



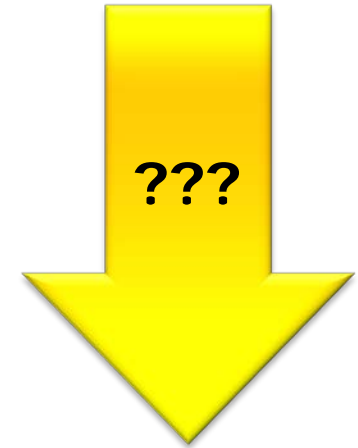
FreeRTOS Kernel Awareness

"Let's be aware of what is going on..."

Prof. Erich Styger
erich.styger@hslu.ch
+41 41 349 33 01

Learning Goals

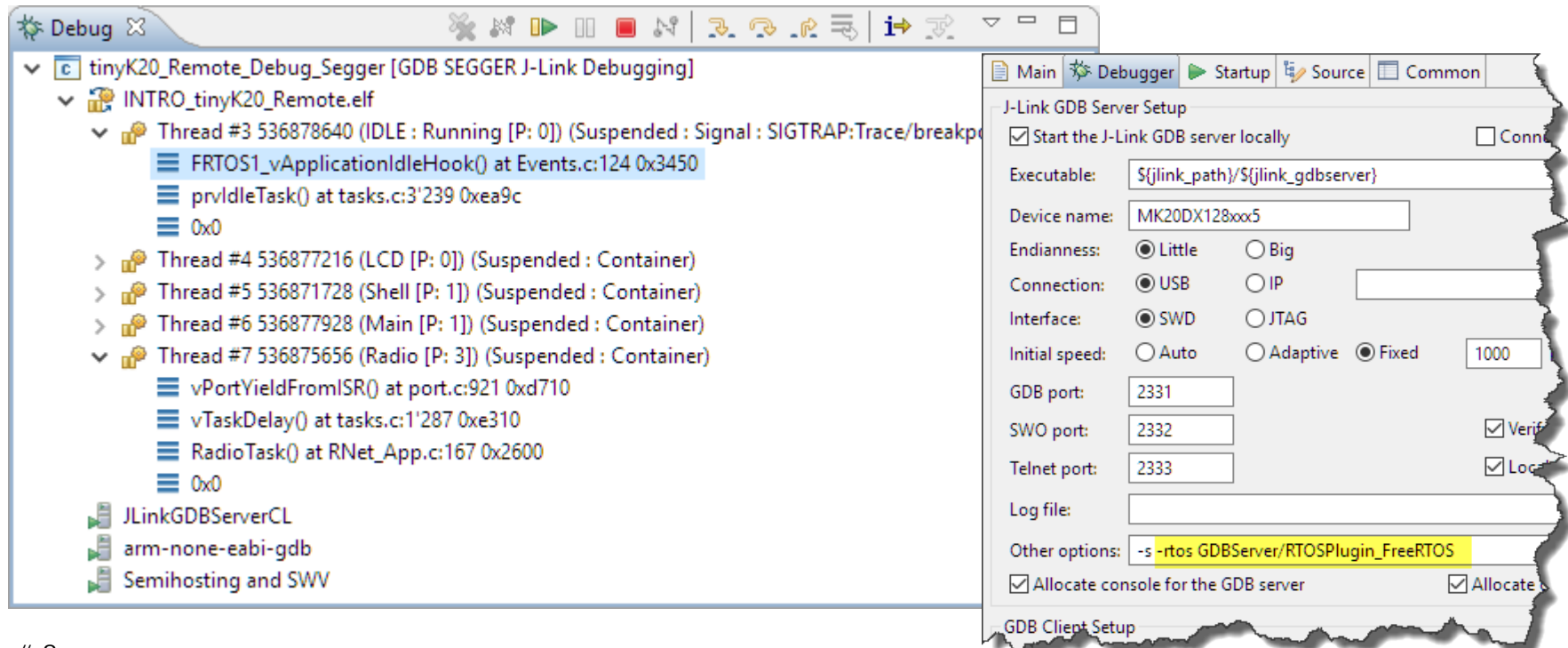
- Problem: Information about tasks/queues
- Goal: FreeRTOS Kernel Awareness
 - Threads
 - Tasks, Heap
 - (Queue, Timer)



Task List (FreeRTOS)							
TCB#	Task Name	Task Handle	Task State	Priority	Stack Usage	Event Object	Runtime
> 1	Shell	0x20000330	Blocked	1 (1)	20 B / 664 B		0x0 (0.0%)
> 2	Radio	0x20001288	Blocked	3 (3)	72 B / 880 B		0x1 (0.0%)
> 3	LCD	0x200018a0	Blocked	0 (0)	168 B / 600 B		0x17 (0.9%)
> 4	Main	0x20001b68	Blocked	1 (1)	0 B / 480 B		0x0 (0.0%)
▼ 5	IDLE	0x20001e30	Running	0 (0)	0 B / 512 B		0x99b (99.0%)
	Task Number:	0x0					
	Stack Base:	0x20001bd0					
	Stack Top:	0x20001dd0					
	Stack High Water Mark:	0x20001dd0					

Thread Debugging (Segger)

- Debug view with threads
- Launch Configuration Setting (Segger)
 - rtos GDBServer/RTOSPlugin_FreeRTOS



Kernel Awareness Views

- <http://freescale.com/lqfiles/updates/Eclipse/KDS>
- <https://mcuoneclipse.com/2016/07/06/freertos-kernel-awareness-for-eclipse-from-nxp/>
- Menu: FreeRTOS
- Stop-Mode Views
 - Only if target stops
 - Fetches data from target (performance!)

The screenshot displays the FreeRTOS kernel awareness views in the Eclipse IDE. The main window, titled "NXP Task List (FreeRTOS)", shows a list of tasks with columns: TCB#, Task Name, Task H..., Task St..., P..., Stack Usage, Event Object, and Runtime. The tasks listed are TzCtrl, Shell, Refl, Radi, Main, Line, IDLE, and Drive. A secondary window, titled "NXP Queue List (FreeRTOS)", shows a list of queues with columns: #, Queue Name, Address, Leng..., Item Size, # Tx ..., # Rx ..., and Queue Type. The queues listed are RefStartStopSem, 1/1, 0/6, 0/6, and 0/48. A third window, titled "NXP Heap Usage (FreeRTOS)", shows a table with columns: Type, Heap Base, Heap End, Heap Usage, Free Space, and Heap Usage Graph. The table shows the heap usage for the FreeRTOS kernel, with a red bar indicating 61.12% used. A fourth window, titled "NXP Timer List (FreeRTOS)", shows a table with columns: #, Details, Block Start, Block End, and Size. The table shows the timer usage for the FreeRTOS kernel, with a red bar indicating 61.12% used.

TCB#	Task Name	Task H...	Task St...	P...	Stack Usage	Event Object	Runtime
> 1	TzCtrl	0x20000...	00 Bloc...	1 (...)			
> 2	Shell	0x20000...	00 Bloc...	1 (...)			
> 3	Refl	0x20000...	00 Bloc...	4 (...)			
> 5	Radi						
> 7	Main						
> 4	Line						
> 8	IDLE						
> 6	Drive						

#	Queue Name	Address	Leng...	Item Size	# Tx ...	# Rx ...	Queue Type
> 1	RefStartStopSem	0x20000848	0/1	Empty	0	0	Binary Semaphore
1/1			Empty		0	0	Mutex
0/6			0x22 (34 B)		0	0	Queue
0/6			0x22 (34 B)		0	0	Queue
0/48			0x1 (1 B)		0	0	Queue

Type	Heap Base	Heap End	Heap Usage	Free Space	Heap Usage Graph
0x20000000	0x20004e20	11.94 kB / 19....	38.88% (7.59 ...)	61.12% Used	

#	Details	Block Start	Block End	Size
1	Allocated	0x20000000	0x20000007	0x8 (8 B)
2	TzCtrl (Task Stack)	0x20000008	0x2000029b	0x294 (660 B)
3	Allocated	0x2000029c	0x2000032f	0x94 (148 B)
4	TzCtrl (Task TCB)	0x20000330	0x2000038b	0x5c (92 B)

Queues

- vQueueAddToRegistry()
- FreeRTOS Queue Registry Size > 0

The screenshot shows the 'Queue List (FreeRTOS)' window with the following data:

#	Queue Name	Address	Leng...	Item Size	# Tx ...	# Rx ...	Queue Type
> 1	RefStartStopSem	0x20000848	0/1	Empty	0	0	Binary Semaphore
2	RefSem	0x200008a0	1/1	Empty	0	0	Mutex
> 3	RadioRxMsg	0x20001138	0/6	0x22 (34 B)	0	0	Queue
> 4	RadioTxMsg	0x20001260	0/6	0x22 (34 B)	0	0	Queue
> 5	RxStdInQ	0x20001388	0/48	0x1 (1 B)	0	0	Queue

Below the queue list, the 'LDD Tick' settings are shown:

Setting	Value
LDD Tick	Disabled
Queues	Settings for Queues
Queue Registry Size	5
Queue Sets	no
Semaphores and Mutexes	Settings for Mutex and Semap...
Use Mutexes	yes

```
void SQUEUE_Init(void) {
    SQUEUE_Queue = FRTOS1_xQueueCreate(SQUEUE_LENGTH, SQUEUE_ITEM_SIZE);
    if (SQUEUE_Queue==NULL) {
        for(;;){} /* out of memory? */
    }
    FRTOS1_vQueueAddToRegistry(SQUEUE_Queue, "Shell");
#ifdef PL_HAS_RTOS_TRACE
    RTOSTRC1_vTraceSetQueueName(SQUEUE_Queue, "ShellQueue");
#endif
}
```

Runtime Statistics

- How much time a task spends
- **configGENERATE_RUNTIME_STATS**
- Counting time for each task
 - Counter at task start and suspend time
 - SysTick (Ticks): limited resolution!
 - Timer (recommendation: 10x of Ticks)

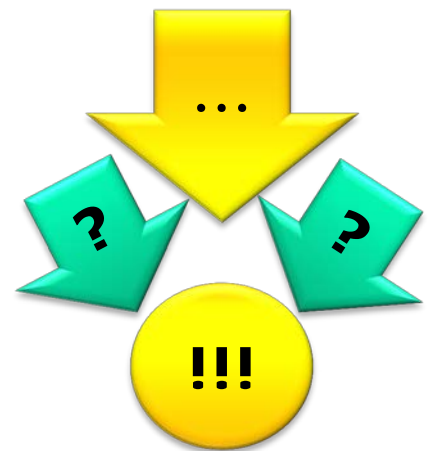
The screenshot shows the IDE's configuration and runtime statistics. The 'Properties' window on the left shows the 'Generate Runtime Statistics' settings. The 'Timer List (FreeRTOS)' window on the right shows a list of tasks with their priorities, stack usage, and runtime statistics. The task 'Eve...' is highlighted in green, indicating it is the current task.

Name	Value
Generate Runtime Statistics	Enabled
Use Tick Counter	no
LDD	Enabled
Runtime Counter LDD	Legacy User Components/Runtim...
non-LDD	Disabled
Runtime Counter	
Scheduler	Settings for the scheduler
ColdFire V1	Disabled

Prio...	Stack Usage	Eve...	Runtime
1 (1)	12 B / 660 B		0x38 (0.1%)
1 (1)	152 B / 676 B		0x2f (0.1%)
0 (0)	0 B / 700 B		0xe677 (98.6%)
4 (4)	76 B / 876 B		0xf1 (0.4%)
3 (3)	180 B / 1.05 kB		0x4a (0.1%)
3 (3)	100 B / 660 B		0x5 (0.0%)
2 (2)	12 B / 668 B		0x1 (0.0%)
1 (1)	100 B / 860 B		0x1b6 (0.7%)

Summary

- *Problem: Need info about tasks/queues/timers*
- Kernel Awareness
 - Segger: RTOS Threads in Debug View
 - NXP: Views for task, timer, queue, heap
 - Stop mode views



Lab: Kernel Awareness

- Enable threads in Debug view (Segger Debug Configuration)
- Use Heap usage view to inspect heap
- Use Task List to inspect tasks
- Enable performance counter to measure task relative performance

