REAL TIME OPERATING SYSTEM PROGRAMMING-II: Windows CE, OSEK and Real time Linux

Lesson-13:

RT Linux

1. RT Linux

RT Linux

- For real time tasks and predictable hard real time behaviour, an extension of Linux is a POSIX hard real-time environment using a real time core.
- The core is called RTLinuxFree and RTLinuxPro , freeware and commercial software respectively. V. Yodaiken developed RTLinux, later FSM Labs commercialized RTLinuxPro and now Wind River has acquired it

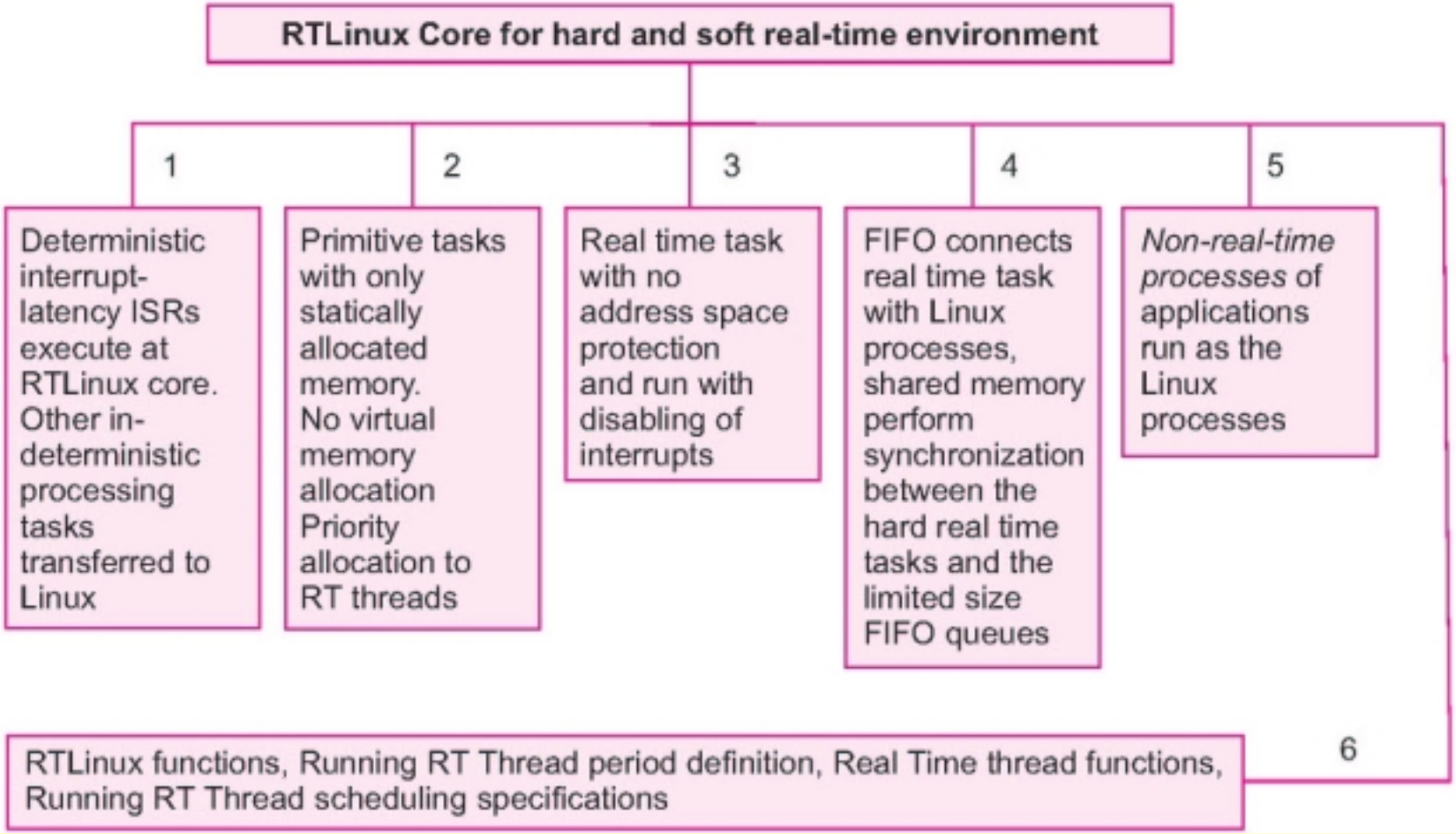
RT Linux…

- Relatively simple modifications, which converts the existing Linux kernel into a hard real-time environment.
- Deterministic interrupt-latency ISRs execute at RTLinux core and other in-deterministic processing tasks are transferred to Linux.

RT Linux…

- The forwarded Linux functions are placed in FIFO with sharing of memory between RTLinux threads as highest priority and Linux functions running as low priority threads. Figure

RT Linux basic features



Running the task for hard real time performance

- Run the primitive tasks with only statically allocated memory.
- The dynamic memory allocation or virtual memory allocation introduces unpredictable allocation and load timings

Running the task for hard real time performance…

- Run the real time task with no address space protection.
- The memory address protection involves additional checks, which also introduce the unpredictable allocation and load timings

Running the task for hard real time performance…

- Run with disabling of interrupts so that other interrupts don't introduce the unpredictability.
- Run a simple fixed priority scheduler.

Running the task for hard real time performance…

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Running the task for soft real time performance…

- Applications can be configured to run differently.
- RTLinux allows flexibility in defining real-time task behaviour, synchronization and communication
- RTLinux kernel designed with modules, which can be replaced to make behaviour flexible wherever possible

Running the task for non real time tasks

- Applications run as the Linux processes.

2. Programming with RT Linux

Example RT Linux

- include rtl.mk /* Include RTLinux make file. The rtl.mk file is an include file which contains all the flags needed to compile the code. */
- all: module1.o /* Object file at module1.o */
- clean: rm -f .o /* Remove using function rm object files inserted before this file */
- module1.0: module1.c /* module1.0 is object file of source file module1.c */
- $(cc) ${include} ${cflags} -c module1.c /* Compile, include, Cflags C module module1.c */

3. Functions in RT Linux

Module and thread functions in RT Linux

init insmod, claenup, and rmmod	The init_module(), insmod_module(), cleanup ()and rmmod_module() functions same as Linux
RT Linux functions	1. rtl_hard_enable_irq ( );/* Enables hard real time interrupts */ 2. rtl_hard_disable_irq ( );/* Gets current clock schedule */ 3. rtlinux_sigaction ( ); /* to RTLinux signal handling function of the application */ 4. rtl_getschedclcok ( );/* Gets current clock schedule */ 5. rtl_request_irq ( ); /*to install real time interrupt handler */ 6. rtl_restore_interrupts ( ); /* Restores the CPU interrupts state */ 7. rtl_ stop_interrupts ( ); /* Stops the CPU interrupts */ 8. rtl_printf ( ); /*to print text from real time thread */ 9. rtl_no_interrupts ( ); /* /* No CPU interrupts permitted*/
Thread creation and getting thread ID	Creation and getting ID is same as Linux threads pthread_create ( ) and pthread_self ( ).
Semaphore and mutex functions	Same as in Linux.
Thread wait	pthread_wait_np(); /*thread waits for other thread to complete*/.

Functions in RT Linux

Running RT thread period definition	pthread_make_periodic_np (pthread_self(), gethrtime(), 800000000); /* defines periodicity of thread with a thread self. First argument is reference to self thread (thread itself). Second argument is gethrtime() is a function to get thread time. Third argument is to define period of thread run = 800000000 ns. Any other period can be defined in third argument.*/
RT thread deletion	pthread_delete_np (thread_1); /* Delete the thread thread_1*/ .
Thread priority	1. struct sched_param thrd1, thrd2; /* Defines two structures for threads thrd1, thrd2 assignment parameters. */ 2. thrd1.sched_priority = 1; /* Defines thrd1 scheduled priority parameter = 1 (=high). Similarly thrd2 priority can be defined */ 3. pthread_setschedparam (pthread_self (), SCHED_FIFO, & thrd1;/* Function setschedparam arguments are self function, schedule defines as FIFO and thread structure thrd1. Similarly thrd2 arguments for Function setschedparam can be defined */
Put into the FIFO from thread	thrd1_put(fid, &queuebuff, 1); ;/* Function thrd1_put arguments are fid (= an integer for FIFO descriptor ID, say, 1, 2, 3, ..), address of queue buffer queuebuff and an option = 1 */

Real Time Thread Functions in RT Linux

1. pthread_attr_setcpu_ np ( ); /* Set CPU pthread attributes. */
2. pthread_attr_getcpu_ np ( ); /* Get CPU pthread attributes. */
3. pthread_attr_setfp_ np ( ); /* Set CPU pthread floating point enable attributes.*/
4. pthread_ suspend_ np ( ); /* Suspends thread run.*/
5. pthread_ wakeup_ np ( ); /* Wakes up the thread .*/
6. pthread_ wait_ np ( ); /* Wait for start (message or signal) the thread .*/
7. pthread_ setfp_ np ( ); /* Allows floating point arithmetic.*/
8. pthread_delete_ np ( ); /* Delete the thread.*/

Real Time FIFO functions

1. rtf_create ( ), rtf_create_rt_handler ( ), rtf_open ( ), rtf_close ( ) and rtf_unlink ( ) are the functions to createFIFO device, create real-time handler, initialize, close and remove a named RT FIFIO. unlink ( ) does not destroy the queue immediately but prevents the other tasks from using the queue. The queue will get destroyed only if the last task closes the queue. Destroy means to de-allocate the memory associated with queue ECB.
2. rtf_setattr ( ) sets the attributes.
3. rtf_lock ( ) and rtf_unlock ( ) lock and unlock a queue.

Real Time FIFO functions

3. rtf_lock ( ) and rtf_unlock ( ) lock and unlock a queue.
4. rtf_put (fid, &queuebuff, 1); ;/* Function rtf_put arguments are fid (= an integer for FIFO descriptor ID, say, 1, 2, 3, ..), address of queue buffer queuebuff and an option = 1 */.
5. rtf_get (fid, &queuebuff, 1); ;/* Function rtf_get arguments are fid (= an integer for FIFO descriptor ID, say, 1, 2, 3, ..), address of queue buffer queuebuff and an option = 1 */.
6. rtf_send ( ) and rtf_receive ( ) to send and receive into a queue. rtf_send four arguments are fid (FIFO device ID), (void *) &qsendingdata (pointer to address of user data), sizeof (qsendingdata) and 0. mq_ receive five arguments are msgid (message queue ID), (void *) &qreceivedata (pointer to address of bufferdata), sizeof (qreceivingdata), 0 and 0.

Real Time FIFO functions

7. rtf_notify ( ) signals to a single waiting task that the message is now available. The notice is exclusive for a single task, which has been registered for a notification (registered means later on takes note of the rtf_notify).
8. rtf_getattr ( ) retrieves the attribute of a RT FIFO.
9. rtf_flush ( ) flushes the data of a RT FIFO.
10. rtf_allow_interrupts ; ( ) /* Controls real time interrupt handler */.
11. rtf_free_irq ( ); /*Frees real time interrupt handler */.

Summary

We learnt

- RTLinux provides hard real functionalities in a separate layer, which runs the primitive tasks with only statically allocated memory, no dynamic memory allocation, no virtual memory allocation, no address space protection, run with disabling of interrupts, runs a simple fixed priority scheduler,

We learnt

- It provides for running of real time tasks by RTLinux layer and no deterministic non real time tasks by Linux.
- A FIFO connects real time tasks with Linux processes,
- Synchronization between the hard real time tasks and the limited size FIFO queues is achieved through use of shared memory (not through IPCs).

We learnt

- RTLinux separate functions rtl_hard_enable_irq ( ); rtl_hard_disable_irq ( );rtlinux_sigaction ( ); rtl_getschedclcok ( ); rtl_request_irq ( ); rtl_restore_interrupts ( ); rtl_ stop_interrupts ( ); rtl_printf ( ); and rtl_no_interrupts ( );

We learnt

- RTLinux supports priority for the real time threads. RTLinux has real time thread wait, thread period definition, thread deletion, priority assignment, and FIFO device-functions.

End Lesson-13 on

RT Linux