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New Features and Services since

μC/OS-II V2.00

Jean J. Labrosse
Jean.Labrosse@Micrium.com
www.Micrium.com

Introduction

This document describes all the features and services added to μ C/OS-II since the introduction of the hard cover book *MicroC/OS-II, The Real-Time Kernel*, ISBN 0-87930-543-6. The software provided with the book was version 2.00 or V2.04. The version number of the change is shown when appropriate.

Timer Manager (V2.81)

μ C/OS-II now provides support for periodic as well as one-shot timers. This functionality is found in `OS_TMR.C` and is enabled by setting `OS_TMR_EN` to 1 in `OS_CFG.H`. Your application can have any number of timers (up to 65500). When a timer times out, an optional callback function can be called allowing you to perform any action (signal a task, turn on/off a light, etc.). Each timer has its own callback function.

IMPORTANT

The APIs for the Timer Manager were changed in V2.83 from what they were in V2.81 and V2.82. This was necessary to correct some issues with the Timer Manager. Please consult the Reference Manual for the new APIs.

When timer management is enabled, μ C/OS-II creates a timer task (`OSTmrTask()`) which is responsible for updating all the timers. The priority of this task is determined by `OS_TASK_TMR_PRIO` which should be defined in your application's `APP_CFG.H`.

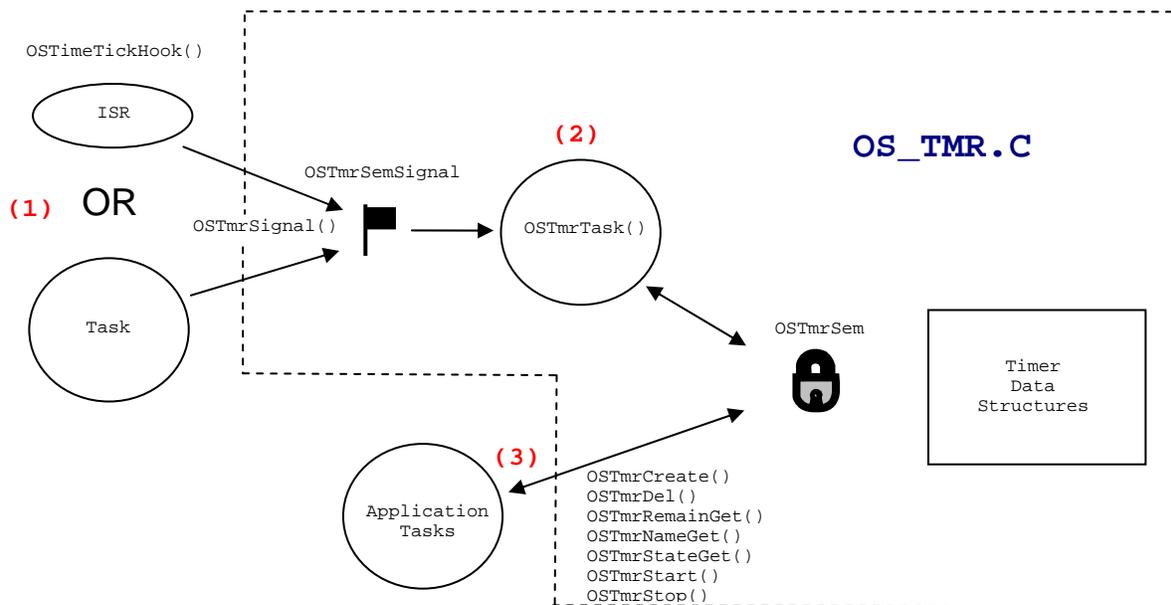
The timer manager provides a number of services to your applications. Specifically, you can call one of the following functions (see the μ C/OS-II reference manual for a description of these functions) from your tasks:

<code>OSTmrCreate()</code>	Create a timer
<code>OSTmrDel()</code>	Delete a timer
<code>OSTmrRemainGet()</code>	Determine how much time before a timer expires
<code>OSTmrNameGet()</code>	Get the name of a timer
<code>OSTmrStateGet()</code>	Get the state of a timer (UNUSED, STOPPED, RUNNING, COMPLETED)
<code>OSTmrStart()</code>	Start a timer
<code>OSTmrStop()</code>	Stop a timer

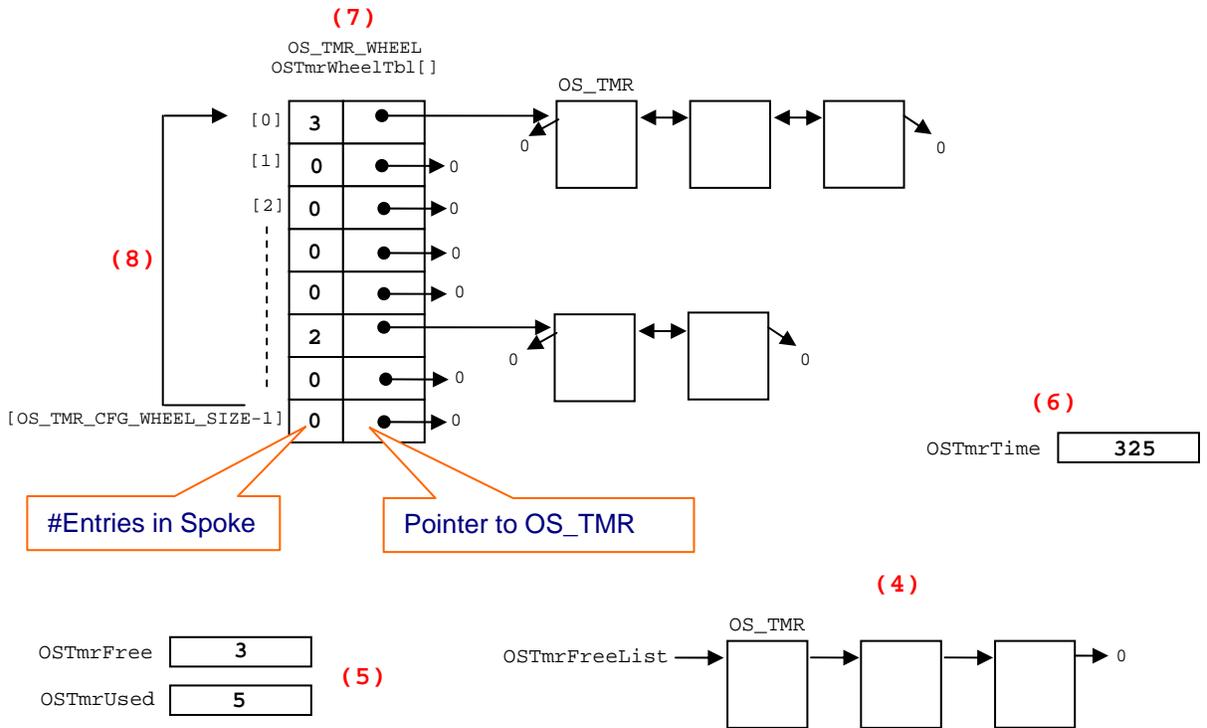
You should note that you **CANNOT** call these functions from ISRs.

The drawing below shows the task model of the Timer Manager. You should note that semaphore management needs to be enabled (you need to set `OS_SEM_EN` to 1 in `OS_CFG.H`) for the timer manager to work. The timer manager requires two (2) semaphores.

- (1) An ISR or an application task needs to ‘signal’ a counting semaphore by calling `OSTmrSignal()` at the rate specified in `OS_TMR_CFG_TICK_RATE` (see `OS_CFG.H`). The counting semaphore is called `OSTmrSemSignal` that is initialized to 0 by `μC/OS-II` when `OSInit()` is called. You should note that you should ONLY call `OSTmrSignal()` and not worry about the semaphore; it’s encapsulated by `OSTmrSignal()`.
- (2) The timer management task (`OSTmrTask()`) pends forever on the counting semaphore waiting for it to be signaled. When the semaphore is signaled, `OSTmrTask()` acquires another semaphore (a binary semaphore in this case, `OSTmrSem`) to gain exclusive access to timer data structures. When `OSTmrTask()` is the owner of the semaphore it updates all the timers created by your application.
- (3) Your application accesses timer data structure via interface functions. These functions allow you to create, delete, start and stop timers as well as examine the amount of time remaining before a timer times out.



The drawing below shows the data structures used in the timer manager.



- (4) Each timer is characterized by a data structure of type OS_TMR (see ucos_ii.h). Each timer contains the 'period' of the timer (if the timer is to operate in periodic mode), the name of the timer, a timer 'match' value (described later) and other fields used to link the timer. Free timers are placed in a singly linked list of 'unused' timers pointed to by OSTmrFreeList.
- (5) The number of free timers is held in OSTmrFree and the number of used (or allocated) timers is held in OSTmrUsed. Of course, the total number of timers is the sum of these two fields and, unless you don't properly use the timer management services, that sum should always equal OS_TMR_CFG_MAX.
- (6) Every time OSTmrSignal() is called, the unsigned 32-bit variable OSTmrTime is incremented by one and used to see if timers have expired.
- (7) The timer manager keeps track of which timer it needs to update using a 'timer wheel'. The wheel is basically an array of structures of type OS_TMR_WHEEL (see ucos_ii.h) that wraps around. This structure contains two fields: a pointer to a doubly-linked list of OS_TMR structures and, the number of entries in that list.
- (8) The 'wheel' contains OS_TMR_CFG_WHEEL_SIZE entries or spokes.

OS_TMR structures are inserted in the wheel when you call OSTmrStart(). The position (i.e. spoke) in OSTmrWheelTbl[] for a specific timer is given by:

```
match = OSTmrTime + period;
spoke = match % OS_TMR_CFG_WHEEL_SIZE;
```

The 'match' corresponds to the value that OSTmrTime needs to reach before the timer expires. For example, let's say that OSTmrTime is 0 (just initialized) and we want to create a timer that will expire every second (assuming OS_TMR_CFG_TICKS_PER_SEC is set to 10). Also, let's assume that OS_TMR_CFG_WHEEL_SIZE is 8 (as shown in the diagram above).

```
match = OSTmrTime + period;
match = 0 + 10;
match = 10;

spoke = match % OS_TMR_CFG_WHEEL_SIZE;
spoke = 10 % 8;
spoke = 2;
```

This means that OSTmrStart() will obtain a free OS_TMR data structure from the free list of timers and place this data structure in OSTmrWheelTbl[] at position #2 in the table. OSTmrStart() will then store the 'match' value in the OS_TMR data structure.

Every time OSTmrTime is incremented by OSTmrTask(), OSTmrTask() goes through ALL the OS_TMR structures placed at spoke (OSTmrTime % OS_TMR_CFG_WHEEL_SIZE) to see if OSTmrTime 'matches' the value stored in the OS_TMR structure. If a match occurs, the timer is removed from the list. If the timer was started by OSTmrStart() with a 'periodic' option then, the OS_TMR structure is placed in the OSTmrWheelTbl[] by calculating its new position, again using OSTmrTime + period. In our example, the new 'spoke' would be:

```
match = OSTmrTime + period;
match = 10 + 10;
match = 20;

spoke = match % OS_TMR_CFG_WHEEL_SIZE;
spoke = 20 % 8;
spoke = 4;
```

The use of a timer wheel basically reduces the execution time of the timer task so that it only handles a few of the timers. Of course, the worst case is such that all timers are placed in the same spoke of the timer wheel. However, statistically, this will occur rarely. It's generally recommended to keep the size of the wheel a fraction of the total number of times. In other words, you should set:

```
OS_TMR_CFG_WHEEL_SIZE <= Fraction of (OS_TMR_CFG_MAX)
```

A fraction of 2 to 8 should work well.

RAM usage (in bytes) for the timer manager is shown below:

```
2 * sizeof(INT16U) +
1 * sizeof(INT32U) +
3 * sizeof(POINTER) +
OS_TASK_TMR_STK_SIZE * sizeof(OS_STK) +
OS_TMR_CFG_WHEEL_SIZE * (sizeof(INT16U) + sizeof(POINTER)) +
OS_TMR_CFG_MAX * (4 * sizeof(POINTER) +
                 2 * sizeof(INT32U) +
                 3 * sizeof(INT8U) +
                 OS_TMR_CFG_NAME_SIZE * sizeof(INT8U))
```

Because INT8Us and BOOLEANS are typically 1 byte, INT16Us are 2 bytes and INT32Us are 4 bytes, we can simplify the above equation as follows:

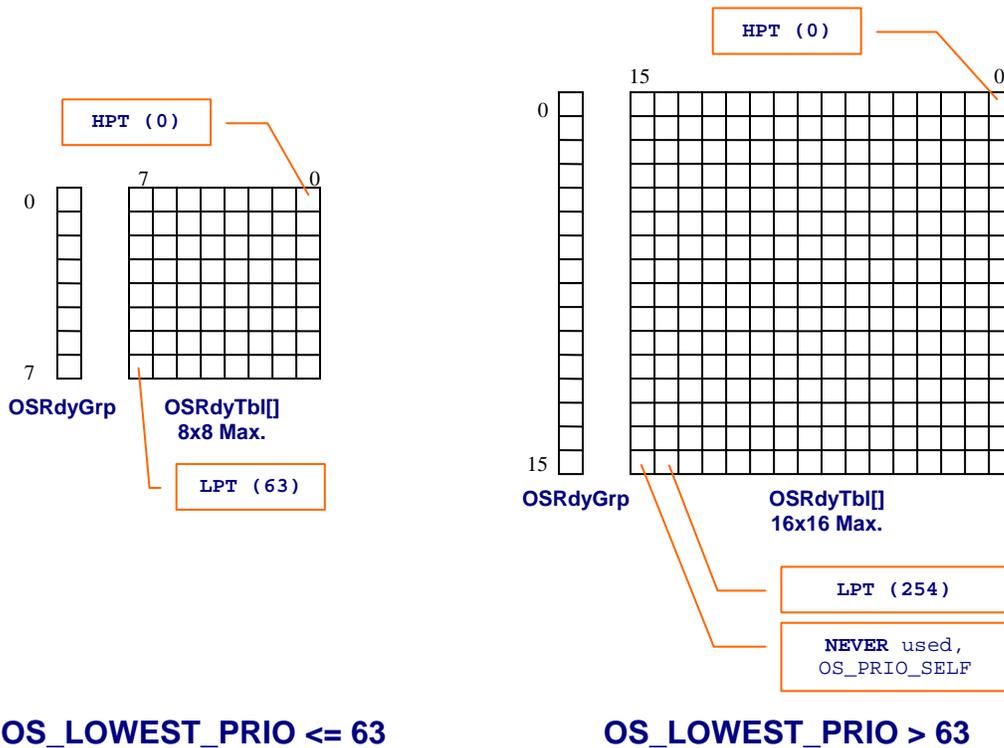
```
2 * 2 +
1 * 4 +
3 * sizeof(POINTER) +
OS_TASK_TMR_STK_SIZE * sizeof(OS_STK) +
OS_TMR_CFG_WHEEL_SIZE * (2 + sizeof(POINTER)) +
OS_TMR_CFG_MAX * (4 * sizeof(POINTER) +
                 2 * 4 +
                 3 +
                 OS_TMR_CFG_NAME_SIZE)
```

Or,

```
8 +
3 * sizeof(POINTER) +
OS_TASK_TMR_STK_SIZE * sizeof(OS_STK) +
OS_TMR_CFG_WHEEL_SIZE * (2 + sizeof(POINTER)) +
OS_TMR_CFG_MAX * (4 * sizeof(POINTER) + 11 + OS_TMR_CFG_NAME_SIZE)
```

Support for 255 tasks (V2.80)

μ C/OS-II can now support up to **255** tasks. To support up to 255 tasks, we simply increased the ready list and event wait lists to a matrix of 16x16 instead of 8x8. In fact, the actual size of the matrix (whether 8x8 or 16x16) depends on the value of OS_LOWEST_PRIO in OS_CFG.H. If OS_LOWEST_PRIO is less than or equal to 63, we use an 8x8 matrix and thus μ C/OS-II behaves exactly the same as it used to. If you specify a value for OS_LOWEST_PRIO to be greater than 63, we use the 16x16 matrix as show below.



You should note that the actual size of the matrix depends on OS_LOWEST_PRIO. For example, if OS_LOWEST_PRIO is 10 then the matrix is actually 2x8 (two bytes of 8 bits). Similarly, if OS_LOWEST_PRIO is set to 47, the matrix will be 6x8. When OS_LOWEST_PRIO is above 63, we use 16-bit wide entries. For example, if you specify OS_LOWEST_PRIO to be 100 then the matrix will be 7x16 (7 entries of 16 bits each). You **CANNOT** set OS_LOWEST_PRIO to 255 because this value is reserved for OS_PRIO_SELF.

New Files

APP_CFG.H (Added in V2.80)

We now assume the presence of a file called APP_CFG.H which is declared in your application. The purpose of this file is to assign task priorities, stack sizes and other configuration information for your application.

OS_CFG_R.H (Added in V2.70)

This file is 'reference' file so that you don't have to create this file from scratch. OS_CFG_R.H has been added in V2.70 and is found in the 'Source' directory of the microprocessor independent portion of [μC/OS-II](#). It is recommended that you *copy* OS_CFG_R.H to OS_CFG.H of your project directory.

OS_TMR.C (Added in V2.81)

We added a timer manager function in [μC/OS-II](#). You can now define any number of timers. The timers can be periodic or one-shots. A user definable function can be called when the timer expires. One such function is definable for each timer in your application.

New Port Files

OS_DBG.C (Added in V2.62 but renamed from OS_DEBUG.C in V2.70)

OS_DBG_R.C (Added in V2.70)

This file should be placed in the same directory as OS_CPU_C.C, OS_CPU.H and OS_CPU_A.ASM of the port you are using. OS_DBG.C defines a series of variables that are placed in ROM (code space). These variables are used by some Kernel Aware Debuggers to get information about [μC/OS-II](#) and its configuration. If you DON'T use a Kernel Aware Debugger that requires this file, you DON'T need to have it. Check you Kernel Aware Debugger documentation. OS_DBG.C used to be called OS_DEBUG.C in V2.62.

OS_DBG_R.C is a 'reference' file so that you don't have to create this file from scratch. OS_DBG_R.C has been added in V2.70 and is found in the 'Source' directory of the microprocessor independent portion of [μC/OS-II](#).

Changes

uCOS_II.H (Changed in V2.70 and V2.80)

This file now includes #include statements to include APP_CFG.H, OS_CPU.H and OS_CFG.H. This allows you to compile [μC/OS-II](#) without the needs of any other library functions.

New #define Constants and Macros

`OS_ARG_CHK_EN` (OS_CFG.H, V2.04)

This constant is used to specify whether argument checking will be performed at the beginning of most of `μC/OS-II` services. You should always choose to turn this feature on (when set to 1) unless you need to get the best performance possible out of `μC/OS-II` or, you need to reduce code size.

`OS_CRITICAL_METHOD #3` (OS_CPU.H, V2.04)

This constant specifies the method used to disable and enable interrupts during critical sections of code. Prior to V2.04, `OS_CRITICAL_METHOD` could be set to either 1 or 2. In V2.04, I added a local variable (i.e. `cpu_sr`) in most function calls to save the processor status register which generally holds the state of the interrupt disable flag(s). You would then declare the two critical section macros as follows:

```
#define OS_ENTER_CRITICAL() (cpu_sr = OS_CPUSR_Save())
#define OS_EXIT_CRITICAL() (OS_CPU_SR_Restore(cpu_sr))
```

Note that the functions `OS_CPU_SR_Save()` and `OS_CPU_SR_Restore()` would be written in assembly language and would typically be found in `OS_CPU_A.ASM` (or equivalent).

`OS_DEBUG_EN` (OS_CFG.H, V2.60)

This constant is used to enable ROM constants used for debugging using a kernel aware debugger. The constants are found in `OS_CORE.C`.

`OS_EVENT_NAME_SIZE` (OS_CFG.H, V2.60)

This constant determines the maximum number of characters that would be used to assign a name to either a semaphore, a mutex, a mailbox or a message queue. The name of these 'objects' would thus have to be smaller (in size) than this value. If `OS_EVENT_NAME_SIZE` is set to 0, this feature is disabled. `OS_EVENT_NAME_SIZE` needs to accommodate a NUL terminated ASCII string.

`OS_FLAG_EN` (OS_CFG.H, V2.51)

This constant is used to specify whether you will enable (when 1) code generation for the event flags.

`OS_FLAG_NAME_SIZE` (OS_CFG.H, V2.60)

This constant determines the maximum number of characters that would be used to assign a name to an event flag group. The name of event flags would thus have to be smaller (in size) than this value. If `OS_FLAG_NAME_SIZE` is set to 0, this feature is disabled. `OS_FLAG_NAME_SIZE` needs to accommodate a NUL terminated ASCII string.

`OS_FLAG_WAIT_CLR_EN` (OS_CFG.H, V2.51)

This constant is used to enable code generation (when 1) to allow to wait on cleared event flags.

OS_ISR_PROTO_EXT (OS_CPU.H, V2.02)

If you place this constant in OS_CPU.H, you can redefine the function prototypes for OSctxSw() and OSTickISR(). In other words, if you add the following definition, YOU will have to declare the prototype for OSctxSw() and OSTickISR().

```
#define OS_ISR_PROTO_EXT 1
```

OS_MAX_FLAGS (OS_CFG.H, V2.51)

This constant is used to determine how many event flags your application will support.

OS_MEM_NAME_SIZE (OS_CFG.H, V2.60)

This constant determines the maximum number of characters that would be used to assign a name to a memory partition. The name of memory partitions would thus have to be smaller (in size) than this value. If OS_MEM_NAME_SIZE is set to 0, this feature is disabled and no RAM is used in the OS_MEM for the memory partition. OS_MEM_NAME_SIZE needs to accommodate a NUL terminated ASCII string.

OS_MUTEX_EN (OS_CFG.H, V2.04)

This constant is used to specify whether you will enable (when 1) code generation for mutual exclusion semaphores.

OS_TASK_NAME_SIZE (OS_CFG.H, V2.60)

This constant determines the maximum number of characters that would be used to assign a name to a task. The name of tasks would thus have to be smaller (in size) than this value. If OS_TASK_NAME_SIZE is set to 0, this feature is disabled and no RAM is used in the OS_TCB for the task name. OS_TASK_NAME_SIZE needs to accommodate a NUL terminated ASCII string.

OS_TASK_PROFILE_EN (OS_CFG.H, V2.60)

This constant allows variables to be allocated in each task's OS_TCB that hold performance data about each task. Specifically, if OS_TASK_PROFILE_EN is set to 1, each task will have a variable to keep track of the number of context switches, the task execution time, the number of bytes used by the task and more.

OS_TASK_STAT_STK_CHK_EN (OS_CFG.H, V2.60)

This constant allows the statistic task to determine the actual stack usage of each active task. If OS_TASK_STAT_EN is set to 0 (the statistic task is not enabled), you can call OS_TaskStatStkChk() yourself from one of your tasks. . If OS_TASK_STAT_EN is set to 1, stack sizes will be determined every second.

OS_TASK_SW_HOOK_EN (OS_CFG.H, V2.60)

Normally, μ C/OS-II requires that you have a context switch hook function called OSTaskSwHook(). When set to 0, this constant allows you to omit OSTaskSwHook() from your code. This configuration constant was added to reduce the amount of overhead during a context switch in applications that doesn't require the context switch hook. Of course, you will also need to remove the calls to OSTaskSwHook() from OSTaskStartHighRdy(), OSctxSw() and OSIntCtxSw() in OS_CPU_A.ASM.

OS_TASK_TMR_STK_SIZE (OS_CFG.H, V2.81)

This #define determines the stack size (in number of stack-size elements, i.e. OS_STK) of the timer task. The size of the timer task's stack greatly depends on the processor architecture and the functions that are called when timers expire. Note that if you set OS_TMR_EN to 0 in OS_CFG.H then the value you set for OS_TASK_TMR_STK_SIZE is irrelevant because the timer functionality would be disabled.

OS_TICK_STEP_EN (OS_CFG.H, V2.60)

[μC/OS-View](#) can now 'halt' [μC/OS-II](#)'s tick processing and allow you to issue 'step' commands from [μC/OS-View](#). In other words, [μC/OS-View](#) can prevent [μC/OS-II](#) from calling OSTimeTick() so that timeouts and time delays are no longer processed. However, though a keystroke from [μC/OS-View](#), you can execute a single tick at a time. If OS_TIME_TICK_HOOK_EN (see below) is set to 1, OSTimeTickHook() is still executed at the regular tick rate in case you have time critical items to take care of in your application.

OS_TIME_TICK_HOOK_EN (OS_CFG.H, V2.60)

Normally, [μC/OS-II](#) requires the presence of a function called OSTimeTickHook() which is called at the very beginning of the tick ISR. When set to 0, this constant allows you to omit OSTimeTickHook() from your code. This configuration constant was added to reduce the amount of overhead during a tick ISR in applications that doesn't require this hook.

OS_TMR_EN (OS_CFG.H, V2.81)

This #define enables (when set to 1) or disables (when set to 0) the timer management code.

OS_TMR_CFG_MAX (OS_CFG.H, V2.81)

This #define determines the maximum number of timers that can exist in the application. If OS_TMR_EN is set to 1, you should declare **AT LEAST** two (2) timers.

OS_TMR_CFG_NAME_SIZE (OS_CFG.H, V2.81)

This #define determines the number of ASCII characters used when naming timers. For example, specifying 16 means that a timer name can have up to 16 characters (including the NUL character).

OS_TMR_CFG_WHEEL_SIZE (OS_CFG.H, V2.81)

This #define determines the number of entries in the timer wheel. This value should be a number between 2 and 1024. Timer management overhead is somewhat determined by the size of the wheel. A large number of entries might reduce the overhead for timer management but would require more RAM. Each entry requires a pointer and a count (16-bit value). We recommend a number that is NOT a multiple of the tick rate. If your application has many timers then it's recommended that you have a high value. As a starting value, you could use OS_TMR_CFG_MAX / 4.

OS_TMR_CFG_TICKS_PER_SEC (OS_CFG.H, V2.81)

This #define determines the rate at which timers will be updated. You would typically set to a fraction of the tick rate (i.e. OS_TICKS_PER_SEC). We recommend that you set OS_TMR_CFG_TICKS_PER_SEC to 10 (i.e. 10 Hz).

OS_VIEW_MODULE (OS_CFG.H, V2.77)

This #define constant indicates whether you are going to be using [μC/OS-View](#) in your product. For details on [μC/OS-View](#), please consult: www.micrium.com.

The following table summarizes some of the new #define constants in OS_CFG.H which were all added in since V2.00.

#define name in OS_CFG.H	... to enable the function:
OS_DEBUG_EN	Enable debug constants in OS_CORE.C. If you are using a kernel aware debugger, you should enable this feature.
OS_EVENT_NAME_SIZE	OSEventNameGet() OSEventNameSet() And, to allow naming semaphores, mutexes, mailboxes and message queues.
OS_FLAG_ACCEPT_EN	OSFlagAccept()
OS_FLAG_DEL_EN	OSFlagDel()
OS_FLAG_NAME_SIZE	OSFlagNameGet() OSFlagNameSet() And, to allow naming event flag groups.
OS_FLAG_QUERY_EN	OSFlagQuery()
OS_MBOX_ACCEPT_EN	OSMboxAccept()
OS_MBOX_DEL_EN	OSMboxDel()
OS_MBOX_POST_EN	OSMboxPost()
OS_MBOX_POST_OPT_EN	OSMboxPostOpt()
OS_MBOX_QUERY_EN	OSMBoxQuery()
OS_MEM_NAME_SIZE	OSMemNameGet() OSMemNameSet()
OS_MEM_QUERY_EN	OSMemQuery()
OS_MUTEX_ACCEPT_EN	OSMutexAccept()
OS_MUTEX_DEL_EN	OSMutexDel()
OS_MUTEX_QUERY_EN	OSMutexQuery()
OS_Q_ACCEPT_EN	OSQAccept()
OS_Q_DEL_EN	OSQDel()
OS_Q_FLUSH_EN	OSQFlush()
OS_Q_POST_EN	OSQPost()
OS_Q_POST_FRONT_EN	OSQPostFront()
OS_Q_POST_OPT_EN	OSQPostOpt()
OS_Q_QUERY_EN	OSQQuery()
OS_SEM_ACCEPT_EN	OSSemAccept()
OS_SEM_DEL_EN	OSSemDel()
OS_SEM_QUERY_EN	OSSemQuery()
OS_SEM_SET_EN	OSSemSet()
OS_TASK_NAME_SIZE	OSTaskNameGet() OSTaskNameSet()

	And, to allow naming tasks.
OS_TASK_PROFILE_EN	To allocate variables in OS_TCB for performance monitoring of each task at run-time.
OS_TASK_QUERY_EN	OSTaskQuery()
OS_TASK_STAT_STK_CHK_EN	OS_TaskStatStkChk()
OS_TASK_SW_HOOK_EN	OSTaskSwHook()
OS_TASK_TMR_STK_SIZE	Size in OS_STK elements of the Timer Management task.
OS_TICK_STEP_EN	To support the stepping feature of μC/OS-View .
OS_TIME_DLY_HMSM_EN	OSTimeDlyHMSM()
OS_TIME_DLY_RESUME_EN	OSTimeDlyResume()
OS_TIME_GET_SET_EN	OSTimeGet() and OSTimeSet()
OS_TIME_TICK_HOOK_EN	OSTimeTickHook()
OS_TMR_EN	Enables (1) or Disables (0) timer management functions.
OS_TMR_CFG_MAX	Determines the maximum number of timers in your application.
OS_TMR_CFG_NAME_SIZE	Determines the maximum number of characters used for timer names.
OS_TMR_CFG_WHEEL_SIZE	Determines the size of the timer wheel (in number of entries).
OS_TMR_CFG_TICKS_PER_SEC	Rate at which timers will be updated (Hz)
OS_SCHED_LOCK_EN	OSSchedLock() and OSSchedUnlock()
OS_VIEW_MODULE	To add μC/OS-View in your product.

New Data Types

`OS_CPU_SR` (OS_CPU.H, V2.04)

This data type is used to specify the size of the CPU status register which is used in conjunction with `OS_CRITICAL_METHOD #3` (see above). For example, if the CPU status register is 16-bit wide then you would typedef accordingly.

`OS_FLAGS` (uCOS_II.H, V2.51)

This data type determines how many bits an event flag group will have. You can thus typedef this data type to either `INT8U`, `INT16U` or `INT32U` to give event flags either 8, 16 or 32 bits, respectively.

`OS_TMR` (uCOS_II.H, V2.81)

This data type is a timer object which contains information about a specific timer that you started (see `OS_TMR.C`).

New Hook Functions

`void OSInitHookBegin(void)` (OS_CPU.C, V2.04)

This function is called at the very beginning of `OSInit()` to allow for port specific initialization BEFORE `μC/OS-II` gets initialized.

`void OSInitHookEnd(void)` (OS_CPU.C, V2.04)

This function is called at the end of `OSInit()` to allow for port specific initialization AFTER `μC/OS-II` gets initialized.

`void OSTCBInitHook(OS_TCB *ptcb)` (OS_CPU.C, V2.04)

This function is called by `OSTCBInit()` during initialization of the TCB assigned to a newly created task. It allows port specific initialization of the TCB.

`void OSTaskIdleHook(void)` (OS_CPU.C, V2.51)

This function is called by `OSTaskIdle()`. This allows you to STOP the CPU and thus reduce power consumption while there is nothing to do.

New Functions

The following table provides a list of all the new functions (i.e. services) that YOUR application can call. The list also includes functions that used to exist but, if these are in this list, it's because their API may have changed.

Refer to the *Reference Manual* of the current release for a description of these functions.

Function Name	File	Enabled By ...
OSEventNameGet()	OS_CORE.C	OS_EVENT_NAME_SIZE
OSEventNameSet()	OS_CORE.C	OS_EVENT_NAME_SIZE
OSFlagAccept()	OS_FLAG.C	OS_FLAG_EN && OS_FLAG_ACCEPT_EN
OSFlagCreate()	OS_FLAG.C	OS_FLAG_EN
OSFlagDel()	OS_FLAG.C	OS_FLAG_EN && OS_FLAG_DEL_EN
OSFlagNameGet()	OS_FLAG.C	OS_FLAG_NAME_SIZE
OSFlagNameSet()	OS_FLAG.C	OS_FLAG_NAME_SIZE
OSFlagPend()	OS_FLAG.C	OS_FLAG_EN
OSFlagPendGetFlagsRdy()	OS_FLAG.C	OS_FLAG_EN
OSFlagPost()	OS_FLAG.C	OS_FLAG_EN
OSFlagQuery()	OS_FLAG.C	OS_FLAG_EN
OSMboxDel()	OS_MBOX.C	OS_MBOX_EN && OS_MBOX_DEL_EN
OSMboxPostOpt()	OS_MBOX.C	OS_MBOX_EN && OS_MBOX_POST_OPT_EN
OSMutexAccept()	OS_MUTEX.C	OS_MUTEX_EN && OS_MUTEX_ACCEPT_EN
OSMutexCreate()	OS_MUTEX.C	OS_MUTEX_EN
OSMutexDel()	OS_MUTEX.C	OS_MUTEX_EN && OS_MUTEX_DEL_EN
OSMutexPend()	OS_MUTEX.C	OS_MUTEX_EN
OSMutexPost()	OS_MUTEX.C	OS_MUTEX_EN
OSMutexQuery()	OS_MUTEX.C	OS_MUTEX_EN && OS_MUTEX_QUERY_EN
OSQAccept()	OS_Q.C	OS_Q_EN && OS_Q_ACCEPT_EN
OSQDel()	OS_Q.C	OS_Q_EN && OS_Q_DEL_EN
OSQFlush()	OS_Q.C	OS_Q_EN && OS_Q_FLUSH_EN
OSQPend()	OS_Q.C	OS_Q_EN
OSQPost()	OS_Q.C	OS_Q_EN
OSQPostFront()	OS_Q.C	OS_Q_EN && OS_Q_POST_FRONT_EN
OSQPostOpt()	OS_Q.C	OS_Q_EN && OS_Q_POST_OPT_EN
OSSemDel()	OS_SEM.C	OS_SEM_EN && OS_SEM_DEL_EN
OSSemSet()	OS_SEM.C	OS_SEM_EN && OS_SEM_SET_EN
OSTaskNameGet()	OS_TASK.C	OS_TASK_NAME_SIZE
OSTaskNameSet()	OS_TASK.C	OS_TASK_NAME_SIZE
OSTmrGetName()	OS_TMR.C	OS_TMR_EN
OSTmrGetRemain()	OS_TMR.C	OS_TMR_EN
OSTmrStart()	OS_TMR.C	OS_TMR_EN
OSTmrStop()	OS_TMR.C	OS_TMR_EN
OSTmrSignal()	OS_TMR.C	OS_TMR_EN

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Contacts

Micrium

949 Crestview Circle
Weston, FL 33327
954-217-2036
954-217-2037 (FAX)
e-mail: Jean.Labrosse@Micrium.com
WEB: www.Micrium.com

CMP Books, Inc.

1601 W. 23rd St., Suite 200
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