16 is 2 byte, Providing an error detection mechanism

Definition in file slip.h.

17.159.2 Enumeration Type Documentation

17.159.2.1 enum SlipChannel

Enumerator

SLIP_CHANNEL_TERMINAL ASCII text mode terminal.

SLIP_CHANNEL_UNISCOPE Uniscope VM command channel.

SLIP_CHANNEL_NVM Non-volatile memory configuration.

SLIP_CHANNEL_RESET Channel used to reset the device...

SLIP_CHANNEL_GRAPHICS Encoded drawing commands.

SLIP_CHANNEL_HID HID commands.

Definition at line 41 of file slip.h.

17.160 slip.h

```
/*===========================================================================
     _____        _____        _____        _____
```

```
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "driver.h"

#ifndef __SLIP_H__
#define __SLIP_H__

//---------------------------------------------------------------------------
typedef enum
{
    SLIP_CHANNEL_TERMINAL = 0,
    SLIP_CHANNEL_UNISCOPE,
    SLIP_CHANNEL_NVM,
    SLIP_CHANNEL_RESET,
    SLIP_CHANNEL_GRAPHICS,
    SLIP_CHANNEL_HID,
//---
    SLIP_CHANNEL_COUNT
} SlipChannel;

//---------------------------------------------------------------------------
typedef struct
{
    K_UCHAR ucSize;
    K_UCHAR *pucData;
}SlipDataVector;

//---------------------------------------------------------------------------
class Slip
{
public:
    void SetDriver( Driver *pclDriver_ ){ m_pclDriver = pclDriver_; }

    Driver *GetDriver() { return m_pclDriver; }

    static K_USHORT EncodeByte( K_UCHAR ucChar_, K_UCHAR *aucBuf_ );

    static K_USHORT DecodeByte( K_UCHAR *ucChar_, const K_UCHAR *aucBuf_ );

    void WriteData( K_UCHAR ucChannel_, const K_CHAR *aucBuf_, K_USHORT usLen_ );

    K_USHORT ReadData( K_UCHAR *pucChannel_, K_CHAR *aucBuf_, K_USHORT usLen_ );

    void WriteVector( K_UCHAR ucChannel_, SlipDataVector *astData_, K_USHORT
usLen_ );

    void SendAck();

    void SendNack();

private:
    void WriteByte(K_UCHAR ucData_);
    Driver *m_pclDriver;
};

#endif
```

17.161 /home/mo/mark3-source/embedded/stage/src/slip_mux.cpp File Reference

FunkenSlip Channel Multiplexer.

```
#include "kerneltypes.h"
#include "driver.h"
#include "drvUART.h"
#include "slip.h"
#include "slip_mux.h"
#include "message.h"
```

Functions

- static void SlipMux_CallBack (Driver ∗pclDriver_)

17.161.1 Detailed Description

FunkenSlip Channel Multiplexer. Demultiplexes FunkenSlip packets transmitted over a single serial channel, and provides an abstraction to attach handlers for each event type.

Definition in file slip_mux.cpp.

17.161.2 Function Documentation

17.161.2.1 static void SlipMux_CallBack (Driver ∗ *pclDriver_*) [static]

Parameters

*pclDriver_*	Pointer to the driver data for the port triggering the callback

Definition at line 43 of file slip_mux.cpp.

17.162 slip_mux.cpp

```
00001 /*===========================================================================
00002      _____        _____        _____        _____
00003  ___|    _|__  __|_    |__ __|__   |__ __| __  |__  ______
00004 |    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
00005 |     \/   | ||     \    ||     \     ||     \     ||___   |
00006 |__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
00007     |_____|      |_____|      |_____|      |_____|
00008
00009 --[Mark3 Realtime Platform]------------------------------------------------
00010
00011 Copyright (c) 2012 Funkenstein Software Consulting, all rights reserved.
00012 See license.txt for more information
00013 ===========================================================================*/
00022 #include "kerneltypes.h"
00023 #include "driver.h"
00024 #include "drvUART.h"
00025 #include "slip.h"
00026 #include "slip_mux.h"
00027 #include "message.h"
00028
00029 //---------------------------------------------------------------------------
00030 MessageQueue *SlipMux::m_pclMessageQueue;
00031 K_UCHAR SlipMux::m_aucData[SLIP_BUFFER_SIZE];
00032 Driver *SlipMux::m_pclDriver;
00033 Slip_Channel SlipMux::m_apfChannelHandlers[SLIP_CHANNEL_COUNT] = {0};
00034 Semaphore SlipMux::m_clSlipSem;
00035 Slip SlipMux::m_clSlip;
00036
00037 //---------------------------------------------------------------------------
00043 static void SlipMux_CallBack( Driver *pclDriver_)
00044 {
00045     Message *pclMsg = GlobalMessagePool::Pop();
00046     if (pclMsg)
00047     {
00048         pclDriver_->Control(CMD_SET_RX_DISABLE, 0, 0, 0, 0);
00049
00050         // Send a message to the queue, letting it know that there's a
00051         // pending slip message that needs to be processed
00052         pclMsg->SetCode(SLIP_RX_MESSAGE_ID);
00053         pclMsg->SetData(NULL);
00054         SlipMux::GetQueue()->Send(pclMsg);
00055     }
00056 }
00057
00058 //---------------------------------------------------------------------------
00059 void SlipMux::Init(const K_CHAR *pcDriverPath_, K_USHORT usRxSize_, K_UCHAR *aucRx_, K_USHORT
      usTxSize_, K_UCHAR *aucTx_)
00060 {
00061     m_pclDriver = DriverList::FindByPath(pcDriverPath_);
00062     m_pclMessageQueue = NULL;
```

```

    m_clSlip.SetDriver(m_pclDriver);
    m_clSlipSem.Init(0, 1);

    m_pclDriver->Control(CMD_SET_BUFFERS, (void*)aucRx_, usRxSize_, (void*)aucTx_, usTxSize_);
    m_pclDriver->Control(CMD_SET_RX_CALLBACK, (void*)SlipMux_CallBack, 0, 0, 0);
    {
        K_UCHAR ucEscape = 192;
        m_pclDriver->Control(CMD_SET_RX_ESCAPE, (void*)&ucEscape, 1, 0, NULL);
    }
}

//---------------------------------------------------------------------------
void SlipMux::InstallHandler( K_UCHAR ucChannel_, Slip_Channel pfHandler_ )
{
    if (pfHandler_)
    {
        m_apfChannelHandlers[ucChannel_] = pfHandler_;
    }
}

//---------------------------------------------------------------------------
void SlipMux::MessageReceive(void)
{
    K_USHORT usLen;
    K_UCHAR ucChannel;

    usLen = m_clSlip.ReadData( &ucChannel, (K_CHAR*)m_aucData, SLIP_BUFFER_SIZE );
    if (usLen && (m_apfChannelHandlers[ucChannel] != NULL))
    {
        m_apfChannelHandlers[ucChannel]( m_pclDriver, ucChannel, &(m_aucData[3]), usLen);
    }

    // Re-enable the driver once we're done.
    m_pclDriver->Control( CMD_SET_RX_ENABLE, 0, 0, 0, 0 );
}

```

17.163 /home/mo/mark3-source/embedded/stage/src/slip_mux.h File Reference

FunkenSlip Channel Multiplexer.

```
#include "kerneltypes.h"
#include "driver.h"
#include "ksemaphore.h"
#include "message.h"
#include "slip.h"
```

Classes

- class SlipMux

  Static-class which implements a multiplexed stream of SLIP data over a single interface.

Macros

- #define **SLIP_BUFFER_SIZE** (32)
- #define **SLIP_RX_MESSAGE_ID** (0xD00D)

Typedefs

- typedef void(∗ **Slip_Channel**)(Driver ∗pclDriver_, K_UCHAR ucChannel_, K_UCHAR ∗pucData_, K_USHORT usLen_)

17.163.1 Detailed Description

FunkenSlip Channel Multiplexer. Demultiplexes FunkenSlip packets transmitted over a single serial channel

Definition in file slip_mux.h.

17.164 slip_mux.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \    ||     |     ||  |/ /     ||___   |
|     \/   | ||     \   ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "driver.h"
#include "ksemaphore.h"
#include "message.h"
#include "slip.h"

#ifndef __SLIP_MUX_H__
#define __SLIP_MUX_H__

//---------------------------------------------------------------------------
#define SLIP_BUFFER_SIZE    (32)

#define SLIP_RX_MESSAGE_ID    (0xD00D)

//---------------------------------------------------------------------------
typedef void (*Slip_Channel)( Driver *pclDriver_, K_UCHAR ucChannel_, K_UCHAR *pucData_, K_USHORT
usLen_ );

//---------------------------------------------------------------------------
class SlipMux
{
public:
    static void Init(const K_CHAR *pcDriverPath_, K_USHORT usRxSize_, K_UCHAR *aucRx_, K_USHORT
usTxSize_, K_UCHAR *aucTx_);

    static void InstallHandler( K_UCHAR ucChannel_, Slip_Channel pfHandler_ );

    static void MessageReceive();

    static Driver *GetDriver(){ return m_pclDriver; }

    static MessageQueue *GetQueue(){ return m_pclMessageQueue; }

    static void SetQueue( MessageQueue *pclMessageQueue_ )
        { m_pclMessageQueue = pclMessageQueue_; }


    static Slip *GetSlip(){ return &m_clSlip; }

private:
    static MessageQueue *m_pclMessageQueue;
    static Driver *m_pclDriver;
    static Slip_Channel m_apfChannelHandlers[SLIP_CHANNEL_COUNT];
    static K_UCHAR m_aucData[SLIP_BUFFER_SIZE];
    static Semaphore m_clSlipSem;
    static Slip m_clSlip;
};

#endif
```

17.165 /home/mo/mark3-source/embedded/stage/src/slipterm.cpp File Reference

Serial debug interface using SLIP protocol, and FunkenSlip multiplexing.

```
#include "kerneltypes.h"
#include "slip.h"
#include "slipterm.h"
```

17.165.1 Detailed Description

Serial debug interface using SLIP protocol, and FunkenSlip multiplexing.

Definition in file slipterm.cpp.

17.166 slipterm.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||  |  \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_____|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "slip.h"
#include "slipterm.h"

//---------------------------------------------------------------------------
void SlipTerm::Init()
{
    m_clSlip.SetDriver( DriverList::FindByPath("/dev/tty" ) );

    m_ucVerbosity = SEVERITY_DEBUG;
}

//---------------------------------------------------------------------------
K_USHORT SlipTerm::StrLen( const char *szLine_ )
{
    K_USHORT i=0;
    while (szLine_[i] != 0 )
    {
        i++;
    }
    return i;
}

//---------------------------------------------------------------------------
void SlipTerm::PrintLn( const char *szLine_ )
{
    SlipDataVector astData[2];
    astData[0].pucData = (K_UCHAR*)szLine_;
    astData[0].ucSize = StrLen(szLine_);
    astData[1].pucData = (K_UCHAR*)"\r\n";
    astData[1].ucSize = 2;

    m_clSlip.WriteVector(SLIP_CHANNEL_TERMINAL, astData, 2);
}

//---------------------------------------------------------------------------
void SlipTerm::PrintLn( K_UCHAR ucSeverity_, const char *szLine_ )
{
    if (ucSeverity_ <= m_ucVerbosity)
    {
        PrintLn( szLine_ );
    }
}
```

17.167 /home/mo/mark3-source/embedded/stage/src/slipterm.h File Reference

Serial debug interface using SLIP serial, and Funkenslip serial port multiplexing.

```
#include "kerneltypes.h"
#include "driver.h"
#include "slip.h"
```

Classes

- class SlipTerm

  Class implementing a simple debug terminal interface.

Macros

- #define **SEVERITY_DEBUG** 4
- #define **SEVERITY_INFO** 3
- #define **SEVERITY_WARN** 2
- #define **SEVERITY_CRITICAL** 1
- #define **SEVERITY_CATASTROPHIC** 0
- #define **__SLIPTERM_H__**

17.167.1 Detailed Description

Serial debug interface using SLIP serial, and Funkenslip serial port multiplexing.

Definition in file slipterm.h.

17.168 slipterm.h

```
/*============================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__ ______
|    \  /  | ||    \    ||     |     ||  |/ /     ||___   |
|     \/   | ||     \   ||     \     ||  |  \     ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||______|
    |_____|      |_____|     |_____|     |_____|

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============================================================================*/
#include "kerneltypes.h"
#include "driver.h"
#include "slip.h"

//----------------------------------------------------------------------------
#define SEVERITY_DEBUG                4
#define SEVERITY_INFO                3
#define SEVERITY_WARN                2
#define SEVERITY_CRITICAL            1
#define SEVERITY_CATASTROPHIC        0

//----------------------------------------------------------------------------
#ifndef __SLIPTERM_H__
#define __SLIPTERM_H__

class SlipTerm
{
public:
    void Init();

    void PrintLn( const char *szLine_ );

    void PrintLn( K_UCHAR ucSeverity_, const char *szLine_ );

    void SetVerbosity( K_UCHAR ucLevel_ ) { m_ucVerbosity = ucLevel_; }
private:
    K_USHORT StrLen( const char *szString_ );

    K_UCHAR m_ucVerbosity;

    Slip m_clSlip;
};

#endif
```

17.169 /home/mo/mark3-source/embedded/stage/src/system_heap.cpp File Reference

Global system-heap implementation.

```
#include "kerneltypes.h"
#include "system_heap_config.h"
#include "system_heap.h"
```

17.169.1 Detailed Description

Global system-heap implementation. Provides a system-wide malloc/free paradigm allocation scheme.

Definition in file system_heap.cpp.

17.170 system_heap.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_____|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "system_heap_config.h"
#include "system_heap.h"

#if USE_SYSTEM_HEAP

//---------------------------------------------------------------------------
K_UCHAR    SystemHeap::m_pucRawHeap[ HEAP_RAW_SIZE ];
HeapConfig SystemHeap::m_pclSystemHeapConfig[ HEAP_NUM_SIZES + 1];
FixedHeap  SystemHeap::m_clSystemHeap;
bool       SystemHeap::m_bInit;

//---------------------------------------------------------------------------
void SystemHeap::Init(void)
{
#if HEAP_NUM_SIZES > 0
    m_pclSystemHeapConfig[0].m_usBlockSize  = HEAP_BLOCK_SIZE_1;
    m_pclSystemHeapConfig[0].m_usBlockCount = HEAP_BLOCK_COUNT_1;
#endif
#if HEAP_NUM_SIZES > 1
    m_pclSystemHeapConfig[1].m_usBlockSize  = HEAP_BLOCK_SIZE_2;
    m_pclSystemHeapConfig[1].m_usBlockCount = HEAP_BLOCK_COUNT_2;
#endif
#if HEAP_NUM_SIZES > 2
    m_pclSystemHeapConfig[2].m_usBlockSize  = HEAP_BLOCK_SIZE_3;
    m_pclSystemHeapConfig[2].m_usBlockCount = HEAP_BLOCK_COUNT_3;
#endif
#if HEAP_NUM_SIZES > 3
    m_pclSystemHeapConfig[3].m_usBlockSize  = HEAP_BLOCK_SIZE_4;
    m_pclSystemHeapConfig[3].m_usBlockCount = HEAP_BLOCK_COUNT_4;
#endif
#if HEAP_NUM_SIZES > 4
    m_pclSystemHeapConfig[4].m_usBlockSize  = HEAP_BLOCK_SIZE_5;
    m_pclSystemHeapConfig[4].m_usBlockCount = HEAP_BLOCK_COUNT_5;
#endif
#if HEAP_NUM_SIZES > 5
    m_pclSystemHeapConfig[5].m_usBlockSize  = HEAP_BLOCK_SIZE_6;
    m_pclSystemHeapConfig[5].m_usBlockCount = HEAP_BLOCK_COUNT_6;
#endif
#if HEAP_NUM_SIZES > 6
    m_pclSystemHeapConfig[6].m_usBlockSize  = HEAP_BLOCK_SIZE_7;
    m_pclSystemHeapConfig[6].m_usBlockCount = HEAP_BLOCK_COUNT_7;
#endif
#if HEAP_NUM_SIZES > 7
    m_pclSystemHeapConfig[7].m_usBlockSize  = HEAP_BLOCK_SIZE_8;
    m_pclSystemHeapConfig[7].m_usBlockCount = HEAP_BLOCK_COUNT_8;
#endif
#if HEAP_NUM_SIZES > 8
    m_pclSystemHeapConfig[8].m_usBlockSize  = HEAP_BLOCK_SIZE_9;
    m_pclSystemHeapConfig[8].m_usBlockCount = HEAP_BLOCK_COUNT_9;
#endif
#if HEAP_NUM_SIZES > 9
    m_pclSystemHeapConfig[9].m_usBlockSize  = HEAP_BLOCK_SIZE_10;
    m_pclSystemHeapConfig[9].m_usBlockCount = HEAP_BLOCK_COUNT_10;
#endif
#if HEAP_NUM_SIZES > 10
    m_pclSystemHeapConfig[10].m_usBlockSize  = HEAP_BLOCK_SIZE_11;
    m_pclSystemHeapConfig[10].m_usBlockCount = HEAP_BLOCK_COUNT_11;
#endif
#if HEAP_NUM_SIZES > 11
    m_pclSystemHeapConfig[11].m_usBlockSize  = HEAP_BLOCK_SIZE_12;
    m_pclSystemHeapConfig[11].m_usBlockCount = HEAP_BLOCK_COUNT_12;
#endif
#if HEAP_NUM_SIZES > 12
    m_pclSystemHeapConfig[12].m_usBlockSize  = HEAP_BLOCK_SIZE_13;
    m_pclSystemHeapConfig[12].m_usBlockCount = HEAP_BLOCK_COUNT_13;
#endif
#if HEAP_NUM_SIZES > 13
    m_pclSystemHeapConfig[13].m_usBlockSize  = HEAP_BLOCK_SIZE_14;
    m_pclSystemHeapConfig[13].m_usBlockCount = HEAP_BLOCK_COUNT_14;
#endif
#if HEAP_NUM_SIZES > 14
    m_pclSystemHeapConfig[14].m_usBlockSize  = HEAP_BLOCK_SIZE_15;
    m_pclSystemHeapConfig[14].m_usBlockCount = HEAP_BLOCK_COUNT_15;
#endif
#if HEAP_NUM_SIZES > 15
    m_pclSystemHeapConfig[15].m_usBlockSize  = HEAP_BLOCK_SIZE_16;
    m_pclSystemHeapConfig[15].m_usBlockCount = HEAP_BLOCK_COUNT_16;
#endif
#if HEAP_NUM_SIZES > 16
    m_pclSystemHeapConfig[16].m_usBlockSize  = HEAP_BLOCK_SIZE_17;
    m_pclSystemHeapConfig[16].m_usBlockCount = HEAP_BLOCK_COUNT_17;
#endif
#if HEAP_NUM_SIZES > 17
    m_pclSystemHeapConfig[17].m_usBlockSize  = HEAP_BLOCK_SIZE_18;
    m_pclSystemHeapConfig[17].m_usBlockCount = HEAP_BLOCK_COUNT_18;
#endif
#if HEAP_NUM_SIZES > 18
    m_pclSystemHeapConfig[18].m_usBlockSize  = HEAP_BLOCK_SIZE_19;
    m_pclSystemHeapConfig[18].m_usBlockCount = HEAP_BLOCK_COUNT_19;
#endif
#if HEAP_NUM_SIZES > 19
    m_pclSystemHeapConfig[19].m_usBlockSize  = HEAP_BLOCK_SIZE_20;
    m_pclSystemHeapConfig[19].m_usBlockCount = HEAP_BLOCK_COUNT_20;
#endif
#if HEAP_NUM_SIZES > 20
    m_pclSystemHeapConfig[20].m_usBlockSize  = HEAP_BLOCK_SIZE_21;
    m_pclSystemHeapConfig[20].m_usBlockCount = HEAP_BLOCK_COUNT_21;
#endif

    m_pclSystemHeapConfig[HEAP_NUM_SIZES].
m_usBlockSize = 0;
    m_pclSystemHeapConfig[HEAP_NUM_SIZES].
m_usBlockCount = 0;

    m_clSystemHeap.Create((void*)m_pucRawHeap,
m_pclSystemHeapConfig);

    m_bInit = true;
}

//---------------------------------------------------------------------------
void *SystemHeap::Alloc(K_USHORT usSize_)
{
    if (!m_bInit)
    {
        return NULL;
    }
    return m_clSystemHeap.Alloc(usSize_);
}
```

```

//------------------------------------------------------------------------
void SystemHeap::Free(void* pvBlock_)
{
    if (!m_bInit)
    {
        return;
    }
    m_clSystemHeap.Free(pvBlock_);
}

#endif // USE_SYSTEM_HEAP
```

17.171 /home/mo/mark3-source/embedded/stage/src/system_heap.h File Reference

Global system-heap implmentation.

```
#include "system_heap_config.h"
#include "fixed_heap.h"
```

Classes

- class SystemHeap

  The SystemHeap class implements a heap which is accessible from all components in the system.

Macros

- #define HEAP_RAW_SIZE_1 ((HEAP_BLOCK_SIZE_1 + sizeof(LinkListNode) + sizeof(void∗)) ∗ HEAP_BL-OCK_COUNT_1)

  Really ugly computations used to auto-size the heap footprint based on the user-configuration data.
- #define **HEAP_RAW_SIZE_2** ((HEAP_BLOCK_SIZE_2 + sizeof(LinkListNode) + sizeof(void∗)) ∗ HEAP_BL-OCK_COUNT_2)
- #define **HEAP_RAW_SIZE_3** ((HEAP_BLOCK_SIZE_3 + sizeof(LinkListNode) + sizeof(void∗)) ∗ HEAP_BL-OCK_COUNT_3)
- #define **HEAP_RAW_SIZE_4** 0
- #define **HEAP_RAW_SIZE_5** 0
- #define **HEAP_RAW_SIZE_6** 0
- #define **HEAP_RAW_SIZE_7** 0
- #define **HEAP_RAW_SIZE_8** 0
- #define **HEAP_RAW_SIZE_9** 0
- #define **HEAP_RAW_SIZE_10** 0
- #define **HEAP_RAW_SIZE_11** 0
- #define **HEAP_RAW_SIZE_12** 0
- #define **HEAP_RAW_SIZE_13** 0
- #define **HEAP_RAW_SIZE_14** 0
- #define **HEAP_RAW_SIZE_15** 0
- #define **HEAP_RAW_SIZE_16** 0
- #define **HEAP_RAW_SIZE_17** 0
- #define **HEAP_RAW_SIZE_18** 0
- #define **HEAP_RAW_SIZE_19** 0
- #define **HEAP_RAW_SIZE_20** 0
- #define **HEAP_RAW_SIZE_21** 0
- #define **HEAP_RAW_SIZE**

17.171.1 Detailed Description

Global system-heap implmentation. Provides a basic malloc()/free() allocation scheme.

Definition in file system_heap.h.

17.171.2 Macro Definition Documentation

17.171.2.1 #define HEAP_RAW_SIZE

Value:

```
HEAP_RAW_SIZE_1 + \
HEAP_RAW_SIZE_2 + \
HEAP_RAW_SIZE_3 + \
HEAP_RAW_SIZE_4 + \
HEAP_RAW_SIZE_5 + \
HEAP_RAW_SIZE_6 + \
HEAP_RAW_SIZE_7 + \
HEAP_RAW_SIZE_8 + \
HEAP_RAW_SIZE_9 + \
HEAP_RAW_SIZE_10 + \
HEAP_RAW_SIZE_11 + \
HEAP_RAW_SIZE_12 + \
HEAP_RAW_SIZE_13 + \
HEAP_RAW_SIZE_14 + \
HEAP_RAW_SIZE_15 + \
HEAP_RAW_SIZE_16 + \
HEAP_RAW_SIZE_17 + \
HEAP_RAW_SIZE_18 + \
HEAP_RAW_SIZE_19 + \
HEAP_RAW_SIZE_20 + \
HEAP_RAW_SIZE_21
```

Definition at line 161 of file system_heap.h.

17.171.2.2 #define HEAP_RAW_SIZE_1 ((HEAP_BLOCK_SIZE_1 + sizeof(LinkListNode) + sizeof(void∗)) ∗ HEAP_BLOCK_COUNT_1)

Really ugly computations used to auto-size the heap footprint based on the user-configuration data.

(don't touch this!!!)

Definition at line 35 of file system_heap.h.

17.172 system_heap.h

```
00001 /*===========================================================================
00002      _____        _____        _____        _____
00003  ___|    _|__  __|_    |__  __|__   |__  __| __  |__ _______
00004 |    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
00005 |     \/   | ||     \     ||     \     ||     \     ||___   |
00006 |__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
00007     |_____|      |_____|      |_____|      |_____|
00008 
00009 --[Mark3 Realtime Platform]--------------------------------------------------
00010 
00011 Copyright (c) 2012 Funkenstein Software Consulting, all rights reserved.
00012 See license.txt for more information
00013 ===========================================================================*/
00021 #ifndef __SYSTEM_HEAP_H__
00022 #define __SYSTEM_HEAP_H__
00023 
00024 #include "system_heap_config.h"
00025 #include "fixed_heap.h"
00026 
00027 #if USE_SYSTEM_HEAP
00028 
00029 //---------------------------------------------------------------------------
00034 #if HEAP_NUM_SIZES > 0
00035     #define HEAP_RAW_SIZE_1 ((HEAP_BLOCK_SIZE_1 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_1 )
#else
    #define HEAP_RAW_SIZE_1 0
#endif

#if HEAP_NUM_SIZES > 1
    #define HEAP_RAW_SIZE_2 ((HEAP_BLOCK_SIZE_2 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_2 )
#else
    #define HEAP_RAW_SIZE_2 0
#endif

#if HEAP_NUM_SIZES > 2
    #define HEAP_RAW_SIZE_3 ((HEAP_BLOCK_SIZE_3 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_3 )
#else
    #define HEAP_RAW_SIZE_3 0
#endif

#if HEAP_NUM_SIZES > 3
    #define HEAP_RAW_SIZE_4 ((HEAP_BLOCK_SIZE_4 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_4 )
#else
    #define HEAP_RAW_SIZE_4 0
#endif

#if HEAP_NUM_SIZES > 4
    #define HEAP_RAW_SIZE_5 ((HEAP_BLOCK_SIZE_5 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_5 )
#else
    #define HEAP_RAW_SIZE_5 0
#endif

#if HEAP_NUM_SIZES > 5
    #define HEAP_RAW_SIZE_6 ((HEAP_BLOCK_SIZE_6 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_6 )
#else
    #define HEAP_RAW_SIZE_6 0
#endif

#if HEAP_NUM_SIZES > 6
    #define HEAP_RAW_SIZE_7 ((HEAP_BLOCK_SIZE_7 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_7 )
#else
    #define HEAP_RAW_SIZE_7 0
#endif

#if HEAP_NUM_SIZES > 7
    #define HEAP_RAW_SIZE_8 ((HEAP_BLOCK_SIZE_8 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_8 )
#else
    #define HEAP_RAW_SIZE_8 0
#endif

#if HEAP_NUM_SIZES > 8
    #define HEAP_RAW_SIZE_9 ((HEAP_BLOCK_SIZE_9 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_9 )
#else
    #define HEAP_RAW_SIZE_9 0
#endif

#if HEAP_NUM_SIZES > 9
    #define HEAP_RAW_SIZE_10 ((HEAP_BLOCK_SIZE_10 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_10 )
#else
    #define HEAP_RAW_SIZE_10 0
#endif

#if HEAP_NUM_SIZES > 10
    #define HEAP_RAW_SIZE_11 ((HEAP_BLOCK_SIZE_11 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_11 )
#else
    #define HEAP_RAW_SIZE_11 0
#endif

#if HEAP_NUM_SIZES > 11
    #define HEAP_RAW_SIZE_12 ((HEAP_BLOCK_SIZE_12 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_12 )
#else
    #define HEAP_RAW_SIZE_12 0
#endif

#if HEAP_NUM_SIZES > 12
    #define HEAP_RAW_SIZE_13 ((HEAP_BLOCK_SIZE_13 + sizeof(LinkListNode) + sizeof(void*)) * HEAP_BLOCK_COUNT_13 )
#else
    #define HEAP_RAW_SIZE_13 0
```

```
#endif

#if HEAP_NUM_SIZES > 13
    #define HEAP_RAW_SIZE_14 ((HEAP_BLOCK_SIZE_14 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_14 )
#else
    #define HEAP_RAW_SIZE_14 0
#endif

#if HEAP_NUM_SIZES > 14
    #define HEAP_RAW_SIZE_15 ((HEAP_BLOCK_SIZE_15 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_15 )
#else
    #define HEAP_RAW_SIZE_15 0
#endif

#if HEAP_NUM_SIZES > 15
    #define HEAP_RAW_SIZE_16 ((HEAP_BLOCK_SIZE_16 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_16 )
#else
    #define HEAP_RAW_SIZE_16 0
#endif

#if HEAP_NUM_SIZES > 16
    #define HEAP_RAW_SIZE_17 ((HEAP_BLOCK_SIZE_17 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_17 )
#else
    #define HEAP_RAW_SIZE_17 0
#endif

#if HEAP_NUM_SIZES > 17
    #define HEAP_RAW_SIZE_18 ((HEAP_BLOCK_SIZE_18 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_18 )
#else
    #define HEAP_RAW_SIZE_18 0
#endif

#if HEAP_NUM_SIZES > 18
    #define HEAP_RAW_SIZE_19 ((HEAP_BLOCK_SIZE_19 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_19 )
#else
    #define HEAP_RAW_SIZE_19 0
#endif

#if HEAP_NUM_SIZES > 19
    #define HEAP_RAW_SIZE_20 ((HEAP_BLOCK_SIZE_20 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_20 )
#else
    #define HEAP_RAW_SIZE_20 0
#endif

#if HEAP_NUM_SIZES > 20
    #define HEAP_RAW_SIZE_21 ((HEAP_BLOCK_SIZE_21 + sizeof(LinkListNode) + sizeof(void*)) *
 HEAP_BLOCK_COUNT_21 )
#else
    #define HEAP_RAW_SIZE_21 0
#endif

//---------------------------------------------------------------------------
#define HEAP_RAW_SIZE    \
HEAP_RAW_SIZE_1 + \
HEAP_RAW_SIZE_2 + \
HEAP_RAW_SIZE_3 + \
HEAP_RAW_SIZE_4 + \
HEAP_RAW_SIZE_5 + \
HEAP_RAW_SIZE_6 + \
HEAP_RAW_SIZE_7 + \
HEAP_RAW_SIZE_8 + \
HEAP_RAW_SIZE_9 + \
HEAP_RAW_SIZE_10 + \
HEAP_RAW_SIZE_11 + \
HEAP_RAW_SIZE_12 + \
HEAP_RAW_SIZE_13 + \
HEAP_RAW_SIZE_14 + \
HEAP_RAW_SIZE_15 + \
HEAP_RAW_SIZE_16 + \
HEAP_RAW_SIZE_17 + \
HEAP_RAW_SIZE_18 + \
HEAP_RAW_SIZE_19 + \
HEAP_RAW_SIZE_20 + \
HEAP_RAW_SIZE_21

//---------------------------------------------------------------------------
class SystemHeap
{
public:
    static void  Init(void);
    static void* Alloc(K_USHORT usSize_);

    static void  Free(void *pvData_);

private:
    static K_UCHAR m_pucRawHeap[ HEAP_RAW_SIZE ];
    static HeapConfig m_pclSystemHeapConfig[
HEAP_NUM_SIZES + 1 ];
    static FixedHeap m_clSystemHeap;
    static bool m_bInit;
};

#endif // USE_SYSTEM_HEAP

#endif // __SYSTEM_HEAP_H__
```

17.173 /home/mo/mark3-source/embedded/stage/src/system_heap_config.h File Reference

System heap configuration - defines the block sizes and counts used to fulfill system/service allocations.

`#include "kerneltypes.h"`

Macros

- #define USE_SYSTEM_HEAP (1)

  Set this to "1" if you want the system heap to be built as part of this library.
- #define HEAP_NUM_SIZES (3)

  Define the number of heap block sizes that we want to have attached to our system heap.
- #define HEAP_BLOCK_SIZE_1 ((K_USHORT) 8)

  Define the block sizes for each of the fixed-size blocks that will be managed by our heaps.
- #define **HEAP_BLOCK_SIZE_2** ((K_USHORT) 16)
- #define **HEAP_BLOCK_SIZE_3** ((K_USHORT) 24)
- #define **HEAP_BLOCK_SIZE_4** ((K_USHORT) 32)
- #define **HEAP_BLOCK_SIZE_5** ((K_USHORT) 48)
- #define **HEAP_BLOCK_SIZE_6** ((K_USHORT) 64)
- #define **HEAP_BLOCK_SIZE_7** ((K_USHORT) 96)
- #define **HEAP_BLOCK_SIZE_8** ((K_USHORT) 128)
- #define **HEAP_BLOCK_SIZE_9** ((K_USHORT) 192)
- #define **HEAP_BLOCK_SIZE_10** ((K_USHORT) 256)
- #define HEAP_BLOCK_COUNT_1 ((K_USHORT) 4)

  Define the number of blocks in each bin, tailored for a particular application.
- #define **HEAP_BLOCK_COUNT_2** ((K_USHORT) 4)
- #define **HEAP_BLOCK_COUNT_3** ((K_USHORT) 2)
- #define **HEAP_BLOCK_COUNT_4** ((K_USHORT) 2)
- #define **HEAP_BLOCK_COUNT_5** ((K_USHORT) 2)
- #define **HEAP_BLOCK_COUNT_6** ((K_USHORT) 2)
- #define **HEAP_BLOCK_COUNT_7** ((K_USHORT) 1)
- #define **HEAP_BLOCK_COUNT_8** ((K_USHORT) 1)
- #define **HEAP_BLOCK_COUNT_9** ((K_USHORT) 1)
- #define **HEAP_BLOCK_COUNT_10** ((K_USHORT) 1)

17.173.1 Detailed Description

System heap configuration - defines the block sizes and counts used to fulfill system/service allocations.

Definition in file system_heap_config.h.

17.173.2 Macro Definition Documentation

17.173.2.1 #define HEAP_BLOCK_SIZE_1 ((K_USHORT) 8)

Define the block sizes for each of the fixed-size blocks that will be managed by our heaps.

Must be defined in incrementing order.

Definition at line 44 of file system_heap_config.h.

17.174 system_heap_config.h

```
00001 /*===========================================================================
00002      _____     _____     _____     _____
00003  ___|    _|__ __|_    |__ __|__   |__ __| __  |__  _____
00004 |    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
00005 |     \/   | ||     \    ||     \     ||     \     ||___   |
00006 |__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_____|
00007     |_____|      |_____|      |_____|      |_____|
00008 
00009 --[Mark3 Realtime Platform]--------------------------------------------------
00010 
00011 Copyright (c) 2012 Funkenstein Software Consulting, all rights reserved.
00012 See license.txt for more information
00013 ===========================================================================*/
00020 #ifndef __SYSTEM_HEAP_CONFIG_H__
00021 #define __SYSTEM_HEAP_CONFIG_H__
00022 
00023 #include "kerneltypes.h"
00024 
00025 //---------------------------------------------------------------------------
00030 #define USE_SYSTEM_HEAP        (1)
00031 
00032 //---------------------------------------------------------------------------
00037 #define HEAP_NUM_SIZES        (3)
00038 
00039 //---------------------------------------------------------------------------
00044 #define HEAP_BLOCK_SIZE_1        ((K_USHORT) 8)
00045 #define HEAP_BLOCK_SIZE_2        ((K_USHORT) 16)
00046 #define HEAP_BLOCK_SIZE_3        ((K_USHORT) 24)
00047 #define HEAP_BLOCK_SIZE_4        ((K_USHORT) 32)
00048 #define HEAP_BLOCK_SIZE_5        ((K_USHORT) 48)
00049 #define HEAP_BLOCK_SIZE_6        ((K_USHORT) 64)
00050 #define HEAP_BLOCK_SIZE_7        ((K_USHORT) 96)
00051 #define HEAP_BLOCK_SIZE_8        ((K_USHORT) 128)
00052 #define HEAP_BLOCK_SIZE_9        ((K_USHORT) 192)
00053 #define HEAP_BLOCK_SIZE_10        ((K_USHORT) 256)
00054 
00055 //---------------------------------------------------------------------------
00060 #define HEAP_BLOCK_COUNT_1        ((K_USHORT) 4)
00061 #define HEAP_BLOCK_COUNT_2        ((K_USHORT) 4)
00062 #define HEAP_BLOCK_COUNT_3        ((K_USHORT) 2)
00063 #define HEAP_BLOCK_COUNT_4        ((K_USHORT) 2)
00064 #define HEAP_BLOCK_COUNT_5        ((K_USHORT) 2)
00065 #define HEAP_BLOCK_COUNT_6        ((K_USHORT) 2)
00066 #define HEAP_BLOCK_COUNT_7        ((K_USHORT) 1)
00067 #define HEAP_BLOCK_COUNT_8        ((K_USHORT) 1)
00068 #define HEAP_BLOCK_COUNT_9        ((K_USHORT) 1)
00069 #define HEAP_BLOCK_COUNT_10        ((K_USHORT) 1)
00070 
00071 #endif
00072 
```

17.175 /home/mo/mark3-source/embedded/stage/src/thread.cpp File Reference

Platform-Independent thread class Definition.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "thread.h"
#include "scheduler.h"
#include "kernelswi.h"
#include "timerlist.h"
#include "ksemaphore.h"
#include "quantum.h"
#include "kernel.h"
#include "kernel_debug.h"
```

Macros

- #define **__FILE_ID__** THREAD_CPP

Functions

- static void ThreadSleepCallback (Thread ∗pclOwner_, void ∗pvData_)

  This callback is used to wake up a thread once the interval has expired.

17.175.1 Detailed Description

Platform-Independent thread class Definition.

Definition in file thread.cpp.

17.176 thread.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /    ||___   |
|     \/   | ||     \    ||     \     ||  |  \    ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]-------------------------------------------------

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See license.txt for more information
===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "thread.h"
#include "scheduler.h"
#include "kernelswi.h"
#include "timerlist.h"
#include "ksemaphore.h"
#include "quantum.h"
#include "kernel.h"
#include "kernel_debug.h"

//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     THREAD_CPP

//---------------------------------------------------------------------------
void Thread::Init(  K_WORD *pwStack_,
                K_USHORT usStackSize_,
                K_UCHAR ucPriority_,
                ThreadEntry_t pfEntryPoint_,
                void *pvArg_ )
{
    static K_UCHAR ucThreadID = 0;

    KERNEL_ASSERT( pwStack_ );
    KERNEL_ASSERT( pfEntryPoint_ );

    m_ucThreadID = ucThreadID++;

    KERNEL_TRACE_1( STR_STACK_SIZE_1, usStackSize_ );
    KERNEL_TRACE_1( STR_PRIORITY_1, (K_UCHAR)ucPriority_ );
    KERNEL_TRACE_1( STR_THREAD_ID_1, (K_USHORT)m_ucThreadID );
    KERNEL_TRACE_1( STR_ENTRYPOINT_1, (K_USHORT)pfEntryPoint_ );

    // Initialize the thread parameters to their initial values.
    m_pwStack = pwStack_;
    m_pwStackTop = TOP_OF_STACK(pwStack_, usStackSize_);

    m_usStackSize = usStackSize_;

#if KERNEL_USE_QUANTUM
    m_usQuantum = 4;
#endif

    m_ucPriority = ucPriority_;
    m_ucCurPriority = m_ucPriority;
    m_pfEntryPoint = pfEntryPoint_;
    m_pvArg = pvArg_;

#if KERNEL_USE_THREADNAME
    m_szName = NULL;
#endif

    // Call CPU-specific stack initialization
    ThreadPort::InitStack(this);

    // Add to the global "stop" list.
    CS_ENTER();
    m_pclOwner = Scheduler::GetThreadList(
m_ucPriority);
    m_pclCurrent = Scheduler::GetStopList();
    m_pclCurrent->Add(this);
    CS_EXIT();
}

//---------------------------------------------------------------------------
void Thread::Start(void)
{
    // Remove the thread from the scheduler's "stopped" list, and add it
    // to the scheduler's ready list at the proper priority.
    KERNEL_TRACE_1( STR_THREAD_START_1, (K_USHORT)m_ucThreadID );

    CS_ENTER();
    Scheduler::GetStopList()->Remove(this);
    Scheduler::Add(this);
    m_pclOwner = Scheduler::GetThreadList(
m_ucPriority);
    m_pclCurrent = m_pclOwner;

    if (Kernel::IsStarted())
    {
        if (m_ucPriority >= Scheduler::GetCurrentThread()->
GetCurPriority())
        {
#if KERNEL_USE_QUANTUM
            // Deal with the thread Quantum
            Quantum::RemoveThread();
            Quantum::AddThread(this);
#endif
        }
        if (m_ucPriority > Scheduler::GetCurrentThread()->
GetPriority())
        {
            Thread::Yield();
        }
    }
    CS_EXIT();
}

//---------------------------------------------------------------------------
void Thread::Stop()
{
    K_UCHAR bReschedule = 0;

    CS_ENTER();

    // If a thread is attempting to stop itself, ensure we call the scheduler
    if (this == Scheduler::GetCurrentThread())
    {
        bReschedule = true;
    }

    // Add this thread to the stop-list (removing it from active scheduling)
    Scheduler::Remove(this);
    m_pclOwner = Scheduler::GetStopList();
    m_pclCurrent = m_pclOwner;
    m_pclOwner->Add(this);

    CS_EXIT();

    if (bReschedule)
    {
        Thread::Yield();
    }
}

#if KERNEL_USE_DYNAMIC_THREADS
//---------------------------------------------------------------------------
void Thread::Exit()
{
    K_UCHAR bReschedule = 0;

    KERNEL_TRACE_1( STR_THREAD_EXIT_1, m_ucThreadID );

    CS_ENTER();

    // If this thread is the actively-running thread, make sure we run the
    // scheduler again.
    if (this == Scheduler::GetCurrentThread())
    {
        bReschedule = 1;
    }

    // Remove the thread from scheduling
    m_pclCurrent->Remove(this);

#if KERNEL_USE_TIMERS
    // Just to be safe - attempt to remove the thread's timer
    // from the timer-scheduler (does no harm if it isn't
    // in the timer-list)
    TimerScheduler::Remove(&m_clTimer);
#endif

    CS_EXIT();

    if (bReschedule)
    {
        // Choose a new "next" thread if we must
        Thread::Yield();
    }
}
#endif

#if KERNEL_USE_SLEEP
//---------------------------------------------------------------------------
static void ThreadSleepCallback( Thread *pclOwner_, void *pvData_ )
{
    Semaphore *pclSemaphore = static_cast<Semaphore*>(pvData_);
    // Post the semaphore, which will wake the sleeping thread.
    pclSemaphore->Post();
}

//---------------------------------------------------------------------------
void Thread::Sleep(K_ULONG ulTimeMs_)
{
    Semaphore clSemaphore;
    Timer *pclTimer = g_pstCurrent->GetTimer();

    // Create a semaphore that this thread will block on
    clSemaphore.Init(0, 1);

    // Create a one-shot timer that will call a callback that posts the
    // semaphore, waking our thread.
    pclTimer->Init();
    pclTimer->SetIntervalMSeconds(ulTimeMs_);
    pclTimer->SetCallback(ThreadSleepCallback);
    pclTimer->SetData((void*)&clSemaphore);
    pclTimer->SetFlags(TIMERLIST_FLAG_ONE_SHOT);

    // Add the new timer to the timer scheduler, and block the thread
    TimerScheduler::Add(pclTimer);
    clSemaphore.Pend();
}

//---------------------------------------------------------------------------
void Thread::USleep(K_ULONG ulTimeUs_)
```

```
{
    Semaphore clSemaphore;
    Timer *pclTimer = g_pstCurrent->GetTimer();

    // Create a semaphore that this thread will block on
    clSemaphore.Init(0, 1);

    // Create a one-shot timer that will call a callback that posts the
    // semaphore, waking our thread.
    pclTimer->Init();
    pclTimer->SetIntervalUSeconds(ulTimeUs_);
    pclTimer->SetCallback(ThreadSleepCallback);
    pclTimer->SetData((void*)&clSemaphore);
    pclTimer->SetFlags(TIMERLIST_FLAG_ONE_SHOT);

    // Add the new timer to the timer scheduler, and block the thread
    TimerScheduler::Add(pclTimer);
    clSemaphore.Pend();
}
#endif // KERNEL_USE_SLEEP

//---------------------------------------------------------------------------
K_USHORT Thread::GetStackSlack()
{
    K_USHORT usCount = 0;

    CS_ENTER();

    for (usCount = 0; usCount < m_usStackSize; usCount++)
    {
        if (m_pwStack[usCount] != 0xFF)
        {
            break;
        }
    }

    CS_EXIT();

    return usCount;
}

//---------------------------------------------------------------------------
void Thread::Yield()
{
    CS_ENTER();

    // Run the scheduler
    if (Scheduler::IsEnabled())
    {
        Scheduler::Schedule();

        // Only switch contexts if the new task is different than the old task
        if (Scheduler::GetCurrentThread() !=
Scheduler::GetNextThread())
        {
#if KERNEL_USE_QUANTUM
            // new thread scheduled.  Stop current quantum timer (if it exists),
            // and restart it for the new thread (if required).
            Quantum::RemoveThread();
            Quantum::AddThread(g_pstNext);
#endif
            Thread::ContextSwitchSWI();
        }
    }
    else
    {
        Scheduler::QueueScheduler();
    }

    CS_EXIT();
}

//---------------------------------------------------------------------------
void Thread::SetPriorityBase(K_UCHAR ucPriority_)
{
     GetCurrent()->Remove(this);

     SetCurrent(Scheduler::GetThreadList(
m_ucPriority));

     GetCurrent()->Add(this);
}

//---------------------------------------------------------------------------
void Thread::SetPriority(K_UCHAR ucPriority_)
{
    K_UCHAR bSchedule = 0;
    CS_ENTER();
    // If this is the currently running thread, it's a good idea to reschedule
    // Or, if the new priority is a higher priority than the current thread's.
    if ((g_pstCurrent == this) || (ucPriority_ > g_pstCurrent->GetPriority()))
    {
        bSchedule = 1;
    }
    Scheduler::Remove(this);
    CS_EXIT();

    m_ucCurPriority = ucPriority_;
    m_ucPriority = ucPriority_;

    CS_ENTER();
    Scheduler::Add(this);
    CS_EXIT();

    if (bSchedule)
    {
        if (Scheduler::IsEnabled())
        {
            CS_ENTER();
            Scheduler::Schedule();
    #if KERNEL_USE_QUANTUM
            // new thread scheduled.  Stop current quantum timer (if it exists),
            // and restart it for the new thread (if required).
            Quantum::RemoveThread();
            Quantum::AddThread(g_pstNext);
    #endif
            CS_EXIT();
            Thread::ContextSwitchSWI();
        }
        else
        {
            Scheduler::QueueScheduler();
        }
    }
}

//---------------------------------------------------------------------------
void Thread::InheritPriority(K_UCHAR ucPriority_)
{
    SetOwner(Scheduler::GetThreadList(ucPriority_));
    m_ucCurPriority = ucPriority_;
}

//---------------------------------------------------------------------------
void Thread::ContextSwitchSWI()
{
    // Call the context switch interrupt if the scheduler is enabled.
    if (Scheduler::IsEnabled() == 1)
    {
        KERNEL_TRACE_1( STR_CONTEXT_SWITCH_1, (K_USHORT)g_pstNext->GetID() );
        KernelSWI::Trigger();
    }
}

//---------------------------------------------------------------------------
Timer *Thread::GetTimer()                      { return &
m_clTimer; }
//---------------------------------------------------------------------------

void Thread::SetExpired( K_BOOL bExpired_ )     { m_bExpired = bExpired_; }
//---------------------------------------------------------------------------

K_BOOL Thread::GetExpired()                     { return m_bExpired; }
```

17.177 /home/mo/mark3-source/embedded/stage/src/thread.h File Reference

Platform independent thread class declarations.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"
#include "threadlist.h"
#include "scheduler.h"
#include "threadport.h"
#include "quantum.h"
```

Classes

- class Thread

  Object providing fundamental multitasking support in the kernel.

Typedefs

- typedef void(∗ ThreadEntry_t)(void ∗pvArg_)

  Function pointer type used for thread entrypoint functions.

17.177.1 Detailed Description

Platform independent thread class declarations. Threads are an atomic unit of execution, and each instance of the thread class represents an instance of a program running of the processor. The Thread is the fundmanetal user-facing object in the kernel - it is what makes multiprocessing possible from application code.

In Mark3, threads each have their own context - consisting of a stack, and all of the registers required to multiplex a processor between multiple threads.

The Thread class inherits directly from the LinkListNode class to facilitate efficient thread management using Double, or Double-Circular linked lists.

Definition in file thread.h.

17.178 thread.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__  |__ __| __  |__  ______
|    \  /  | ||    \    ||     |     ||  |/ /    ||___   |
|     \/   | ||     \   ||     \     ||     \    ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __THREAD_H__
#define __THREAD_H__

#include "kerneltypes.h"
#include "mark3cfg.h"

#include "ll.h"
#include "threadlist.h"
#include "scheduler.h"
#include "threadport.h"
#include "quantum.h"

//---------------------------------------------------------------------------
typedef void (*ThreadEntry_t)(void *pvArg_);
class Timer;
//---------------------------------------------------------------------------
class Thread : public LinkListNode
{
public:
    void Init(K_WORD *paucStack_,
              K_USHORT usStackSize_,
              K_UCHAR ucPriority_,
              ThreadEntry_t pfEntryPoint_,
              void *pvArg_ );

    void Start();


    void Stop();

#if KERNEL_USE_THREADNAME

```

```
    void SetName(const K_CHAR *szName_) { m_szName = szName_; }

    const K_CHAR* GetName() { return m_szName; }
#endif

    ThreadList *GetOwner(void) { return m_pclOwner; }

    ThreadList *GetCurrent(void) { return m_pclCurrent; }

    K_UCHAR GetPriority(void) { return m_ucPriority; }

    K_UCHAR GetCurPriority(void) { return m_ucCurPriority; }

#if KERNEL_USE_QUANTUM

    void SetQuantum( K_USHORT usQuantum_ ) { m_usQuantum = usQuantum_; }

    K_USHORT GetQuantum(void) { return m_usQuantum; }
#endif

    void SetCurrent( ThreadList *pclNewList_ ) {
m_pclCurrent = pclNewList_; }

    void SetOwner( ThreadList *pclNewList_ ) { m_pclOwner = pclNewList_; }


    void SetPriority(K_UCHAR ucPriority_);

    void InheritPriority(K_UCHAR ucPriority_);

#if KERNEL_USE_DYNAMIC_THREADS

    void Exit();
#endif

#if KERNEL_USE_SLEEP

    static void Sleep(K_ULONG ulTimeMs_);

    static void USleep(K_ULONG ulTimeUs_);
#endif

    static void Yield(void);

    void SetID( K_UCHAR ucID_ ) { m_ucThreadID = ucID_; }

    K_UCHAR GetID() { return m_ucThreadID; }


    K_USHORT GetStackSlack();

#if KERNEL_USE_EVENTFLAG

    K_USHORT GetEventFlagMask() { return m_usFlagMask; }

    void SetEventFlagMask(K_USHORT usMask_) { m_usFlagMask = usMask_; }

    void SetEventFlagMode(EventFlagOperation_t eMode_ ) {
m_eFlagMode = eMode_; }

    EventFlagOperation_t GetEventFlagMode() { return m_eFlagMode; }
#endif

#if KERNEL_USE_TIMERS

    Timer *GetTimer();
    void SetExpired( K_BOOL bExpired_ );
    K_BOOL GetExpired();
#endif

    friend class ThreadPort;

private:
    static void ContextSwitchSWI(void);

    void SetPriorityBase(K_UCHAR ucPriority_);

    K_WORD *m_pwStackTop;

    K_WORD *m_pwStack;

    K_USHORT m_usStackSize;

#if KERNEL_USE_QUANTUM
    K_USHORT m_usQuantum;
#endif

```

```
    K_UCHAR m_ucThreadID;

    K_UCHAR m_ucPriority;

    K_UCHAR m_ucCurPriority;

    ThreadEntry_t m_pfEntryPoint;

    void *m_pvArg;

#if KERNEL_USE_THREADNAME
    const K_CHAR *m_szName;
#endif

#if KERNEL_USE_EVENTFLAG
    K_USHORT m_usFlagMask;

    EventFlagOperation_t m_eFlagMode;
#endif

#if KERNEL_USE_TIMERS
    Timer  m_clTimer;
    K_BOOL  m_bExpired;
#endif

    ThreadList *m_pclCurrent;

    ThreadList *m_pclOwner;
};

#endif
```

17.179 /home/mo/mark3-source/embedded/stage/src/threadlist.cpp File Reference

Thread linked-list definitions.

```
#include "kerneltypes.h"
#include "ll.h"
#include "threadlist.h"
#include "thread.h"
#include "kernel_debug.h"
```

Macros

- #define **__FILE_ID__** THREADLIST_CPP

17.179.1 Detailed Description

Thread linked-list definitions.

Definition in file threadlist.cpp.

17.180 threadlist.cpp

```
/*============================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||   |       ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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============================================================================*/
#include "kerneltypes.h"
```

```
#include "ll.h"
#include "threadlist.h"
#include "thread.h"
#include "kernel_debug.h"
//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     THREADLIST_CPP

//---------------------------------------------------------------------------
void ThreadList::SetPriority(K_UCHAR ucPriority_)
{
    m_ucPriority = ucPriority_;
}

//---------------------------------------------------------------------------
void ThreadList::SetFlagPointer( K_UCHAR *pucFlag_)
{
    m_pucFlag = pucFlag_;
}

//---------------------------------------------------------------------------
void ThreadList::Add(LinkListNode *node_) {
    CircularLinkList::Add(node_);

    // If the head of the list isn't empty,
    if (m_pstHead != NULL)
    {
        // We've specified a bitmap for this threadlist
        if (m_pucFlag)
        {
            // Set the flag for this priority level
            *m_pucFlag |= (1 << m_ucPriority);
        }
    }
}

//---------------------------------------------------------------------------
void ThreadList::Add(LinkListNode *node_, K_UCHAR *pucFlag_, K_UCHAR ucPriority_
) {
    // Set the threadlist's priority level, flag pointer, and then add the
    // thread to the threadlist
    SetPriority(ucPriority_);
    SetFlagPointer(pucFlag_);
    Add(node_);
}

//---------------------------------------------------------------------------
void ThreadList::Remove(LinkListNode *node_) {
    // Remove the thread from the list
    CircularLinkList::Remove(node_);

    // If the list is empty...
    if (!m_pstHead)
    {
        // Clear the bit in the bitmap at this priority level
        if (m_pucFlag)
        {
            *m_pucFlag &= ~(1 << m_ucPriority);
        }
    }
}

//---------------------------------------------------------------------------
Thread *ThreadList::HighestWaiter()
{
    Thread *pclTemp = static_cast<Thread*>(GetHead());
    Thread *pclChosen = pclTemp;

    K_UCHAR ucMaxPri = 0;

    // Go through the list, return the highest-priority thread in this list.
    while(1)
    {
        // Compare against current max-priority thread
        if (pclTemp->GetPriority() >= ucMaxPri)
        {
            ucMaxPri = pclTemp->GetPriority();
            pclChosen = pclTemp;
        }

        // Break out if this is the last thread in the list
        if (pclTemp == static_cast<Thread*>(GetTail()))
        {
            break;
        }
        pclTemp = static_cast<Thread*>(pclTemp->GetNext());
    }
    return pclChosen;
}
```

17.181 /home/mo/mark3-source/embedded/stage/src/threadlist.h File Reference

Thread linked-list declarations.

```
#include "kerneltypes.h"
#include "ll.h"
```

Classes

- class ThreadList

    This class is used for building thread-management facilities, such as schedulers, and blocking objects.

17.181.1 Detailed Description

Thread linked-list declarations.

Definition in file threadlist.h.

17.182 threadlist.h

```
/*===========================================================================
     _____         _____         _____         _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __THREADLIST_H__
#define __THREADLIST_H__

#include "kerneltypes.h"
#include "ll.h"

class Thread;

class ThreadList : public CircularLinkList
{
public:
    ThreadList() { m_ucPriority = 0; m_pucFlag = NULL; }

    void SetPriority(K_UCHAR ucPriority_);

    void SetFlagPointer(K_UCHAR *pucFlag_);

    void Add(LinkListNode *node_);

    void Add(LinkListNode *node_, K_UCHAR *pucFlag_, K_UCHAR ucPriority_);

    void Remove(LinkListNode *node_);

    Thread *HighestWaiter();
private:

    K_UCHAR m_ucPriority;

    K_UCHAR *m_pucFlag;
};
```

```

#endif

```

17.183 /home/mo/mark3-source/embedded/stage/src/threadport.cpp File Reference

ATMega328p Multithreading.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "thread.h"
#include "threadport.h"
#include "kernelswi.h"
#include "kerneltimer.h"
#include "timerlist.h"
#include "quantum.h"
#include <avr/io.h>
#include <avr/interrupt.h>
```

Functions

- static void **Thread_Switch** (void)
- ISR (INT0_vect) __attribute__((signal

  SWI using INT0 - used to trigger a context switch.
- ISR (TIMER1_COMPA_vect)

  Timer interrupt ISR - causes a tick, which may cause a context switch.

Variables

- Thread ∗ **g_pstCurrentThread**
- **naked**

17.183.1 Detailed Description

ATMega328p Multithreading.

Definition in file threadport.cpp.

17.184 threadport.cpp

```
/*===========================================================================
     _____       _____        _____       _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "thread.h"
#include "threadport.h"
#include "kernelswi.h"
#include "kerneltimer.h"
```

```
#include "timerlist.h"
#include "quantum.h"
#include <avr/io.h>
#include <avr/interrupt.h>

//---------------------------------------------------------------------------
Thread *g_pstCurrentThread;

//---------------------------------------------------------------------------
void ThreadPort::InitStack(Thread *pclThread_)
{
    // Initialize the stack for a Thread
    K_USHORT usAddr;
    K_UCHAR *pucStack;
    K_USHORT i;

    // Get the address of the thread's entry function
    usAddr = (K_USHORT)(pclThread_->m_pfEntryPoint);

    // Start by finding the bottom of the stack
    pucStack = (K_UCHAR*)pclThread_->m_pwStackTop;

    // clear the stack, and initialize it to a known-default value (easier
    // to debug when things go sour with stack corruption or overflow)
    for (i = 0; i < pclThread_->m_usStackSize; i++)
    {
        pclThread_->m_pwStack[i] = 0xFF;
    }

    // Our context starts with the entry function
    PUSH_TO_STACK(pucStack, (K_UCHAR)(usAddr & 0x00FF));
    PUSH_TO_STACK(pucStack, (K_UCHAR)((usAddr >> 8) & 0x00FF));

    // R0
    PUSH_TO_STACK(pucStack, 0x00);    // R0

    // Push status register and R1 (which is used as a constant zero)
    PUSH_TO_STACK(pucStack, 0x80);  // SR
    PUSH_TO_STACK(pucStack, 0x00);  // R1

    // Push other registers
    for (i = 2; i <= 23; i++) //R2-R23
    {
        PUSH_TO_STACK(pucStack, i);
    }

    // Assume that the argument is the only stack variable
    PUSH_TO_STACK(pucStack, (K_UCHAR)(((K_USHORT)(pclThread_->
m_pvArg)) & 0x00FF));    //R24
    PUSH_TO_STACK(pucStack, (K_UCHAR)((((K_USHORT)(pclThread_->
m_pvArg))>>8) & 0x00FF)); //R25

    // Push the rest of the registers in the context
    for (i = 26; i <=31; i++)
    {
        PUSH_TO_STACK(pucStack, i);
    }

    // Set the top o' the stack.
    pclThread_->m_pwStackTop = (K_UCHAR*)pucStack;

    // That's it!  the thread is ready to run now.
}

//---------------------------------------------------------------------------
static void Thread_Switch(void)
{
    g_pstCurrent = g_pstNext;
}


//---------------------------------------------------------------------------
void ThreadPort::StartThreads()
{
    KernelSWI::Config();                 // configure the task switch SWI
    KernelTimer::Config();                 // configure the kernel timer

    Scheduler::SetScheduler(1);                // enable the scheduler
    Scheduler::Schedule();                 // run the scheduler - determine the first
 thread to run

    Thread_Switch();                     // Set the next scheduled thread to the current thread

    KernelTimer::Start();                  // enable the kernel timer
    KernelSWI::Start();                      // enable the task switch SWI

    // Restore the context...
    Thread_RestoreContext();        // restore the context of the first running thread
    ASM("reti");                    // return from interrupt - will return to the first scheduled thread
}

//---------------------------------------------------------------------------
//---------------------------------------------------------------------------
ISR(INT0_vect) __attribute__ ( ( signal, naked ) );
ISR(INT0_vect)
{
    Thread_SaveContext();         // Push the context (registers) of the current task
    Thread_Switch();             // Switch to the next task
    Thread_RestoreContext();     // Pop the context (registers) of the next task
    ASM("reti");                 // Return to the next task
}

//---------------------------------------------------------------------------
//---------------------------------------------------------------------------
ISR(TIMER1_COMPA_vect)
{
#if KERNEL_USE_TIMERS
    TimerScheduler::Process();
#endif
#if KERNEL_USE_QUANTUM
    Quantum::UpdateTimer();
#endif
}
```

17.185 /home/mo/mark3-source/embedded/stage/src/threadport.h File Reference

ATMega328p Multithreading support.

```
#include "kerneltypes.h"
#include "thread.h"
#include <avr/io.h>
#include <avr/interrupt.h>
```

Classes

- class ThreadPort

  Class defining the architecture specific functions required by the kernel.

Macros

- #define ASM(x) asm volatile(x);

  ASM Macro - simplify the use of ASM directive in C.
- #define SR_ 0x3F

  Status register define - map to 0x003F.
- #define SPH_ 0x3E

  Stack pointer define.
- #define **SPL_** 0x3D
- #define TOP_OF_STACK(x, y) (K_UCHAR∗) (((K_USHORT)x) + (y-1))

  Macro to find the top of a stack given its size and top address.
- #define PUSH_TO_STACK(x, y) ∗x = y; x--;

  Push a value y to the stack pointer x and decrement the stack pointer.
- #define Thread_SaveContext()

  Save the context of the Thread.
- #define Thread_RestoreContext()

  Restore the context of the Thread.
- #define CS_ENTER()

  These macros must be used in pairs !

- #define CS_EXIT()

    Exit critical section (restore status register)
- #define ENABLE_INTS() ASM("sei");

    Initiate a contex switch without using the SWI.
- #define **DISABLE_INTS**() ASM("cli");

17.185.1 Detailed Description

ATMega328p Multithreading support.

Definition in file threadport.h.

17.185.2 Macro Definition Documentation

17.185.2.1 #define CS_ENTER( )

Value:

```
{ \
volatile K_UCHAR x; \
x = _SFR_IO8(SR_); \
ASM("cli");
```

These macros *must* be used in pairs !

Enter critical section (copy status register, disable interrupts)

Definition at line 142 of file threadport.h.

17.185.2.2 #define CS_EXIT( )

Value:

```
_SFR_IO8(SR_) = x;\
}
```

Exit critical section (restore status register)

Definition at line 149 of file threadport.h.

17.186 threadport.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#ifndef __THREADPORT_H_
#define __THREADPORT_H_

#include "kerneltypes.h"
#include "thread.h"

#include <avr/io.h>
#include <avr/interrupt.h>

```

```
//---------------------------------------------------------------------------
#define ASM(x)      asm volatile(x);
#define SR_         0x3F
#define SPH_        0x3E
#define SPL_        0x3D


//---------------------------------------------------------------------------
#define TOP_OF_STACK(x, y)        (K_UCHAR*) ( ((K_USHORT)x) + (y-1) )
#define PUSH_TO_STACK(x, y)        *x = y; x--;

//---------------------------------------------------------------------------
#define Thread_SaveContext() \
ASM("push r0"); \
ASM("in r0, __SREG__"); \
ASM("cli"); \
ASM("push r0"); \
ASM("push r1"); \
ASM("clr r1"); \
ASM("push r2"); \
ASM("push r3"); \
ASM("push r4"); \
ASM("push r5"); \
ASM("push r6"); \
ASM("push r7"); \
ASM("push r8"); \
ASM("push r9"); \
ASM("push r10"); \
ASM("push r11"); \
ASM("push r12"); \
ASM("push r13"); \
ASM("push r14"); \
ASM("push r15"); \
ASM("push r16"); \
ASM("push r17"); \
ASM("push r18"); \
ASM("push r19"); \
ASM("push r20"); \
ASM("push r21"); \
ASM("push r22"); \
ASM("push r23"); \
ASM("push r24"); \
ASM("push r25"); \
ASM("push r26"); \
ASM("push r27"); \
ASM("push r28"); \
ASM("push r29"); \
ASM("push r30"); \
ASM("push r31"); \
ASM("lds r26, g_pstCurrent"); \
ASM("lds r27, g_pstCurrent + 1"); \
ASM("adiw r26, 4"); \
ASM("in    r0, 0x3D"); \
ASM("st    x+, r0"); \
ASM("in    r0, 0x3E"); \
ASM("st    x+, r0");

//---------------------------------------------------------------------------
#define Thread_RestoreContext() \
ASM("lds r26, g_pstCurrent"); \
ASM("lds r27, g_pstCurrent + 1");\
ASM("adiw r26, 4"); \
ASM("ld     r28, x+"); \
ASM("out 0x3D, r28"); \
ASM("ld     r29, x+"); \
ASM("out 0x3E, r29"); \
ASM("pop r31"); \
ASM("pop r30"); \
ASM("pop r29"); \
ASM("pop r28"); \
ASM("pop r27"); \
ASM("pop r26"); \
ASM("pop r25"); \
ASM("pop r24"); \
ASM("pop r23"); \
ASM("pop r22"); \
ASM("pop r21"); \
ASM("pop r20"); \
ASM("pop r19"); \
ASM("pop r18"); \
ASM("pop r17"); \
ASM("pop r16"); \
ASM("pop r15"); \
ASM("pop r14"); \
ASM("pop r13"); \
ASM("pop r12"); \
ASM("pop r11"); \
ASM("pop r10"); \
ASM("pop r9"); \
ASM("pop r8"); \
ASM("pop r7"); \
ASM("pop r6"); \
ASM("pop r5"); \
ASM("pop r4"); \
ASM("pop r3"); \
ASM("pop r2"); \
ASM("pop r1"); \
ASM("pop r0"); \
ASM("out __SREG__, r0"); \
ASM("pop r0");

//---------------------------------------------------------------------------
//---------------------------------------------------------------------------
#define CS_ENTER()    \
{ \
volatile K_UCHAR x; \
x = _SFR_IO8(SR_); \
ASM("cli");
//---------------------------------------------------------------------------
#define CS_EXIT() \
_SFR_IO8(SR_) = x;\
}

//---------------------------------------------------------------------------
#define ENABLE_INTS()        ASM("sei");
#define DISABLE_INTS()       ASM("cli");

//---------------------------------------------------------------------------
class Thread;
class ThreadPort
{
public:
    static void StartThreads();
    friend class Thread;
private:

    static void InitStack(Thread *pstThread_);
};

#endif //__ThreadPORT_H_
```

17.187 /home/mo/mark3-source/embedded/stage/src/timerlist.cpp File Reference

Timer data structure + scheduler implementations.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "timerlist.h"
#include "kerneltimer.h"
#include "threadport.h"
#include "kernel_debug.h"
```

Macros

- #define **__FILE_ID__** TIMERLIST_CPP

17.187.1 Detailed Description

Timer data structure + scheduler implementations.

Definition in file timerlist.cpp.

17.188 timerlist.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

--[Mark3 Realtime Platform]--------------------------------------------------

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===========================================================================*/
#include "kerneltypes.h"
#include "mark3cfg.h"

#include "timerlist.h"
#include "kerneltimer.h"
#include "threadport.h"
#include "kernel_debug.h"
//---------------------------------------------------------------------------
#if defined __FILE_ID__
    #undef __FILE_ID__
#endif
#define __FILE_ID__     TIMERLIST_CPP

#if KERNEL_USE_TIMERS

//---------------------------------------------------------------------------
TimerList TimerScheduler::m_clTimerList;

//---------------------------------------------------------------------------
void TimerList::Init(void)
{
    m_bTimerActive = 0;
    m_ulNextWakeup = 0;
}

//---------------------------------------------------------------------------
void TimerList::Add(Timer *pclListNode_)
{
#if KERNEL_TIMERS_TICKLESS
    K_UCHAR bStart = 0;
#endif

    K_LONG lDelta;
    CS_ENTER();

#if KERNEL_TIMERS_TICKLESS
    if (GetHead() == NULL)
    {
        bStart = 1;
    }
#endif

    pclListNode_->ClearNode();
    DoubleLinkList::Add(pclListNode_);

    // Set the initial timer value
    pclListNode_->m_ulTimeLeft = pclListNode_->m_ulInterval;

#if KERNEL_TIMERS_TICKLESS
    if (!bStart)
    {
        // If the new interval is less than the amount of time remaining...
        lDelta = KernelTimer::TimeToExpiry() - pclListNode_->
m_ulInterval;

        if (lDelta > 0)
        {
            // Set the new expiry time on the timer.
            m_ulNextWakeup = KernelTimer::SubtractExpiry((K_ULONG)
lDelta);
        }
    }
    else
    {
        m_ulNextWakeup = pclListNode_->m_ulInterval;
        KernelTimer::SetExpiry(m_ulNextWakeup);
        KernelTimer::Start();
    }
#endif

    // Set the timer as active.
    pclListNode_->m_ucFlags |= TIMERLIST_FLAG_ACTIVE;
    CS_EXIT();
}

```

```
//---------------------------------------------------------------------------
void TimerList::Remove(Timer *pclLinkListNode_)
{
    CS_ENTER();

    DoubleLinkList::Remove(pclLinkListNode_);

#if KERNEL_TIMERS_TICKLESS
    if (this->GetHead() == NULL)
    {
        KernelTimer::Stop();
    }
#endif

    CS_EXIT();
}

//---------------------------------------------------------------------------
void TimerList::Process(void)
{
#if KERNEL_TIMERS_TICKLESS
    K_ULONG ulNewExpiry;
    K_ULONG ulOvertime;
    K_UCHAR bContinue;
#endif

    Timer *pclNode;
    Timer *pclPrev;

#if KERNEL_TIMERS_TICKLESS
    // Clear the timer and its expiry time - keep it running though
    KernelTimer::ClearExpiry();
    do
    {
#endif
        pclNode = static_cast<Timer*>(GetHead());
        pclPrev = NULL;

#if KERNEL_TIMERS_TICKLESS
        bContinue = 0;
        ulNewExpiry = MAX_TIMER_TICKS;
#endif

        // Subtract the elapsed time interval from each active timer.
        while (pclNode)
        {
            // Active timers only...
            if (pclNode->m_ucFlags & TIMERLIST_FLAG_ACTIVE)
            {
                // Did the timer expire?
#if KERNEL_TIMERS_TICKLESS
                if (pclNode->m_ulTimeLeft <= m_ulNextWakeup)
#else
                pclNode->m_ulTimeLeft--;
                if (0 == pclNode->m_ulTimeLeft)
#endif
                {
                    // Yes - set the "callback" flag - we'll execute the callbacks later
                    pclNode->m_ucFlags |= TIMERLIST_FLAG_CALLBACK;

                    if (pclNode->m_ucFlags & TIMERLIST_FLAG_ONE_SHOT)
                    {
                        // If this was a one-shot timer, deactivate the timer.
                        pclNode->m_ucFlags |= TIMERLIST_FLAG_EXPIRED;
                        pclNode->m_ucFlags &= ~TIMERLIST_FLAG_ACTIVE;

                    }
                    else
                    {
                        // Reset the interval timer.
                        // I think we're good though...
                        pclNode->m_ulTimeLeft = pclNode->m_ulInterval;

#if KERNEL_TIMERS_TICKLESS
                        // If the time remaining (plus the length of the tolerance interval)
                        // is less than the next expiry interval, set the next expiry interval.
                        if ((pclNode->m_ulTimeLeft + pclNode->m_ulTimerTolerance) < ulNewExpiry)
                        {
                            ulNewExpiry = pclNode->m_ulTimeLeft + pclNode->m_ulTimerTolerance;
                        }
#endif
                    }
                }
#if KERNEL_TIMERS_TICKLESS
```

```
                else
                {
                    // Not expiring, but determine how K_LONG to run the next timer interval for.
                    pclNode->m_ulTimeLeft -= m_ulNextWakeup;
                    if (pclNode->m_ulTimeLeft < ulNewExpiry)
                    {
                        ulNewExpiry = pclNode->m_ulTimeLeft;
                    }
                }
#endif
            }
            pclNode = static_cast<Timer*>(pclNode->GetNext());
        }

        // Process the expired timers callbacks.
        pclNode = static_cast<Timer*>(GetHead());
        while (pclNode)
        {
            pclPrev = NULL;

            // If the timer expired, run the callbacks now.
            if (pclNode->m_ucFlags & TIMERLIST_FLAG_CALLBACK)
            {
                // Run the callback. these callbacks must be very fast...
                pclNode->m_pfCallback( pclNode->m_pclOwner, pclNode->
m_pvData );
                pclNode->m_ucFlags &= ~TIMERLIST_FLAG_CALLBACK;

                // If this was a one-shot timer, let's remove it.
                if (pclNode->m_ucFlags & TIMERLIST_FLAG_ONE_SHOT)
                {
                    pclPrev = pclNode;
                }
            }
            pclNode = static_cast<Timer*>(pclNode->GetNext());

            // Remove one-shot-timers
            if (pclPrev)
            {
                Remove(pclPrev);
            }
        }

#if KERNEL_TIMERS_TICKLESS
        // Check to see how much time has elapsed since the time we
        // acknowledged the interrupt...
        ulOvertime = KernelTimer::GetOvertime();

        if( ulOvertime >= ulNewExpiry ) {
            m_ulNextWakeup = ulOvertime;
            bContinue = 1;
        }

    // If it's taken longer to go through this loop than would take us to
    // the next expiry, re-run the timing loop

    } while (bContinue);

    // This timer elapsed, but there's nothing more to do...
    // Turn the timer off.
    if (ulNewExpiry >= MAX_TIMER_TICKS)
    {
        KernelTimer::Stop();
    }
    else
    {
        // Update the timer with the new "Next Wakeup" value, plus whatever
        // overtime has accumulated since the last time we called this handler
        m_ulNextWakeup = KernelTimer::SetExpiry(ulNewExpiry +
ulOvertime);
    }
#endif
}

//---------------------------------------------------------------------------
void Timer::Start( K_UCHAR bRepeat_, K_ULONG ulIntervalMs_, TimerCallback_t pfCallback_, void *
pvData_ )
{
    SetIntervalMSeconds(ulIntervalMs_);
    m_pfCallback = pfCallback_;
    m_pvData = pvData_;
    if (!bRepeat_)
    {
        m_ucFlags = TIMERLIST_FLAG_ONE_SHOT;
    }
    else
    {
        m_ucFlags = 0;
    }
    m_pclOwner = Scheduler::GetCurrentThread();
    TimerScheduler::Add(this);
}

//---------------------------------------------------------------------------
void Timer::Start( K_UCHAR bRepeat_, K_ULONG ulIntervalMs_, K_ULONG ulToleranceMs_,
TimerCallback_t pfCallback_, void *pvData_ )
{
    m_ulTimerTolerance = MSECONDS_TO_TICKS(ulToleranceMs_);
    Start(bRepeat_, ulIntervalMs_, pfCallback_, pvData_);
}

//---------------------------------------------------------------------------
void Timer::Stop()
{
    TimerScheduler::Remove(this);
}

//---------------------------------------------------------------------------
void Timer::SetIntervalTicks( K_ULONG ulTicks_ )
{
    m_ulInterval = ulTicks_;
}

//---------------------------------------------------------------------------
//---------------------------------------------------------------------------
void Timer::SetIntervalSeconds( K_ULONG ulSeconds_)
{
    m_ulInterval = SECONDS_TO_TICKS(ulSeconds_);
}

//---------------------------------------------------------------------------
void Timer::SetIntervalMSeconds( K_ULONG ulMSeconds_)
{
    m_ulInterval = MSECONDS_TO_TICKS(ulMSeconds_);
}

//---------------------------------------------------------------------------
void Timer::SetIntervalUSeconds( K_ULONG ulUSeconds_)
{
    m_ulInterval = USECONDS_TO_TICKS(ulUSeconds_);
}

//---------------------------------------------------------------------------
void Timer::SetTolerance(K_ULONG ulTicks_)
{
    m_ulTimerTolerance = ulTicks_;
}


#endif //KERNEL_USE_TIMERS
```

17.189 /home/mo/mark3-source/embedded/stage/src/timerlist.h File Reference

Timer list and timer-scheduling declarations.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "ll.h"
```

Classes

- class Timer

  Timer - an event-driven execution context based on a specified time interval.

- class TimerList

  TimerList class - a doubly-linked-list of timer objects.

- class TimerScheduler

  "Static" Class used to interface a global TimerList with the rest of the kernel.

Macros

- #define TIMERLIST_FLAG_ONE_SHOT (0x01)

  Timer is one-shot.
- #define TIMERLIST_FLAG_ACTIVE (0x02)

  Timer is currently active.
- #define TIMERLIST_FLAG_CALLBACK (0x04)

  Timer is pending a callback.
- #define TIMERLIST_FLAG_EXPIRED (0x08)

  Timer is actually expired.
- #define MAX_TIMER_TICKS (0x7FFFFFFF)

  Maximum value to set.
- #define **SECONDS_TO_TICKS**(x) ((((K_ULONG)x) ∗ TIMER_FREQ))
- #define **MSECONDS_TO_TICKS**(x) ((((((K_ULONG)x) ∗ (TIMER_FREQ/100)) + 5) / 10))
- #define **USECONDS_TO_TICKS**(x) ((((((K_ULONG)x) ∗ TIMER_FREQ) + 50000) / 1000000))
- #define MIN_TICKS (3)

  The minimum tick value to set.

Typedefs

- typedef void(∗ **TimerCallback_t**)(Thread ∗pclOwner_, void ∗pvData_)

17.189.1 Detailed Description

Timer list and timer-scheduling declarations. These classes implements a linked list of timer objects attached to the global kernel timer. Unlike other kernels which use a fully-synchronous "tick-based" timing mechanism, where the OS timing facilities are based on a fixed-frequency timer (which causes regular timer interrupts), Mark3 uses a "tickless" timer implementation, which only triggers interrupts when absolutely required. This is much more efficient in most cases - timer interrupts occur less frequently, allowing the kernel to stay in sleep much longer than it would otherwise.

Definition in file timerlist.h.

17.189.2 Macro Definition Documentation

17.189.2.1 #define TIMERLIST_FLAG_EXPIRED (0x08)

Timer is actually expired.

Definition at line 45 of file timerlist.h.

17.190 timerlist.h

```
00001 /*===========================================================================
00002      _____        _____        _____        _____
00003  ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
00004 |    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
00005 |     \/   | ||     \     ||     \     ||     \     ||___   |
00006 |__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
00007     |_____|      |_____|      |_____|      |_____|
00008 
00009 --[Mark3 Realtime Platform]--------------------------------------------------
00010 
00011 Copyright (c) 2012 Funkenstein Software Consulting, all rights reserved.
00012 See license.txt for more information
00013 ===========================================================================*/
00030 #ifndef __TIMERLIST_H__
00031 #define __TIMERLIST_H__
```

```

#include "kerneltypes.h"
#include "mark3cfg.h"

#include "ll.h"

#if KERNEL_USE_TIMERS
class Thread;

//---------------------------------------------------------------------------
#define TIMERLIST_FLAG_ONE_SHOT         (0x01)
#define TIMERLIST_FLAG_ACTIVE           (0x02)
#define TIMERLIST_FLAG_CALLBACK         (0x04)
#define TIMERLIST_FLAG_EXPIRED          (0x08)

//---------------------------------------------------------------------------
#if KERNEL_TIMERS_TICKLESS

//---------------------------------------------------------------------------
#define MAX_TIMER_TICKS                 (0x7FFFFFFF)

//---------------------------------------------------------------------------
/*
    Ugly macros to support a wide resolution of delays.
    Given a 16-bit timer @ 16MHz & 256 cycle prescaler, this gives us...
    Max time, SECONDS_TO_TICKS:  68719s
    Max time, MSECONDS_TO_TICKS: 6871.9s
    Max time, USECONDS_TO_TICKS: 6.8719s
     With a 16us tick resolution.
*/
//---------------------------------------------------------------------------
#define SECONDS_TO_TICKS(x)             ((((K_ULONG)x) * TIMER_FREQ))
#define MSECONDS_TO_TICKS(x)            ((((((K_ULONG)x) * (TIMER_FREQ/100)) + 5) / 10))
#define USECONDS_TO_TICKS(x)            ((((((K_ULONG)x) * TIMER_FREQ) + 50000) / 1000000))

//---------------------------------------------------------------------------
#define MIN_TICKS                        (3)
//---------------------------------------------------------------------------

#else
//---------------------------------------------------------------------------
// Tick-based timers, assuming 1khz tick rate
#define MAX_TIMER_TICKS                 (0x7FFFFFFF)

//---------------------------------------------------------------------------
#define SECONDS_TO_TICKS(x)             ((K_ULONG)(x) * 1000)
#define MSECONDS_TO_TICKS(x)            ((K_ULONG)(x))
#define USECONDS_TO_TICKS(x)            (((K_ULONG)(x + 999)) / 1000)

//---------------------------------------------------------------------------
#define MIN_TICKS                       (1)
//---------------------------------------------------------------------------

#endif // KERNEL_TIMERS_TICKLESS

typedef void (*TimerCallback_t)(Thread *pclOwner_, void *pvData_);

//---------------------------------------------------------------------------
class TimerList;
class TimerScheduler;
class Quantum;
class Timer : public LinkListNode
{
public:
    Timer() { Init(); }

    void Init() { m_ulInterval = 0; m_ulTimerTolerance = 0;
m_ulTimeLeft = 0; m_ucFlags = 0; }

    void Start( K_UCHAR bRepeat_, K_ULONG ulIntervalMs_, TimerCallback_t pfCallback_, void *pvData_ );

    void Start( K_UCHAR bRepeat_, K_ULONG ulIntervalMs_, K_ULONG ulToleranceMs_, TimerCallback_t
pfCallback_, void *pvData_ );

    void Stop();

    void SetFlags (K_UCHAR ucFlags_) { m_ucFlags = ucFlags_; }

    void SetCallback( TimerCallback_t pfCallback_){ m_pfCallback = pfCallback_; }

    void SetData( void *pvData_ ){ m_pvData = pvData_; }

    void SetOwner( Thread *pclOwner_){ m_pclOwner = pclOwner_; }

    void SetIntervalTicks(K_ULONG ulTicks_);

    void SetIntervalSeconds(K_ULONG ulSeconds_);


    K_ULONG GetInterval()   { return m_ulInterval; }

    void SetIntervalMSeconds(K_ULONG ulMSeconds_);

    void SetIntervalUSeconds(K_ULONG ulUSeconds_);

    void SetTolerance(K_ULONG ulTicks_);

private:

    friend class TimerList;

    K_UCHAR m_ucFlags;

    TimerCallback_t m_pfCallback;

    K_ULONG m_ulInterval;

    K_ULONG m_ulTimeLeft;

    K_ULONG m_ulTimerTolerance;

    Thread  *m_pclOwner;

    void    *m_pvData;
};

//---------------------------------------------------------------------------
class TimerList : public DoubleLinkList
{
public:
    void Init();

    void Add(Timer *pclListNode_);

    void Remove(Timer *pclListNode_);

    void Process();

private:
    K_ULONG m_ulNextWakeup;

    K_UCHAR m_bTimerActive;
};

//---------------------------------------------------------------------------
class TimerScheduler
{
public:
    static void Init() { m_clTimerList.Init(); }

    static void Add(Timer *pclListNode_)
        {m_clTimerList.Add(pclListNode_); }

    static void Remove(Timer *pclListNode_)
        {m_clTimerList.Remove(pclListNode_); }

    static void Process() {m_clTimerList.Process();}
private:

    static TimerList m_clTimerList;
};

#endif // KERNEL_USE_TIMERS

#endif
```

17.191 /home/mo/mark3-source/embedded/stage/src/tracebuffer.cpp File Reference

Kernel trace buffer class definition.

```
#include "kerneltypes.h"
#include "tracebuffer.h"
#include "mark3cfg.h"
#include "writebuf16.h"
#include "kernel_debug.h"
```

17.191.1 Detailed Description

Kernel trace buffer class definition.

Definition in file tracebuffer.cpp.

17.192 tracebuffer.cpp

```
/*===========================================================================
     _____       _____       _____       _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  _____
|   \  /  | ||   \     ||     |    ||  |/ /    ||___   |
|    \/   | ||    \    ||     \    ||     \    ||___  |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||______|
    |_____|     |_____|     |_____|     |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "tracebuffer.h"
#include "mark3cfg.h"
#include "writebuf16.h"
#include "kernel_debug.h"

#if KERNEL_USE_DEBUG

//---------------------------------------------------------------------------
WriteBuffer16 TraceBuffer::m_clBuffer;
volatile K_USHORT TraceBuffer::m_usIndex;
K_USHORT TraceBuffer::m_ausBuffer[ (TRACE_BUFFER_SIZE/sizeof(K_USHORT)) ];

//---------------------------------------------------------------------------
void TraceBuffer::Init()
{
    m_clBuffer.SetBuffers(m_ausBuffer, TRACE_BUFFER_SIZE/sizeof(K_USHORT));
    m_usIndex = 0;
}

//---------------------------------------------------------------------------
K_USHORT TraceBuffer::Increment()
{
    return m_usIndex++;
}

//---------------------------------------------------------------------------
void TraceBuffer::Write( K_USHORT *pusData_, K_USHORT usSize_ )
{
    // Pipe the data directly to the circular buffer
    m_clBuffer.WriteData(pusData_, usSize_);
}

#endif

```

17.193 /home/mo/mark3-source/embedded/stage/src/tracebuffer.h File Reference

Kernel trace buffer class declaration.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "writebuf16.h"
```

17.193.1 Detailed Description

Kernel trace buffer class declaration. Global kernel trace-buffer. Used to instrument the kernel with lightweight encoded print statements. If something goes wrong, the tracebuffer can be examined for debugging purposes. Also, subsets of kernel trace information can be extracted and analyzed to provide information about runtime performance, thread-scheduling, and other nifty things in real-time.

Definition in file tracebuffer.h.

17.194 tracebuffer.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /    ||___   |
|     \/   | ||     \     ||     \     ||     \    ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\ __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __TRACEBUFFER_H__
#define __TRACEBUFFER_H__

#include "kerneltypes.h"
#include "mark3cfg.h"
#include "writebuf16.h"

#if KERNEL_USE_DEBUG

#define TRACE_BUFFER_SIZE            (16)

class TraceBuffer
{
public:
    static void Init();

    static K_USHORT Increment();

    static void Write( K_USHORT *pusData_, K_USHORT usSize_ );

    void SetCallback( WriteBufferCallback pfCallback_ )
        { m_clBuffer.SetCallback( pfCallback_ ); }
private:

    static WriteBuffer16 m_clBuffer;
    static volatile K_USHORT m_usIndex;
    static K_USHORT m_ausBuffer[ (TRACE_BUFFER_SIZE / sizeof( K_USHORT )) ];
};

#endif //KERNEL_USE_DEBUG

#endif
```

17.195 /home/mo/mark3-source/embedded/stage/src/transaction.cpp File Reference

Transaction Queue Implementation.

```
#include "transaction.h"
```

17.195.1 Detailed Description

Transaction Queue Implementation.

Definition in file transaction.cpp.

17.196 transaction.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__  ______
|    \  /  | ||    \    ||     |     ||  |/ /    ||___   |
|     \/   | ||     \   ||     \     ||     \    ||___   |
|__/\__/|__|_||__|\__\ __||__|\__\ __||__|\__\ __||______|
    |_____|      |_____|     |_____|     |_____|

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===========================================================================*/
#include "transaction.h"

//---------------------------------------------------------------------------
DoubleLinkList TransactionQueue::m_clGlobalQueue;
Transaction    TransactionQueue::m_aclTransactions[TRANSACTION_QUEUE_SIZE];

//---------------------------------------------------------------------------
void TransactionQueue::GlobalQueueInit()
{
    for (K_UCHAR i = 0; i < TRANSACTION_QUEUE_SIZE; i++)
    {
        m_clGlobalQueue.Add(&m_aclTransactions[i]);
    }
}

//---------------------------------------------------------------------------
void TransactionQueue::Enqueue( K_USHORT usData_, void *pvData_)
{
    // Note - We do not do this from a critical section, as we assume
    // that anything calling Enqueue() is already running in a critical
    // section.

    Transaction *pclTrx;

    pclTrx = static_cast<Transaction*>(m_clGlobalQueue.GetHead());

    KERNEL_ASSERT(pclTrx);

    m_clGlobalQueue.Remove(pclTrx);

    pclTrx->Set( usData_, pvData_ );
    Add(pclTrx);
}

//---------------------------------------------------------------------------
Transaction *TransactionQueue::Dequeue()
{
    Transaction *pclTrx;

    CS_ENTER();
    pclTrx = static_cast<Transaction*>(GetHead());

    KERNEL_ASSERT(pclTrx);

    Remove(pclTrx);
    CS_EXIT();

    return pclTrx;
}

//---------------------------------------------------------------------------
void TransactionQueue::Finish( Transaction *pclTransaction_ )
{
    CS_ENTER();
    m_clGlobalQueue.Add(pclTransaction_);
    CS_EXIT();
}

```

17.197 /home/mo/mark3-source/embedded/stage/src/transaction.h File Reference

Transaction Queue Implementation.

```
#include "kerneltypes.h"
#include "mark3cfg.h"
#include "threadport.h"
#include "ll.h"
#include "kernel_debug.h"
```

Classes

- class Transaction

  The Transaction class.
- class TransactionQueue

  The TransactionQueue class.

17.197.1 Detailed Description

Transaction Queue Implementation.

Definition in file transaction.h.

17.198 transaction.h

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|       |_____|       |_____|

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===========================================================================*/
#ifndef __TRANSACTION_H__
#define __TRANSACTION_H__

#include "kerneltypes.h"
#include "mark3cfg.h"
#include "threadport.h"
#include "ll.h"
#include "kernel_debug.h"

//---------------------------------------------------------------------------
class Transaction : public LinkListNode
{
public:
    void Set( K_USHORT usCode_, void *pvData_ )
    {
        m_usCode = usCode_;
        m_pvData = pvData_;
    }

    K_USHORT GetCode()
    {
        return m_usCode;
    }

    void *GetData()
    {
        return m_pvData;
    }

private:
    K_USHORT    m_usCode;
    void        *m_pvData;
};

//---------------------------------------------------------------------------
class TransactionQueue : public DoubleLinkList
```

```
{
public:
    static void GlobalQueueInit();

    void Enqueue( K_USHORT usData_, void *pvData_);

    Transaction *Dequeue();

    void Finish( Transaction *pclTransaction_ );

private:

    static DoubleLinkList m_clGlobalQueue;
    static Transaction    m_aclTransactions[
TRANSACTION_QUEUE_SIZE];
};

#endif
```

17.199 /home/mo/mark3-source/embedded/stage/src/unit_test.cpp File Reference

Unit test class definition.

```
#include "kerneltypes.h"
#include "unit_test.h"
```

17.199.1 Detailed Description

Unit test class definition.

Definition in file unit_test.cpp.

17.200 unit_test.cpp

```
/*===========================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "unit_test.h"

//---------------------------------------------------------------------------
UnitTest::UnitTest()
{
    m_bIsActive = false;
    m_usIterations = 0;
    m_usPassed = 0;
    m_bComplete = false;
}

//---------------------------------------------------------------------------
void UnitTest::Pass()
{
    if (m_bComplete)
    {
        return;
    }

    if (m_bIsActive)
    {
        m_bIsActive = false;
        m_usIterations++;
        m_usPassed++;
        m_bStatus = true;
    }
}

//----------------------------------------------------------------------------
void UnitTest::Fail()
{
    if (m_bComplete)
    {
        return;
    }

    if (m_bIsActive)
    {
        m_bIsActive = false;
        m_usIterations++;
        m_bStatus = false;
    }
}
```

17.201 /home/mo/mark3-source/embedded/stage/src/unit_test.h File Reference

Unit test class declarations.

`#include "kerneltypes.h"`

Classes

- class UnitTest

    Class used to implement a simple unit-testing framework.

17.201.1 Detailed Description

Unit test class declarations.

Definition in file unit_test.h.

17.202 unit_test.h

```
/*============================================================================
     _____        _____        _____        _____
 ___|    _|__  __|_    |__  __|__   |__  __| __  |__  ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||_______|
    |_____|      |_____|      |_____|      |_____|

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============================================================================*/
#ifndef __UNIT_TEST_H__
#define __UNIT_TEST_H__


#include "kerneltypes.h"

//----------------------------------------------------------------------------
class UnitTest
{
public:
    UnitTest();

    void SetName( const K_CHAR *szName_ ) { m_szName = szName_; }

    void Start() { m_bIsActive = 1; }

    void Pass();

    void Fail();

    void ExpectTrue( bool bExpression_ )
        { bExpression_ ? Pass() : Fail(); }

    void ExpectFalse( bool bExpression_ )
        { !bExpression_ ? Pass() : Fail(); }

    void ExpectEquals( bool bVal_, bool bExpression_ )
        { (bVal_ == bExpression_) ? Pass() : Fail(); }

    void ExpectEquals( K_UCHAR ucVal_, K_UCHAR ucExpression_ )
        { (ucVal_ == ucExpression_) ? Pass() : Fail(); }

    void ExpectEquals( K_USHORT usVal_, K_USHORT usExpression_ )
        { (usVal_ == usExpression_) ? Pass() : Fail(); }

    void ExpectEquals( K_ULONG ulVal_, K_ULONG ulExpression_ )
        { (ulVal_ == ulExpression_) ? Pass() : Fail(); }

    void ExpectEquals( K_CHAR cVal_, K_CHAR cExpression_ )
        { (cVal_ == cExpression_) ? Pass() : Fail(); }

    void ExpectEquals( K_SHORT sVal_, K_SHORT sExpression_ )
        { (sVal_ == sExpression_) ? Pass() : Fail(); }

    void ExpectEquals( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ == lExpression_) ? Pass() : Fail(); }

    void ExpectEquals( void* pvVal_, void* pvExpression_ )
        { (pvVal_ == pvExpression_) ? Pass() : Fail(); }


    void ExpectFailTrue( bool bExpression_ )
        { bExpression_ ? Fail() : Pass(); }

    void ExpectFailFalse( bool bExpression_ )
        { !bExpression_ ? Fail() : Pass(); }

    void ExpectFailEquals( bool bVal_, bool bExpression_ )
        { (bVal_ == bExpression_) ? Fail() : Pass(); }

    void ExpectFailEquals( K_UCHAR ucVal_, K_UCHAR ucExpression_ )
        { (ucVal_ == ucExpression_) ? Fail() : Pass(); }

    void ExpectFailEquals( K_USHORT usVal_, K_USHORT usExpression_ )
        { (usVal_ == usExpression_) ? Fail() : Pass(); }

    void ExpectFailEquals( K_ULONG ulVal_, K_ULONG ulExpression_ )
        { (ulVal_ == ulExpression_) ? Fail() : Pass(); }

    void ExpectFailEquals( K_CHAR cVal_, K_CHAR cExpression_ )
        { (cVal_ == cExpression_) ? Fail() : Pass(); }

    void ExpectFailEquals( K_SHORT sVal_, K_SHORT sExpression_ )
        { (sVal_ == sExpression_) ? Fail() : Pass(); }

    void ExpectFailEquals( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ == lExpression_) ? Fail() : Pass(); }

    void ExpectFailEquals( void* pvVal_, void* pvExpression_ )
        { (pvVal_ == pvExpression_) ? Fail() : Pass(); }

    void ExpectGreaterThan( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ > lExpression_) ? Pass() : Fail(); }

    void ExpectLessThan( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ < lExpression_) ? Pass() : Fail(); }

    void ExpectGreaterThanEquals( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ >= lExpression_) ? Pass() : Fail(); }

    void ExpectLessThanEquals( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ <= lExpression_) ? Pass() : Fail(); }

    void ExpectFailGreaterThan( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ > lExpression_) ? Fail() : Pass(); }

    void ExpectFailLessThan( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ < lExpression_) ? Fail() : Pass(); }

    void ExpectFailGreaterThanEquals( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ >= lExpression_) ? Fail() : Pass(); }

    void ExpectFailLessThanEquals( K_LONG lVal_, K_LONG lExpression_ )
        { (lVal_ <= lExpression_) ? Fail() : Pass(); }

    void Complete() { m_bComplete = 1; }

    const K_CHAR *GetName(){ return m_szName; }

    K_BOOL GetResult() { return m_bStatus; }

    K_USHORT GetPassed() { return m_usPassed; }

    K_USHORT GetFailed() { return m_usIterations -
m_usPassed; }

    K_USHORT GetTotal() { return m_usIterations; }

private:
    const K_CHAR *m_szName;
    K_BOOL m_bIsActive;
    K_UCHAR m_bComplete;
    K_BOOL m_bStatus;
    K_USHORT m_usIterations;
    K_USHORT m_usPassed;
};

#endif
```

17.203 /home/mo/mark3-source/embedded/stage/src/writebuf16.cpp File Reference

16 bit circular buffer implementation with callbacks.

```
#include "kerneltypes.h"
#include "writebuf16.h"
#include "kernel_debug.h"
#include "threadport.h"
```

17.203.1 Detailed Description

16 bit circular buffer implementation with callbacks.

Definition in file writebuf16.cpp.

17.204 writebuf16.cpp

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__ ______
|    \  /  | ||    \     ||     |     ||  |/ /     ||___   |
|     \/   | ||     \    ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#include "kerneltypes.h"
#include "writebuf16.h"
#include "kernel_debug.h"
#include "threadport.h"
//---------------------------------------------------------------------------
void WriteBuffer16::WriteData( K_USHORT *pusBuf_, K_USHORT usLen_ )
{
    K_USHORT *apusBuf[1];
    K_USHORT ausLen[1];

    apusBuf[0] = pusBuf_;
    ausLen[0] = usLen_;

    WriteVector( apusBuf, ausLen, 1 );
}

//---------------------------------------------------------------------------
void WriteBuffer16::WriteVector( K_USHORT **ppusBuf_, K_USHORT *pusLen_, K_UCHAR
ucCount_ )
{
    K_USHORT usTempHead;
    K_UCHAR i;
    K_UCHAR j;
    K_USHORT usTotalLen = 0;
    bool bCallback = false;
    bool bRollover = false;
    // Update the head pointer synchronously, using a small
    // critical section in order to provide thread safety without
    // compromising on responsiveness by adding lots of extra
    // interrupt latency.

    CS_ENTER();

    usTempHead = m_usHead;
    {
        for (i = 0; i < ucCount_; i++)
        {
            usTotalLen += pusLen_[i];
        }
        m_usHead = (usTempHead + usTotalLen) % m_usSize;
    }
    CS_EXIT();

    // Call the callback if we cross the 50% mark or rollover
    if (m_usHead < usTempHead)
    {
        if (m_pfCallback)
        {
            bCallback = true;
            bRollover = true;
        }
    }
    else if ((usTempHead < (m_usSize >> 1)) && (m_usHead >= (
m_usSize >> 1)))
    {
        // Only trigger the callback if it's non-null
        if (m_pfCallback)
        {
            bCallback = true;
        }
    }

    // Are we going to roll-over?
    for (j = 0; j < ucCount_; j++)
    {
        K_USHORT usSegmentLength = pusLen_[j];
        if (usSegmentLength + usTempHead >= m_usSize)
        {
            // We need to two-part this... First part: before the rollover
            K_USHORT usTempLen;
            K_USHORT *pusTmp = &m_pusData[ usTempHead ];
            K_USHORT *pusSrc = ppusBuf_[j];
            usTempLen = m_usSize - usTempHead;
            for (i = 0; i < usTempLen; i++)
            {
                *pusTmp++ = *pusSrc++;
            }

            // Second part: after the rollover
            usTempLen = usSegmentLength - usTempLen;
            pusTmp = m_pusData;
            for (i = 0; i < usTempLen; i++)
            {
                *pusTmp++ = *pusSrc++;
            }
        }
        else
        {
            // No rollover - do the copy all at once.
            K_USHORT *pusSrc = ppusBuf_[j];
            K_USHORT *pusTmp = &m_pusData[ usTempHead ];
            for (K_USHORT i = 0; i < usSegmentLength; i++)
            {
                *pusTmp++ = *pusSrc++;
            }
        }
    }


    // Call the callback if necessary
    if (bCallback)
    {
        if (bRollover)
        {
            // Rollover - process the back-half of the buffer
            m_pfCallback( &m_pusData[ m_usSize >> 1],
m_usSize >> 1 );
        }
        else
        {
            // 50% point - process the front-half of the buffer
            m_pfCallback( m_pusData, m_usSize >> 1);
        }
    }
}
```

17.205 /home/mo/mark3-source/embedded/stage/src/writebuf16.h File Reference

Thread-safe circular buffer implementation with 16-bit elements.

`#include "kerneltypes.h"`

Classes

- class WriteBuffer16

  This class is used to provide a general-purpose, fully thread-safe circular buffer implementation which can be used for creating tracebuffers, data logging queues, transaction queues, etc.

Typedefs

- typedef void(∗ WriteBufferCallback)(K_USHORT ∗pusData_, K_USHORT usSize_)

  Function pointer type used to define a callback handler for when the circular buffer reaches 50% capacity,.

17.205.1 Detailed Description

Thread-safe circular buffer implementation with 16-bit elements.

Definition in file writebuf16.h.

17.206 writebuf16.h

```
/*===========================================================================
     _____     _____     _____     _____
 ___|    _|__ __|_    |__ __|__   |__ __| __  |__ ______
|    \  /  | ||    \      ||     |     ||  |/ /     ||___   |
|     \/   | ||     \     ||     \     ||     \     ||___   |
|__/\__/|__|_||__|\__\  __||__|\__\  __||__|\__\  __||______|
    |_____|      |_____|      |_____|      |_____|

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===========================================================================*/
#ifndef __WRITEBUF16_H__
#define __WRITEBUF16_H__

#include "kerneltypes.h"

typedef void (*WriteBufferCallback)( K_USHORT *pusData_, K_USHORT usSize_ );

class WriteBuffer16
{
public:
    void SetBuffers( K_USHORT *pusData_, K_USHORT usSize_ )
    {
        m_pusData = pusData_;
        m_usSize = usSize_;
        m_usHead = 0;
        m_usTail = 0;
    }

    void SetCallback( WriteBufferCallback pfCallback_ )
        { m_pfCallback = pfCallback_; }

    void WriteData( K_USHORT *pusBuf_, K_USHORT usLen_ );

    void WriteVector( K_USHORT **ppusBuf_, K_USHORT *pusLen_, K_UCHAR ucCount_);

private:
    K_USHORT *m_pusData;

    volatile K_USHORT m_usSize;
    volatile K_USHORT m_usHead;
    volatile K_USHORT m_usTail;

    WriteBufferCallback m_pfCallback;
};

#endif
```

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