acontis technologies GmbH

SOFTWARE

RTOS Virtual Machine

User Manual
Edition: 2024-10-10

Content

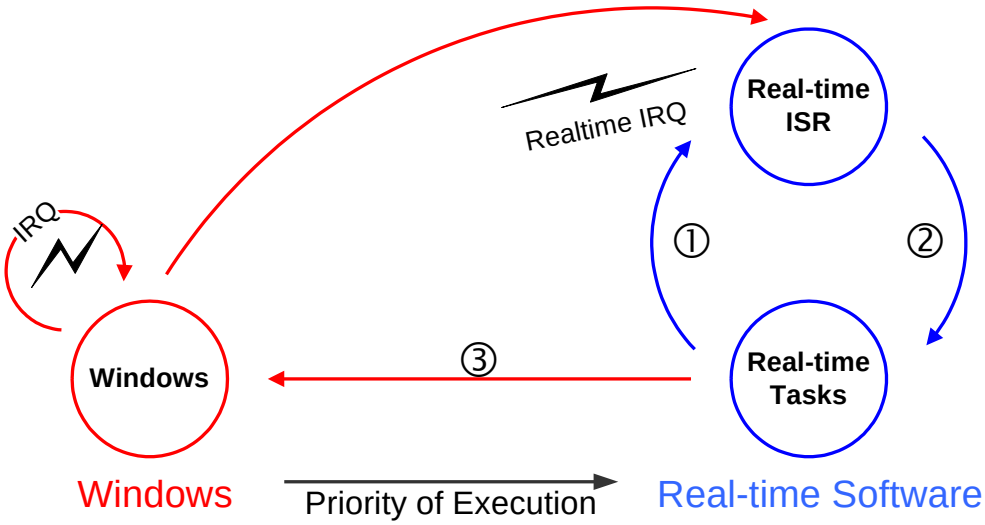
1 ACONTIS RTOS Virtual Machine Overview

The ACONTIS RTOS-VM provides a light-weight real-time virtualization platform for Windows.
On top of this platform either real-time firmware, custom or off-the-shelf real-time operating systems can be executed.
When using multicore CPUs one can choose between two general operation modes. A more detailed description about possible operation modes can also be found in section 4.

1.1 Shared Mode Operation

Windows shall run on all CPU cores and only one CPU core shall additionally run the real-time software. If the Windows application needs a lot of CPU power (e.g. for image processing) this will be the appropriate operation mode even on multi-core CPUs. In shared mode operation Windows (on this core) will usually only get CPU time when the real-time software is idle.

The following diagram illustrates the flow of control:



Operating states of the RTOS-VM in shared mode

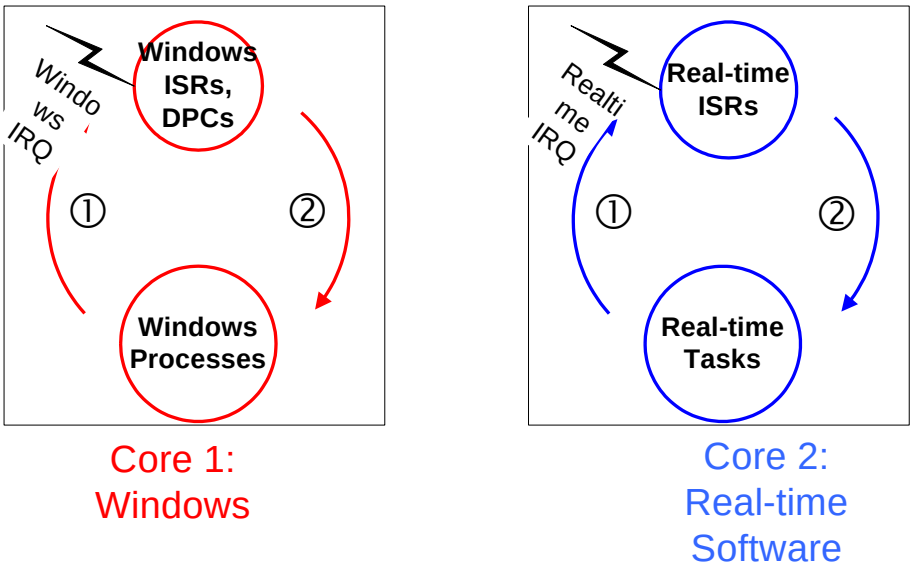
① Exception-handling or a higher priority interrupt becomes outstanding.
② Interrupt Service Routine optionally starts a new task and then finishes.
③ From the idle-state, VxWorks transfers control to Windows operating system.

Note: When running the RTOS-VM in shared mode on multiprocessor/multicore systems this state diagram is only applicable for one CPU core in the system (by default on the first core). All other CPU cores will run Windows only.

1.2 Exclusive Mode Operation

Windows and the real-time software shall run fully independently on different CPU cores. Using this mode will lead to much shorter interrupt and task latencies as there is no need to switch from Windows to the real-time software.

The following diagram, illustrates the flow of control on a dual core system:



Core 1:
Windows

Core 2:
Real-time
Software

Operating states of the RTOS-VM in exclusive mode

① Exception-handling or a higher priority interrupt becomes outstanding.
② Interrupt Service Routine optionally starts a new task and then finishes.

Note: When running the RTOS-VM in exclusive mode Windows will never be interrupted. Application and interrupt processing run concurrently and independently on both CPU cores. There is no need in the real-time software to enter the idle state.

2 Virtual Machine Framework

Using the ACONTIS RTOS-VM there is no need to understand the complex hardware of modern PC systems. The basic hardware components of the PC (architecture specific processor registers, timer, interrupt controller, memory handling/partitioning) can be accessed in the real-time software by simply calling the appropriate functions that the RTOS-VM hardware abstraction layer (HAL) provides.
Besides the HAL functions the RTOS-VM provides additional services, especially for communication with Windows:

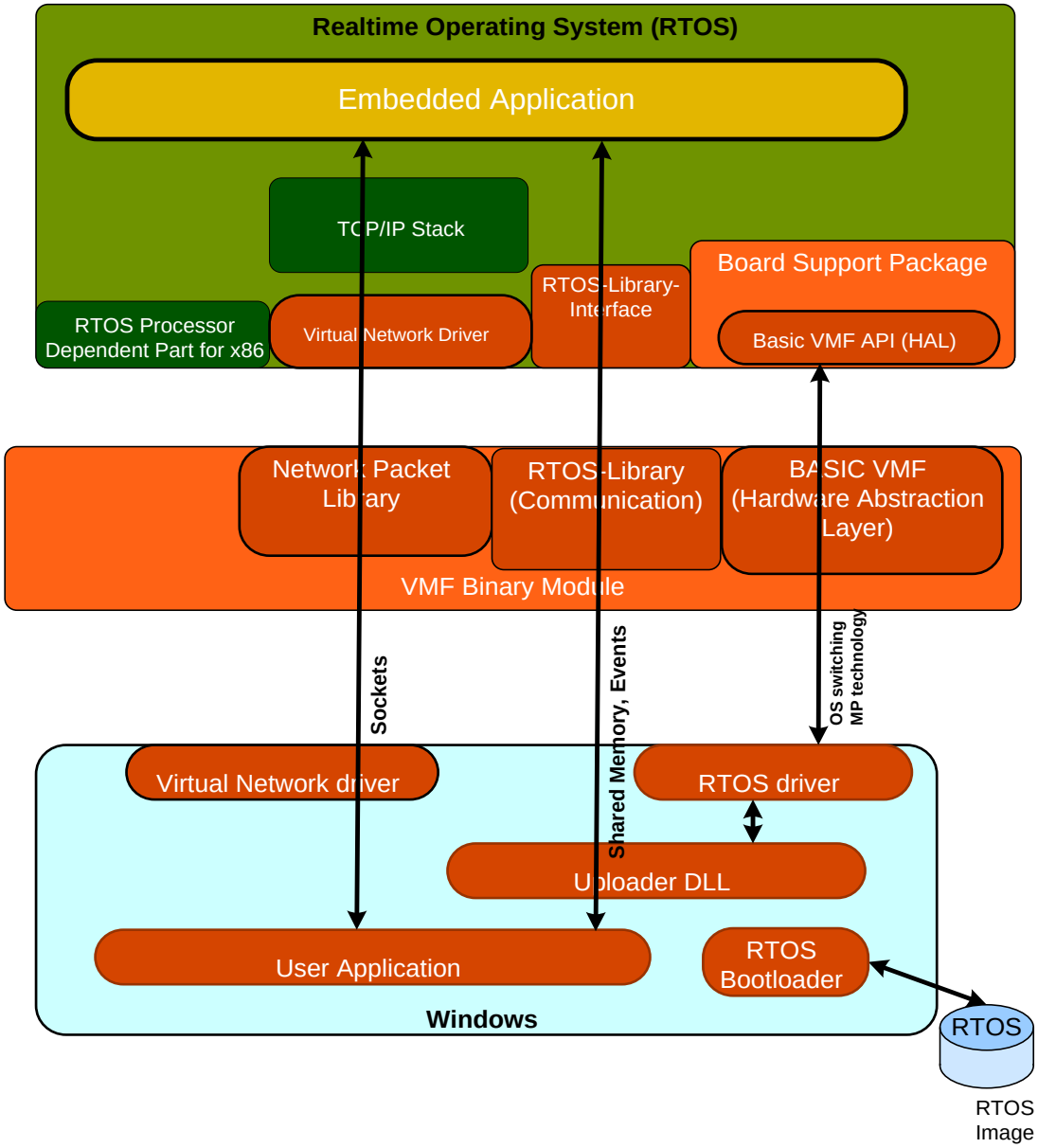
- Shared Memory: Direct access to shared memory areas
- Shared Events: Notification using named events
- Data Access Synchronization: Interlocked Data Access
- Date and Time Synchronization
- Virtual Serial Channel
- Network Packet Library: basic Ethernet data transfer service
- RTOS configuration services (e.g. for dynamically setting the IP address of the virtual network)

The application interface between the real-time software and the RTOS-VM is called the Virtual Machine Framework (VMF).
When calling VMF hardware functions the hardware will be directly accessed and not emulated. These functions are called the VMF Hardware Abstraction Layer (HAL) functions.

When using a product from the RTOSWin product family calling VMF functions is normally not necessary. Calling framework functions is done in the RTOS adaptation for the RTOS Virtual Machine (usually the Board Support Package).

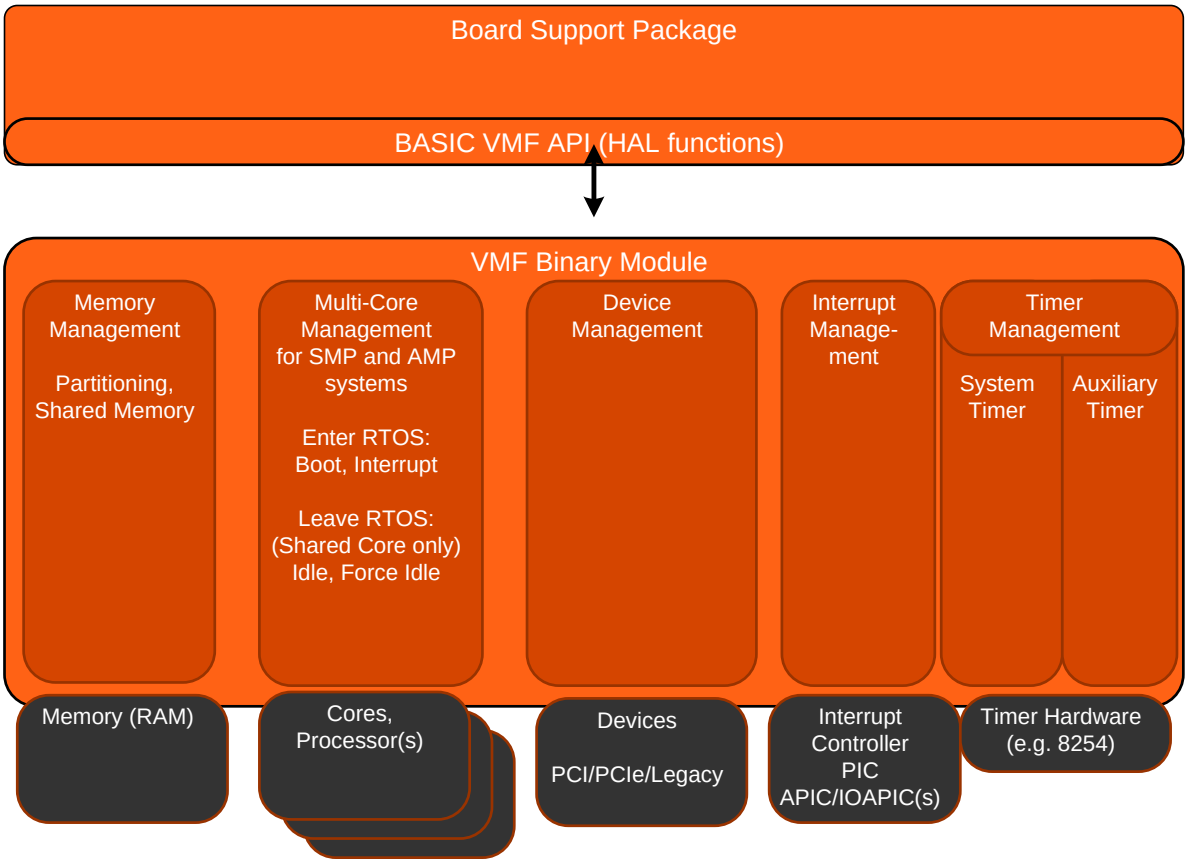
2.1.1 VMF Architecture

The following figure shows the general architecture of the VMF when a RTOS is embedded within Windows. Besides the basic VMF API (the HAL) which usually is required to build a RTOS BSP (Board Support Package) the VMF contains functions for communication between Windows and the RTOS (e.g. shared memory, events, network packet library). On top of the network packet library a virtual network driver can be built which will then provide a virtual network connection between Windows and the RTOS.



2.1.2 Basic VMF Services (Hardware Abstraction Layer)

The basic VMF services provide a simple programming interface to access the otherwise complex PC hardware.
The following figure shows in more detail the basic VMF services which usually are used within a RTOS Board Support Package.

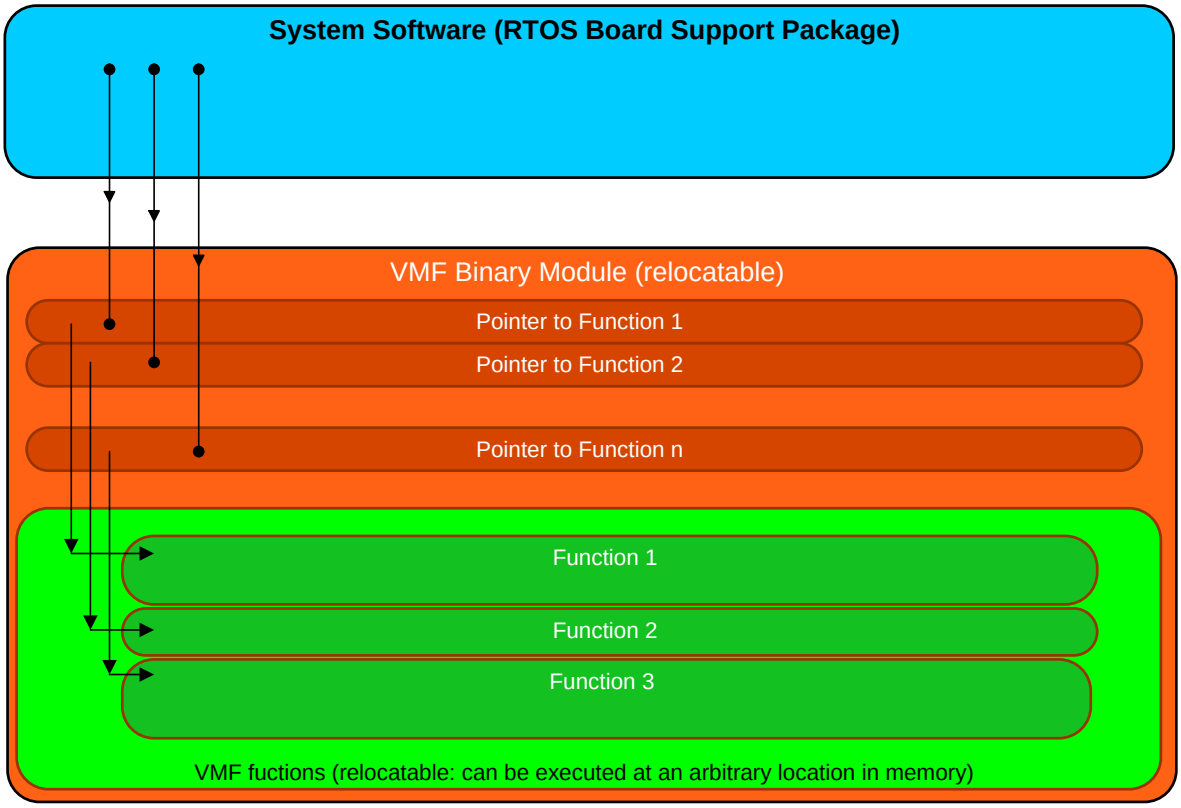


When adapting a RTOS to run with the ACONTIS RTOS-VM there is no need to directly access PC hardware like timers or interrupt controllers.
The VMF as well provides a generic method for booting the RTOS and for setting up the RTOS memory context (virtual memory).
When running on multi-core systems the VMF also provides methods for executing a RTOS which supports Symmetric Multiprocessing (SMP).
Summarized, using the VMF one gets the following advantages:

- Fully virtualized hardware access (via Hardware Abstraction Layer functions). No need to understand the complex PC hardware.
- Either run the RTOS and Windows together on one single core or use dedicated cores exclusively for each operating system.
- The **same** RTOS image can be run either on a shared or a non-shared CPU core.
- Sophisticated Multi Core Support
    - Run the RTOS on one single or on multiple cores (SMP)
    - A RTOS can run in SMP mode even on dual core CPUs

2.2 Portability

When using standard frameworks or libraries the customer usually gets either source-code which in a first step would have to be ported to his specific environment (operating system, compiler, linker).
In cases where the supplier of such a framework/library does not want to ship the source-code the customer would have to wait until a version for the framework/library is available for his environment.
To avoid these implications the ACONTIS VMF is not shipped as a library or source code but as a relocatable binary module. This binary module will be loaded by the ACONTIS RTOS-VM at an arbitrary location in the memory (the VMF code can be executed at any location in memory!).
Every call to a VMF function will then be redirected via well-known locations inside a jump table, this jump table is stored at a well-defined location inside the binary module.
Thus, there is no need to port one single line of C language or assembly language code (and no need to add the VMF as an additional library to the customer's environment).
The only requirement is to include one single header file. Within this header file the VMF functions are simply defined as macros which call the appropriate functions using the function pointer in the jump table.



Summarized, using the VMF binary module leads to the following advantages:

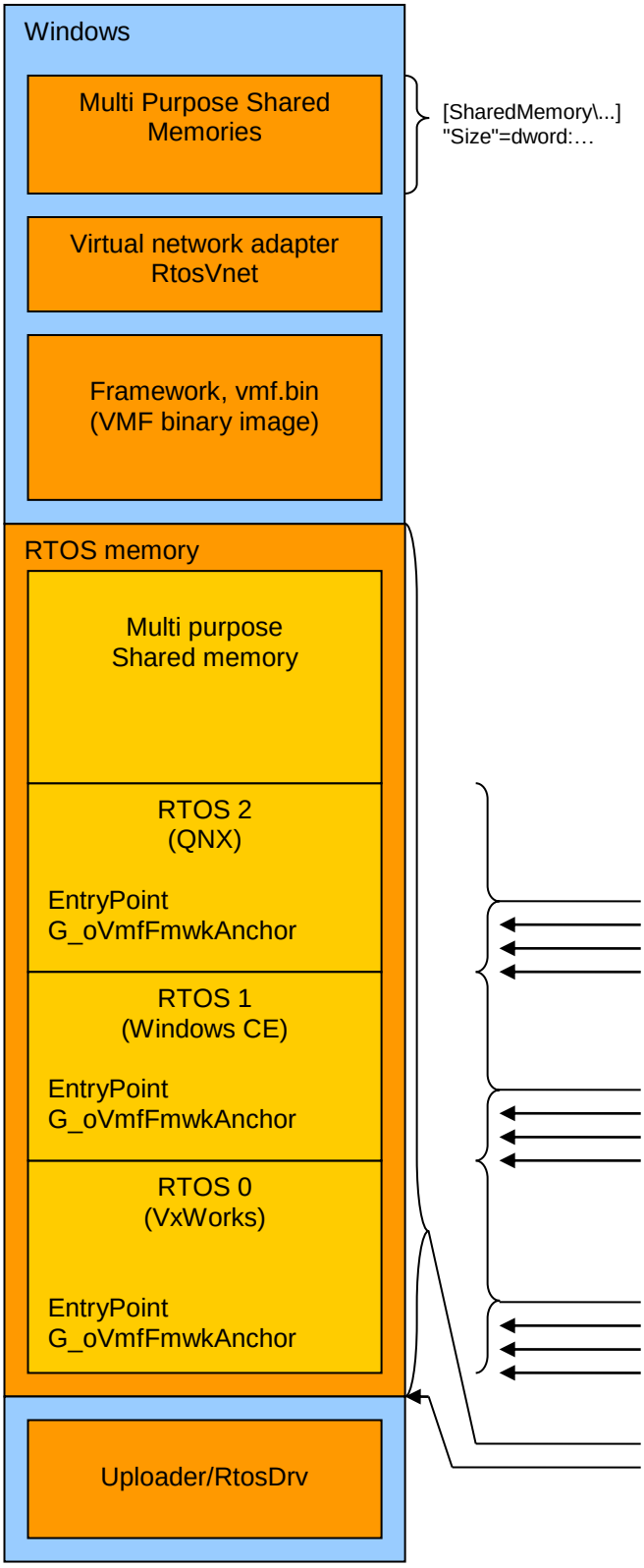
- No porting necessary, just include a C header file.
- No change necessary in the system software when new VMF versions are released (just exchange the binary module by the new one).
- The same binary VMF module will be used together with different RTOSes; this ensures a higher quality than if the VMF code would have been ported individually for any RTOS.

2.3 VMF management anchor

Some information about the VMF is needed within the RTOS, e.g. the physical base address of the framework binary image. This data is located at a specific location inside the RTOS memory.
After loading the RTOS image into the memory the uploader will copy the VMF management data at the appropriate location inside the RTOS memory

2.4 Memory Layout

VMF = Virtual Machine Framework
RTOS Framework = RTOS interface (VMF interface functions)



1 – The RTOS memory area (orange) will not be used by Windows

2 – The Uploader (RTOS Bootloader) copies the VMF binary image (Framework) file vmf.bin into an area allocated by Windows (blue). The RTOS image is copied into the RTOS memory (orange).

3 – At a specific location in the RTOS area (the anchor, G_oVmfFmwkAnchor) some basic VMF information is located, among other information the uploader will store the physical base address of the VMF image here.

4 – After loading the RTOS image into memory the uploader will enter the RTOS boot entrypoint.

5 – The RTOS kernel will then boot. All memory areas needed by the VMF (Internal / User Shm, virtual network, LocalAPIC, IoAPICs etc.) will have to be mapped by the RTOS.

2.5 The RTOS Library

VMF communication service functions (e.g. for shared events) only provide basic services without any synchronization, some of them also have to be called within a well-defined memory context (ring 0 context, kernel context).
The Windows/RTOS communication services are therefore summarized within the RTOS library which is based on VMF services. This library is split into two parts, an OS independent part and an OS dependent part.
Synchronization (e.g. interrupt locking or mutexes) are part of the OS dependent part.
A detailed description of the RTOS library can be found in chapter 9.

3 Real-time Device Management

3.1 Overview

To achieve real-time behaviour the RTOS will have to directly access its hardware devices. In fact, hardware devices are never emulated, neither in Windows nor in the RTOS. Every specific device, e.g. a PCI network adapter card will, then either be used by Windows or by the RTOS exclusively.

In Windows all hardware devices which shall be used by the RTOS have to be managed by the generic Windows RtosPnp driver shipped with the ACONTIS RTOS-VM. It will forward all required information to RTOS.
In RTOS a device specific driver will be required.

Within the Windows Device Manager all RTOS devices will then appear in the “Realtime OS Devices” tree:

For the RTOS the Virtual Machine Framework (VMF) provides several methods to detect whether a device is assigned and usable or not:

- vmfIdGetByName(szDeviceName, VMF_ID_DEVICE, …) : search by Name
- vmfDevicePciIsForRtos(nBus, nDevice, nFunction, …) : search by PCI address
- vmfDeviceIoIsForRtos(dwIoPort, …) : search by IO-Port

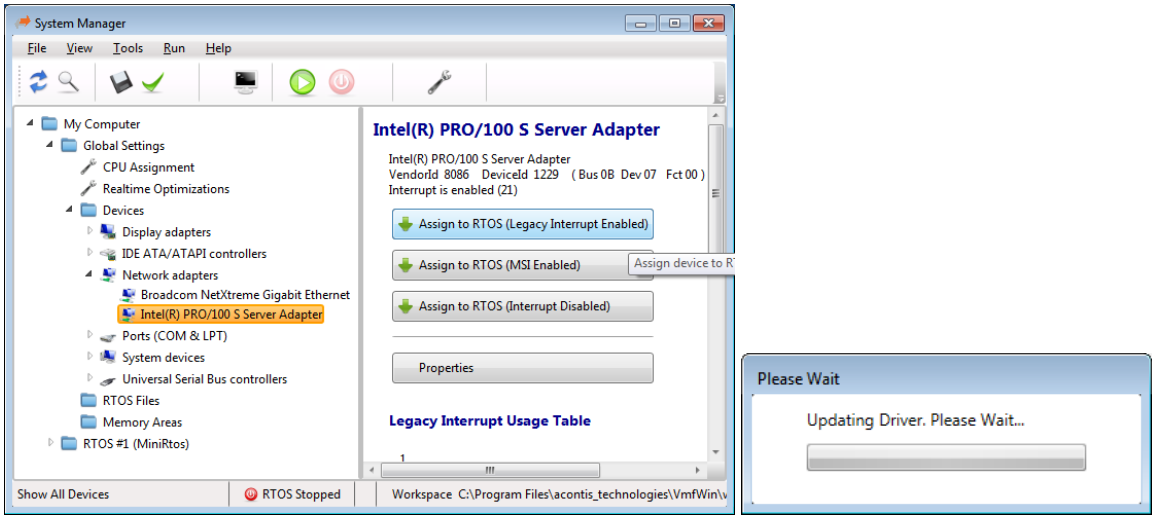
Older methods:

- vmfDeviceIsForRtos(szDeviceName, …) : search by Name
- vmfDeviceInterruptIdFromName(szDeviceName, …) : search by Name

More information about these functions can be found in the VMF documentation.
Usually the RTOS adaptation (e.g. the Board Support Package) for the RTOS-VM uses these functions internally. A RTOS user application normally doesn’t need to call these functions. More information can be found in the corresponding documentation (e.g. in the VxWin, CeWin, QWin or Rtos32Win/RtVmf documentation).

3.2 Assign a device to a RTOS

3.2.1 Using System Manager

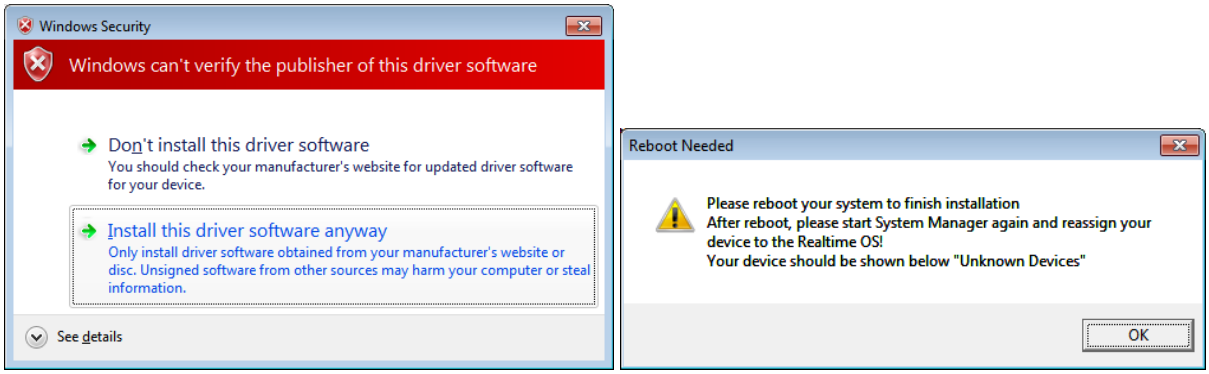


The System Manager can be used to assign a device to a RTOS.
There are three different types of assignment:

1) "Legacy Interrupt Enabled"
   The device will be configured to use a physical interrupt line.
   Advantage:
   - No PCI bus access required to enable or disable the interrupt
   Disadvantage:
   - Interrupt conflicts when another card uses the same interrupt line.

2) "MSI Enabled"
   This option can be used for PCIe cards supporting Message Signalled Interrupts.
   Advantage:
   - No interrupt conflicts
   Disadvantage:
   - Enabling or disabling the interrupt requires PCI bus access.

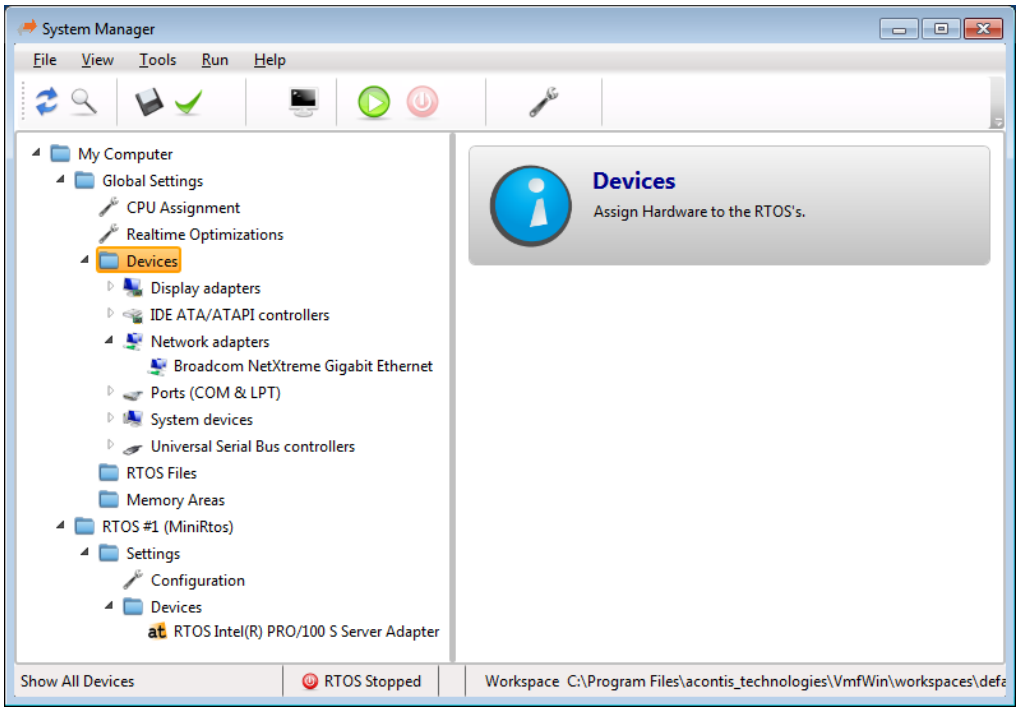
3) "Interrupt Disabled"
   This option can only be used in combination with a specialized driver supporting polling mode.
   The acontis EC-Master Link Layers for example are such.
   Any regular network driver instead will always require an interrupt to work.
   Advantage:
   - No interrupt conflicts and no PCI bus access
   Disadvantage:
   - Special driver required



When assigning a device to RTOS it is possible Windows asks how to continue.
Please select "Install this driver software anyway" to continue.

Such a message can be prevented by providing a signed driver package, as described in chapter "3.5 Driver Signing".

In case a reboot is required please reboot the system to continue.



After the device was assigned successfully it can be found below RTOS.

In case of starting the RTOS now brings up an interrupt conflict error please check chapter “3.3 Interrupt sharing conflicts” for possible solutions.

3.2.2 Using RtosUpload.exe or RtosLib API

Device assignment can also be done

- by calling RtosUpload.exe using the option “/device”
  → see chapter “6.2 Uploader operation, command line options”

- programmatically using RtosLib function “RtosDevice”
  → see RtosDevice() API at chapter “10.1.20 RTOS Library – device functions”

3.3 Interrupt sharing conflicts

3.3.1 Principle

When a physical device shall be controlled by the RTOS it will be under direct control of the RTOS. There is no virtualization of any physical device and no interference by the RTOS Virtual Machine. Thus, the regular device driver provided by the RTOS can be used (e.g. a network driver, USB driver, IEEE1394 driver, …).
Usually the device driver will:

a) read and/or write to device memory areas
b) read and/or write to device I/O areas
c) handle device interrupts

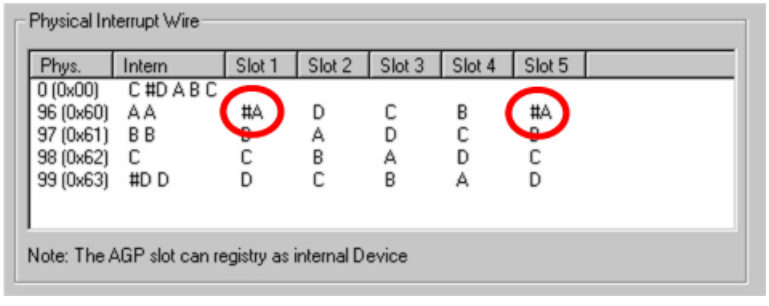
In case the device generates an interrupt, the driver's interrupt handler is responsible to acknowledge and handle the interrupt.

Important:
The same interrupt may never be used by both operating systems, Windows and the RTOS.

But why not?
Example: an Intel PRO/100 network adapter card that is using interrupt 20 shall be controlled by the RTOS and an USB host controller device which is used by Windows is also using interrupt 20.
In that case, every time the USB host controller generates an interrupt the RTOS interrupt handler for the Intel PRO/100 network adapter card would be called (real-time interrupts have a higher priority than Windows interrupts). This handle is not capable to acknowledge and handle the interrupt of the USB host controller. One could now transfer control back to Windows to let the corresponding Windows handler process the interrupt. But in that case the real-time behaviour of the system would be violated. So, there is no way to both share interrupts between Windows and the RTOS and guarantee deterministic real-time behaviour for the RTOS.

3.3.2 Understanding interrupt conflicts

In order to understand and finally prevent interrupt conflicts between several PCI cards, the physical arrangement of these cards should be carefully considered.
Each PCI board may generate up to four hardware interrupts on four physical interrupt lines (INTA, INTB, INTC and INTD). In most IBM-compatible PCs, each of the four interrupt lines on the PCI-bus is hard-wired to the next interrupt position, offset by one, in the neighbouring slot. This means that INTA of slot 1 is (typically) hard wired to INTB of slot 2, and to INTC of slot 3, and to INTD of slot 4. Repeating this pattern, it is also wired to INTA of slot 5, and so on.
Since PCI card manufacturers generally lay out their boards to assert an interrupt on just one line (INTA), this has the affect of forcing the A-level interrupts of four adjacent cards to assert physically on INTA, INTB, INTC and INTD. In accord with this scheme, a fifth adjacent card would also assert its INTA on the same line as the first card. The next screenshot illustrates this principle.
Caution: Multi-function PCI boards may use more than one interrupt line.



But even when two PCI devices use different physical interrupt lines, they may be hard-wired together by the PC's *interrupt router*. The *interrupt router* maps various physical interrupt lines to the inputs of the Programmable Interrupt Controller.

The inputs of the *interrupt router* are the physical interrupt lines (refer to screenshot). The output of the *interrupt router* is connected to the interrupt controller of the PC. How many of the physical interrupt lines will be gathered together by the interrupt router depends on both the interrupt router and the number of free interrupts available at the Programmable Interrupt Controller.
If you desire, you can increase the number of free interrupt lines by using the BIOS to disable some PC components: COM ports, USB controller, or Audio/Sound controller, for example.
The number of output lines the *interrupt router* provides depends on the PC hardware (chipset). If the interrupt router has a small number of output lines, it is quite likely that you will discover that several physical interrupts have been wired to a common interrupt on the controller.

Problems with sharing interrupts:
PCI devices that interrupt along the same interrupt pin route have no choice but to share an interrupt. The routing of interrupt pins to an *interrupt router* is system (chipset) dependent. While in many cases, finding and isolating the desired interrupt lines is not much of a problem, experience has nonetheless shown that it is not at all possible in some PCs to separate the interrupt lines as required by the RTOSWin solution.

Assume that Device A (installed under Windows) physically shares an interrupt with device B (installed under the RTOS). If Device A generates an interrupt while the RTOS is running, how could interrupt-handling software process the interrupt without impairing the ability of the real-time system to fulfil its tasks within prescribed times?

One might be tempted to solve this problem in either of the following ways:

- Disable the interrupt in the interrupt controller and re-enable it only when the RTOS returns to its idle state and returns control to Windows. Using this approach, however, interrupts generated from device B would also be blocked for some time, a circumstance that would not be acceptable for real-time operations.

- By implementing an appropriate RTOS interrupt handler, one could prevent Device A from generating an interrupt until after the RTOS returned to Windows. Thereafter, the interrupt intended for Windows could be handled. While this theoretically could solve the dilemma, there could be no way to handle this in a general fashion. Requiring an *intelligent* real-time interrupt handler to be written for each device that shares an interrupt with a Windows device would very likely mean that the Windows device driver (depending on the device) would have to be modified, too. For this reason, this approach does not provide an adequate solution for handling shared interrupts either.

The foregoing scenarios can lead to but a single conclusion: In a dual system, such as the RTOSWin solution, Interrupt-sharing between Windows and the RTOS must be prohibited.
And that implies that PCI cards that are controlled by the RTOS may not be plugged into a PCI slot that uses the same hard-wired interrupt line (normally INTA) as does either an external or internal Windows device.
Conclusion: Windows devices can share Windows interrupts and RTOS devices can share RTOS interrupts, but never can interrupts be shared across the two operating systems.

Fortunately, most of the time, system designers can eliminate interrupt conflicts.

If it were possible to identify an otherwise unused interrupt pin route to real-time devices, the RTOS could manage multiple interrupts along that route via interrupt sharing.

Custom boards that provide a means for specifying on which of the interrupt pins – INTA#, INTB#, INTC#, or INTD# – the board's interrupts should be asserted, very well suit the scheme of having multiple-function or single-function PCI devices sharing an interrupt. Such boards allow great flexibility in combining devices that require real-time servicing with those that do not.

3.3.3 Resolving interrupt conflicts

Prior to start resolving interrupt conflicts the device has to be under control of the RTOS. This has to be done by installing the RtosPnp Device Driver (see section 3.4). This driver will request an exclusive interrupt from the Windows Resource Manager. If no other device requests an exclusive interrupt and if the hardware (motherboard, chipset) is also capable of providing an exclusive interrupt then a unique interrupt will be assigned for this device.

If this fails, there are several ways how to resolve interrupt conflicts then.

a) Try to find another slot where to insert the PCI/PCIe card.
b) If capable then configure the device to use message signalled interrupt (MSI) instead (see section 3.4.3.3)
c) Disable all unused devices in the BIOS
d) Disable the conflicting Windows device either by disabling it in the BIOS or by disabling it in the Windows Device Manager.

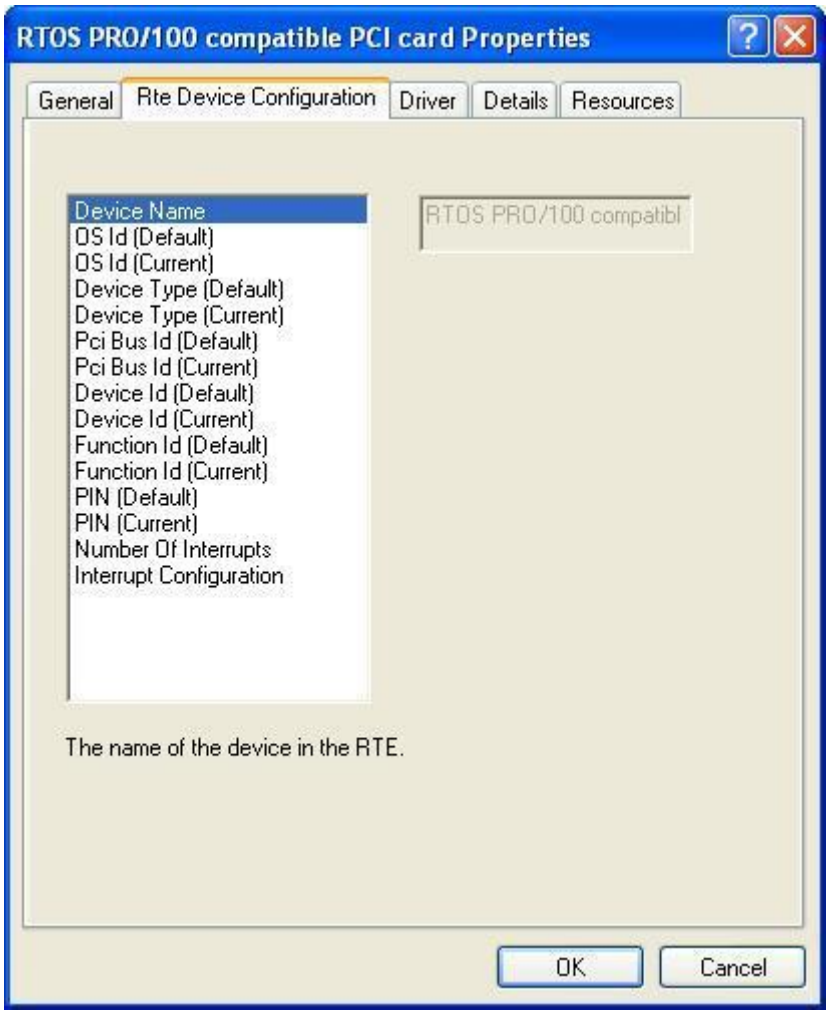
In case your RTOS device driver does not use interrupts (i.e. if used polling) you may configure the device using polling mode. This can be either done by the System Manager, RtosUpload.exe, RtosLib RtosDevice() or by modifying the standard Windows INF file that is used to assign the device to the RTOS. See section 3.4.3.3 for more information.

Sometimes a Windows device is assigned an interrupt but the device never generates an interrupt. For example, in many cases the SMBus device doesn't generate interrupts even if it is assigned one. In that case you may also ignore interrupt conflicts. But it is also necessary to modify the standard Windows INF file that is used to assign the device to the RTOS. See section 3.4.3.5 for more information.

3.4 Configuration

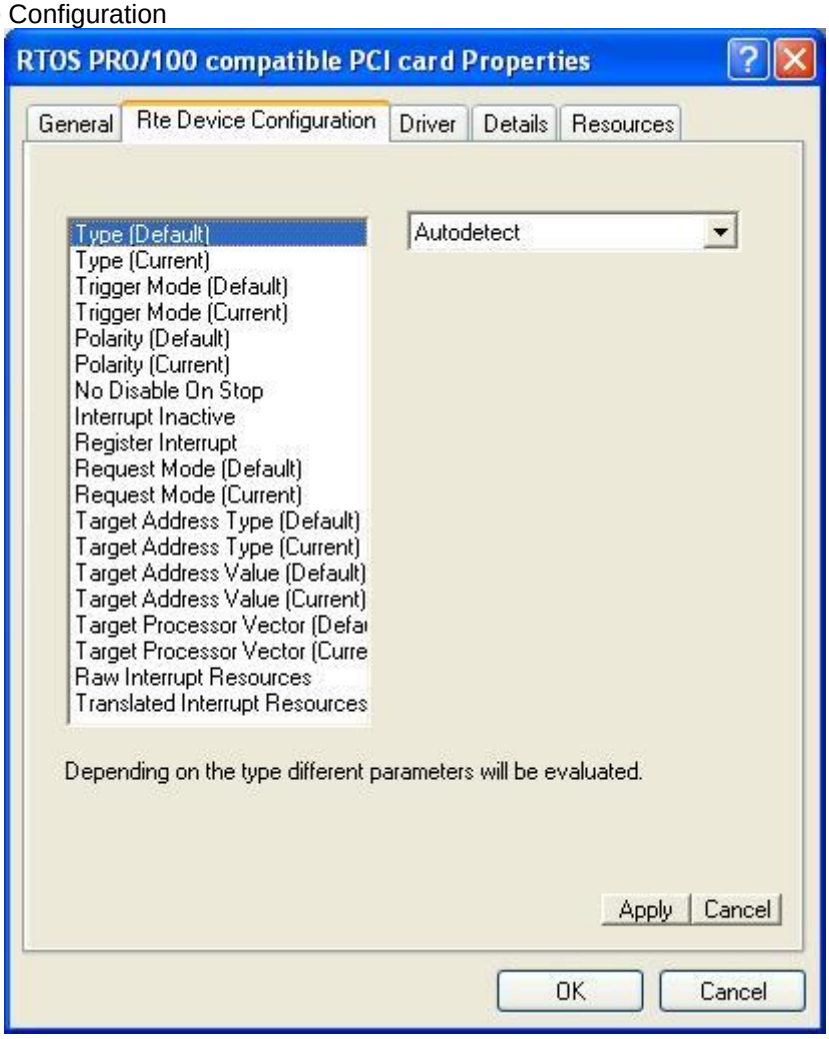
3.4.1 Properties dialog

Using the Windows Device Manager, it is possible to change the device configuration parameters. The meaning of the parameters is identical to the corresponding settings in section [DriverInstall_HwAddRegUsrDef] in the INF file of the driver (see section 3.4.2).



Rte Device Configuration parameter	Corresponding entry in [DriverInstall_HwAddRegUsrDef]
OS Id	OsId
Device Type	DeviceType
Pci Bus Id	PciBus
Device Id	PciDevice
Function Id	PciFunction
PIN	PciPin

Interrupt Source Configuration



Rte Device Configuration parameter	Corresponding entry in [DriverInstall_HwAddRegUsrDef]
Type	InterruptType
Trigger Mode	InterruptTriggerMode
Polarity	InterruptPolarity
No Disable On Stop	InterruptDontDisableOnRtosStop
Interrupt Inactive	InterruptDoesntInterrupt
Register Interrupt	InterruptRegisterToWindows
Request Mode	InterruptRequestMode
Target Address Type	InterruptTargetAddressType
Target Address Value	InterruptTargetAddress
Target Processor Vector	InterruptProcessorVector
Raw Interrupt Resources	Windows internal information (read only)
Translated Interrupt Resources	Windows internal information (read only)

3.4.2 RtosUpload.exe / RtosLib API

The RtosUpload.exe option “/device” and RtosLib API “RtosDevice()” allows the modification of some device configuration values like interrupt mode, device name and OS id using parameter ‘rte_configure’.
See RtosDevice() API at chapter “10.1.20 RTOS Library – device functions” for details

3.4.3 Windows INF file

When a device should be assigned to RTOS a Windows INF file is required to install the generic RtosPnp driver for Windows so the device information can be forwarded to RTOS.

There are several RtosPnp INF files shipped with the product, but under some circumstances it is required to create a new file:

- Support a new device and prevent the “Windows Security Warning” during driver installation

- An option should be changed to another default (for example always using polling mode) so no re-configuration is required after assigning the device

After creating or modifying an INF file it must be signed to prevent the “Windows Security Warning” during driver installation – see chapter “3.5 Driver Signing” for details.

3.4.3.1 Supporting a new device

In most cases the template INF file has only to be adjusted by a few changes.

3.4.3.1.1 Device Names

The device name has to be adjusted, optionally several additional name string may be adjusted.

Template INF file:

```
[Strings]
DEVICEDISPLAYNAME       = "RTOS Device Name"                                ; (r)
DEVICECLASSNAME         = "Realtime OS Devices"                             ; (o)
MFGNAME                 = "acontis technologies GmbH"                       ; (o)
INSTDISKNAME            = "acontis technologies GmbH Installation Disc"     ; (o)
SERVICEDISPLAYNAME      = "RTOS PnP Driver"                                 ; (o)
SERVICEDESCRIPTION      = "RTOS PnP Driver"                                 ; (o)
```

Example adjustments (device name and company name):

```
[Strings]
DEVICEDISPLAYNAME       = "My PCI Card"                                     ; (r)
DEVICECLASSNAME         = "Realtime OS Devices"                             ; (o)
MFGNAME                 = "My Company"                                      ; (o)
INSTDISKNAME            = "My Company Installation Disc"                    ; (o)
SERVICEDISPLAYNAME      = "RTOS PnP Driver"                                 ; (o)
SERVICEDESCRIPTION      = "RTOS PnP Driver"                                 ; (o)
```

3.4.3.1.2 PCI Device Identifications

A PCI device is uniquely identified by at least two identifiers: the Vendor ID (e.g. 8086 for Intel) and the Device ID (e.g. 1229 for the Intel PRO/100 device).
Some PCI devices belong to a device family (for example the Intel PRO/1000 family). In this case the same INF file may be used by several such devices.
The [DeviceList] section in the INF file contains at least entry with the appropriate vendor and device id.

Template INF file:

```
[DeviceList]
%DEVICEDISPLAYNAME%     = DriverInstall, PCI\VEN_FFFF&DEV_FFFF              ; (r)
```

Example adjustments (two devices with vendor id ABCD and device ids 1234 and 5678):

```
[DeviceList]
%DEVICEDISPLAYNAME%     = DriverInstall, PCI\VEN_ABCD&DEV_1234              ; (r)
%DEVICEDISPLAYNAME%     = DriverInstall, PCI\VEN_ABCD&DEV_5678              ; (r)
```

3.4.3.2 Forcing the RtosPnp driver to be loaded – determine interrupt sharing conflicts

In case the device which shall be controlled by the RTOS (using the RtosPnp driver) shares its interrupt with another device that is controlled by Windows two scenarios may occur:

a) The Windows Device Manager successfully loads the RtosPnp driver
b) The Windows Device Manager refuses to load the RtosPnp driver

The reason why sometimes the driver is not loaded is an entry in the INF file that forces the Windows Resource Manager to assign a unique interrupt to the device. If Windows cannot find a unique interrupt then it may not load the driver.
To avoid this behavior the entry in the INF file has to be changed in a way that the Windows Resource Manager is allowed to assign an interrupt that is already used by another device.

There are several ways to change the interrupt mode to MSI:

- By modifying the devices Windows INF file to change the installation default:

  Template INF file (by default the entry is not existing which means device exclusive):

```
[DriverInstall_HwAddRegUsrDef]
;HKR,"ConfigInterrupt0", "InterruptRequestMode",       %REG_DWORD%,    0x00
; (o) 00=exclusive, 01=shared
```

  Required adjustment (uncomment and set the value to 0x01):

```
[DriverInstall_HwAddRegUsrDef]
HKR,"ConfigInterrupt0", "InterruptRequestMode",       %REG_DWORD%,    0x01
; (o) 00=exclusive, 01=shared
```

  After adjusting the INF file a driver update with the new INF file has to be executed.

- Using the Windows device manager
  Select the RTOS device driver, open device properties, select the tab “Rte Device Configuration”, select and click “Interrupt Configuration” and change “Request Mode (Default)” from “Exclusive” to “Shared”. At last click “OK” and reboot to update the settings.

3.4.3.3 Use message signalled interrupt (MSI) to solve interrupt conflicts

If a device and the chipset are capable of using message signalled interrupts (MSIs) a RTOS controlled PCI device can be configured to use MSI instead of a line interrupt.
This solves interrupt conflicts often caused by the classic line interrupt.
The advantage of MSI instead of classic line interrupt is that it needs not to be shared with other devices. The line interrupt is a wire connecting multiple slots on the mainboard and so the same wire might be shared by multiple cards. MSI on the opposite uses the PCI bus address and data lines to generate an interrupt message. The only limit for exclusivity on MSI is the number of available CPU interrupt vectors.

In case a device is configured to use MSI but it does not support MSI an error message will be shown as soon as the driver wants to enable the interrupt.

A device can be configured for using MSIs either by modifying the inf file before the device driver installation or by changing the device configuration using the Windows device manager after the installation.

There are several ways to change the interrupt mode to MSI:

- In the System Manager device options
- By using RtosDevice() API directly or by RtosUpload.exe – see RtosDevice() API for details!
- By modifying the devices Windows INF file to change the installation default:

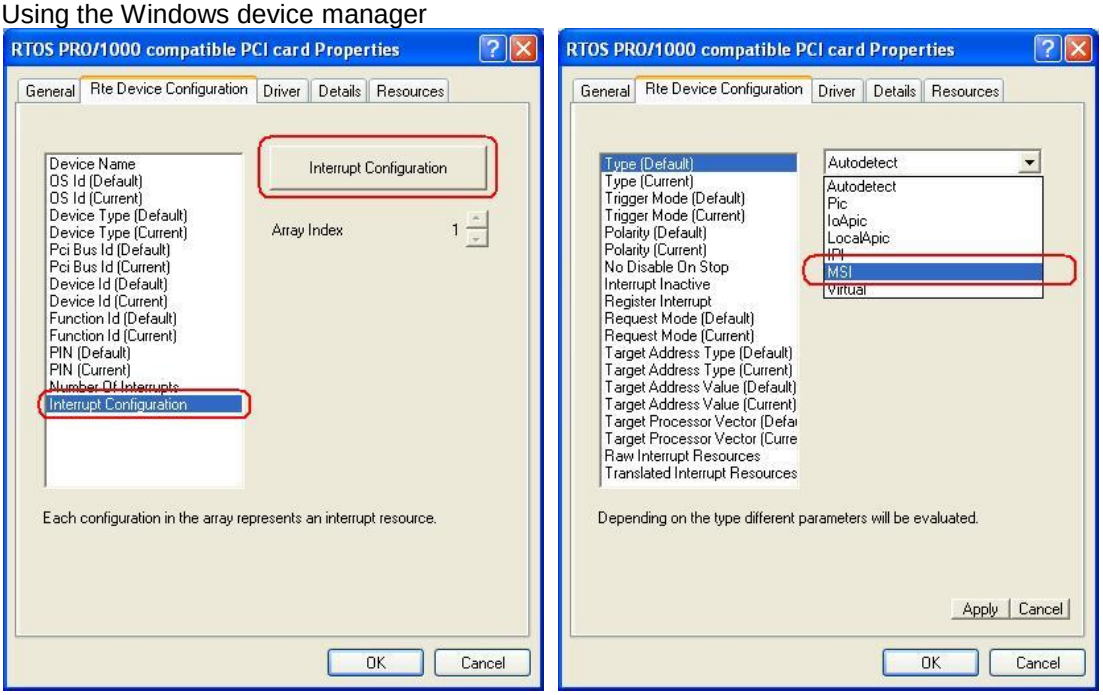
  Template INF file:

```
[DriverInstall_HwAddRegUsrDef]
;HKR,"ConfigInterrupt0", "InterruptType",   %REG_DWORD%,    0xFFFFFFFE
```

  Required adjustment:

```
[DriverInstall_HwAddRegUsrDef]
HKR,"ConfigInterrupt0", "InterruptType",   %REG_DWORD%,    0x04
```

- Using the Windows device manager



Select the RTOS device driver, open device properties, select the tab “Rte Device Configuration”, select and click “Interrupt Configuration” and change “Type (Default)” from “Autodetect” to “MSI”. At last click “OK” and reboot to update the settings.

3.4.3.4 RTOS controlled PCI devices not using interrupts

Sometimes the RTOS device driver that controls the PCI device does not require to handle interrupts from this device.
In such cases it is possible that other devices which are controlled by Windows are allowed to use the same interrupt line as the RTOS device would use – normally it is not allowed that the same interrupt line is used by both, Windows and the RTOS (see section 3.2).

There are several ways to change the interrupt mode to polling:

- In the System Manager device options
- By using RtosDevice() API directly or by RtosUpload.exe – see RtosDevice() API for details!
- By modifying the devices Windows INF file to change the installation default:

  Template INF file:

```
[DriverInstall_HwAddRegUsrDef]
;HKR,"ConfigInterrupt0", "InterruptDoesntInterrupt",   %REG_DWORD%,    0x00
```

  Required adjustment:

```
[DriverInstall_HwAddRegUsrDef]
HKR,"ConfigInterrupt0", "InterruptDoesntInterrupt",   %REG_DWORD%,    0x01
```

  After adjusting the INF file a driver update with the new INF file has to be executed (see section 16.2.1 Realtime OS Driver).

3.4.3.5 RtosPnp driver Windows INF file parameters

This section describes all Windows INF file parameters of the RtosPnp driver that can be adjusted to fit to specific requirements. Shipped with the RTOSWin solution are some pre-defined INF files and two template INF files, RTOS_Template.inf (template for one PCI device configuration) and RTOS_MFC_Template.inf (template for multiple PCI device configurations).

3.4.3.5.1 Section [DriverInstall_HwAddReg]

- FriendlyName
  If this entry exists it will override any automatically generated device friendly name. Normally the device's friendly name will be automatically generated by the RTOS Device Class Installer (RtosPnpInstaller.dll), this name is based on the DEVICEDISPLAYNAME defined in section [Strings].

3.4.3.5.2 Section [Strings]

- DEVICEDISPLAYNAME
  Will be displayed as device name (in the Windows Device Manager)
- DEVICECLASSNAME
  Will be displayed as the device class name (in the Windows Device Manager)
- MFGNAME
  Manufacturer name
- INSTDISKNAME
  Name of the installation resource
- SERVICEDISPLAYNAME
  Name of the driver
- SERVICEDESCRIPTION
  Description of the driver

3.4.3.5.3 Section [RteInstall]

- AutoDeviceFriendlyName
  The RTOS Device Class Installer uses this entry to determine how to create the device's friendly name (which is shown in the Windows Device Manager).
  Bit 0: create a friendly name if set to 1 (otherwise DEVICEDISPLAYNAME will be used by Windows)
  Bit 1: if set to 1 then append the DOS device (COMx, LPTx)
  Bit 2: if set to 1 then append a unique ID (assure that all device names are unique)

3.4.3.5.4 Section [DriverInstall.RteInstall]

- MatchBusDevFunc = 0xFFFFFF00
  this INF file will only be valid for PCI devices which are matching the given pattern.
  Value pattern 0xBBDDFFUU:
  – BB = PCI bus index
  – DD = PCI device index
  – FF = PCI function index
  – UU = unused (reserved)
  If the value for BB, DD or FF is set to 0xFF then all such devices will match, otherwise only the specified one will match.
  Example: 0xFFFF0100 → only the PCI device with function 01 will match (bus and device don't care).
  This entry is required in case that two identical PCI cards shall be controlled by the RTOS and different settings in the INF file shall be used (e.g. one device generates an interrupt and the second does not). In this case either two different INF are required or one INF file with two different configurations has to be created.

3.4.3.5.5 Section [DeviceList]

This section contains at least one condition which PCI device shall use the RtosPnp driver. The PCI device is determined by its PCI vendor and device ID. If more than one PCI device shall use the RtosPnp driver then multiple of these entries have to be made.

- %DEVICEDISPLAYNAME% = DriverInstall, PCI\VEN_XXXX&DEV_YYYY
  PCI devices with vendor id XXXX and device id YYYY will use this INF file.

3.4.3.5.6 Section [DriverInstall_HwAddRegUsrDef]

- OsId
  determines the OS the device should be assigned to: `FFFFFFFE=auto, FFFFFFFD=OsIdependent FFFFFFFC=Host(Windows), else=value`
- DeviceType
  determines the device type: FFFFFFFE=auto, 00=other, 01=virtual, 02=PCI
- PciBus
  determines the PCI bus index value: FFFFFFFE=auto, FFFFFFFF=unused, else=value
- PciDevice
  determines the PCI device index value: FFFFFFFE=auto, FFFFFFFF=unused, else=value
- PciFunction
  determines the PCI function index value: FFFFFFFE=auto, FFFFFFFF=unused, else=value
- PciPin
  determines the PCI interrupt pin value: FFFFFFFE=auto, FFFFFFFF=unused, else=value
- ConfigInterrupt0
  These entries describe the source of the first interrupt on the device. If a device is capable to generate more than one interrupt (e.g. PCIe devices using MSIs) then additional ConfigInterruptX entries exist (ConfigInterrupt1, ConfigInterrupt2, …)
  - InterruptType
    FFFFFFFE=auto detect, normally you should not change this value
    (00=Pic, 01=IoApic, 02=LocalApic, 03=IPI, 04=MSI, 05=Virtual)
  - InterruptTriggerMode
    FFFFFFFE=auto detect (PCI = level, legacy = edge)
    00: set to level triggered
    01: set to edge triggered
  - InterruptPolarity
    FFFFFFFE=auto detect (PCI = low/falling, legacy = high/rising)
    00: low level when level triggered or falling edge when edge triggered
    01: high level when level triggered or rising edge when edge triggered
  - InterruptDontDisableOnRtosStop
    0: disable interrupts after the RTOS is stopped (to avoid system crash)
    1: don't disable interrupt on RTOS stop (requires a handler on Windows)
  - InterruptDoesntInterrupt
    0: device generates interrupts
    1: device doesn’t generate interrupts (allow interrupt sharing with Windows)
  - InterruptRegisterToWindows
    0: don’t register a interrupt handler to Windows
    1: register a interrupt handler to Windows (normally this is required if the device generate interrupts)
    Note: if InterruptDoesntInterrupt is set to 1 no handler will be registered, the value set for InterruptRegisterToWindows is ignored
  - InterruptRequestMode
    00: exclusive
    01: shared
    Note: if InterruptDoesntInterrupt is set to 1 the value set for InterruptRequestMode is ignored

  - InterruptTargetAddressType
    FFFFFFFE=auto detect, normally you should not change this value
    00=Processor bit mask,
    01=Local Apic Id,
    02=Logical Id (Flat),
    03=Logical Id (Cluster)
    Currently only the Local APIC is supported (value 01)!
  - InterruptTargetAddress
    Interrupt target address, meaning depends on InterruptTargetAddressType
    (01 = local APIC ID, this value will be determined automatically)
  - InterruptProcessorVector
    Interrupt vector to be used.
    FFFFFFFE=auto detect
    00 .. FF: manually determined interrupt vector
    The following restrictions for the interrupt vector exist:
    a) If Windows is using one single CPU core and the RTOS is running in exclusive

mode, values from 0x00 up to 0xFF are allowed. Note: automatic configuration will only use values between 0xE0 and 0xFF.
b) If Windows is using more than one CPU core, values have to be 0xF0 or higher.
c) If the RTOS is running in shared mode and Windows is using only one single CPU core, values have to be 0xE0 or higher.

3.4.4 RTOS config file

3.4.4.1 Windows controlled PCI devices not using interrupts

Sometimes a conflicting Windows device is known to never really generate interrupts.
In such cases it is possible that other devices which are controlled by the RTOS are allowed to use the same interrupt line as the Windows device would use – normally it is not allowed that the same interrupt line is used by both, Windows and the RTOS (see section 3.2).

If the RTOS is started by the Windows Uploader it will first check for interrupt conflicts. If such conflicts are detected an error message will be shown and the RTOS will not be started.
The error message identifies the conflicting devices.

Example:
Interrupt conflict between a PRO/100 card that shall be controlled by the RTOS and a USB host controller that shall be controlled by Windows. The following error message will be displayed.

```
ERROR: Device Configuration - conflicting devices for interrupt (16)
   - Intel(R) 6300ESB USB universal host controller - 25A9
     (PCI\VEN_8086&DEV_25A9&SUBSYS_25A18086&REV_02\3&267A616A&0&E8)
   - RTOS PRO/100 compatible PCI card
     (PCI\VEN_8086&DEV_1229&SUBSYS_000C8086&REV_08\4&3ABFD0AC&0&00F0)
```

The USB host controller is identified by the following device string:

```
PCI\VEN_8086&DEV_25A9&SUBSYS_25A18086&REV_02\3&267A616A&0&E8
```

In case you know that this USB host controller will never generate interrupts you may insert the following configuration setting into the RTOS configuration file:

```
[WindowsDevices]
"MaxInterruptShareDeviceIndex"=dword:01
"InterruptShareDevice0"="PCI\VEN_8086&DEV_25A9&SUBSYS_25A18086&REV_02\3&267A616A&0&E8"
```

The value of InterruptShareDevice0 must be identical to the device name shown in the Uploader error message. Wildcards ‘*’ for multiple and ‘!’ for a single character are supported.

3.5 Driver Signing

Digital signatures are used to prevent viruses from installing or manipulating drivers by ensuring their integrity. To be able to install a driver without a signing warning or error the signatures must be correct.
Since Windows Vista it is possible for a software publisher to sign a driver using a KernelMode CodeSigning certificate, which can be bought from a Certificate Authority (CA).

3.5.1 Driver Package Signing

A RtosPnp driver package typically contains:

- RtosPnp.sys — Driver
- RtosPnpInstaller.dll — Class(Co)Installer
- WdfCoInstaller01009.dll — Driver Framework
- MyDriver.inf — Inf-File
- MyDriver.cat — Catalog file

RtosPnp.sys, RtosPnpInstaller and WdfCoInstaller01009.dll are signed to prevent code manipulation. MyDriver.inf is not signed - its integrity is ensured by the catalog file.

The catalog file contains the filename and hash information about all other files which are part of the driver package. To protect against any changes the file is signed.

After modifying an Inf-File it is required to rebuild and sign the catalog file.
The catalog filename is defined by the Inf-File entry “CatalogFile”.

Prerequisites:

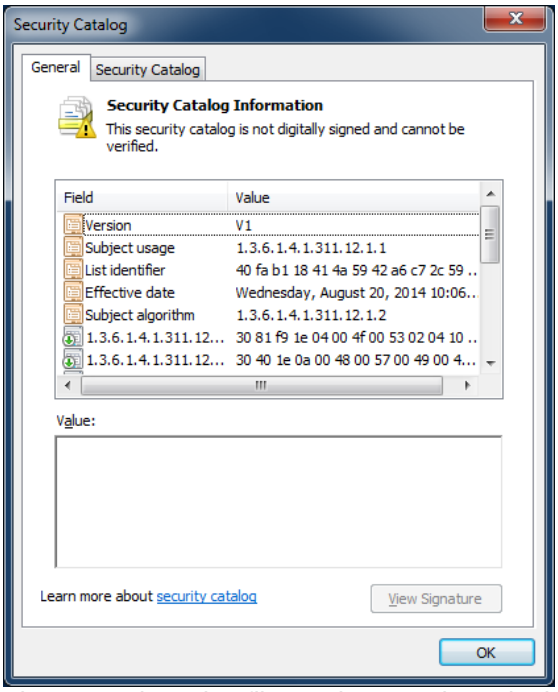
- Windows Driver Kit fro the code signing tools
- A “Kernel Mode Code Signing” certificate issued for example from DigiCert, GlobalSign, Thawte, VeriSign or any other authority listet in Microsoft “Cross-Certificates for Kernel Mode Code Signing”
- A Microsoft Cross-Certificate corresponding to the “Kernel Mode Code Signing” certificate.
  A list can be found in the MSDN “Cross-Certificates for Kernel Mode Code Signing”
  http://msdn.microsoft.com/en-us/library/windows/hardware/dn170454(v=vs.85).aspx
- The driver package to be signed

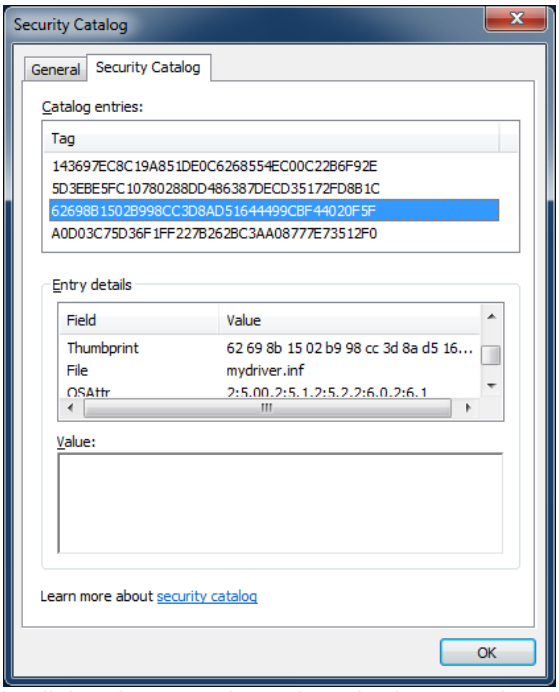
Signing:

1) Open a WDK Build Environment - for example Windows 7 “x86 Free Build Environment”.
2) Change into the directory containing all your driver package files.
3) Ensure the Inf-File contains all required modifications.
   Tip: The Inf-File name and “CatalogFile” entry should be different from their original.
4) Delete any existing catalog file in the driver package directory.
5) Creating a new catalog file by calling:

   ```
   C:\MyDriverPackage>inf2cat.exe /driver:"."
   /os:2000,XP_X86,XP_X64,Server2003_X86,Server2003_X64,Vista_X86,Vista_X64,Server2008_X86,Server2008_X64,7_X86,7_X64,Server2008R2_X64 /verbose
   ```

   You may add or remove supported OS as required. A list of possible options will be shown calling: “inf2cat.exe /?”



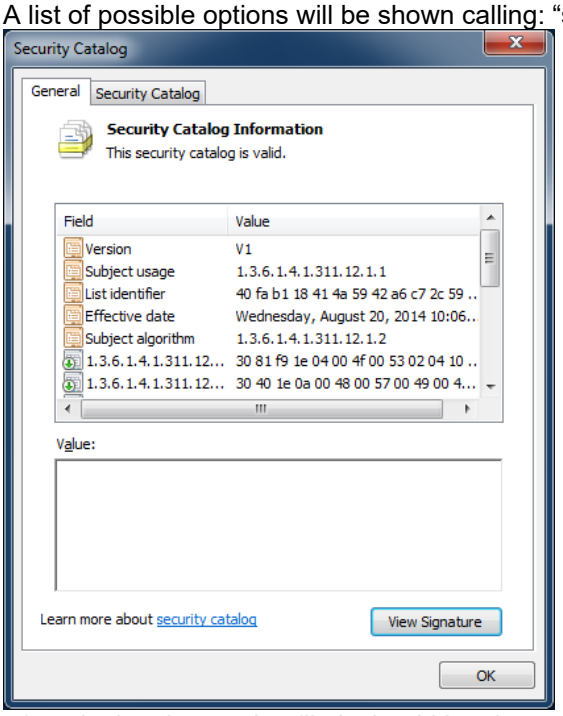


The created catalog file can be open by a double click. It is currently unsigned. The Security Catalog lists all covered files.

6) Sign a catalog file by calling:

   C:\MyDriverPackage>signtool.exe sign /v /ac "C:\MyCerts\MyCrossSignCert.cer" /f "C:\MyCerts\MyCodeSignCert.pfx" /p MyCodeSignCertPassword /t http://timestamp.verisign.com/scripts/timestamp.dll MyDriver.cat

   A list of possible options will be shown calling: “signtool.exe /?”



After signing the catalog file it should be shown as valid and contain a signature.

7) Verifying a catalog file for "default authenticode signing policy" by calling:

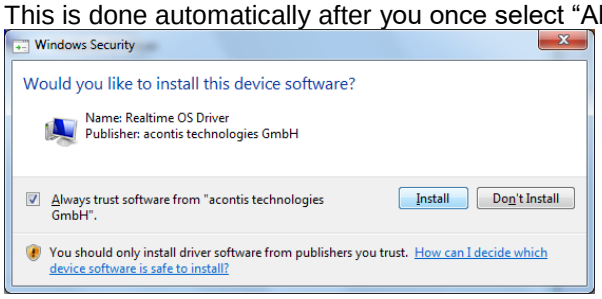
   C:\MyDriverPackage>signtool.exe verify /tw /pa /v MyDriver.cat

Please remember that this has to be done separately for 32 and 64 bit driver package.

3.5.2 Certificate Pre-Installation

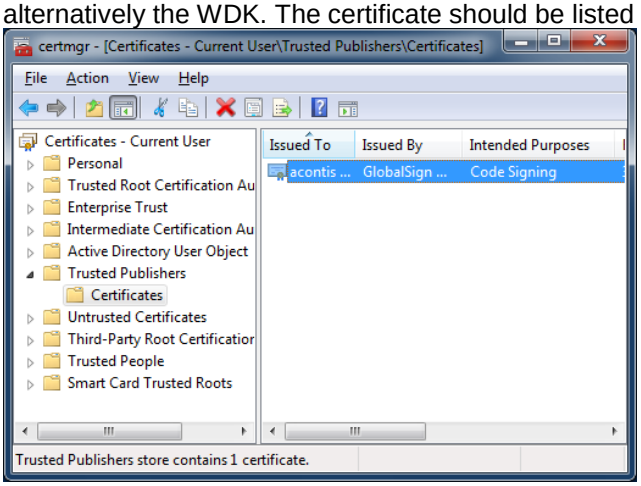
To prevent the “Do you trust this publisher” question during driver installation the certificate has to be installed in the “Trusted Publishers Certificate Store”.

This is done automatically after you once select “Always trust software from …”.

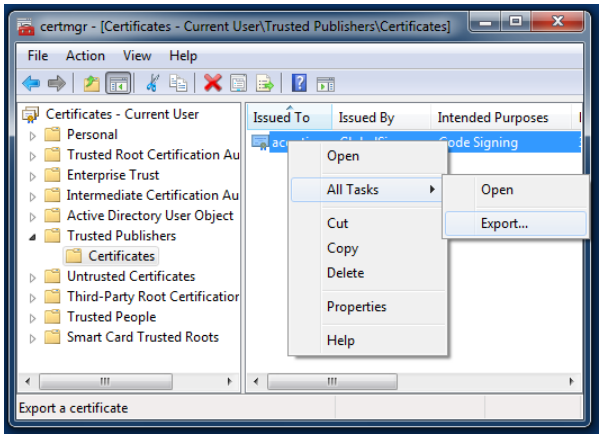


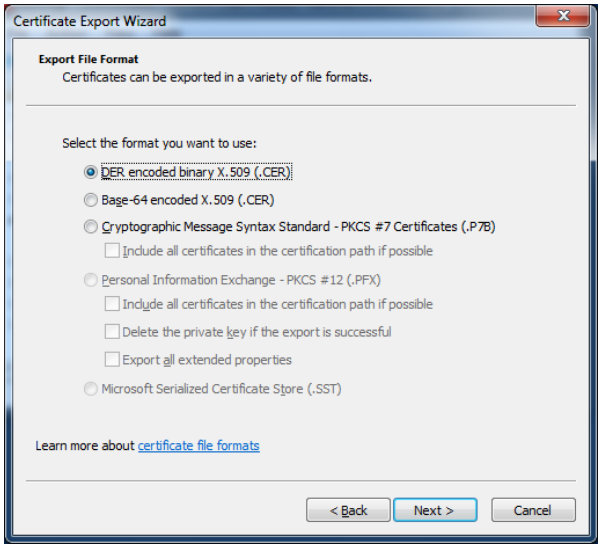
As an alternative you can pre-install the certificate in the store and so prevent the question.

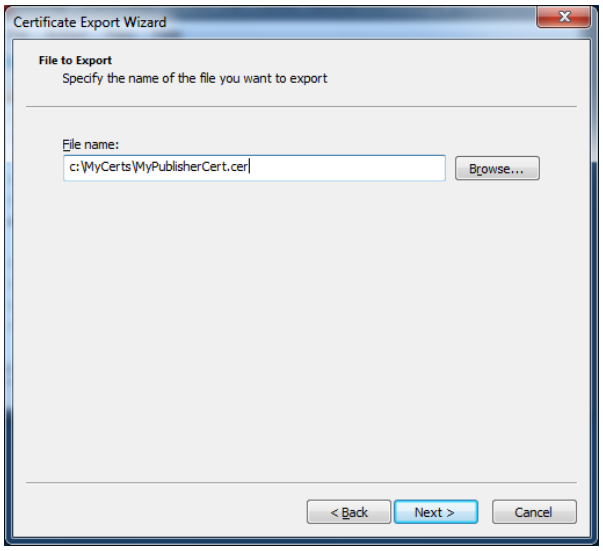
1) Install the driver on a system and select “Always trust software from….”
2) Call “certmgr” from an administrator command line. The tool is part of Windows 7 or alternatively the WDK. The certificate should be listed below “Trusted Publishers”:

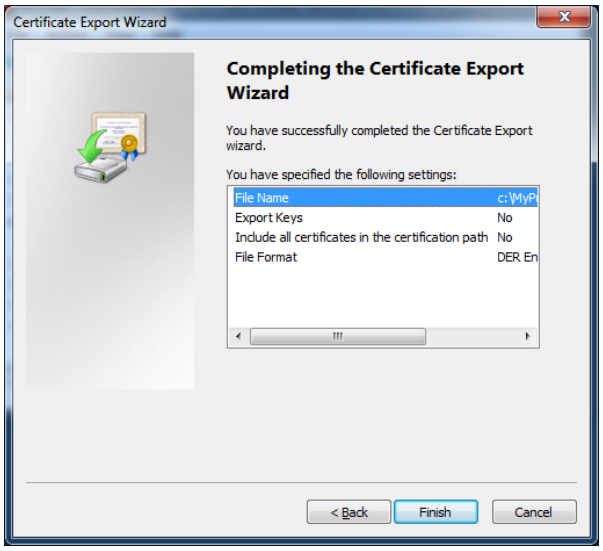


3) Export the certificate into a file:



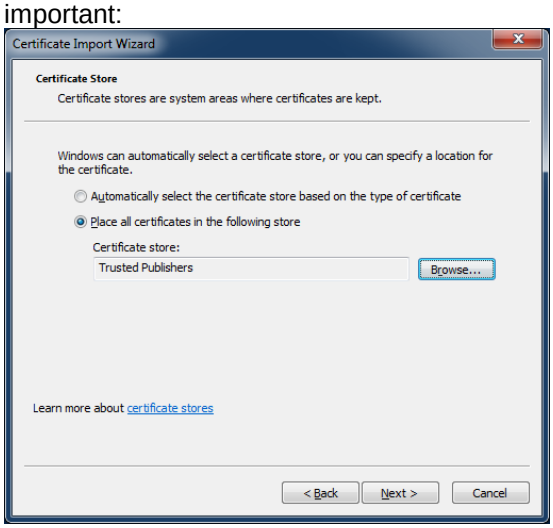






This file can now be used for pre-install the certificate on any PC and prevent the dialog during driver installation.

The pre-installation can be done by right-click the file and select “install”. The correct store is important:



Alternatively the certmgr.exe tool can be used to automatically install the certificate:
C:\MyCerts>certmgr.exe -add MyPublisherCert.cer -s -r localMachine trustedpublisher

A programmatically solution is also possible. The following calls will be required:
- CertOpenStore
- CertEnumCertificatesInStore
- CertAddCertificateContextToStore
- CertFreeCertificateContext
- CertCloseStore

4 RTOS Operation Mode

The basic decision that has to be made is the RTOS Operation Mode that shall be used.
The following variants are available:

- Shared Mode operation (single core system):
  Windows and the RTOS both run on one single cpu core. Windows will only get CPU time when the RTOS becomes idle.
- Shared Mode operation (multi core system):
  Windows utilizes all cpu cores in the system, the RTOS may run on an arbitrary cpu core. Thus, the core where the RTOS is running will be shared by Windows and the RTOS. Windows will only get CPU time on this core when the RTOS becomes idle.
  Note: if the RTOS doesn't become idle all Windows activities on that core will cease which will also block all other Windows cores to operate correctly.
- Exclusive Mode Operation
  On a system with n cpu cores Windows will use the first (n-1) cores and the RTOS will use the last cpu core. Both operating systems run completely independent from each other.
- SMP Exclusive mode operation
  On a system with n cpu cores Windows will use the first w cores and the RTOS will use the remaining r cpu cores (where r > 1). The RTOS thus will use more than one core and run in SMP mode (Symmetric Multiprocessing mode). Both operating systems run completely independent from each other.
- SMP Shared mode operation
  On a multi core system Windows utilizes only the first cpu core, the RTOS will use all other cpu cores in SMP mode. Thus, the first core will be shared by Windows and the RTOS. Windows will only get CPU time when the RTOS becomes idle on this core.

The operation mode can be determined as follows.

a) The number of cpu cores used by Windows is determined by the Windows boot configuration.

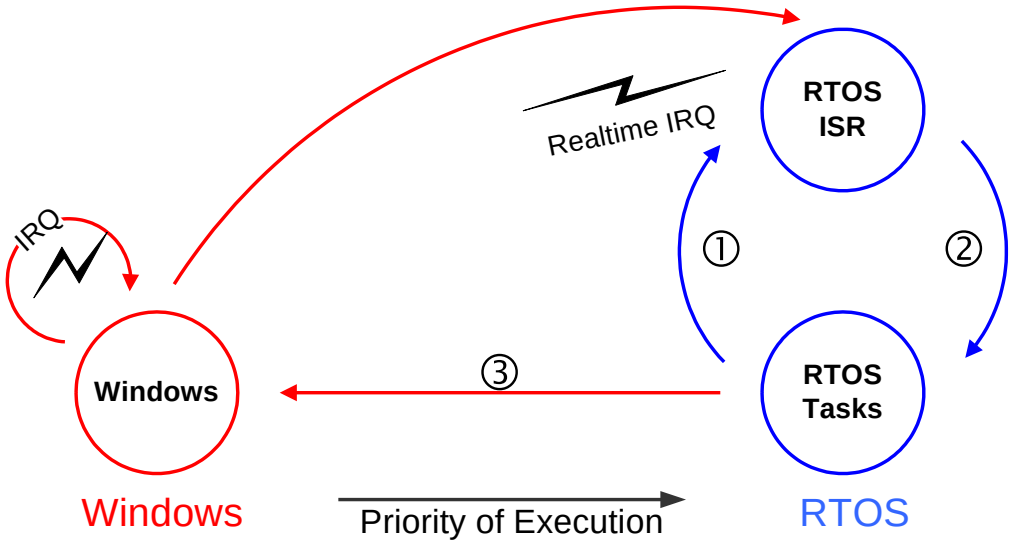
   Windows Vista / 7 / 8 / 10
   The boot configuration has to be edited using "BCDEdit" from the command line.
   - Open a command line (cmd) with administrator rights (right click, start as administrator)
   - enter "***bcdedit /set numproc n***" to configure Windows to use 'n' processor(s).
   The setting can be removed with "bcdedit /deletevalue numproc"

   To be able to start RTOS on an exclusive core on Windows Vista or newer the Uploader ***automatically*** sets the following entry: "bcdedit /set firstmegabytepolicy useall"
   This will ***not*** be removed when the product gets uninstalled.
   The entry can be removed ***manually*** by calling "bcdedit /deletevalue firstmegabytepolicy"

b) The cpu cores that shall be used by the RTOS are determined by the configuration parameter ***ProcessorMask*** in section ***[Rtos].*** Bit 0 represents the first cpu core, bit 1 the second etc..
   Examples:
   ProcessorMask = 1: RTOS will run on core 0 (first core)
   ProcessorMask = 2: RTOS will run on core 1 (second core)
   ProcessorMask = 3: RTOS will run on core 0 and 1 (first two cores)
   ProcessorMask = C: RTOS will run on core 2 and 3

4.1 Shared Mode operation (single core)

Windows and the RTOS both run on one single cpu core. Windows will only get CPU time when the RTOS becomes idle.

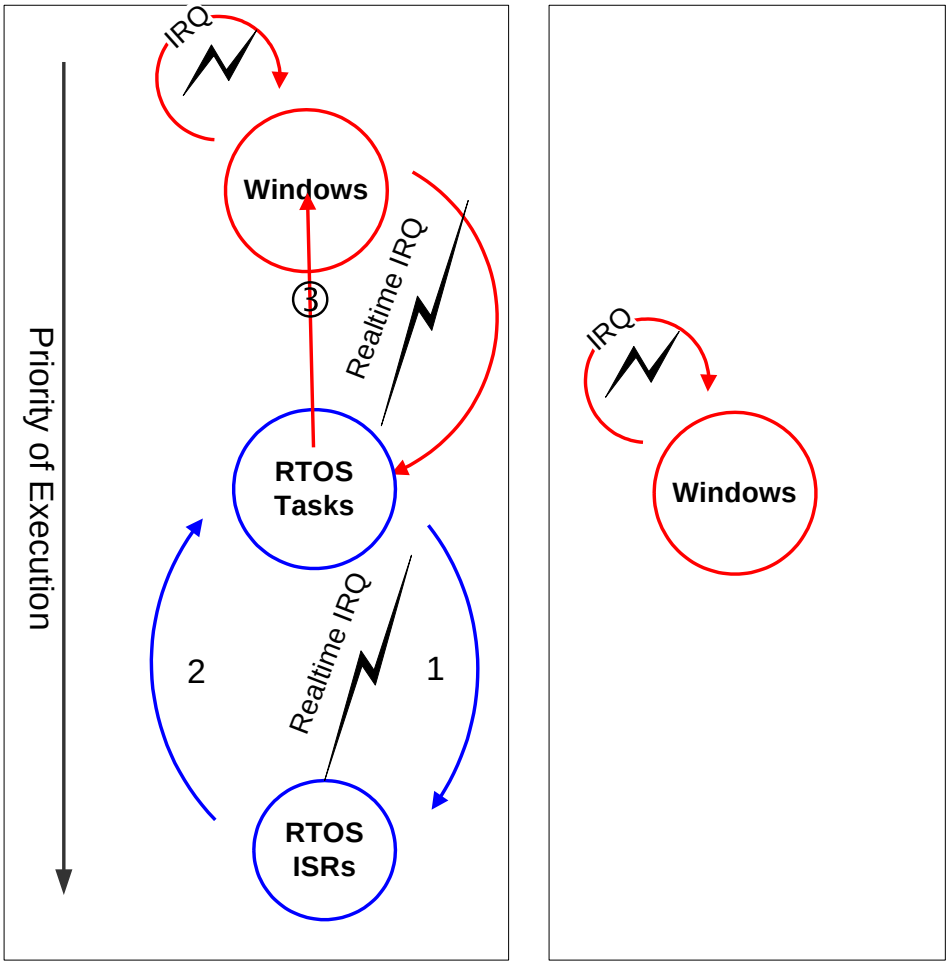


Configuration

Boot configuration: no adjustment is necessary
ProcessorMask: 1

4.2 Shared Mode operation (multi core)

Windows utilizes all cpu cores in the system, the RTOS may run on an arbitrary cpu core. Thus, the core where the RTOS is running will be shared by Windows and the RTOS. Windows will only get CPU time on this core when the RTOS becomes idle.
Note: if the RTOS doesn't become idle all Windows activities on that core will cease which will also block all other Windows cores to operate correctly.



Core 1:
RTOS +
Windows

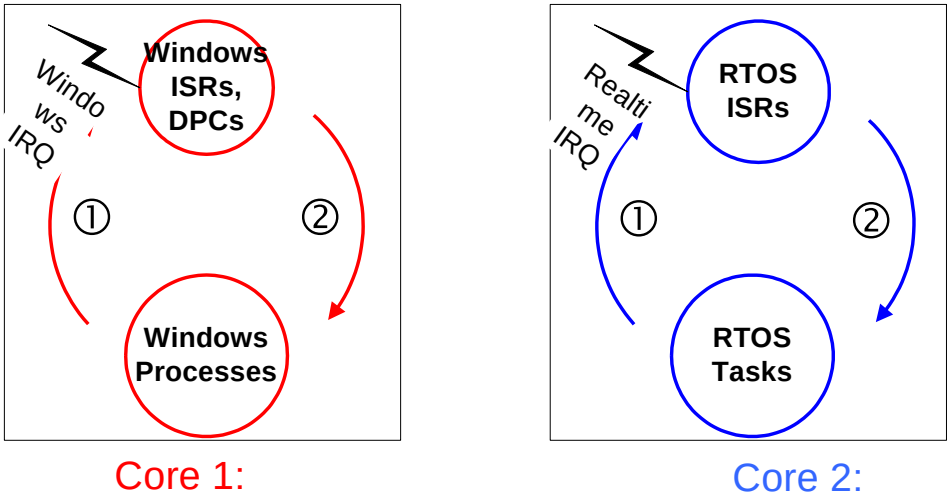
Core 2 (or 3,4,..):
Windows

Configuration example 1 (RTOS running on first core, see picture)
Windows uses all cpu cores, the RTOS uses the first cpu core.
Boot configuration: no adjustment is necessary
ProcessorMask: 1

Configuration example 2 (RTOS running on second core)
Windows uses all cpu cores, the RTOS uses the second cpu core.
Boot configuration: no adjustment is necessary
ProcessorMask: 2

4.3 Exclusive Mode operation

On a system with n cpu cores Windows will use the first (n-1) cores and the RTOS will use the last cpu core. Both operating systems run completely independent from each other.

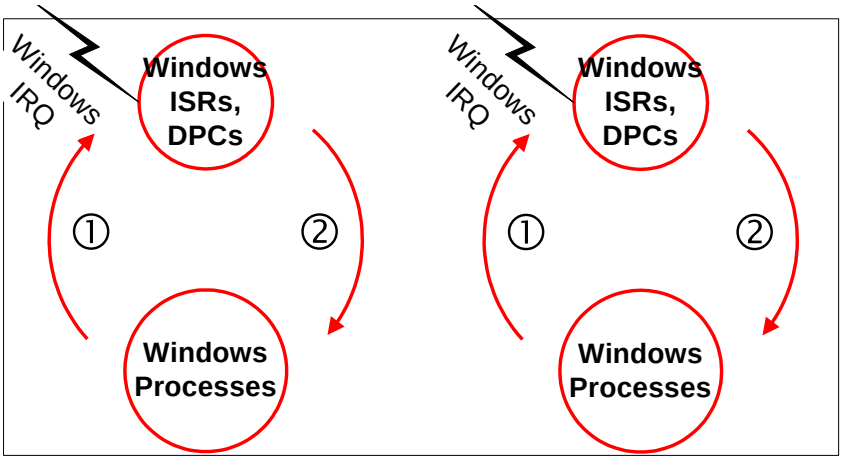


Configuration example 1 (dual core system, see picture)
Windows uses the first cpu core, the RTOS uses the second cpu core.
Boot configuration: set NUMPROC to 1
ProcessorMask: 2

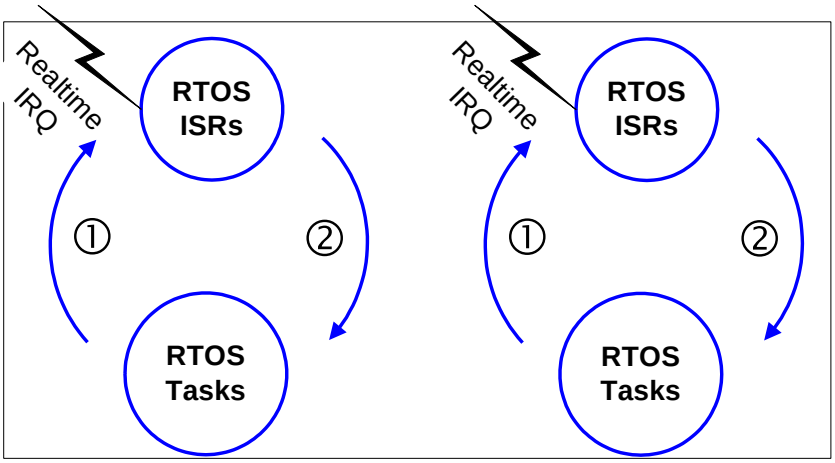
Configuration example 2 (quad core system)
Windows uses the first 3 cpu cores, the RTOS uses the fourth cpu core.
Boot configuration: set NUMPROC to 3
ProcessorMask: 8

4.4 SMP Exclusive Mode operation

On a system with n cpu cores Windows will use the first w cores and the RTOS will use the remaining r cpu cores (where r > 1). The RTOS thus will use more than one core and run in SMP mode (Symmetric Multiprocessing mode). Both operating systems run completely independent from each other.



Cores 1 + 2: Windows in SMP Mode



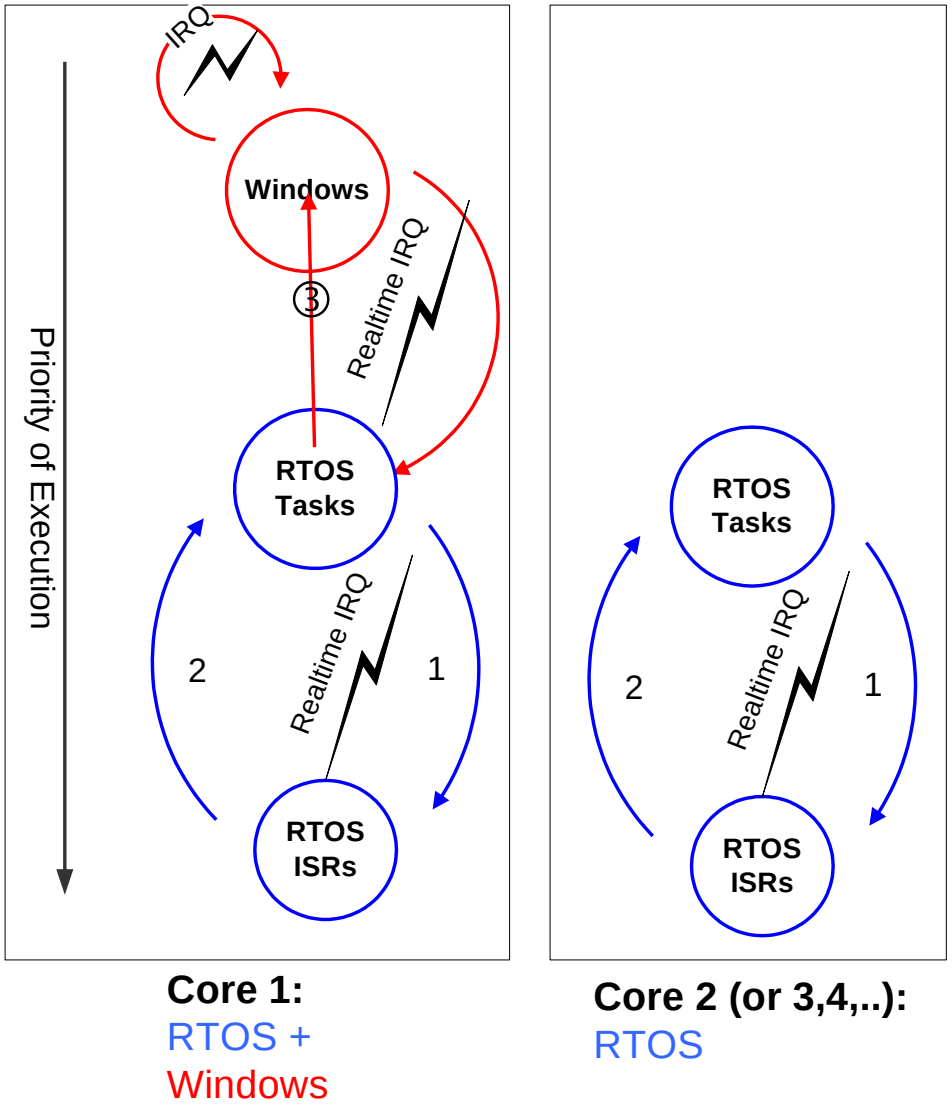
Cores 3 + 4: RTOS in SMP Mode

Configuration example 1 (quad core system, see picture)
Windows uses the first 2 cpu cores, the RTOS uses the last 2 cpu cores.
Boot configuration: set NUMPROC to 2
ProcessorMask: C

Configuration example 2 (octal core system)
Windows uses the first 4 cpu cores, the RTOS uses the last 4 cpu cores.
Boot configuration: set NUMPROC to 4
ProcessorMask: F0

4.5 SMP Shared Mode operation

On a multi core system Windows utilizes only the first cpu core, the RTOS will use all other cpu cores in SMP mode. Thus, the first core will be shared by Windows and the RTOS. Windows will only get CPU time when the RTOS becomes idle on this core.



Core 1:
RTOS +
Windows

Core 2 (or 3,4,..):
RTOS

Configuration example 1 (dual core system, see picture)
Windows uses the first cpu core, the RTOS uses all cpu cores.
Boot configuration: set NUMPROC to 1
ProcessorMask: 3

Configuration example 2 (quad core system)
Windows uses the first cpu core, the RTOS uses all 4 cpu cores.
Boot configuration: set NUMPROC to 1
ProcessorMask: F

5 RTOS VM configuration files (*.config files)

Configuration of the RTOS Virtual Machine is controlled using ASCII type config files.
Additional RTOS specific settings will also be stored in these files.

A config file has to start with the following header / signature:

```
RtosConfig
```

Another config file can be included (nested includes are possible) using:

```
#include "AnotherConfigFile.config"
```

A comment can be made for a whole line or at the end of a line

```
; This is a comment example
#include "AnotherConfigFile.config" ; This is another comment example
```

A config file should end with a new line to prevent compatibility problems with some versions.

This manual only covers generic settings valid for all RTOSWin solutions.
The configuration file is divided into the following main sections:

- [Upload] = Upload settings
- [Vmf] = Virtual Machine Framework settings
- [Host] = Host (Windows/Linux) configuration settings
- [Rtos] = RTOS 1 configuration settings for OsId 0
  [Rtos1] = RTOS 2 configuration settings for OsId 1
  [Rtos2] = RTOS 3 configuration settings for OsId 2
  …
  When document refers to [Rtos] this is also applicable for [Rtos1], [Rtos2], … .

5.1 Processor configuration (RTOS)

Please see chapter "4 RTOS Operation Mode" for additional details.

Section [Rtos]

Entry Name	Type	Description
ProcessorMask	Dword	Each bit represents a CPU to be used by a RTOS. 0x1 means 1st CPU, 0x2 means 2nd CPU, 0x5 means 1st and 3rd CPU Limitations: - Different Rtos can't share CPU(s). - An OS using multiple CPUs can't share CPU(s) with another OS also using multiple CPUs.

5.2 Interrupt Processor Vector Ranges

At the default configuration the RTOS interrupt processor vector range is always above the Windows interrupt processor vector range – for compatibility even on exclusive core configuration.

Example 1 (QuadCore):
Windows Boot configuration: set NUMPROC to 1
Rtos Config file: [Rtos] “ProcessorMask”=dword:0F
→ Windows vector range: 0x20-0xDF
→ RTOS vector range: 0xE0-0xFF

Example 2 (QuadCore):
Windows Boot configuration: set NUMPROC to 2
Rtos Config file: [Rtos] “ProcessorMask”=dword:0C
→ Windows vector range: 0x20-0xEF
→ RTOS vector range: 0xE0-0xFF

At example 2 Windows uses the first two cores and RTOS the other two cores.
Because the vector ranges overlap it must be ensured that the RTOS can handle incoming broadcast interrupts. This feature (Multi-SMP with Windows 7) is supported since version 5.0.00.31.

When Windows uses only one processor which is not shared with RTOS it might be possible to allow RTOS to use all available vectors from lowest 0x20 to highest 0xFF.
This can be done at the [Rtos] section in the config file. Because of compatibility with old versions this is not the default configuration.

Example 3 (QuadCore + processor vector settings):
Windows Boot configuration: set NUMPROC to 1
Rtos Config file: [Rtos] “ProcessorMask”=dword:0E
→ Windows vector range: 0x20-0xEF
→ RTOS vector range: 0x20-0xDF

Section [Rtos]

Entry Name	Type	Description
ProcessorVectorLowest	Dword	Optional; Set lowest vector allowed for range determination Warning: Do not change this value without request. An invalid value causes system instability.
ProcessorVectorHighest	Dword	Optional; Set highest vector allowed for range determination Warning: Do not change this value without request. An invalid value causes system instability.

5.3 Memory configuration

Each RTOS has to be configured to use an individual, specific physical memory range.

The individual memory range of each RTOS must be defined in the RTOS specific section.
Section [Rtos] for first, section [Rtos1] for second RTOS and so on.

Entry Name	Type	Description
MemoryStartAddress	Dword	RTOS memory physical base address (in bytes). omitted = use allocated memory x = use this base address
MemorySize	Dword	RTOS memory size
MemorySizeMin	Dword	Optional value usefull with MemoryType 4. Will return error 0x00153B6D if allocated size is below.
Alignment	Dword	Physical memory adress alignment (in bytes). Only relevant when “MemoryStartAddress” = 0. 0 = no alignment used Omitted equals 0
AddressMax	Dword	Highest physical address usable (in bytes). Only relevant when “MemoryStartAddress” = 0. Omitted equals 0xFFFFFFFF
MemoryType	Dword	0 = Autodetermination 1 = (reserved) 2 = RA; not usable on EFI systems 3 = BCD; Maximum for x86=~512MB and x64=~3MB 4 = MEM; Allocated memory (contiguous) Omitted equals 0

How MemoryType autodetermination selects a type:

If „MemoryStartAddress“ is omitted : MEM (4)

Else if BCD is available and (MemorySize < maximum reservable) and (MemorySize < 128MB) : BCD (3)

Else if Legacy- and not UEFI- firmware : RA (2)

Else if BCD is available : BCD

Else : Error

* BCD is available starting with Windows 7 – except on W10-2004.

** If MemorySize is above BCD limit an additional SharedMemory named “OsXHeap”, where X is OS-ID, will be allocated:
If MemorySize is <=16MB the SharedMemory will be of the same size – if not its size will be (MemorySize – BCD limit). The MemorySize will be set to the BCD limit.

The global physical memory range, defined in the [Upload] section, has been superseded by redesigned memory management and may only be useful to override automatic determination.

Entry Name	Type	Description
~~RteMemoryStartAddress~~	~~Dword~~	~~Physical base address where the first RTOS is located~~
~~RteMemorySize~~	~~Dword~~	~~Memory size to be reserved for all RTOS~~

The following RTOS specific settings are deprecated and have been superseded by VMF_OSIMAGE_INFO
(Exception: RTOS-32 still requires them for the debugger)

Entry Name	Type	Description
~~ImageOffset~~	~~Dword~~	~~Offset where the RTOS image has to be copied by the uploader~~
~~EntryPointOffset~~	~~Dword~~	~~Boot entrypoint offset of the RTOS~~
~~VmfAnchorOffset~~	~~Dword~~	~~VMF management anchor offset. After loading the RTOS image the uploader will copy the VMF management information data at this location.~~
~~VmfVersionOffset~~	~~Dword~~	~~VMF version offset. After loading the RTOS image the uploader will check the VMF version used by the RTOS.~~

5.3.1 Advantages and disadvantages of different OS memory reservation methods

This is an overall table. Specific OS may have additional limits like maximum usable memory or maximum usable address.

Memory Type	MEM		BCD		RA	
Use Virtualization Technology (VT)	No	Yes	No	Yes	No	Yes
Available on UEFI systems	Yes	Yes	Yes	Yes	No	No
Size limit on 64bit host >W10-2004	<4GB	<4GB	<512MB	<512MB	<4GB	<4GB
Size limit on 64bit host =W10-2004	<4GB	<4GB	0MB	0MB	<4GB	<4GB
Size limit on 64bit host <W10-2004	<4GB	<4GB	<3MB	<3MB	<4GB	<4GB
Size limit on 32bit host != W10-2004	<4GB	<4GB	<512MB	<512MB	<4GB	<4GB
Size limit on 32bit host = W10-2004	<4GB	<4GB	0MB	0MB	<4GB	<4GB
Size limited to physical contiguous memory being available	Yes	Yes (1)	Yes	Yes	Yes	Yes
Address limited to 32bit	Yes	No	Yes	Yes	Yes	Yes
Allocation size guaranteed	No	No	Yes	Yes	Yes	Yes
RTOS must be relocatable (2)	Yes	No	No	No	No	No
Influence by Windows Update:						
Driver memory allocations	Yes	Yes	No	No	No	No
BCD-store “bad memory” settings	No	No	Yes	Yes	No	No
Boot loader replacement	No	No	No	No	Yes	Yes
Registry “HiberbootEnabled” setting	No	No	No	No	Yes	Yes

(1) ‘No’ for a further version supporting non-contiguous memory.
(2) Currently RTOS-32 and VxWorks are neither relocatable nor planed to become.

5.4 Time/Date and Timezone synchronization

The RTOSWin solution supports time/date and timezone synchronization to assure that all partizipating operating systems show the same date and time. Each operating system may decide to either use its own date, time and timezone or shall be synchronized by another OS.

The config file settings regarding the time/date and timezone synchronization are OS specific and have to be made in an OS section like [Host\TimeSync] or [Rtos\TimeSync].

Entry Name	Type	Description
ModeGet	dword	0 Auto (=RTC) 1 Time from RTC (Chipset) will be used 2 Time from Soft-RTC (OS) will be used omitted = 0 = Default = RTC This setting is currently evaluated by Windows only.
ModeSet	dword	0 Auto (=UTC when available else Local) 1 UTC time will be set 2 Local time will be set omitted = 0 = Default = UTC
TaskEnabled	dword	0 Task will not be started 1 Task will be started 2 Task will be started, init time and timezone once and then finish. omitted = 1 = Task will be started
TaskPriority	dword	This defines the task priority for the time/date and timezone synchronization thread. The values are OS specific. The delivered config file contains OS specific information about lowest and highest possible priority. If the entry does not exist then the OS uses an OS specific priority compatible to older versions.
TimeSyncMaster	string	Identification string of the OS which is the source of the time and date. Possible values are “Windows” and “Rtos”. If the entry does not exist then the OS will act as master and use its own time/date.
TimezoneSyncMaster	string	Identification string of the OS which is the source of the timezone. Possible values are “Windows” and “Rtos”. If the entry does not exist then the OS will act as master and use its own timezone.

Shortly said every OS has to know where to take its info from – from itself (→ master) or another OS (→ slave). When no configuration is found an OS takes its infos from itself.

5.4.1 Windows

By default Windows uses its own clock and is not being synchronized with another clock.
If the (first) RTOS shall be used as time and timezone master the following entries have to be activated:

```
[Host\TimeSync]
"TimeSyncMaster"="Rtos"
"TimezoneSyncMaster"="Rtos"

[Rtos\TimeSync]
"TimeSyncMaster"="Rtos"
"TimezoneSyncMaster"="Rtos"
```

5.4.2 RTOS

By default the RTOS is being synchronized with the Windows clock.
The following entries have to be activated:

```
[Host\TimeSync]
"TimeSyncMaster"="Windows"
"TimezoneSyncMaster"="Windows"

[Rtos\TimeSync]
"TimeSyncMaster"="Windows"
"TimezoneSyncMaster"="Windows"
```

5.4.3 Windows / RTOS

Both OS are running separately without time/date and timezone synchronization. This is the default if no configuration entries are found. Alternatively the following entries can be activated:

```
[Host\TimeSync]
"TimeSyncMaster"="Windows"
"TimezoneSyncMaster"="Windows"

[Rtos\TimeSync]
"TimeSyncMaster"="Rtos"
"TimezoneSyncMaster"="Rtos"
```

5.5 Section [Vmf]

This chapter describes all settings in the [Vmf] section of the config file. It contains VMF settings valid for the whole RTOSWin system.

[Vmf]

Entry Name	Type	Description
AddressMax	hex	This parameter defines the maximum physical address allowed for VMF memory. When omitted “FF,FF,FF,1F,00,00,00,00” (= 0x000000001FFFFFFF = below 512MB) will be used. The default value is “FF,FF,FF,FF,00,00,00,00” (= 0x00000000FFFFFFFF = below 4GB). Sometimes using SharedCore requires a value of “FF,FF,FF,8F,00,00,00,00” (= 0x000000008FFFFFFF = below 2GB). Uploader will inform about this requirement. Before changing the value please affirm this will be supported by RTOS.
EventCount	dword	Maximum number of events supported. 100 (fixed) for versions < 6.1.00.06 500 (default) for versions >= 6.1.00.06 Starting with 6.1.00.06 the number can be modified using config entry “EventCount”.
TimerHwInputFreq	dword	This parameter can be used to override the determined VMF hardware timer input frequency with a specific value (unit Herz).
TimerMeasureDelayLimit	dword	This parameter specifies the maximum delay in TSC ticks for reading all required timer and counter values for a single point in time during timer and TSC frequency determination. Exceeding the default limit may indicate inaccuracy in the determined frequencies. =0 Use best value – recommended for running VmWare >0 Limit in TSC ticks If omitted “0x1388” (5000) is the default.
VerbosityLevel	dword	This parameter specifies the message level to be displayed by a message box: 0 – only fatal errors 1 – also other errors 2 – also warnings If omitted “0” is the default.
VtAllowed	dword	This parameter contains flags for Hardware Virtualization support: Bit 0: Allow VT support for VT-x and VT-d. Bit 1: Do not move host into a guest (Debug Flag) Bit 2: Do not use VT-d (Debug Flag) *CAUTION: VT mode must be licensed separately!*

[Vmf\Interrupts]

Entry Name	Type	Description
IdRenumber	dword	This parameter specifies if VMF should renumber interrupt IDs. On default the IDs are given by Uploader. This numeration is not contiguous and might become values above 100. Some OS may not be compatible with such high interrupt numbers so VMF can renumber the IDs (contiguous, starting with given value). 0 – do not renumber IDs >0 – renumber IDs equal or above given value If omitted “0” is the default. For example 0x30 (48) would mean that all IDs equal or above 48 will be renumberd to contiguous ID’s starting with 48.

[Vmf\MessageBox]

Entry Name	Type	Description
TextBufferLength	dword	This parameter specifies the buffer size to be used for vmfMessageBox API. The minimum value is 522 = (VMF_MESSAGEBOX_MAX_TEXT_SIZE + VMF_MESSAGEBOX_MAX_TITLE_SIZE + 2). When omitted the minimum will be used as default.

5.6 Section [Upload]

This chapter describes all settings in the [Upload] section of the config file. It contains generic settings valid for the whole RTOSWin system.

Entry Name	Type	Description
Trace	dword	Enable or Disable the Uploader tracing facility. Disable tracing = 0 (default). Enable tracing = 1
TraceFile	string	If tracing is enabled, all trace data will be stored in this named file. Default = "trace.txt".
WaitForRtosCommSubsystems	dword	Disabled = 0. Enabled = 1(default). If enabled: upon starting the RTOS, the Uploader will wait for communication subsystems to be initialized before finishing. Enabling this parameter can increase the start time. Disabling it could cause synchronization problems.
LaunchRtosControl	dword	This parameter causes the ***RtosControl*** system tray application to be launched. 0 = do not launch 1 = (default) launch RtosControl tray application 2 = Don't start RtosControl, but let RtosService do message box handling. If "MessageBoxShow" value is not configured it will be set to 0.
RtosControlPath	string	This parameter is optional and can contain a relative or absolute path with or without the executable name to ***RtosControl***.
MessageBoxShow	dword	This parameter causes message box to be auto-answered without showing a dialog to ask for user input: VMF_MESSAGEBOX_ABORTRETRYIGNORE will return "Abort" VMF_MESSAGEBOX_YESNOCANCELand VMF_MESSAGEBOX_YESNO will return "Yes" VMF_MESSAGEBOX_RETRYCANCEL will return "Cancel" all other will return "OK" 0 = auto-answer. 1 = show message box (default).
MessageBoxLog	dword	This parameter causes message box messages to be also written into application system log. This feature is independent from Microsoft Build-In feature of logging message boxes to system log. 0 = do not write log entry. 1 = write log entry. Default depends on "MessageBoxShow" setting. If a message will be shown logging is disabled – else enabled.
BootCodeReservationForce	dword	0 = (default) reservation is not forced. 1 = forces Uploader to statically reserve processor boot code memory. On default the static reservation is not forced and will be done only in case the RtosDrv could not dynamically reserve the memory. Activating static boot code reservation requires a reboot. Reservation will be removed with "-memcfg -u" (or "-ur") option only.
BootCodeBaseFallback	dword	Fallback base address to be used for processor boot code memory reservation. Default value is 0x40000.

Entry Name	Type	Description
SetFirstMegabytePolicy	dword	0 = force FirstMegabytePolicy not to be set. 1 = (default) set policy when required. Policy will also not be set if BootCodeReservationForce is active.
AllowMultiSmp	dword	Deprecated – this setting has been superseded by VMF_OSIMAGE_INFO flag VMF_OSIMAGE_INFO_FLAG_1_MULTISMP. This parameter enables the option to run Windows 7 SMP with RTOS SMP (Multi-SMP). 0 = (default) Multi-SMP not allowed for Windows 7. 1 = Allowed. Attention: RTOS must explicit support Windows 7 Multi-SMP or the system might crash! Please check release notes if Multi-SMP is supported.
Flags	dword	Bit 0: When clear (default) RtosStart will not unload VMF or OS after an error. When set RtosStart will unload VMF and/or OS after an error. But OS start failure will not unload VMF when it was previously loaded by a separate call.

5.7 Multi Purpose Shared Memory

This chapter describes all settings of the config file regarding multi purpose shared memories in the sections [SharedMemory\UserDefinedShmName] respectively [SharedMemory\UserDefinedShmName\AccessModes].
("UserDefinedShmName" can be a user defined name)

Attention:
When multiple large shared memories are configured it is possible the system has not enough memory remaining to boot. Such a situation can be solved this way:

- Start the system in Safe Mode
- Change the SharedMemory configuration
- Start the RTOS to update with the new configuration
- Reboot the system

[SharedMemory\UserDefinedShmName]

Entry Name	Type	Description
Name	string	This parameter specifies the name of the shared memory. This name can be used to query the ID using vmfIdGetByName() respectively RtosGetIdByName() function.
Description	string	A string describing the shared memory.
Base	dword	Base address of shared memory. 0 = automatic allocation (recommended) x = use this static address as base omitted = equals 0 Limitations for static addresses: - The address must be within the range of "RteMemoryStartAddress" and "RteMemoryStartAddress" + "RteMemorySize" - The memory can not be accessed directly from Windows.
Alignment	dword	Physical memory adress alignment (in bytes). Only relevant when "Base" = 0. 0 = default = no alignment used
AddressMax	dword	Highest physical address usable (in bytes). Only relevant when "Base" = 0. 0xFFFFFFFF = default
Size	dword	Size of shared memory (in bytes)
File	string	Path and Filename to load the shared memory content from a file or save it to.
Initialize	dword	0 = don't initialize memory. The memory will nevertheless be zeroed once after allocation, but not each time VMF gets loaded. 1 = zero memory 2 = initialize memory with file 3 = as (2) but initialize with '0' if file not found instead of error 7 = as (3) but on load renames "File" to "File.loaded". Existing file will be replaced. In combination with "Save" this prevents re-use of old data e.g. after power-failure. F = as (7) but rename also read only files

Entry Name	Type	Description
Save	dword	Default value = 0 = don't save on stop Possible flags: 0x1 = save content to file 0x2 = overwrite also write protected file 0x4 = also save during power failure handling
AccessDefault	dword	default access mode mask (default = 1 = present,r+w,cached,no execute) Possible flags are: 0x01 = present 0x02 = readonly 0x04 = uncached 0x08 = execute

[SharedMemory\UserDefinedShmName\AccessModes]

Entry Name	Type	Description
"0" … "n"	dword	Define an explicit access mode for OS X (0 … n) This overwrites the default access mode set by "AccessDefault" for a specific OS.

5.8 OS Communication

5.8.1 Settings

The config file settings regarding the communication are OS specific and have to be made in an OS section like [Host\Comm] or [Rtos\Comm].

Entry Name	Type	Description
CommTimeout	dword	Communication timeout in seconds (How long this OS should wait for another). Default = 5.
CommInterruptMode	dword	Interrupt mode. 0=Polling, 1=Interrupt, omitted= Windows: depending on "Realtime OS Driver" interrupt mode. Rtos: depending on host (Windows) Comm interrupt mode.
TaskPriority	dword	This defines the task priority for the comm thread. The values are OS specific. The delivered config file contains OS specific information about lowest and highest possible priority. If the entry does not exist then the OS uses an OS specific priority compatible to older versions.
TaskEnabled	dword	0 Task will not be started 1 Task will be started omitted = 1 = Task will be started
CommPollPeriodUs	dword	Set polling period in µs. Minimum period is 100 µs. Default value is 0 which represents a duration of 1 jiffie. This parameter is only valid in RTOSVisor.

For a higher performance of Inter–OS communication interrupts can be used.
This will minimize event round-trip times between the OS.

After changing the config file setting “CommInterruptMode” RTE should be stopped for at least 10 seconds before restarted with the new configuration setting. Without waiting between stop and start the configuration change of “CommInterruptMode“ might not be completed.

5.8.2 Enable / Disable Comm Interrupt

The Comm interrupt configuration depends on:

- Config file settings “CommInterruptMode”, as described above.
  This can be configured separately for Windows and each RTOS.

5.9 Resource Descriptor Technology (RDT)

Please read chapter “14.3 Intel(R) Resource Director Technology (RDT)” for details.

Section [Vmf\RDT]

Entry Name	Type	Description
CatAllowed	Dword	0 CacheAllocationTechnology (CAT) is not allowed 1 CAT can be used when available omitted = 1 = CAT will be used when available
CatMaskL%u1Cos%u2Cpu%u3	Dword	Configures the bitmask to be used for cache-level ‘%u1’ in CAT-COS register index ‘%u2’ on CPU ‘%u3’. ‘%u1’ has to be replaced with cache-level (typical 2 or 3). ‘%u2’ has to be replaced with COS config register index. ‘%u3’ has to be replaced with CPU index
CatCdpAllowed	Dword	0 CAT-CodeDataPrioritization (CDP) is not allowed 1 CAT-CDP can be used when available omitted = 0 = CAT-CDP will not be used When active the COS registers are remapped from for example 8x1 to 4x2 to individually configure data and code.
CatMaskDataL%u1Cos%u2Cpu%u3	Dword	Used with CDP only. Configures data priority. Equal to “CatMaskL%u1Cos%u2Cpu%u3”.
CatMaskCodeL%u1Cos%u2Cpu%u3	Dword	Used with CDP only. Configures code priority. Equal to “CatMaskL%u1Cos%u2Cpu%u3”.
MbaAllowed	Dword	0 MBA is not allowed 1 MBA can be used when available omitted = 0 = MBA will not be used
MbaThrottleCos%u1Cpu%u2	Dword	Configures the value to be used in MBA-COS register index ‘%u1’ on CPU ‘%u2’. ‘%u1’ has to be replaced with COS config register index. ‘%u2’ has to be replaced with CPU index

Section [Rtos\RTD]

Entry Name	Type	Description
CosIdxCpu%u	Dword	Configures the COS-selector to be used by this OS on a specific CPU. ‘%u’ has to be replaced with CPU index.

5.10 Virtualization Technology (VT)

[Vmf]

Entry Name	Type	Description
VtAllowed	dword	This parameter contains flags for Hardware Virtualization support: Bit 0: Allow VT support for VT-x and VT-d. Bit 1: Do not move host into a guest (Debug Flag) Bit 2: Do not use VT-d (Debug Flag) ***CAUTION**: VT mode must be licensed separately!*

[…\Vmf]
These settings are OS specific and made in an OS sub-section like [Rtos\Vmf].

Entry Name	Type	Description
MapReservedMemory	Dword	Some devices (mainly USB) are configured by BIOS to access BIOS owned memory. When a BIOS does not proper declare this memory a “DMA Fault” will occur. In such a case this setting might be a workaround by granting RTOS devices access to all system reserved memory: 0: no access 1: read+write access 3: read only access omitted = 0 = no access
MapSystemTables	Dword	This setting allows RTOS to access ACPI tables and memory maped PCI config space. On default such access would cause an Extended-Page-Table (EPT) fault. Our latest config files already contain this entry when it is required by RTOS. 0: access denied 1: access granted omitted = 0 = no access

6 Start/Stop the RTOS: Uploader Utility

6.1 Introduction

After the RTOSWin solution has been installed, you can use the Uploader Utility program to start the real-time system. By taking advantage of command-line parameters, you can cause it to perform a variety of functions.

For RTE 4.x The tool consists of two files:

- ***UploadRTOS.exe*** (Command line program)
- ***UploadRTOS.dll***

For RTE 5.x The tool consists of three files:

- ***RtosUpload.exe*** (Command line program)
- ***RtosLib32.dll*** (For 32 bit applications)
- ***RtosLib64.dll*** (For 64 bit applications)

To run existing programs linked to UploadRtos.dll the file RtosLib32.dll can be copied to UploadRtos.dll.

Caution: starting with RtE version 7.1.1 the RtosUpload.exe will be started with **AsInvoke** rights. For most operations **no** admin rights are required. If the desired operation fails then the call must be **rerun** with admin rights.

When the Uploader Utility is called to start the RTOS, it reads and processes its own command line options. It also reads and processes configuration parameters from the system configuration file. After the RTOS image has been loaded, it is given control.
Here is a summary of the services that the Uploader Utility together with other RTOSWin components performs:

- Collects device configuration information (queries all RTOS devices),
- Loads configuration data (content of the *.config files) into memory,
- Performs system and device configuration consistency checks (e.g. detects interrupt sharing conflicts),
- Reserves memory for the RTOS,
- Loads a RTOS image into memory,
- Defines physical memory areas for use by the RTOS,
- Initiates execution of the RTOS image,
- Terminates a running RTOS session and releases system resources.

6.2 Uploader operation, command line options

Command-line Syntax: RtosUpload <Mode> [Options…]

Mode (prefix can be '-' or '/')	Options / Description
-config "'f1' <options>"	Load VMF using config file 'f1'. This will stop all running OS and unload already loaded VMF. 'f1' use this file as config file possible options are: -vmf 'f2' use f2 as VMF binary (default is vmf.bin)
"f1"	Start OS 'f1'. 'f1' use this file OS image file This can be used in combination with '-config' and - or '-osid'. Default OS id is 0.
-x	Stop the RTOS given by option 'osid'. Without option 'osid' all RTOS will be stopped and VMF will be unloaded.
-osid <id>	Start or stop OS with this id
-memcfg "<params>"	Update memory configuration. Possible parameter are: '-u' uninstall '-a' install or update (requires >>-config "f1"<<) '-v' show current configuration. Also usable with '-u' or '-a'
-shmsave "Name" "f1"	Dump shared memory 'Name' into file 'f1'
-lic <parameter>	Configure runtime license Possible parameter are: <LicenseId> To install a license ID for this computer -remove To remove an installed license ID
-nosleep	Do not insert a delay after starting the RTOS
-nowait	Do not wait for a key pressed in case of errors
-noerror	Never return an error code
-device "<string>"	Call RtosDevice(<string>). See RtosDeviceA() API for details.
-isvmfloaded	Checks if VMF is loaded. Returns: RTE_SUCCESS if VMF is loaded. RTE_ERROR_VMF_NOTREADY if VMF is not loaded. Any other return value means an error occurred during the query. Errorvalues are defined in rteError.h
-isosrunning	Checks if OS given by option 'osid' is running. Returns: RTE_SUCCESS if OS is running. RTE_ERROR_OSNOTRUNNING if OS is not running. Any other return value means an error occurred during the query. Errorvalues are defined in rteError.h
-isvmmapped	Checks if memory is mapped into a VM. Returns: RTE_SUCCESS if no memory is mapped. RTE_ERROR_VM_MAPPED if memory is mapped. Any other return value means an error occurred during the query.

	Errorvalues are defined in rteError.h This parameter is only valid in RTOSVisor.
-?	Show help about possible options
Special Options	**Special Options – not generally supported**
-faststart "<opt1> <opt2> ..."	FastStart configuration Possible options are: -config 'f1' use config file 'f1' (only with <-file>) -file 'f2' use FastStart configuration file 'f2' -vmf 'f3' use VMF binary file 'f3' -os 'f4' use OS binary file 'f4' -[disable|once|always] disable FastStart, use only once or always -[startvmf|startvmfos] start only VMF or start VMF and OS
-f "f1"	Freeze system into file 'f1'
-u "f1"	Unfreeze system from file 'f1'
-loop <count>	Option for testing. Repeat start for 'count' times - without unloading Dll.

When the Uploader is called using “-config” mode first all running OS will be stopped and a loaded VMF will be unloaded. Then the following steps are performed:

- RTOS device configuration data is collected and stored in memory.
- RTOS Device consistency checks are performed (e.g. interrupt sharing conflicts).
- RTOSWin configuration data (content of the *.config files) is loaded into memory.
- The RTOSWin configuration is verified (e.g. detect overlapped memory areas).
- The VMF binary image is loaded into memory.
- If an OS image was specified (“f1” mode), it will now be loaded into memory and then booted.

Load VMF and start first OS (any running OS will be stopped and VMF unloaded first):
RtosUpload.exe /config “vxwin.config” “C:\Tornado\target\config\VxWin\vxWorks.bin”

Start or Restart OS 0 (VMF must already be loaded) without loading VMF again:
RtosUpload.exe /osid 0 “C:\MyOsImages\\vxWorks.bin”

VMF will be loaded first (any running OS will be stopped and VMF unloaded first), followed by two OS:
RtosUpload.exe /config vxwin.config
RtosUpload.exe /osid 0 “C:\MyOsImages\\vxWorks.bin”
RtosUpload.exe /osid 1 “C:\MyOsImages\vxWorks2.bin”

Using the “-x” mode in combination with “-osid” will stop the specified OS while “-x” without “-osid” will stop all OS and unload VMF.

All OS will be stopped and VMF be unloaded:
RtosUpload.exe -x

Only OS 1 will be stopped. Other OS and VMF will not be affected:
RtosUpload.exe -x -osid 1

Remove memory reservation:
RtosUpload.exe -memcfg “-u”

Set or update memory configuration by config-file:
RtosUpload.exe /memcfg “-a” -config “C:\MyConfigFiles\MyOs.config”

7 RTOS tray-icon application (RtosControl.exe)

If you start the demo version of the RTOSWin solution, the RtosControl tray-icon application will automatically run. When it does, a tray icon will automatically appear in Windows taskbar. After it has run for 30 minutes, the RTOS will be stopped and a dialog window is displayed on the PC monitor. At this point, you can either command the program to run again or terminate it.
If your proprietary icon (rtoscontrol.ico) file is in the same directory as the ***RtosControl.exe*** program, it will be displayed in place of ACONTIS's icon. Otherwise, the ACONTIS icon will appear.
Even if you have installed a full version of RTOSWin, this program will be executed. The RtosControl application is responsible for showing a message box generated by the RTOS Virtual Machine adaptation (e.g. in fatal error situations).

RtosControl specific settings in config file section [Upload]

Entry Name	Type	Description
LaunchRtosControl	dword	This parameter causes the ***RtosControl*** system tray application to be launched. 0 = do not launch 1 = (default) launch RtosControl tray application 2 = Don't start RtosControl, but let RtosService do message box handling. If "MessageBoxShow" value is not configured it will be set to 0.
RtosControlPath	string	This parameter is optional and can contain a relative or absolute path with or without the executable name to ***RtosControl***.
MessageBoxShow	dword	This parameter causes message box to be auto-answered without showing a dialog to ask for user input: VMF_MESSAGEBOX_ABORTRETRYIGNORE will return "Abort" VMF_MESSAGEBOX_YESNOCANCELand VMF_MESSAGEBOX_YESNO will return "Yes" VMF_MESSAGEBOX_RETRYCANCEL will return "Cancel" all other will return "OK" 0 = auto-answer. 1 = show message box (default).
MessageBoxLog	dword	This parameter causes message box messages to be also written into application system log. This feature is independent from Microsoft Build-In feature of logging message boxes to system log. 0 = do not write log entry. 1 = write log entry. Default depends on "MessageBoxShow" setting. If a message will be shown logging is disabled – else enabled.

RtosControl specific settings in config file section [Host\MessageBox]

Entry Name	Type	Description
TaskPriority	dword	This defines the task priority for the message box thread. The values are OS specific. The delivered config file contains OS specific information about lowest and highest possible priority. If the entry does not exist then the OS uses an OS specific priority compatible to older versions.
TaskEnabled	dword	0 Task will not be started 1 Task will be started omitted = 1 = Task will be started

8 The RTOS service application (RtosService.exe)

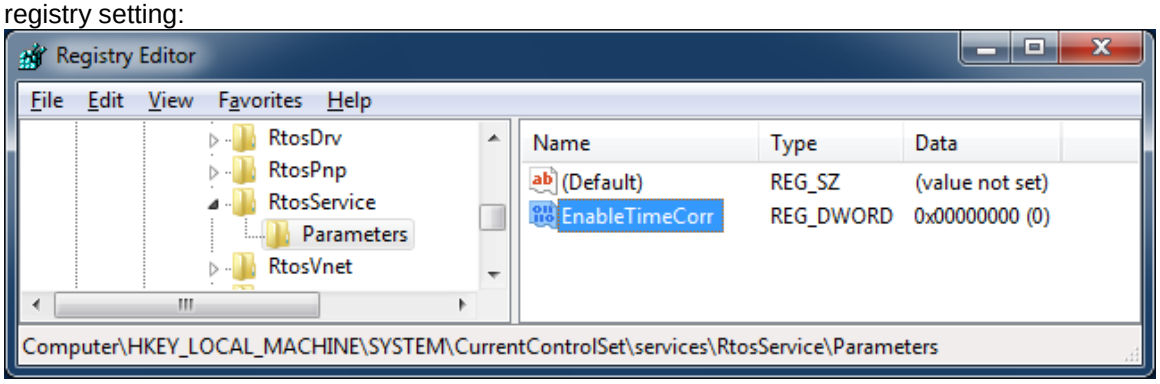
When installing RTOSWin the RtosService component is added into the list of services which will be automatically started when Windows boots.
The service is responsible for the following tasks:

- Windows Clock Correction (assures the Windows clock does not run too slow)
- Date and Time synchronization between Windows and the RTOS
- RTOS File Server for RtosFile support
- RTOS Gateway

8.1 Clock Correction

When running in SharedCore mode Windows will loose timer interrupts when RTOS occupies the CPU longer than a timer interval. As a result the Windows clock will be delayed
The clock correction compensates this problem by regulating the timer increments per clock tick.
The clock correction is enabled on default.

Before version 5.1.0.30 / 6.0.0.11 ClockCorretion could only be disabled by the following Windows registry setting:



Starting with 5.1.0.30 / 6.0.0.11 ClockCorretion can also be disabled by a config file entry:

ClockCorrection specific settings in config file section [Host\ClockCorrection]

Entry Name	Type	Description
TaskEnabled	dword	0 Task will not be started 1 Task will be started omitted = 1 = Task will be started

8.2 Date and Time synchronization

See chapter “0 Time/Date and Timezone synchronization” for details.

8.3 RTOS File Server for RtosFile support

See chapter “10.1.14 RTOS Library – files” for details.

8.4 RTOS Gateway

RtosGateway forwards a RtosSocket to an IP socket.
When a RTOS application supports using RtosSocket, like for example acontis EC-Master does, the RtosGateway allows access to that application from an external PC.
In case of EC-Master it allows to visualize EtherCat data on an external PC.

RtosGateway specific settings in config file section [Host\Gateway]

Entry Name	Type	Description

Entry Name	Type	Description
TaskPriority	dword	This defines the task priority for the gateway thread. The values are OS specific. The delivered config file contains OS specific information about lowest and highest possible priority. If the entry does not exist then the OS uses an OS specific priority compatible to older versions.
TaskEnabled	dword	0 Task will not be started 1 Task will be started omitted = 1 = Task will be started
Port	dword	TCP port to be used
PipeThreadRxTimeout	dword	Timeout reading RX pipe. Do not change without request!
PipeRxBufSize	dword	RX pipe buffer size. Do not change without request!

9 The Realtime OS Virtual Network Adapter (RtosVnet.sys)

All OS (Windows and RTOS) can communicate using a virtual network.
The “Realtime OS Virtual Network Adapter” (RtosVnet.sys) enables Windows to access this virtual network.

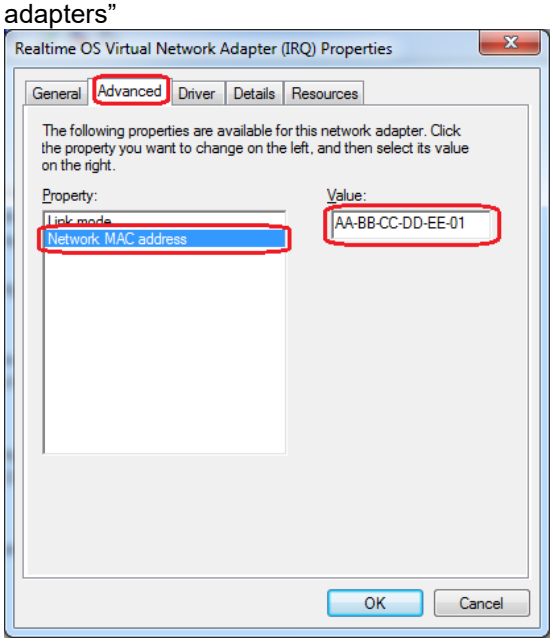
9.1 Configuration

It is OS dependent which features of the “Realtime OS Virtual Network Adapter” can be configured.

9.1.1 Windows

9.1.1.1 MAC Address

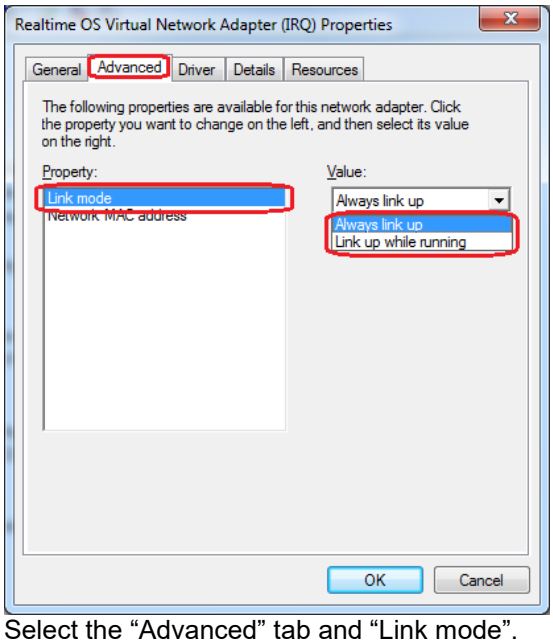
The MAC address can be configured using the Windows device manager.
Open the device manager and double-click “Realtime OS Virtual Network Adapter” below “Network adapters”



Select the “Advanced” tab and “Network MAC address” to change the MAC address value.

9.1.1.2 Link Mode

The link mode can be configured using the Windows device manager.
Open the device manager and double-click “Realtime OS Virtual Network Adapter” below “Network adapters”

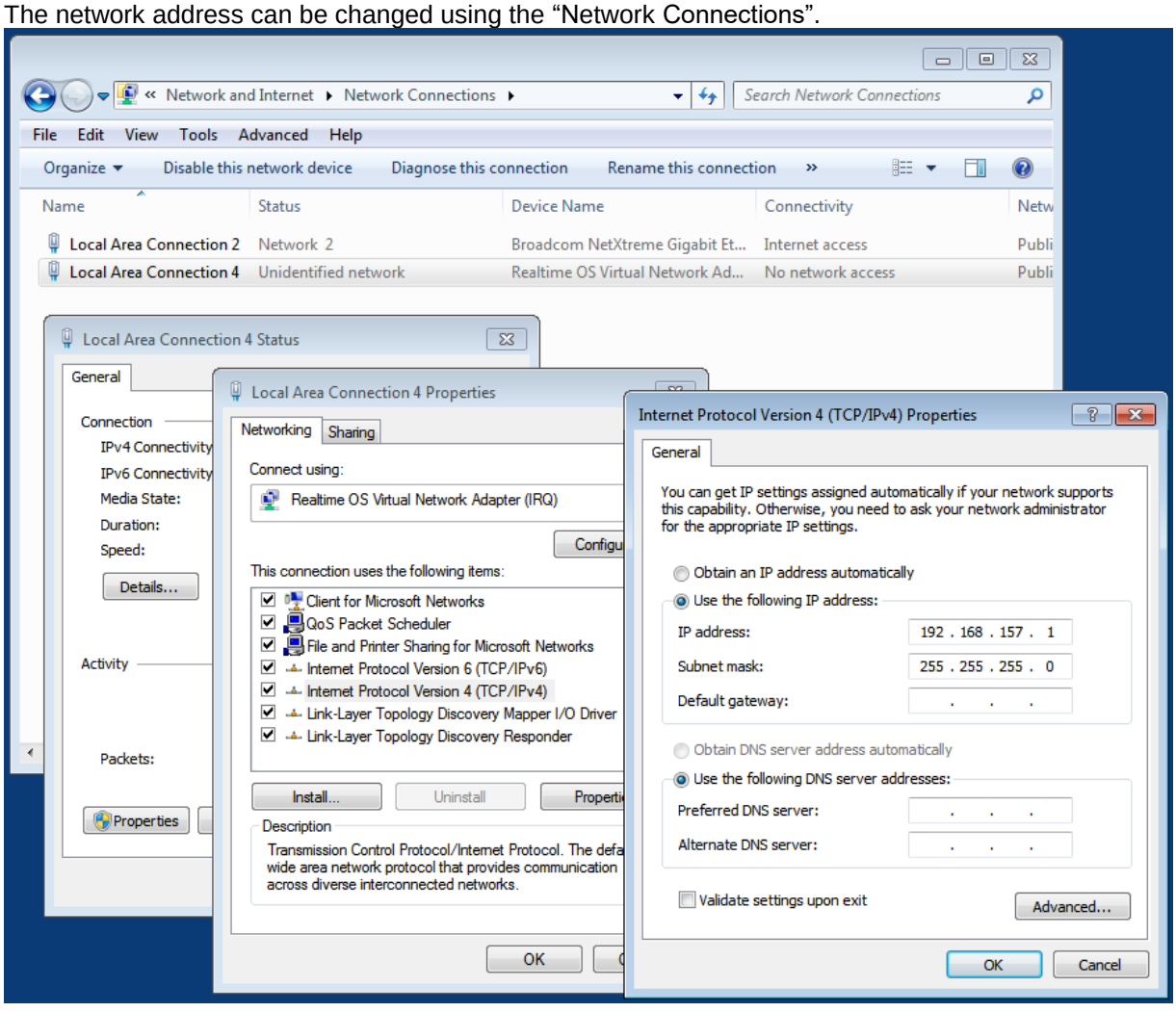


Select the “Advanced” tab and “Link mode”.

- “Always link up” means the adapter behaves like a network card always connected to a switch or hub.
- “Link up while running” means the adapter behaves like a network card connected with a crossover cable to another PCs network card. If the other PC is turned off the link is down. When a RTOS is running the link will be up and when it’s stopped the link will go down.

9.1.1.3 Network Address

The network address can be changed using the “Network Connections”.



9.1.2 RTOS

Please check the product specific manual for virtual network adapter configuration possibilities.

10 The RTOS Library

The RTOS library provides higher level communication services for synchronizing Windows with the RTOS or to exchange data between the operating systems. The RTOS library is based on VMF functions which provide the basic communication functionality.
This library is provided in source code as it has to be ported to the RTOS. To make this job easier most of the source code is written OS independently. The OS adaptation is done in a separate OS adaptation layer. VmfWin provides example implementations.

10.1 RTOS Library – Application Layer API

This section describes the RTOS library functions provided for the user.
User applications will have to include the RtosLib.h header file prior to using the RTOS library functions.

10.1.1 Windows applications

10.1.1.1 General Restriction

Before version 5.1.00.29 / 6.0.00.04 the RTOS Library API can only be called concurrently by a total number of maximum 31 threads (total sum of threads used in one or multiple executable applications).

10.1.1.2 RTE Version 4.x

The Windows part of the RTOS Library is implemented in the UploadRtos.dll dynamic link library.
Windows applications have to be linked together with the library UploadRtos.lib.

10.1.1.3 RTE Version 5.x

The Windows part of the RTOS Library is implemented in the RtosLib32.dll (32 bit) and RtosLib64.dll (64 bit) dynamic link library.
Windows applications have to be linked together with the library RtosLib32.lib (32 bit) or RtosLib64.lib (64 bit).
To run existing programs linked to UploadRtos.dll the file RtosLib32.dll can be copied to UploadRtos.dll.

10.1.2 RTOS applications

The RTOS part of the RTOS Library in most cases is implemented in a binary library. Details of the RTOS part can be found in the corresponding RTOSWin product manual.

10.1.3 RTOS Library – initialization and shutdown

The first step which has to be taken when the RTOS Library shall be used is calling the appropriate initialization routines of the library. After this step the RTOS Library routines are available. If the system shall be shut down, the de-initialization functions have to be called.

10.1.3.1 RtosLibInit

Initialize the RTOS Library.

UINT32 RtosLibInit (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
Each process must call this function at least once before using RtosLib.
An internal call counter is incremented each call. The initialization will be done when the value goes from 0 to 1 and the de-initialization when it goes from 1 to 0.
There are some RtosLib functions not requiring RtosLibInit to be called:

- RtosSetOutputPrintf
- RtosResultGetModule
- RtosResultGetText
- RtosDevice
- RtosSetMemoryConfiguration

10.1.3.2 RtosLibDeinit

De-Initialize the RTOS Library.

UINT32 RtosLibDeinit (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A process must first close all RtosLib handles and call all Stop functions where it called Start before.
An internal call counter is decremented each call. The initialization will be done when the value goes from 0 to 1 and the de-initialization when it goes from 1 to 0.
After De-Init was done no other RtosLib function except RtosLibInit should be called.

10.1.3.3 RtosCommStart

Start the inter OS communication subsystem (e.g. required for events).

UINT32 RtosCommStart (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment

The following OS will do this automatically:
- Windows: Handled by RtosDrv
- VxWorks: Done by BSP
- Windows CE: Done by RtosService

It is responsible for communication services.
Please check chapter 5.8 “OS Communication” for configuration details.

10.1.3.4 RtosCommStop

Stop the inter OS communication subsystem.

UINT32 RtosCommStop (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The following OS will do this automatically:
Windows: Handled by RtosDrv
VxWorks: Done by BSP
Windows CE: Done by RtosService

10.1.3.5 RtosCommWaitForSubsystems

Wait until all required subsystems are up and running. The application has to wait until all communication subsystems are ready prior to calling the inter OS communication functions of the RTOS Library (e.g. events, interlocked data access, …).

UINT32 RtosCommWaitForSubsystems (
UINT32 dwOsId,
UINT32 dwTimeout,
BOOL* pbSubsystemsInitialized)

Parameter
dwOsId
[in] Operating System ID.
dwTimeout
[in] Timeout in seconds.
pbSubsystemsInitialized
[out] TRUE if the subsystems are initialized, FALSE if not.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The application wants to communicate with at least one OS (usually Windows). The value given in dwOsId has to be set to the appropriate value corresponding with this OS, it can be determined by RtosGetIdByName(). If communication with more than one OS is requested then this function has to be called for each of the corresponding operating systems.

10.1.3.6 RtosMsgBoxStart

Start the inter RTOS message box communication mechanism.

UINT32 RtosMsgBoxStart (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
If the caller's operating system will show the message box it has to be assured that the process calling RtosMsgBoxStart() is able to do this job (e.g. on the Windows side this function may not be called by a Windows Service as services are not able to get a Window handle).
This function is called by default on

- Windows (by RtosControl)

10.1.3.7 RtosMsgBoxStop

Stop the inter RTOS message box communication mechanism.

UINT32 RtosMsgBoxStop (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
This function is called by default on

- Windows (by RtosControl)

10.1.3.8 RtosGetIdByNameA

Get a VMF ID by a given name.

UINT32 RtosGetIdByNameA(
Const CHAR* szName,
UINT32 dwIdType,
UINT32* pdwId)

Parameter
szName
[in] Name of the desired element
dwIdType
[in] Element type to get an ID of. See comment for supported types (RTOS_ID_xxx).
pdwOsId
[out] requested ID.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
RTOS_ID_OS:
Every operating system which is part of the RTOS VM (at least Windows and one RTOS) is required to have a unique name by which it can be identified. This name will be determined by setting the appropriate entry “Name” in the OS config section in the RTOS VM configuration files. The RTOS VM then assigns a unique OS ID to internally identify the OS.

RTOS_ID_DEVICE:
Each device has an OS unique name (devices with same name may be assigned to another OS). The RTOS VM assigns a unique device ID to internally identify the device.

RTOS_ID_SHM:
Each shared memory requires an unique name. The RTOS VM assigns a unique shared memory ID to internally identify the shared memory.

The macro RtosGetIdByName can be used to call RtosGetIdByNameW if UNICODE is defined and RtosGetIdByNameA if not.

10.1.3.9 RtosGetIdByNameW

Get a VMF ID by a given name.

UINT32 RtosGetIdByNameW (
Const WCHAR* wszName,
UINT32 dwIdType,
UINT32* pdwId)

Parameter
szName
[in] Unicode name of the desired element
dwIdType
[in] Element type to get an ID of. See comment for supported types (RTOS_ID_xxx).
pdwOsId
[out] requested ID.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
See RtosGetIdByNameA().
The macro RtosGetIdByName can be used to call RtosGetIdByNameW if UNICODE is defined and RtosGetIdByNameA if not.

10.1.4 RTOS Library – events

This feature makes it possible for RTOS applications (thread or process) to asynchronously notify an application under Windows of the occurrence of some event. *Shared Events* supports signaling in both directions.
A typical use for *Shared Events* would be, for example, to coordinate activities between the two operating systems. For example, if two applications use a shared memory area to communicate data back and forth, the *shared events* mechanism could be used to synchronize the reading and writing, i.e., to protect the integrity of the data.
In the rare case that events require a short round trip time Communication interrupt mode can be enabled as described in chapter 5.8 “OS Communication”.
Starting with version 6.1.00.06 the formaly fixed total number of events (100) has changed to 500 per default and can be modified using

[Vmf]
"EventCount"=dword:X

See chapter “5.5

Section [Vmf]" for details.

10.1.4.1 RtosCreateEventA

Create a named event.

```
UINT32 RtosCreateEventA (
   BOOL                 bManualReset,
   BOOL                 bInitialState,
   const CHAR*          szName,
   RTOSLIB_HANDLE*      phEvent)
```

Parameter

bManualReset
[in] Currently only auto-reset events are supported (bManualReset = FALSE).

bInitialState
[in] Currently the initial-state has always set to FALSE (non-signalled).

szName
[in] Event name

phEvent
[out] Event handle

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

If the event already exists a handle to the existing event object will be returned.
The handle returned by ***RtosCreateEvent*** may be used for all subsequent accesses to the new event object.
Any thread in the operating system that expects notification of an event can use the event's object-handle in a call to ***RtosWaitForEvent***. Correspondingly, any thread in the other operating system that wishes to send notification may use ***RtosSetEvent*** to send the signal. The setting and waiting functions work in either direction. When the state of the specified object is triggered, the ***RtosWaitForEvent*** function returns, and the waiting thread will continue executing.
Even though the initial state of the event object is formally specified by the *bInitialState* parameter, the only valid initial state is the non-signalled state.
All Shared Event objects are auto-reset objects. If the initial state of a event is not set to *non-signalled*, an error will be returned. After the event has been signalled *(**RtosSetEvent***), it remains signalled only until the waiting thread is released. Thereupon, the system will reset the state to non-signalled. If no threads are waiting, the event object remains signalled.
Use ***RtosCloseEvent*** to close the handle. The application is responsible for resource reclamation.
Shared events only work between the RTOS and Windows. Setting an event under Windows, can only wake a thread in the RTOS and vice versa. It is impossible to use shared Events to wake up a thread in the operating system under which the ***RtosSetEvent*** has been issued.
The macro RtosCreateEvent can be used to call RtosCreateEventW if UNICODE is defined and RtosCreateEventA if not.

10.1.4.2 RtosCreateEventW

Create a named event.

```
UINT32 RtosCreateEventW (
    BOOL                bManualReset,
    BOOL                bInitialState,
    const WCHAR*        wszName,
    RTOSLIB_HANDLE*     phEvent)
```

Parameter

bManualReset
[in] Currently only auto-reset events are supported (bManualReset = FALSE).

bInitialState
[in] Currently the initial-state has always set to FALSE (non-signalled).

szName
[in] Unicode event name

phEvent
[out] Event handle

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

See RtosCreateEventA().
The macro RtosCreateEvent can be used to call RtosCreateEventW if UNICODE is defined and RtosCreateEventA if not.

10.1.4.3 RtosOpenEventA

Open an already existing event object.

```
UINT32 RtosOpenEventA (
    const CHAR*         szName,
    RTOSLIB_HANDLE*     phEvent)
```

Parameter

szName
[in] Event name

phEvent
[out] Event handle

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

If the event already exists a handle to the existing event object will be returned.
The macro RtosOpenEvent can be used to call RtosOpenEventW if UNICODE is defined and RtosOpenEventA if not.

10.1.4.4 RtosOpenEventW

Open an already existing event object.

UINT32 RtosOpenEventW (
const WCHAR* wszName,
RTOSLIB_HANDLE* phEvent)

Parameter
szName
[in] Unicode event name
phEvent
[out] Event handle

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
See RtosOpenEventA().
The macro RtosOpenEvent can be used to call RtosOpenEventW if UNICODE is defined and RtosOpenEventA if not.

10.1.4.5 RtosCloseEvent

Close access to a already existing event object.

UINT32 RtosCloseEvent (
RTOSLIB_HANDLE hEvent)

Parameter
hEvent
[in] Event handle

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A call to this function closes a handle to the event object.
RtosCloseEvent invalidates the specified object handle, decrements the object's handle count. Once the last handle to an object is closed, the object is removed from the operating system.

10.1.4.6 RtosSetEvent

Signal a new event.

UINT32 RtosSetEvent (
RTOSLIB_HANDLE hEvent)

Parameter
hEvent
[in] Event handle

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The state of an auto-reset event object remains signalled until a single waiting thread is released, at which time the system automatically sets the state to non-signalled. If no threads are waiting, the event object's state remains signalled.
Note 1: Only auto-reset events are supported.
Note 2: If you call *RtosSetEvent* in the RTOS, you can only call *RtosWaitForEvent* in Windows. That is, you cannot wait for the same event in the RTOS. If you do, the result is unpredictable.
Note 3: A call to *RtosSetEvent* will not immediately set the event int the counter-part OS due to interactions between the two operating systems.
Note 4: Multiple calls to the *RtosSetEvent* function may be made, however, if the counterpart does not consume one of them, a subsequent *RtosSetEvent* function call will replace the former unconsumed event.

10.1.4.7 RtosWaitForEvent

Signal a new event.

UINT32 RtosWaitForEvent (
RTOSLIB_HANDLE hEvent,
DWORD dwTimeout)

Parameter
hEvent
[in] Event handle
dwTimeout
[in] Timeout in milliseconds. The function returns if the interval elapses, even if the object's state is non-signalled. If dwTimeout is set to zero, the function tests the object's state and returns immediately. If dwTimeout is set to RTOS_WAIT_INFINITE, the function's time-out interval will never elapse.

Return
RTE_SUCCESS on success (event was signalled) and an error-code on failure (RTE_ERROR_TIMEOUT on timeout).

Comment
RtosWaitForEvent checks the current state of the specified event object. If the object's state is *non-signalled*, the calling thread will block.
Since only auto-reset event objects are used, the wait function that successfully receives the signal resets the object's state to non-signalled before returning.

10.1.5 RTOS Library – interlocked data access

Interlocked data access is required whenever an atomic access to a shared data variable shall be performed.

10.1.5.1 RtosInterlockedCompareExchange

The function performs an atomic comparison of the specified values and exchanges the values, based on the outcome of the comparison. The function prevents more than one thread inside the callers OS as well as multiple operating systems from simultaneously accessing the same variable.

UINT32 RtosInterlockedCompareExchange (
UINT32* volatile pdwDestination,
UINT32 dwExchange,
UINT32 dwComparand,
UINT32* pdwInitial)

Parameter

pdwDestination
[in] Pointer to the destination value.

dwExchange
[in] Exchange value.

dwComparand
[in] Value to compare to destination.

pdwInitial
[out] Destination value found at start of compare.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The function performs an atomic comparison of the *Destination* value with the comparand value. If the destination value is equal to the comparand value, the exchange value is stored in the address specified by pnDestination. Otherwise, no operation is performed.
The interlocked functions provide a simple mechanism for synchronizing access to a variable that is shared by multiple threads or operating systems. The threads of different processes or different operating systems can use this mechanism if the variable is in shared memory.
The parameters for this function must be aligned on a 32-bit boundary; otherwise, the function will behave unpredictably.

Example (how to synchronize access to a shared memory region)

```
INT32* pnShmValue;        /* points into shared memory area */
INT32  nTimeout;
UINT32 dwRes;
UINT32 dwInitVal;         /* initial value when starting exchange */
BOOL   bAccess = FALSE;

// when set to 0 no one owns the shared memory
// when set to 1 the counterpart may access shared memory
// when set to 2 we may access shared memory
for( nTimeout = 1000; 0 < nTimeout; nTimeout-- )
{
    dwRes = RtosInterlockedCompareExchange( pnShmValue, 2, 0, & dwInitVal );
    if( RTE_SUCCESS != dwRes )
    {
        /* error during call */
        goto Exit;
    }

    if( 0 == dwInitVal )
    {
        /* success: value exchanged */
        bAccess = TRUE;
        break;
    }
    Sleep(1);
```

```
}

/* check for access */
if( TRUE == bAccess )
{
    // now access the shared memory region
    :    :    :
    :    :    :
    // now release access to the shared memory region
    *pnShmValue = 0;
}
```

10.1.5.2 RtosInterlockedExchangeAdd

The function performs an atomic addition. The function prevents more than one thread inside the callers OS as well as multiple operating systems from simultaneously accessing the same variable.

UINT32 RtosInterlockedExchangeAdd (
INT32* volatile pnDestination,
INT32 nValue,
INT32* pnInitial)

Parameter

pnDestination
[in] Pointer to the destination value.

nValue
[in] The value to be added (might be negative).

pnInitial
[out] Destination value found before addition.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The function performs an atomic addition.
The interlocked functions provide a simple mechanism for synchronizing access to a variable that is shared by multiple threads or operating systems. The threads of different processes or different operating systems can use this mechanism if the variable is in shared memory.
The parameters for this function must be aligned on a 32-bit boundary; otherwise, the function will behave unpredictably.

10.1.5.3 RtosInterlockedAnd

The function performs an atomic AND operation. The function prevents more than one thread inside the callers OS as well as multiple operating systems from simultaneously accessing the same variable.

```
UINT32 RtosInterlockedAnd (
    UINT32* volatile   pdwDestination,
    UINT32             dwValue,
    UINT32*            pdwInitial)
```

Parameter

pdwDestination
[in] Pointer to the destination value.

dwValue
[in] The value used for the logical operation with the destination value.

pdwInitial
[out] Destination value found before logical operation.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The function performs an atomic AND operation.
The interlocked functions provide a simple mechanism for synchronizing access to a variable that is shared by multiple threads or operating systems. The threads of different processes or different operating systems can use this mechanism if the variable is in shared memory.
The parameters for this function must be aligned on a 32-bit boundary; otherwise, the function will behave unpredictably.

10.1.5.4 RtosInterlockedOr

The function performs an atomic OR operation. The function prevents more than one thread inside the callers OS as well as multiple operating systems from simultaneously accessing the same variable.

```
UINT32 RtosInterlockedOr (
    UINT32* volatile   pdwDestination,
    UINT32             dwValue,
    UINT32*            pdwInitial)
```

Parameter

pdwDestination
[in] Pointer to the destination value.

dwValue
[in] The value used for the logical operation with the destination value.

pdwInitial
[out] Destination value found before logical operation.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The function performs an atomic OR operation.
The interlocked functions provide a simple mechanism for synchronizing access to a variable that is shared by multiple threads or operating systems. The threads of different processes or different operating systems can use this mechanism if the variable is in shared memory.
The parameters for this function must be aligned on a 32-bit boundary; otherwise, the function will behave unpredictably.

10.1.5.5 RtosInterlockedXor

The function performs an atomic XOR operation. The function prevents more than one thread inside the callers OS as well as multiple operating systems from simultaneously accessing the same variable.

UINT32 RtosInterlockedXor (
UINT32* volatile pdwDestination,
UINT32 dwValue,
UINT32* pdwInitial)

Parameter
pdwDestination
[in] Pointer to the destination value.
dwValue
[in] The value used for the logical operation with the destination value.
pdwInitial
[out] Destination value found before logical operation.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The function performs an atomic XOR operation.
The interlocked functions provide a simple mechanism for synchronizing access to a variable that is shared by multiple threads or operating systems. The threads of different processes or different operating systems can use this mechanism if the variable is in shared memory.
The parameters for this function must be aligned on a 32-bit boundary; otherwise, the function will behave unpredictably.

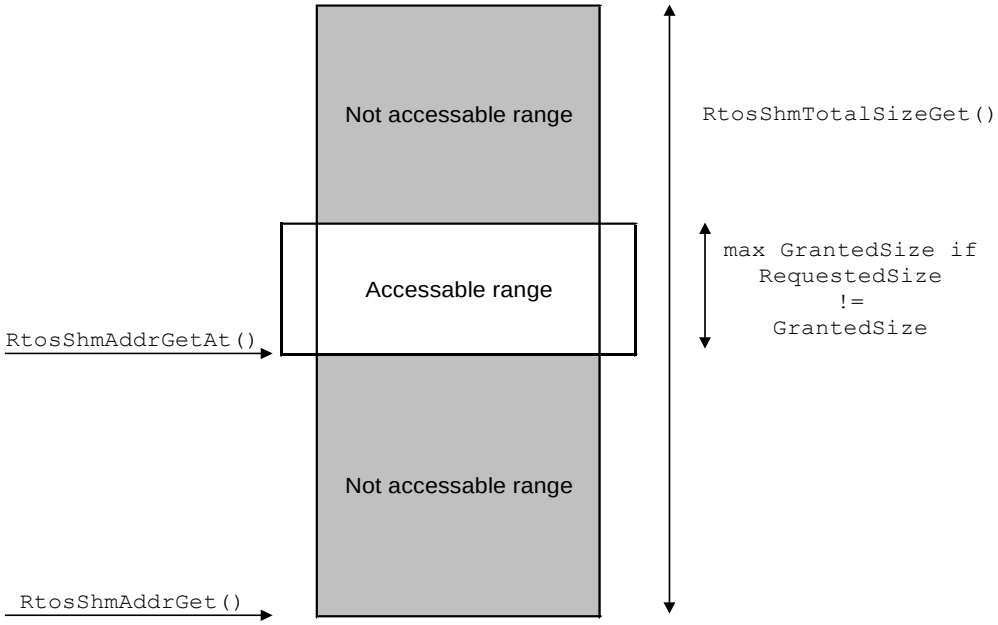
10.1.6 RTOS Library – shared memory

The RTOS VM platform provides one system-wide shared memory area to exchange data between multiple operating systems. Some operating systems may only provide a limited amount of the shared memory area to be mapped into the caller's memory context (e.g. Windows). In this case it is necessary to use windowing technique to access the whole shared memory area.

To use Shared Memory, the following steps must be performed:

- using the function ***RtosShmAddrGet***, an application acquires a pointer to a block of Shared Memory.

Note: While the size of the Shared Memory is limited only by the physical size of RAM, Windows has internal limitations that restrict the amount of shared memory that can be accessed at one time. Therefore, if you wish to take full advantage of a physically large shared memory, you will have to use windowing techniques to do so:



- Use the ***RtosShmTotalSizeGet*** function to acquire the size of the shared memory range.
- After setting the input parameter ***dwRequestedSize*** to the value returned by ***RtosShmTotalSizeGet***, call the ***RtosShmAddrGet*** function.
- If the returned parameter ***pdwGrantedSize*** is not equal to ***dwRequestedSize***, then ***pdwGrantedSize*** represents the largest shared memory window you can access at that time.
- Through successive calls to ***RtosShmAddrGetAt***, however, you can acquire the entire shared memory.

Note 1: Once an ***RtosShmAddrGet*** or ***RtosShmAddrGetAt*** function has been used, subsequent use of the same function will invalidate a previously returned address.
Note 2: Most RTOS and Windows applications address *virtual* memory space. While multiple calls to these functions might return numerically identical virtual addresses, such addresses, acquired at different times, will very likely point to different data areas.

10.1.6.1 RtosShmAddrGet

Determine the base address of the shared memory area.

If (RTOSLIB_API_VERSION < 50):

```
UINT32 RtosShmAddrGet (
    UINT32          dwRequestedSize,
    UINT32*         pdwGrantedSize,
    VOID**          ppvShmAddr)
```

Parameter

dwRequestedSize
[in] Requested size of shared memory to be accessed by the application.

pdwGrantedSize
[out] Actually granted size that is mapped into the caller's memory context.

ppvShmAddr
[out] Base address of the mapped shared memory area.

If (RTOSLIB_API_VERSION >= 50):

```
UINT32 RtosShmAddrGet (
    UINT32          dwShmId,
    UINT32          dwRequestedSize,
    UINT32*         pdwGrantedSize,
    VOID**          ppvShmAddr)
```

Parameter

dwShmId
[in] Shared memory ID – can be requested by RtosGetIdByName(…)

dwRequestedSize
[in] Requested size of shared memory to be accessed by the application.

pdwGrantedSize
[out] Actually granted size that is mapped into the caller's memory context.

ppvShmAddr
[out] Base address of the mapped shared memory area.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

Any pointer previously initialized with a call to ***RtosShmAddrGet*** or ***RtosShmAddrGetAt*** must be considered as invalid after a renewed call to those functions.

10.1.6.2 RtosShmAddrGetAt

Determine the address of the shared memory area at a given offset.

If (RTOSLIB_API_VERSION < 50):

```
UINT32 RtosShmAddrGetAt (
    UINT32          dwOffset,
    UINT32          dwRequestedSize,
    UINT32*         pdwGrantedSize,
    VOID**          ppvShmAddr)
```

Parameter

dwOffset
[in] Offset from the shared memory base where to map the memory into the caller's memory context.

dwRequestedSize
[in] Requested size of shared memory to be accessed by the application.

pdwGrantedSize
[out] Actually granted size that is mapped into the caller's memory context.

ppvShmAddr
[out] Base address of the mapped shared memory area.

If (RTOSLIB_API_VERSION >= 50):

```
UINT32 RtosShmAddrGetAt (
    UINT32          dwShmId,
    UINT32          dwOffset,
    UINT32          dwRequestedSize,
    UINT32*         pdwGrantedSize,
    VOID**          ppvShmAddr)
```

Parameter

dwShmId
[in] Shared memory ID – can be requested by RtosGetIdByName(…)

dwOffset
[in] Offset from the shared memory base where to map the memory into the caller's memory context.

dwRequestedSize
[in] Requested size of shared memory to be accessed by the application.

pdwGrantedSize
[out] Actually granted size that is mapped into the caller's memory context.

ppvShmAddr
[out] Base address of the mapped shared memory area.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

Any pointer previously initialized with a call to ***RtosShmAddrGet*** or ***RtosShmAddrGetAt*** must be considered as invalid after a renewed call to those functions.

10.1.6.3 RtosShmTotalSizeGet

Determine the total size of the system-wide shared memory area.

If (RTOSLIB_API_VERSION < 50):

UINT32 RtosShmTotalSizeGet(
UINT32* pdwSize)

Parameter
pdwSize
[out] Total shared memory size.

If (RTOSLIB_API_VERSION >= 50):

UINT32 RtosShmTotalSizeGet(
UINT32 dwShmId,
UINT32* pdwSize)

Parameter
dwShmId
[in] Shared memory ID – can be requested by RtosGetIdByName(…)
pdwSize
[out] Total shared memory size.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
–

10.1.6.4 RtosShmSaveFileA

Save a shared memory to a file.

UINT32 RtosShmSaveFileA (
UINT32 dwShmId,
const CHAR* szFilename)

Parameter
dwShmId
[in] Shared memory ID
szFilename
[out] File to write shared memory data to.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A shared memory ID can be queried using “RtosGetIdByName”.
The macro RtosShmSaveFile can be used to call RtosShmSaveFileW if UNICODE is defined and RtosShmSaveFileA if not.

10.1.6.5 RtosShmSaveFileW

Save a shared memory to a file.

UINT32 RtosShmSaveFileA (
UINT32 dwShmId,
const WCHAR* wszFilename)

Parameter
dwShmId
[in] Shared memory ID
wszFilename
[out] File to write shared memory data to.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A shared memory ID can be queried using “RtosGetIdByName”.
The macro RtosShmSaveFile can be used to call RtosShmSaveFileW if UNICODE is defined and RtosShmSaveFileA if not.

10.1.7 RTOS Library – date and time synchronization (clock synchronization)

10.1.7.1 RtosTimeSyncStart

Start the date and time synchronization.

UINT32 RtosTimeSyncStart (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
This function is called by default on
- Windows (by RtosService)
- Windows CE (by RtosService)
- VxWorks (by VxWin BSP)

On other OS the time and date synchronization is not running by default and the initial RTOS date and time value will have to be set to a reasonable initial value by the RTOS Board Support Package.
In the default configuration Windows is the master. Configuration is described in chapter “5.4 Time/Date and Timezone synchronization”.

10.1.7.2 RtosTimeSyncStop

Stop the date and time synchronization.

UINT32 RtosTimeSyncStop (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
–

10.1.8 RTOS Library – OS scheduling

When running in shared mode (Windows and the RTOS share one single processor core) by default the RTOS will always be executed with higher priority than Windows. Windows effectively runs as idle task of the RTOS.
RTOS should never run any other task on the same or a lower priority than the idle task because it might not get any CPU time.
In case the RTOS never enters its idle state this would lead to a situation where Windows never gets CPU time. Therefore it is possible to control OS scheduling manually, e.g. to force the RTOS to switch back to Windows.

10.1.8.1 RtosIdle

Regardless of the priority of the currently executing RTOS thread that calls *RtosIdle()*, this function forces the execution context to switch immediately to Windows. Should you have a task that monopolizes the CPU time, you can use this function to make certain that Windows receives additional CPU time. Upon the occurrence of the next real-time interrupt (e.g. from the real-time system timer), control will be returned to the real-time system.

VOID RtosIdle (VOID)

Parameter
–

Return
–

Comment
Before RTE version 5.0.00.02 / 4.5.00.20 / 4.1.01.13:

- If this function is called in exclusive mode it will return immediately.

Starting with RTE version 5.0.00.02 / 4.5.00.20 / 4.1.01.13:

- If this function is called in exclusive mode the processor will idle until next interrupt.

10.1.9 RTOS Library – notification events

The RTOS VM will notify the application about the occurrence of several events. If the RTOS application waits for such an event the RTOS VM will signal this event and wait until the RTOS application acknowledges that it has finished event handling.
For example, the RTOS application may wait for the STOP event, which will be signalled if the RTOS is stopped by the Windows Uploader tool. In that case the application may block stopping the RTOS until a safe state has been reached. After acknowledging this notification the RTOS will finally be stopped by the Windows Uploader tool.

Important:
RtosNotification : Only one single thread is allowed to wait for a specific event.
RtosNotificationEx : Multiple thread are allowed but the API is currently implemented for Windows only.

10.1.9.1 RtosNotificationWait

Wait for specific notification event.

UINT32 RtosNotificationWait (
UINT32 dwNotificationId
UINT32 dwTimeout)

Parameter
dwNotificationId
[in] Notification identifier. The following notification identifiers may be generated:

RTOS_NOTIFICATION_ID_BSOD	→ Windows BSOD
RTOS_NOTIFICATION_ID_SUSPEND	→ Windows Suspend
RTOS_NOTIFICATION_ID_RESUME	→ Windows Resume
RTOS_NOTIFICATION_ID_STOP	→ Uploader requests RTOS Stop

dwTimeout
[in] Timeout in milliseconds

Return
RTE_SUCCESS on success and an error-code on failure. If another thread called RtosNotificationBreakWait with the corresponding id then RTE_ERROR_BREAK_WAIT will be returned.

Comment
If this function is called the RTOS VM will notify the application about the corresponding event. The normal event handling in the RTOS VM will be blocked until the application calls the appropriate RtosNotificationDone() routine. For example if the application waits for the BSOD event then Windows will not enter its normal BSOD handling until RtosNotificationDone(RTOS_NOTIFICATION_ID_BSOD) is called.

10.1.9.2 RtosNotificationDone

Acknowledge event handling.

UINT32 RtosNotificationDone (
UINT32 dwNotificationId)

Parameter
dwNotificationId
[in] Notification identifier. The following notification identifiers exist:

RTOS_NOTIFICATION_ID_BSOD	→ Windows BSOD
RTOS_NOTIFICATION_ID_SUSPEND	→ Windows Suspend
RTOS_NOTIFICATION_ID_RESUME	→ Windows Resume
RTOS_NOTIFICATION_ID_STOP	→ Uploader requests RTOS Stop

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
Tell the RTOS VM that the corresponding event was processed by the application and the RTOS VM can continue its normal event handling.

10.1.9.3 RtosNotificationBreakWait

Continue the thread which is waiting for the specified event.

UINT32 RtosNotificationBreakWait (
UINT32 dwNotificationId)

Parameter
dwNotificationId
[in] Notification identifier. The following notification identifiers exist:

RTOS_NOTIFICATION_ID_BSOD	→ Windows BSOD
RTOS_NOTIFICATION_ID_SUSPEND	→ Windows Suspend
RTOS_NOTIFICATION_ID_RESUME	→ Windows Resume
RTOS_NOTIFICATION_ID_STOP	→ Uploader requests RTOS Stop

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
In case a thread is waiting for the given notification id it will immediately return to the application. The caller then will get a return value of RTE_ERROR_BREAK_WAIT.

10.1.9.4 BSOD handling example

```
DWORD dwRes;

dwRes = RtosNotificationWait(RTOS_NOTIFICATION_ID_BSOD, RTOS_WAIT_INFINITE);
if (dwRes == RTE_SUCCESS)
{
    // Handle the BSOD situation!
    // […]
    // Now enter normal BSOD handling (the RTOS will be stopped now)
    RtosNotificationDone(RTOS_NOTIFICATION_ID_BSOD);
}
```

10.1.9.5 RtosNotificationExCreate

Create a notification object to wait for specific notification(s).

UINT32 RtosNotificationExCreate (
UINT32 dwMaskWait,
RTOSLIB_HANDLE* phObject)

Parameter

dwMaskWait

[in] Mask of notifications to be notified. The following values exist (can be combined):

RTOSNOTIFICATION_MASK_VMFLOADED	→ VMF was loaded
RTOSNOTIFICATION_MASK_VMFUNLOAD	→ VMF will be unloaded
RTOSNOTIFICATION_MASK_VMFSUSPEND	→ VMF will be suspended
RTOSNOTIFICATION_MASK_VMFRESUMED	→ VMF was resumed
RTOSNOTIFICATION_MASK_OSSTARTED	→ OS was started
RTOSNOTIFICATION_MASK_OSSTOP	→ OS will be stopped
RTOSNOTIFICATION_MASK_OSSUSPEND	→ OS will be suspended
RTOSNOTIFICATION_MASK_OSRESUMED	→ OS was resumed
RTOSNOTIFICATION_MASK_OSBSOD	→ Windows BSOD

phObject

[out] Pointer to receive a RTOSLIB_HANDLE object (notification-ex).

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The returned handle can be used with the generic object functions.
From the moment the handle all notifications will be received and must be confirmed by calling RtosNotificationExWait() again or closing the handle.
Ther Uploader for example will be blocked if an application registered for VMF load notification but did not confirm the notification after it was notified.

10.1.9.6 RtosNotificationExWait

Wait for a notification.

UINT32 RtosNotificationExWait (
RTOSLIB_HANDLE hObject,
PRTOS_NOTIFICATION_INFO pInfo,
UINT32 dwTimeoutMs)

Parameter
hObject
[in] Notification handle
pInfo
[out] Pointer to a RTOS_NOTIFICATION_INFO structure. Its dwSize must be initialized to sizeof(RTOS_NOTIFICATION_INFO)
dwTimeoutMs
[in] Timeout in milliseconds

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The function will return on timeout or when a notification occurred.
After a notification occurred it must be confirmed by calling RtosNotificationExWait again or closing the handle so the process can continue.
For any OS specific notification (RTOSNOTIFICATION_MASK_OS…)
RTOS_NOTIFICATION_INFO.dwOsId contains the ID of the related OS.
Additionally should be pointet out that when VMF is being unloaded it is possible that RTOSNOTIFICATION_MASK_VMFUNLOAD is received before RTOSNOTIFICATION_MASK_OSSTOP!

10.1.9.1 RtosNotificationExBreakWait

This is a synonym for RtosObjectBreakWait. See RtosObjectBreakWait for details.

UINT32 RtosNotificationExBreakWait (
RTOSLIB_HANDLE hObject)

10.1.9.1 RtosNotificationExClose

This is a synonym for RtosObjectClose. See RtosObjectClose for details.

UINT32 RtosNotificationExClose (
RTOSLIB_HANDLE hObject)

10.1.10 RTOS Library – uploader API

These functions are provided only for the Windows version of the RTOS Library. It is related to starting and stopping the RTOS.

10.1.10.1 SetOutputBuffer

The Uploader tool will internally generate null-terminated ANSI-string messages. If the user application wants to get these messages it has to tell the Uploader where to store these messages.
If the message buffer is full no further messages will be stored (no wrap).

UINT32 SetOutputBuffer (
VOID* pvOutputBuffer,
UINT32 dwSize)

Parameter
pvOutputBuffer
[in] Pointer to the buffer where ANSI string messages shall be stored.
dwSize
[in] Size of the buffer.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
This function has been superseded by RtosSetOutputPrintf() to ensure synchronized output and solve buffer limitation problems.

10.1.10.2 RtosSetOutputPrintfA

The Uploader tool will internally generate messages. If the user application wants to get these messages it can register a printf - callback function.

UINT32 RtosSetOutputPrintfA(
RTOSLIB_PFN_PRINTF_A pfnPrintfA)

Parameter
pfnPrintfA
[in] Pointer to a ANSI printf callback function of type
INT32 (RTOSLIB_CALLCONV *RTOSLIB_PFN_PRINTF_A)(const CHAR *szFormat, ...);

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosSetOutputPrintf can be used to call RtosSetOutputPrintfW if UNICODE is defined and RtosSetOutputPrintfA if not.
The function does not require RtosLibInit to be called.

10.1.10.1 RtosSetOutputPrintfW

The Uploader tool will internally generate messages. If the user application wants to get these messages it can register a printf - callback function.

UINT32 RtosSetOutputPrintfW(
RTOSLIB_PFN_PRINTF_W pfnPrintfW)

Parameter
pfnPrintfW
[in] Pointer to a UNICODE printf callback function of type INT32 (RTOSLIB_CALLCONV *RTOSLIB_PFN_PRINTF_W)(const WCHAR *wszFormat, ...);

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosSetOutputPrintf can be used to call RtosSetOutputPrintfW if UNICODE is defined and RtosSetOutputPrintfA if not.
The function does not require RtosLibInit to be called.

10.1.10.2 RtosStartA

Upload and start the RTOS image.

UINT32 RtosStartA (
const CHAR* szImageName,
const CHAR* szConfigFile)

Parameter
szImageName
[in] Path and filename of the RTOS image file.
szConfigFile
[in] Path and filename of the RTOS configuration file. The RTOS started is described in section [Rtos].

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosStart can be used to call RtosStartW if UNICODE is defined and RtosStartA if not.
RtosStartA internally calls RtosStartExA(szImageName, szConfigFile, 0)
See RtosStartExA.

10.1.10.3 RtosStartW

Upload and start the RTOS image.

UINT32 RtosStartW (
const WCHAR* wszImageName,
const WCHAR* wszConfigFile)

Parameter

wszImageName
[in] Unicode path and filename of the RTOS image file.

wszConfigFile
[in] Unicode path and filename of the RTOS configuration file. The RTOS started is described in section [Rtos].

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The macro RtosStart can be used to call RtosStartW if UNICODE is defined and RtosStartA if not.
RtosStartW internally calls RtosStartExW(wszImageName, wszConfigFile, 0)
See RtosStartExA.

10.1.10.4 RtosStartExA

Upload and start the RTOS image.

UINT32 RtosStartExA (
const CHAR* szImageName,
const CHAR* szConfigFile,
UINT32 dwOsId)

Parameter

szImageName
[in] Path and filename of the RTOS image file.

szConfigFile
[in] Path and filename of the RTOS configuration file.

dwOsId
[in] OS ID of the RTOS to be started. Depending on the ID the RTOS started is described in section:
0: [Rtos]
1: [Rtos1]
2: [Rtos2]
…

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The Uploader tool acts as the RTOS bootloader. It can handle different situations:

1) Load VMF and start a RTOS
   Call using szImageName, szConfigFile, dwOsId.
   This will stop any running RTOS, unload the VMF, load VMF again with values from szConfigFile and start RTOS szImageName.
2) Load VMF but start no RTOS
   Call using szConfigFile (szImageName=NULL, dwOsId will be ignored).
   This will stop any running RTOS, unload the VMF and load VMF again with values from szConfigFile but not start any RTOS.
3) Do not load VMF but start RTOS
   Call using szImageName, dwOsId (szConfigFile=NULL).
   This will start or restart the RTOS with the given dwOsId but not load or reload th VMF.
   This function will fail if no VMF is loaded (1 or 2 was not called before).

Start RTOS means this function will copy the RTOS image file into a memory area not used by Windows and then call the boot entry point of the RTOS.
The macro RtosStartEx can be used to call RtosStartExW if UNICODE is defined and RtosStartExA if not.

The config file string has the format "'f1' <options>".

- 'f1' use this file as config file

Possible options are:

- /vmf 'f2' use f2 as VMF binary (default is vmf.bin)

For example "'c:\MyOs.config' /vmf 'c:\MyVmf.bin'" uses the configuration file "c:\MyOs.config" and the VMF binary "c:\MyVmf.bin".

Load VMF and start OS:

- RtosStartExA("c:\MyOs.bin", "'c:\MyOs.config' /vmf 'c:\MyVmf.bin'", 0);
- RtosStartExA("c:\MyOs.bin", "c:\MyOs.config", 0);

Load VMF but do not start OS:

- RtosStartExA(NULL, "'c:\MyOs.config' /vmf 'c:\MyVmf.bin'", 0);
- RtosStartExA(NULL, "c:\MyOs.config", 0);

Start OS (VMF must already be loaded):

- RtosStartExA("c:\MyOs.bin", NULL, 0);

Remarks:

- Pay attention to the single and double quotation marks!
- On a 64bit system using Windows 8 or newer only a 64bit application can call this function!

10.1.10.5 RtosStartExW

Upload and start the RTOS image.

UINT32 RtosStartExW (
const WCHAR* wszImageName,
const WCHAR* wszConfigFile,
UINT32 dwOsId)

Parameter
wszImageName
[in] Unicode path and filename of the RTOS image file.
wszConfigFile
[in] Unicode path and filename of the RTOS configuration file.
dwOsId
[in] OS ID of the RTOS to be started. Depending on the ID the RTOS started is described in section:
0: [Rtos]
1: [Rtos1]
2: [Rtos2]
…

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
See RtosStartExA()
The macro RtosStartEx can be used to call RtosStartExW if UNICODE is defined and RtosStartExA if not.

10.1.10.6 RtosStop

Stop all RTOS operation and unload the VMF.

UINT32 RtosStop (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
All RTOS will be stopped and VMF will be unloaded.

10.1.10.7 RtosStopEx

Stop the RTOS operation without unloading the VMF.

UINT32 RtosStopEx (
UINT32 dwOsId)

Parameter
dwOsId
[in] OS ID of the RTOS to be stopped.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The RTOS will be stopped but VMF will not be unloaded.

10.1.10.8 RtosRunning

Determine if the RTOS is running.

BOOL RtosRunning (VOID)

Parameter
–

Return
TRUE if the RTOS is running, FALSE if not.

Comment
This function will return the state of RTOS with OsId 0 only.

10.1.10.9 RtosRunningEx

Determine if the RTOS is running.

UINT32 RtosRunningEx (
UINT32 dwOsId
BOOL *pbIsRunning)

Parameter
dwOsId
[in] OS ID of the RTOS to be queried.
pbIsRunning
[out] contains TRUE if the RTOS is running, FALSE if not.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
–

10.1.10.10 RtosVmfIsLoaded

Determine if the VMF is loaded.

UINT32 RtosVmfIsLoaded (VOID)

Parameter
–

Return
RTE_SUCCESS if VMF is loaded.
RTE_ERROR_VMF_NOTREADY if VMF is not loaded.

Comment
–

10.1.10.11 RtosVmIsMapped

Determine if memory is mapped into a VM.

UINT32 RtosVmIsMapped (VOID)

Parameter
–

Return
RTE_SUCCESS if no memory is mapped.
RTE_ERROR_VM_MAPPED if memory is mapped.

Comment
–

10.1.11 RTOS Library – result value

10.1.11.1 RtosResultGetTextA

Get a message text for a result value.

UINT32 RtosResultGetTextA (
UINT32 dwResult,
CHAR* szText,
UINT32* pdwSizeInBytes)

Parameter
dwRteResult
[in] Result value to query text for
szText
[out] String buffer to receive the result message text
pdwSizeInBytes
[in] Length of string buffer in bytes
[out] Number of bytes used for message text

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A text for a result value can be queried using “RtosResultGetText”.
The macro RtosResultGetText can be used to call RtosResultGetTextW if UNICODE is defined and RtosResultGetTextA if not.
The function does not require RtosLibInit to be called.

10.1.11.2 RtosResultGetTextW

Get a message text for a result value.

UINT32 RtosResultGetTextW (
UINT32 dwResult,
WCHAR* wszText,
UINT32* pdwSizeInBytes)

Parameter
dwRteResult
[in] Result value to query text for
wszText
[out] String buffer to receive the result message text
pdwSizeInBytes
[in] Length of string buffer in bytes
[out] Number of bytes used for message text

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A text for a result value can be queried using “RtosResultGetText”.
The macro RtosResultGetText can be used to call RtosResultGetTextW if UNICODE is defined and RtosResultGetTextA if not.
The function does not require RtosLibInit to be called.

10.1.11.3 RtosResultGetModuleA

Get a module name for a result value.

UINT32 RtosResultGetModuleA (
UINT32 dwResult,
CHAR* szText,
UINT32* pdwSizeInBytes)

Parameter
dwRteResult
[in] Result value to query module name for
szText
[out] String buffer to receive the result module name
pdwSizeInBytes
[in] Length of string buffer in bytes
[out] Number of bytes used for module name

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A module name for a result value can be queried using “RtosResultGetModule”.
The macro RtosResultGetModule can be used to call RtosResultGetModuleW if UNICODE is defined and RtosResultGetModuleA if not.
The function does not require RtosLibInit to be called.

10.1.11.4 RtosResultGetModuleW

Get a module name for a result value.

UINT32 RtosResultGetModuleW (
UINT32 dwResult,
WCHAR* wszText,
UINT32* pdwSizeInBytes)

Parameter
dwRteResult
[in] Result value to query text for
wszText
[out] String buffer to receive the result module name
pdwSizeInBytes
[in] Length of string buffer in bytes
[out] Number of bytes used for module name

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A module name for a result value can be queried using “RtosResultGetModule”.
The macro RtosResultGetModule can be used to call RtosResultGetModuleW if UNICODE is defined and RtosResultGetModuleA if not.
The function does not require RtosLibInit to be called.

10.1.12 RTOS Library – licensing

The main licensing functionality is only supported through the Windows part of the RTOS Library. On the real-time parts of the RTOS Library some of these routines are not implemented.

10.1.12.1 RtosLicense

Setting, getting and removing of a license will be handled through this routine.

UINT32 RtosLicense (
UINT32 dwAction
VOID* pvData
UINT32* pdwSizeInBytes)

Parameter
dwAction
[in] License action identifier. See comment for details.
pvData
[in] Supplied data (LicenseID) for a specific “set” action
[out] Requested data by specific “get” action
→ NULL if action = remove license
pdwSizeInBytes
[in] Size of supplied data for a specific “set” action
[out] Size of requested data for a specific “get” action
→ NULL if action = remove license

Return
RTE_SUCCESS on success and an error-code on failure. Calling this routine on the real-time part of the RTOS Library, a RTE_ERROR_NOT_IMPL will be returned.

Comment
This function performs actions for setting, getting and removing of a license.

dwAction	pvData	Description
RTOS_LICENSE_ACTION_SET_A	[IN] License string	Set license
RTOS_LICENSE_ACTION_SET_W	[IN] License string	As before, but UNICODE instead of ANSI
RTOS_LICENSE_ACTION_REMOVE	-	Remove license
RTOS_LICENSE_ACTION_GET_A	[OUT] License string	Get license
RTOS_LICENSE_ACTION_GET_W	[OUT] License string	As before, but UNICODE instead of ANSI
RTOS_LICENSE_ACTION_REQUESTFILE_A	[IN, OPT] Filename	Write request file
RTOS_LICENSE_ACTION_REQUESTFILE_W	[IN, OPT] Filename	As before, but UNICODE instead of ANSI
RTOS_LICENSE_ACTION_SETFILE_A	[IN] Filename	Read license from file
RTOS_LICENSE_ACTION_SETFILE_W	[IN] Filename	As before, but UNICODE instead of ANSI
RTOS_LICENSE_ACTION_GETFILE_A	[IN, OPT] Filename	Write license to file
RTOS_LICENSE_ACTION_GETFILE_W	[IN, OPT] Filename	As before, but UNICODE instead of ANSI
RTOS_LICENSE_ACTION_PARSE_A	[IN] Command + CmdData [OUT] see other [OUT]	Parse data for action and its params Actions: /set, /remove, /get, /requestfile, …
RTOS_LICENSE_ACTION_PARSE_W	[IN] Command + CmdData [OUT] see other [OUT]	As before, but UNICODE instead of ANSI

Notes:
1) If parameter 2 is NULL parameter 3 must also be NULL - otherwise an error will be returned!
2) If not enough memory is supplied for the “get” action only a part of the license ID might be returned!
3) When using the “parse” action for “/get” the input buffer will also be used for the output. This requires the buffer size to be the maximum of input and output.
4) The RtosLicense parse action can be addressed using the Uploader parameter “/lic”.
Examples:
- RtosUpload.exe /lic "/requestfile 'C:\MyFile.HwIdReq'"
- RtosUpload.exe /lic "/setfile 'C:\MyFile.HwIdLic'"

10.1.13 RTOS Library – file server

Please check chapter 10.1.14 “RTOS Library – files” for configuration and further details.

10.1.13.1 RtosFileServerStart

Start the file server for remote file handling.

UINT32 RtosFileServerStart (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
This function is called by default on
- Windows (by RtosService)

RtosFileServer is currently only supported by Windows.

10.1.13.2 RtosFileServerStop

Stop the file server for remote file handling.

UINT32 RtosFileServerStop (VOID)

Parameter
–

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
This function is called by default on
- Windows (by RtosService)

RtosFileServer is currently only supported by Windows.

10.1.14 RTOS Library – files

The RtosLib supports file handling routines to access files on all supported platforms in a uniform way. The RtosLib files can operate in 2 different modes. The default mode accesses the files remotely on the file system of the Windows OS with a file server module of RtosService.

HINT: On CE or RTOS-32 platforms using the new native file system drivers should fits on the most cases and direct access to the RtosFile-API should not be needed.

In the other case the files are supplied via shared memory and acts mainly like memory-mapped files. This so-called SHM-mode has some restrictions which are discussed below.

SHM File Mode: To access a file through a shared memory, the file name path must contain the prefix **//SHM/**<FILENAME>.
The file name must correspond to the shared memory name (**case-sensitive!**)

Example:
SHM-Name: `TestFileXyZ.txt`
SHM-FileName: `//SHM/TestFileXyZ.txt`

A corresponding shared memory must be defined in the config file. The memory can be initialized with zeros, without anything or with an existing file from the file system on Windows. For further details about shared memories prepared for file handling please look at chapter 5.7 Multi Purpose Shared Memory.

Example:
```
[SharedMemory\TestFileXyZ.txt]
    "Name"="TestFileXyZ.txt"
    "Description"="TestFile for SHM file access"
    "Size"=dword:0
    "File"="C:\Temp\TestFileForShmAccess.txt"
    "Initialize"=dword:2
    "Save"=dword:1
    "AccessDefault"=dword:1
[SharedMemory\TestFileXyZ.txt\AccessModes]
```

Limitations: The SHM file depends on a shared memory; therefore it's not possible to increase the size of a SHM file.
The initial size of the shared memory is the maximum possible file size!
Due to technical reasons it’s not possible to rename or remove a SHM file with the RtosFile API!

Remote File Mode: Accessing a file remote is realized by the file server module of RtosService. The default operation directory of the file server is **%RTE_ROOT%\RtFiles**. If not yet available, it will be created at startup. All file operations are restricted to this directory and its subdirs by default.

The config file settings regarding the file server are OS specific and have to be made in an OS section like [Host\FileServer] or [Rtos\FileServer]. Only a file server under Windows is supported at moment!

Entry Name	Type	Description
MaxOpenFiles	dword	Number of concurrently possible open RtosFiles. Default = 10.
HomeDir	string	The home directory of the file server. If no path is specified for a file, all file operations will go to this directory. If directory doesn’t exsist, it will be created at first access. Default: "%RTE_ROOT%\RtFiles"
RestrictedToHomeDir	dword	This value restricts the access of the file server to its home directory and its subdirs. Every file access outlying the home directory will return an error. Default: TRUE

Entry Name	Type	Description
TaskPriority	dword	This defines the task priority for the fileserver threads. The values are OS specific. The delivered config file contains OS specific information about lowest and highest possible priority. If the entry does not exist then the OS uses an OS specific priority compatible to older versions.
TaskEnabled	dword	0 Task will not be started 1 Task will be started omitted = 1 = Task will be started
SuppressAccessDeniedMsg	dword	0 'AccessDenied' message will be shown 1 Message will be suppressed omitted = 0 = Message will be shown
LogLevel	dword	0 No (internal) log messages of the file server will be logged. 1 Internal log messages of file server will be logged at the Windows event log. omitted = 0 = no log messages will be logged

Limitations: Currently 10 simultaneously open remote files are supported. This value could be adjusted with corresponding entry MaxOpenFiles in config file. See above table.
Scan functionality is currently not available for remote files.

Caution: The file handles of RtosFile 6.0 API and RtosFile 6.1 API could not be mixed generally, if not stated otherwise.
Generic functions like RtosFileClose, RtosFileRead, RtosFileWrite, etc can operate on various kinds of handles.

Ways of accessing the file API:

For easier access to the RtosFile API, 3 different ways are supported. For some RTOS's (CE- or RTOS-32-based) we provide native file system driver, which will call the appropriate RtosFile functions and second calling the RtosFile API directly or as (partly deprecated) third method through supplied rtosstdio.h.

On CE- or RTOS-32-based products the default case is using the supplied native file system drivers, which will hide the complete RtosFile-API and native fopen() or CreateFile() calls can be used.

The following rtosstdio.h example should be considered deprecated (on CE- and RTOS-32-based projects) and should be only used for legacy reasons on these platforms.
Porting to native stdio.h on these platforms should be possible without much hassle.

The rtosstdio.h remaps default stdio calls like fopen() to the native RtosFile API. To use the remapping functionality of rtosstdio.h the include file must be added into the source file as the last include.

Minimal example:
```
// other includes...
// #include ...

// last include:
#include <rtosstdio.h>

int main(int argc, char *argv[])
{
  FILE* hFile = NULL;

  RtosLibInit();

  // Create file handle
  hFile = fopen( "//SHM/TestFile.txt", "rw" );
  if( NULL == hFile )
```

```
  {
    // error
  }

  ...

  if( NULL != hFile )
  {
    if( fclose( hFile ) != 0 )
    {
      // error
    }
  }

  RtosLibDeinit();

  return 0;
}
```

The following functions are supported:

```
fopen(); fclose();
fwrite(); fread(); fputs(); fgets(); fputc(); fgetc(); getc(); putc();
fflush(); feof(); rewind(); fseek(); fsetpos(); fgetpos(); ftell();
ferror(); clearerr();
setbuf(); setvbuf();
fprintf(); vfprintf();
fscanf(); vfscanf();
```

Supported only by remote file mode (**not** available in SHM mode)

```
tmpfile(); remove(); rename();
```

The following functions are **NOT** supported:

```
freopen(); ungetc(); tmpnam();
```

For Debugging and/or Logging purposes the `rtosstdio.h` exposes the underlying returned error code through a global error variable:

```
/* To be used in code to determine the underling RTE_ERROR if the function
call fails. */
extern UINT32 rte_errno = RTE_SUCCESS;
```

10.1.14.1 RtosFileCreateA

This is the main function to open an existing file or create a new file. Both remote files as well as SHM files are supported.

UINT32 RtosFileCreateA (
const CHAR* szName,
const CHAR* szOptions,
RTOSLIB_HANDLE* phFileCreate)

Parameter
szName
[in] Name of the file
szOptions
[in] File create options. See comment.
phFileCreate
[out] Pointer to receive a RTOSLIB_HANDLE object (file).

Return
RTE_SUCCESS on success and an error-code on failure.

Comment

"r"	**read:** Open file for read operations. The file must exist.
"w"	**write:** Create an empty file for write operations. If the file yet exists, its contents will be discarded and the file is used like a fresh new file.
"a"	**append:** Open the file for write operations at the end of file, expanding it. Reposition operations (RtosFileSeek, RtosFileRewind, etc) are ignored. If the file doesn't exist, it will be created.
"r+"	**read/update:** Open file for read/write operations. The file must exist.
"w+"	**write/update:** Create an empty file for read/write operations. If the file yet exists, its contents will be discarded and the file is used like a fresh new file.
"a+"	**append/update:** Open the file for read/write operations with write operations at the end of the file, expanding it. Reposition operations (RtosFileSeek, RtosFileRewind, etc) affects only the following read operations, but write operations move the position back to the end of file. If the file doesn't exist, it will be created.
"b"	**binary:** File should be open as binary file.
"t"	**text:** File should be open as text file.

The first character of the option string must be either "r", "w" or "a". The next and further character could be one of the optional "b" or "t" or sign "+" with resulting compound modes: "rb", "rt", "wb", "wt", "ab", "at" and "r+b", "r+t", "w+b", "w+t", "a+b", "a+t" or "rb+", "rt+", "wb+", "wt+", "ab+", "at".

With errors in format string the function will fail with `RTE_ERROR_FILE_INVALID_CREATE_OPTS (0x4461)`.

The macro RtosFileCreate can be used to call RtosFileCreateW if UNICODE is defined and RtosFileCreateA if not.

10.1.14.2 RtosFileCreateW

See RtosFileCreateA

UINT32 RtosFileCreateW (
const WCHAR* wszName,
const WCHAR* wszOptions,
RTOSLIB_HANDLE* phFileCreate)

10.1.14.3 RtosFileClose

This is a synonym for RtosObjectClose. See RtosObjectClose for details.

```
UINT32 RtosFileClose (
    RTOSLIB_HANDLE          hObject )
```

10.1.14.4 RtosFileRead

This is a synonym for RtosObjectRead. See RtosObjectRead for details.

```
UINT32 RtosFileRead(
    RTOSLIB_HANDLE          hObject,
    UINT8                   *pBuffer,
    UINT32                  dwBufferSize,
    UINT32                  *pdwBytesRead,
    UINT32                  dwTimeoutMs )
```

10.1.14.5 RtosFileWrite

This is a synonym for RtosObjectWrite. See RtosObjectWrite for details.

```
UINT32 RtosFileWrite(
    RTOSLIB_HANDLE          hObject,
    const UINT8             *pBuffer,
    UINT32                  dwBufferSize,
    UINT32                  *pdwBytesWritten,
    UINT32                  dwTimeoutMs )
```

10.1.14.6 RtosFileReadStrA

This function read “string” data into an ANSI string.

```
UINT32 RtosFileReadStrA(
    RTOSLIB_HANDLE          hFileCreate,
    CHAR                    *szStr,
    UINT32                  dwNum,
    UINT32                  *pdwNumOfCharRead )
```

Parameter

hFileCreate
[in] Object handle returned from RtosFileCreate()

szStr
[out] String buffer to receive the data read

dwNum
[in] Length of string buffer in characters

pdwNumOfCharRead
[out] Number of characters read into the string buffer

Return

RTE_SUCCESS on success and an error-code on failure.

If the return value is RTE_SUCCESS but *pdwNumOfCharRead returned zero, then the stream should be checked for eof. In that case the szStr remains unchainged.

Comment

If there is no data to be read the function will return and the *pdwNumOfCharRead will contain zero.

If data was read the function will return as soon as (dwNum-1) characters have been read or either a newline or the end-of-file is reached or the read string buffer is full, whichever happens first.

A newline character is considered as a valid character and is included into the returned string.

A terminating null character is appended automatically.

10.1.14.7 RtosFileReadStrW

See RtosFileReadStrA.

```
UINT32 RtosFileReadStrW(
    RTOSLIB_HANDLE      hFileCreate,
    WCHAR               *wszStr,
    UINT32              dwNum,
    UINT32              *pdwNumOfCharRead )
```

10.1.14.8 RtosFileFlush

This function performs a flush on the remote file.

```
UINT32 RtosFileFlush (
    RTOSLIB_HANDLE      hFile )
```

Parameter

hFile

[in] Object handle returned from RtosFileCreate() or RtosFileCreateEx()

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

This function is only supported on the remote file mode. It performs a flush on the real file at the file server.

10.1.14.9 RtosFileEof

This function returns either the RTOSFILE_EOF indicator, if end of file is reached or otherwise 0.

UINT32 RtosFileEof (
RTOSLIB_HANDLE hFileCreate,
INT32* pnEof)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()
pnEof
[out] Pointer to receive the RTOSFILE_EOF indicator.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
Check returned *pnEof value with define RTOSFILE_EOF to indicate, if EoF is reached.

10.1.14.10 RtosFileRewind

This function performs a rewind at the file. It sets the position indicator of the file to the beginning.

UINT32 RtosFileRewind (
RTOSLIB_HANDLE hFileCreate)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.14.11 RtosFileSeek

This function returns either the RTOSFILE_EOF indicator, if end of file is reached or otherwise 0.

UINT32 RtosFileSeek (
RTOSLIB_HANDLE hFileCreate,
INT64 qnOffset,
INT32 nOrigin)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()
qnOffset
[in] Sets the position indicator relative to this offset from origin parameter.
nOrigin
[in] Defines the origin for the offset. Valid values see comment.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment

Origin ID	Description
RTOSFILE_SEEK_SET	Sets the position indicator to the beginning of the file. If qnOffset has a positive value, the position indicator will be set to this offset from the beginning.
RTOSFILE_SEEK_CUR	Uses the qnOffset parameter to move position indicator from current position of the offset value.
RTOSFILE_SEEK_END	Sets the position indicator to the end of the file. The end of file means after the last char. In **SHM file mode**, this means, that the position indicator is beyond the valid memory range! If qnOffset has a negative value, the position indicator will be set to this offset from the end of file towards to the beginning.

10.1.14.12 RtosFileGetPos

This function returns the current position in file.

UINT32 RtosFileGetPos (
RTOSLIB_HANDLE hFileCreate,
INT64* pqnPos)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()
pqnPos
[out] Pointer to receive the current position indicator.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.14.13 RtosFileSetPos

This function sets the current position in file.

UINT32 RtosFileSetPos (
RTOSLIB_HANDLE hFileCreate,
INT64 qnPos)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()
qnPos
[in] Desired value of position indicator.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.14.14 RtosFileSize

This function returns the current size of file.

UINT32 RtosFileSize (
RTOSLIB_HANDLE hFile,
UINT64* pqwSize)

Parameter
hFile
[in] Object handle returned from RtosFileCreate() or RtosFileCreateEx()
pqwSize
[out] Pointer to receive the current file size.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.14.15 RtosFileError

This function returns the current error indicator of file.

UINT32 RtosFileError (
RTOSLIB_HANDLE hFileCreate,
INT64* pqnError)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()
pqnError
[out] Pointer to receive the current error indicator.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.14.16 RtosFileClearError

This function performs resets to both the error and the eof indicator of the file.

UINT32 RtosFileClearError (
RTOSLIB_HANDLE hFileCreate)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.14.17 RtosFileCreateTmpfile

Creates a temporary binary file with a filename guaranteed to be different from any other existing file.

UINT32 RtosFileCreateTmpfile (
RTOSLIB_HANDLE* phFileCreate)

Parameter
phFileCreate
[out] Pointer for receive a RTOSLIB_HANDLE object (file) of a temporary file.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment

This function is not supported on SHM file mode!
Closing this file handle with RtosFileClose() will delete the temporary file automatically.

10.1.14.18 RtosFileRemoveA

Removes a file with the specified name.

UINT32 RtosFileRemoveA (
const CHAR* szName)

Parameter
szName
[in] Name of the file to be removed

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosFileRemove can be used to call RtosFileRemoveW if UNICODE is defined and RtosFileRemoveA if not.
This function is not supported on SHM file mode!

10.1.14.19 RtosFileRemoveW

See RtosFileRemoveA

UINT32 RtosFileRemoveW (
const WCHAR* wszName)

10.1.14.20 RtosFileRenameA

Rename a file with the specified name.

UINT32 RtosFileRenameA (
const CHAR* szOldName,
const CHAR* szNewName)

Parameter
szOldName
[in] Name of the file to be renamed
szNewName
[in] New name of the file

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosFileRename can be used to call RtosFileRenameW if UNICODE is defined and RtosFileRenameA if not.
This function is not supported on SHM file mode!

10.1.14.21 RtosFileRenameW

See RtosFileRenameA

UINT32 RtosFileRenameW (
const WCHAR* wszOldName,
const WCHAR* wszNewName)

10.1.14.22 RtosFileSetBuffer

This function sets a local buffer to the file. At moment not supported.

```
UINT32 RtosFileSetBuffer (
    RTOSLIB_HANDLE          hFileCreate,
    const UINT8*            pBuffer,
    UINT64                  qwBufferSize
    INT32                   nMode )
```

Parameter

hFileCreate
[in] Object handle returned from RtosFileCreate()

pBuffer
[in] Pointer to buffer to be set.

qwBufferSize
[in] Size of the supplied buffer.

nOrigin
[in] Operation mode. Currently don't care.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

This function is currently not supported. It will remember the buffer, but no further action will be taken.

10.1.14.23 RtosFilePrintfA

Works sililar to the classic fprinf() function.

```
UINT32 RtosFilePrintfA (
    RTOSLIB_HANDLE          hFile,
    CHAR*                   szFormat,
    UINT64*                 pqwCharsWitten,
    ... )
```

Parameter

hFile
[in] Object handle returned from RtosFileCreate() or RtosFileCreateEx()

szFormat
[in] Format string. All Visual C fprintf() format sequences are supported.

pqwCharsWritten
[out] Pointer to receive how many chars was written.

...
[in] 0..n additional parameter for the format entries.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

This function is comparable with the ANSI fprintf() function.
The macro RtosFilePrintf can be used to call RtosFilePrintfW if UNICODE is defined and RtosFilePrintfA if not.

10.1.14.24 RtosFilePrintfW

See RtosFilePrintfA

```
UINT32 RtosFilePrintfW (
    RTOSLIB_HANDLE          hFile,
    WCHAR*                  wszFormat,
    UINT64*                 pqwCharsWritten,
    ... )
```

10.1.14.25 RtosFileVPrintfA

This function is similar to RtosFilePrintfA . The main difference is the last parameter. This function expects the parameters for the format string as a va_list. . For futher details see RtosFilePrintfA.

```
UINT32 RtosFileVPrintfA (
    RTOSLIB_HANDLE          hFile,
    CHAR*                   szFormat,
    UINT64*                 pqwCharsWritten,
    va_list                 vaList )
```

10.1.14.26 RtosFileVPrintfW

See RtosFileVPrintfA.

```
UINT32 RtosFileVPrintfW (
    RTOSLIB_HANDLE          hFile,
    WCHAR*                  wszFormat,
    UINT64*                 pqwCharsWritten,
    va_list                 vaList )
```

10.1.14.27 RtosFileScanfA

Works sililar to the classic fscanf() function.

UINT32 RtosFileScanfA (
RTOSLIB_HANDLE hFileCreate,
CHAR* szFormat,
UINT64* pqwItemsRead,
...)

Parameter
hFileCreate
[in] Object handle returned from RtosFileCreate()
szFormat
[in] Format string. All Visual C fscanf() format sequences are supported.
pqwItemsRead
[out] Pointer to receive how many items could be read.
...
[in/out] 0..n additional parameter for the format entries.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
This function is comparable with the ANSI fscanf() function.

The macro RtosFileScanf can be used to call RtosFileScanfW if UNICODE is defined and RtosFileScanfA if not.
Important: This function is currently **not** supported on remote files!
In SHM file mode are up to 20 items supported.

10.1.14.28 RtosFileScanfW

See RtosFileScanfA

UINT32 RtosFileScanfW (
RTOSLIB_HANDLE hFileCreate,
WCHAR* wszFormat,
UINT64* pqwItemsRead,
...)

10.1.14.29 RtosFileVScanfA

This function is similar to RtosFileScanfA . The main difference is the last parameter. This function expects the parameters for the format string as a va_list. . For futher details see RtosFileScanfA.

UINT32 RtosFileVScanfA (
RTOSLIB_HANDLE hFileCreate,
CHAR* szFormat,
UINT64* pqwItemsRead,
va_list vaList)

10.1.14.30 RtosFileVScanfW

See RtosFileVScanfA.

```
UINT32 RtosFileVScanfW (
    RTOSLIB_HANDLE      hFileCreate,
    WCHAR*              wszFormat,
    UINT64*             pqwItemsRead,
    va_list             vaList )
```

10.1.14.31 RtosFileOptionSet

This is a synonym for RtosObjectOptionSet. See RtosObjectOptionSet for details.

```
UINT32 RtosFileOptionSet (
    RTOSLIB_HANDLE      hObject,
    UINT32              dwOptionId,
    const UINT8         *pBuffer,
    UINT32              dwBufferSize )
```

10.1.14.32 RtosFileOptionGet

This is a synonym for RtosObjectOptionGet. See RtosObjectOptionGet for details.

```
UINT32 RtosFileOptionGet (
    RTOSLIB_HANDLE      hObject,
    UINT32              dwOptionId,
    const UINT8         *pBuffer,
    UINT32              dwBufferSize )
```

10.1.15 RTOS Library – files advanced (6.1)

The new file functions from RtE 6.1 on uses the Windows CreateFile()-API on the file server side. Therefore the returned handles are generally not compatible with RtE 6.0 file handles (fopen()-based) and could not be mixed, if not stated otherwise.
Generic functions like Close, Read, Write, etc applies to all kind of handles.

General rule: the name of the handle suggests, which handle are allowed.
See following table:

Parameter Name	Allowed Handles
hObject	All handle types allowed
hFile	hFileCreate or hFileCreateEx handles allowed
hFileCreate	Only hFileCreate handles allowed
hFileCreateEx	Only hFileCreateEx handles allowed
hFind	Only hFind handles allowed

Hint: As most of the following functions have equivalent Windows function calls on the file server side, the main limitation of these native Windows calls applies also to these functions. Please see the functional equivalent function descriptions at the MSDN.

10.1.15.1 RtosFileCreateExA

This is the main function to open an existing file or create a new file. SHM files are NOT supported.

```
UINT32 RtosFileCreateExA (
    const CHAR*                 szFileName,
    UINT32                      dwDesiredAccess,
    UINT32                      dwShareMode,
    PRTOS_SECURITY_ATTRIBUTES   lpSecurityAttributes,
    UINT32                      dwCreationDisposition,
    UINT32                      dwFlagsAndAttributes,
    RTOSLIB_HANDLE              hTemplateFile,
    RTOSLIB_HANDLE*             phFileCreateEx )
```

Parameter

szFileName
[in] Name of the file
dwDesiredAccess
[in] Desired access mode. See comment.
dwShareMode
[in] Shared mode. See comment.
lpSecurityAttributes
[in] Currently only NULL is supported/accepted.
dwCreationDisposition
[in] Creation Disposition. See comment.
dwFlagsAndAttributes
[in] File create flags and attributes. See comment.
hTemplateFile
[in] Currently only NULL is supported/accepted.
phFileCreateEx
[out] Pointer to receive a RTOSLIB_HANDLE object (file).

Return
RTE_SUCCESS on success and an error-code on failure.

Comment

Desired access modes:

Value	Meaning
`RTOSFILE_GENERIC_READ (0x80000000L)`	Read access

RTOSFILE_GENERIC_WRITE (0x40000000L)	Write access
RTOSFILE_GENERIC_EXECUTE (0x20000000L)	Execute access
RTOSFILE_GENERIC_ALL (0x10000000L)	All possible access rights

The most commonly used values are RTOSFILE_GENERIC_READ, RTOSFILE_GENERIC_WRITE, or both (RTOSFILE_GENERIC_READ | RTOSFILE_GENERIC_WRITE).

File shared mode:

Value	Meaning
0 (0x00000000)	Prevents other processes from opening a file or device if they request delete, read, or write access.
RTOSFILE_SHARE_READ (0x00000001)	Enables subsequent open operations on a file or device to request read access.
RTOSFILE_SHARE_WRITE (0x00000002)	Enables subsequent open operations on a file or device to request write access.
RTOSFILE_SHARE_DELETE (0x00000004)	Enables subsequent open operations on a file or device to request delete access.

File attributes:

Value	Meaning
RTOSFILE_ATTRIBUTE_READONLY (0x00000001)	The file is read only. Applications can read the file, but cannot write to or delete it.
RTOSFILE_ATTRIBUTE_HIDDEN (0x00000002)	The file is hidden. Do not include it in an ordinary directory listing.
RTOSFILE_ATTRIBUTE_SYSTEM (0x00000004)	The file is part of or used exclusively by an operating system.
RTOSFILE_ATTRIBUTE_DIRECTORY (0x00000010)	The handle that identifies a directory.
RTOSFILE_ATTRIBUTE_ARCHIVE (0x00000020)	The file should be archived. Applications use this attribute to mark files for backup or removal.
RTOSFILE_ATTRIBUTE_DEVICE (0x00000040)	This value is reserved for system use.
RTOSFILE_ATTRIBUTE_NORMAL (0x00000080)	The file does not have other attributes set. This attribute is valid only if used alone.
RTOSFILE_ATTRIBUTE_TEMPORARY (0x00000100)	The file is being used for temporary storage.
RTOSFILE_ATTRIBUTE_SPARSE_FILE (0x00000200)	A file that is a sparse file.
RTOSFILE_ATTRIBUTE_REPARSE_POINT (0x00000400)	A file or directory that has an associated reparse point, or a file that is a symbolic link.
RTOSFILE_ATTRIBUTE_COMPRESSED (0x00000800)	A file or directory that is compressed.
RTOSFILE_ATTRIBUTE_OFFLINE (0x00001000)	The data of a file is not immediately available.
RTOSFILE_ATTRIBUTE_NOT_CONTENT_INDEXED (0x00002000)	The file or directory is not to be indexed by the content indexing service.
RTOSFILE_ATTRIBUTE_ENCRYPTED (0x00004000)	The file or directory is encrypted.
RTOSFILE_ATTRIBUTE_VIRTUAL (0x00010000)	This value is reserved for system use.

File flags:

Value	Meaning
RTOSFILE_FLAG_WRITE_THROUGH (0x80000000)	Write operations will not go through any intermediate cache; they will go directly to disk.
RTOSFILE_FLAG_NO_BUFFERING (0x20000000)	The file or device is being opened with no system caching for data reads and writes.

RTOSFILE_FLAG_RANDOM_ACCESS (0x10000000)	Access is intended to be random. The system can use this as a hint to optimize file caching.
RTOSFILE_FLAG_SEQUENTIAL_SCAN (0x08000000)	Access is intended to be sequential from beginning to end. The system can use this as a hint to optimize file caching.
RTOSFILE_FLAG_DELETE_ON_CLOSE (0x04000000)	The file is to be deleted immediately after all of its handles are closed, which includes the specified handle and any other open or duplicated handles.
RTOSFILE_FLAG_BACKUP_SEMANTICS (0x02000000)	The file is being opened or created for a backup or restore operation.
RTOSFILE_FLAG_POSIX_SEMANTICS (0x01000000)	Access will occur according to POSIX rules.
RTOSFILE_FLAG_SESSION_AWARE (0x00800000)	The file or device is being opened with session awareness.
RTOSFILE_FLAG_OPEN_REPARSE_POINT (0x00200000)	Normal reparse point processing will not occur; RtosFileCreateEx will attempt to open the reparse point.
RTOSFILE_FLAG_OPEN_NO_RECALL (0x00100000)	The file data is requested, but it should continue to be located in remote storage.

Hint:
If the FILE_FLAG_NO_BUFFERING flag is active, then file access buffer addresses for read and write operations should be physical sector-aligned, which means aligned on addresses in memory that are integer multiples of the volume's physical sector size.

File creation disposition:

Value	Meaning
RTOSFILE_CREATE_NEW (1)	Creates a new file, only if it does not already exist.
RTOSFILE_CREATE_ALWAYS (2)	Creates a new file, always.
RTOSFILE_OPEN_EXISTING (3)	Opens a file or device, only if it exists.
RTOSFILE_OPEN_ALWAYS (4)	Opens a file, always.
RTOSFILE_TRUNCATE_EXISTING (5)	Opens a file and truncates it so that its size is zero bytes, only if it exists.

10.1.15.2 RtosFileCreateExW

See RtosFileCreateExA

```
UINT32 RtosFileCreateExA (
    const WCHAR*                wszFileName,
    UINT32                      dwDesiredAccess,
    UINT32                      dwShareMode,
    PRTOS_SECURITY_ATTRIBUTES   lpSecurityAttributes,
    UINT32                      dwCreationDisposition,
    UINT32                      dwFlagsAndAttributes,
    RTOSLIB_HANDLE              hTemplateFile,
    RTOSLIB_HANDLE*             phFileCreateEx )
```

10.1.15.3 RtosFileReadSeek

This is mainly the same as RtosObjectRead. It contains an additional offset parameter for the desired seek position. See RtosObjectRead for further details.

```
UINT32 RtosFileRead(
    RTOSLIB_HANDLE          hFileCreateEx,
```

UINT8 *pBuffer,
UINT32 dwBufferSize,
UINT32 *pdwBytesRead,
UINT32 dwTimeoutMs,
UINT64 qwOffset)

Additional Parameter
qwOffset
[in] Desired seek position from which the data should be read. The offset starts from file begin.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.15.4 RtosFileWriteSeek

This is mainly the same as RtosObjectWrite. It contains an additional offset parameter for the desired seek position. See RtosObjectWrite for further details.

UINT32 RtosFileWrite(
RTOSLIB_HANDLE hFileCreateEx,
const UINT8 *pBuffer,
UINT32 dwBufferSize,
UINT32 *pdwBytesWritten,
UINT32 dwTimeoutMs,
UINT64 qwOffset)

Additional Parameter
qwOffset
[in] Desired seek position from were the data should be write. The offset starts from file begin.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.15.5 RtosFileSetEndOfFile

This function set the current file pointer to the end of file.

UINT32 RtosFileEof (
RTOSLIB_HANDLE hFileCreateEx)

Parameter
hFileCreateEx
[in] Object handle returned from RtosFileCreateEx()

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.15.6 RtosFileSetFilePointer

This function sets the file pointer on the desired location.

UINT32 RtosFileSetFilePointer (
RTOSLIB_HANDLE hFileCreateEx,
INT64* pqnDistanceToMove,
UINT32 dwMoveMethod)

Parameter
hFileCreateEx
[in] Object handle returned from RtosFileCreateEx()
pqnDistanceToMove
[in/out] Value that specifies the number of bytes to move the file pointer.
dwMoveMethod
[in] The starting point for the file pointer move. See comment.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The following starting points are defined:

Value	Meaning
RTOSFILE_BEGIN (0)	The starting point is zero or the beginning of the file.
RTOSFILE_CURRENT (1)	The starting point is the current value of the file pointer.
RTOSFILE_END (2)	The starting point is the current end-of-file position.

10.1.15.7 RtosFileGetInformationByHandle

This function gets information about the file described by its handle.

UINT32 RtosFileGetInformationByHandle (
RTOSLIB_HANDLE hFileCreateEx,
PRTOSFILE_BY_HANDLE_INFORMATION pFileInfo)

Parameter
hFileCreateEx
[in] Object handle returned from RtosFileCreateEx()
pFileInfo
[out] Collected file information. See comment.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment

The following informations will be collected:

```
typedef struct _RTOSFILE_BY_HANDLE_INFORMATION {
      UINT64 qwCreationTime;        Value that specifies when a file or
                                    directory was created.
      UINT64 qwLastAccessTime;      For a file, the value specifies when the
                                    file was last read from, written to, or
                                    for executable files, run.
                                    For a directory, the structure specifies
                                    when the directory is created.
```

```
      UINT64 qwLastWriteTime;       For a file, the value specifies when the
                                    file was last written to, truncated, or
                                    overwritten.
                                    For a directory, the value specifies
                                    when the directory is created.
      UINT64 qwFileSize;            File size in bytes.
      UINT64 qwFileIndex;           A unique identifier that is associated
                                    with a file.
      UINT32 dwFileAttributes;      The file attributes of a file.
                                    → see RtosFileCreateEx() comment.
      UINT32 dwVolumeSerialNumber;  The serial number of the volume that
                                    contains a file.
      UINT32 dwNumberOfLinks;       The number of links to this file.
      UINT32 dwReservedFor64BitAlignment;
  } RTOSLIB_PACKED(8) RTOSFILE_BY_HANDLE_INFORMATION,
*PRTOSFILE_BY_HANDLE_INFORMATION;
```

10.1.15.8 RtosFileGetTime

This function gets the file time.

UINT32 RtosFileGetTime (

RTOSLIB_HANDLE	**hFileCreateEx,**
UINT64*	**pqwCreationTime,**
UINT64*	**pqwLastAccessTime,**
UINT64*	**pqwLastWriteTime)**

Parameter

hFileCreateEx
[in] Object handle returned from RtosFileCreateEx()

pqwCreationTime
[out] Get the file creation time.

pqwLastAccessTime
[out] Get the file last access time.

pqwLastWriteTime
[out] Get the file last write time.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

If a value is not desired, a NULL could be supplied.

10.1.15.9 RtosFileSetTime

This function sets the file time.

UINT32 RtosFileSetTime (

RTOSLIB_HANDLE	**hFileCreateEx,**
UINT64*	**pqwCreationTime,**
UINT64*	**pqwLastAccessTime,**
UINT64*	**pqwLastWriteTime)**

Parameter

hFileCreateEx
[in] Object handle returned from RtosFileCreateEx()

pqwCreationTime

[in] Set the file creation time, if not NULL.

pqwLastAccessTime

[in] Set the file last access time, if not NULL.

pqwLastWriteTime

[in] Set the file last write time, if not NULL.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

-

10.1.15.10 RtosFileGetTempNameA

Get temp file name based on the values of the parameter.

```
UINT32 RtosFileGetTempNameA (
    const CHAR*         szPathName,
    const CHAR*         szPrefixString,
    UINT32*             pdwUnique,
    CHAR*               szTempFileName )
```

Parameter

szPathName

[in] The directory path for the file name. Applications typically specify a period (.) for the current directory. The string cannot be longer than RTOSFILE_MAX_PATH–14 characters and not NULL.

szPrefixString

[in] The function uses up to the first three characters of this string as the prefix of the file name.

pdwUnique

[in/out] An unsigned integer to be used in creating the temporary file name.

szTempFileName

[out] Generated temporary file name.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The macro RtosFileGetTempName can be used to call RtosFileGetTempNameW if UNICODE is defined and RtosFileGetTempNameA if not.

If *pdwUnique is zero, the function attempts to form a unique file name using the current system time.

If the function succeeds, the returned value in *pdwUnique specifies the unique numeric value used in the temporary file name. If the **pdwUnique* parameter is nonzero, the return value specifies that same number.
If the function fails, the returned value in *pdwUnique is zero.

10.1.15.11 RtosFileGetTempNameW

See RtosFileGetTempNameA.

```
UINT32 RtosFileGetTempNameW (
    const WCHAR*        wszPathName,
    const WCHAR*        wszPrefixString,
    UINT32*             pdwUnique,
    WCHAR*              wszTempFileName )
```

10.1.15.12 RtosFileMoveA

Move a file with the specified name (across directories).

UINT32 RtosFileMoveA (
const CHAR* szExistingFilename,
const CHAR* szNewFilename)

Parameter
szExistingFilename
[in] Name of the file to be moved
szNewFilename
[in] New name and/or location of the file

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosFileMove can be used to call RtosFileMoveW if UNICODE is defined and RtosFileMoveA if not.
This function is not supported on SHM file mode!

10.1.15.13 RtosFileMoveW

See RtosFileMoveA

UINT32 RtosFileMoveW (
const WCHAR* wszExistingFilename,
const WCHAR* wszNewFilename)

10.1.15.14 RtosFileGetAttributesA

Get the file attributes.

UINT32 RtosFileGetAttributesA (
const CHAR* szFileName,
UINT32* pdwFileAttributes)

Parameter
szFileName
[in] Name of the file which attributes are desired
pdwFileAttributes
[out] File attributes. See RtosFileCreateEx() comment.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosFileGetAttributes can be used to call RtosFileGetAttributesW if UNICODE is defined and RtosFileGetAttributesA if not.
This function is not supported on SHM file mode!

10.1.15.15 RtosFileGetAttributesW

See RtosFileGetAttributesA

UINT32 RtosFileGetAttributesW (
const WCHAR* wszFileName,
UINT32* pdwFileAttributes)

10.1.15.16 RtosFileSetAttributesA

Set the file attributes.

UINT32 RtosFileSetAttributesA (
const CHAR* szFileName,
UINT32 dwFileAttributes)

Parameter
szFileName
[in] Name of the file which attributes should be set.
dwFileAttributes
[in] New file attributes. See RtosFileCreateEx() comment.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosFileSetAttributes can be used to call RtosFileSetAttributesW if UNICODE is defined and RtosFileSetAttributesA if not.
This function is not supported on SHM file mode!

10.1.15.17 RtosFileSetAttributesW

See RtosFileSetAttributesA

UINT32 RtosFileSetAttributesW (
const WCHAR* wszFileName,
UINT32 dwFileAttributes)

10.1.15.18 RtosFileGetDiskFreeSpaceA

Get the available free disk space.

UINT32 RtosFileGetDiskFreeSpaceA (
const CHAR* szRootPathName,
UINT32* pdwSectorsPerCluster,
UINT32* pdwBytesPerSector,
UINT32* pdwNumberOfFreeClusters,
UINT32* pdwTotalNumberOfClusters)

Parameter
szFileName
[in] The root directory of the disk for which information is to be returned.
pdwSectorsPerCluster
[out] A pointer to a variable that receives the number of sectors per cluster.
pdwBytesPerSector
[out] A pointer to a variable that receives the number of bytes per sector.
pdwNumberOfFreeClusters
[out] A pointer to a variable that receives the total number of free clusters on the disk.
pdwTotalNumberOfClusters
[out] A pointer to a variable that receives the total number of clusters on the disk.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosFileGetDiskFreeSpace can be used to call RtosFileGetDiskFreeSpaceW if UNICODE is defined and RtosFileGetDiskFreeSpaceA if not.
This function is not supported on SHM file mode!

10.1.15.19 RtosFileGetDiskFreeSpaceW

See RtosFileGetDiskFreeSpaceA

UINT32 RtosFileGetDiskFreeSpaceW (
const WCHAR* wszRootPathName,
UINT32* pdwSectorsPerCluster,
UINT32* pdwBytesPerSector,
UINT32* pdwNumberOfFreeClusters,
UINT32* pdwTotalNumberOfClusters)

10.1.15.20 RtosFileFindFirstA

Find first file and get find file handle for subsequent find next calls.

UINT32 RtosFileFindFirstA (
const CHAR* szName,
PRTOSFILEFIND_DATA_A pFindData,
RTOSLIB_HANDLE* phFind)

Parameter
szName
[in] The directory or path, and the file name, which can include wildcard characters, for example, an asterisk (*) or a question mark (?).

This parameter should not be NULL, an invalid string (for example, an empty string or a string that is missing the terminating null character), or end in a trailing backslash (\).

pFindData
[out] A pointer to the RTOSFILEFIND_DATA structure that receives information about a found file or directory. See comment.

phFind
[out] Handle for subsequent calls of RtosFileFindNext(). See comment.

Return
RTE_SUCCESS on success and an error-code on failure.

If the function fails because no matching files can be found, the function returns RTE_ERROR_FILE_NOT_FOUND.

Comment
The macro RtosFileFindFirst can be used to call RtosFileFindFirstW if UNICODE is defined and RtosFileFindFirstA if not.
This function is not supported on SHM file mode!

```
typedef struct _RTOSFILEFIND_DATA_A
  {
      UINT64 qwCreationTime;        Value that specifies when a file or
                                    directory was created.
      UINT64 qwLastAccessTime;      For a file, the value specifies when the
                                    file was last read from, written to, or
                                    for executable files, run.
                                    For a directory, the structure specifies
                                    when the directory is created.
```

```
    UINT64 qwLastWriteTime;       For a file, the value specifies when the
                                  file was last written to, truncated, or
                                  overwritten.
                                  For a directory, the value specifies
                                  when the directory is created.
    UINT64 qwFileSize;            File size in bytes.
    UINT32 dwReserved0;
    UINT32 dwReserved1;
    UINT32 dwFileAttributes;      The file attributes of a file.
                                  → see RtosFileCreateEx() comment.
    CHAR   tszFileName[RTOSFILE_MAX_PATH];
    CHAR   tszAlternateFileName[RTOSFILE_FIND_FILENAME_ALT_LENGTH];
    UINT16 wReservedFor64BitAlignment;
} RTOSLIB_PACKED(8) RTOSFILEFIND_DATA_A, *PRTOSFILEFIND_DATA_A;
```

`tszFileName` contains the name of the file.
`tszAlternateFileName` contains an alternative name for the file.
This name is in the classic 8.3 file name format.

10.1.15.21 RtosFileFindFirstW

See RtosFileFindFirstA

UINT32 RtosFileFindFirstW (
const WCHAR* wszName,
PRTOSFILEFIND_DATA_W pFindData,
RTOSLIB_HANDLE* phFind)

10.1.15.22 RtosFileFindNextA

Subsequent calls to get all files in specified directory.

UINT32 RtosFileFindNextA (
RTOSLIB_HANDLE hFind,
PRTOSFILEFIND_DATA_A pFindData)

Parameter
hFind
[in] Handle (returned by a previous RtosFileFindFirst call) for subsequent calls of RtosFileFindNext(). See comment.
pFindData
[out] A pointer to the RTOSFILEFIND_DATA structure that receives information about a found file or directory. See comment.

Return
RTE_SUCCESS on success and an error-code on failure.

If the function fails because no more matching files can be found, the function returns RTE_ERROR_FILE_NO_MORE_FILES.

Comment
The macro RtosFileFindNext can be used to call RtosFileFindNextW if UNICODE is defined and RtosFileFindNextA if not.
This function is not supported on SHM file mode!

10.1.15.23 RtosFileFindNextW

See RtosFileFindNextA

UINT32 RtosFileFindNextW (
RTOSLIB_HANDLE hFind,
PRTOSFILEFIND_DATA_W pFindData)

10.1.15.24 RtosFileSetCurrentDirectoryA

Set the current directory.

UINT32 RtosFileSetCurrentDirectoryA (
const CHAR* szPathName)

Parameter
szPathName
[in] The path to the new current directory. This parameter may specify a relative path or a full path. In either case, the full path of the specified directory is calculated and stored as the current directory. See comment

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The string must not exceed RTOSFILE_MAX_PATH characters, including the terminating null character. The final character before the null character must be a backslash ('\'). If you do not specify the backslash, it will be added for you; therefore, specify RTOSFILE_MAX_PATH-2 characters for the path unless you include the trailing backslash, in which case, specify RTOSFILE_MAX_PATH-1 characters for the path.

The macro RtosFileSetCurrentDirectory can be used to call RtosFileSetCurrentDirectoryW if UNICODE is defined and RtosFileSetCurrentDirectoryA if not.
This function is not supported on SHM file mode!

10.1.15.25 RtosFileSetCurrentDirectoryW

See RtosFileSetCurrentDirectoryA

UINT32 RtosFileSetCurrentDirectoryW (
const WCHAR* wszPathName)

10.1.15.26 RtosFileGetCurrentDirectoryA

Get the current directory.

UINT32 RtosFileGetCurrentDirectoryA (
UINT32* pdwBufferLength,
const CHAR* szPathName)

Parameter
pdwBufferLength
[in/out] Size of supplied buffer. The buffer length must include room for a terminating null character.
szPathName
[out] A pointer to the string buffer that receives the current directory string. See comment

Return
RTE_SUCCESS on success and an error-code on failure.

Comment

Setting parameter szPathName to NULL and supply *pdwBufferLength = 0, than the needed buffer size will be determined and returned by pdwBufferLength, in characters, including the null-terminating character.

The macro RtosFileGetCurrentDirectory can be used to call RtosFileGetCurrentDirectoryW if UNICODE is defined and RtosFileGetCurrentDirectoryA if not.
This function is not supported on SHM file mode!

10.1.15.27 RtosFileGetCurrentDirectoryW

See RtosFileGetCurrentDirectoryA

```
UINT32 RtosFileGetCurrentDirectoryW (
    UINT32*                 pdwBufferLength,
    const WCHAR*            wszPathName)
```

10.1.15.28 RtosFileCreateDirectoryA

Create a new directory.

```
UINT32 RtosFileCreateDirectoryA (
    const CHAR*                             szPathName,
    const PRTOS_SECURITY_ATTRIBUTES         pSecurityAttributes )
```

Parameter

szPathName

[in] The path of the directory to be created.

There is a default string size limit for paths of 248 characters.

pSecurityAttributes

[in] Currently only NULL is supported.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The macro RtosFileCreateDirectory can be used to call RtosFileCreateDirectoryW if UNICODE is defined and RtosFileCreateDirectoryA if not.
This function is not supported on SHM file mode!

10.1.15.29 RtosFileCreateDirectoryW

See RtosFileCreateDirectoryA

```
UINT32 RtosFileCreateDirectoryW (
    const WCHAR*                            wszPathName,
    const PRTOS_SECURITY_ATTRIBUTES         pSecurityAttributes )
```

10.1.15.30 RtosFileRemoveDirectoryA

Remove the specified directory.

```
UINT32 RtosFileRemoveDirectoryA (
```

const CHAR* szPathName)

Parameter
szPathName
[in] The path of the directory to be removed. This path must specify an empty directory.

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The macro RtosFileRemoveDirectory can be used to call RtosFileRemoveDirectoryW if UNICODE is defined and RtosFileRemoveDirectoryA if not.
This function is not supported on SHM file mode!

10.1.15.31 RtosFileRemoveDirectoryW

See RtosFileRemoveDirectoryA

UINT32 RtosFileRemoveDirectoryW (
const WCHAR* wszPathName)

10.1.16 RTOS Library – generic object functions

RtosLib provides generic functions for handling different object types like events, files, sockets, etc.

10.1.16.1 RtosObjectRead

This is the generic function to read data into a buffer.

```
UINT32 RtosObjectRead(
    RTOSLIB_HANDLE      hObject,
    UINT8               *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesRead,
    UINT32              dwTimeoutMs )
```

Parameter

hObject
[in] Object handle returned from RtosMsgQueueCreate(), RtosPipeCreate(), RtosSocketCreate(), RtosFileCreate()

pBuffer
[out] Buffer to receive the data read

dwBufferSize
[in] Length of string buffer in bytes

pdwBytesRead
[out] Number of bytes read into the buffer

dwTimeoutMs
[in] Timeout in milliseconds

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

If there is no data to be read the function will return after timeout elapsed.
If data was read the function will return as soon as the read buffer is full or there is no more data to be read.

10.1.16.1 RtosObjectWrite

This is the generic function to write data from a buffer.

UINT32 RtosObjectWrite(
RTOSLIB_HANDLE hObject,
const UINT8 *pBuffer,
UINT32 dwBufferSize,
UINT32 *pdwBytesWritten,
UINT32 dwTimeoutMs)

Parameter
hObject
[in] Object handle returned from RtosMsgQueueCreate(), RtosPipeCreate(), RtosSocketCreate(), RtosFileCreate()
pBuffer
[out] Buffer to receive the data read
dwBufferSize
[in] Length of string buffer in bytes
pdwBytesWritten
[out] Number of bytes written
dwTimeoutMs
[in] Timeout in milliseconds

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The function will return after all data was written or the timeout elapsed.
If the timeout elapsed the number of bytes written will be returned in pdwBytesWritten.

10.1.16.2 RtosObjectWait

This is the generic function to wait for an event. The event is object specific. For details check the comment.

UINT32 RtosObjectWait (
RTOSLIB_HANDLE hObject,
UINT32 dwTimeoutMs)

Parameter
hObject
[in] Object handle returned from RtosCreateEvent(), RtosNotificationExCreate(), RtosMsgQueueCreate(), RtosPipeCreate(),RtosSocketCreate(),RtosFileCreate()
dwTimeoutMs
[in] Timeout in milliseconds

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The function will return when the object was signalled or after timeout elapsed.
The signal is object specific:
- Event : The event was set
- NotificationEx : A notification occurred - use RtosNotificationWait instead for details.
- MsgQueue : Reader: Read data available / Writer: Data can be send
- Pipe : Read data available
- Socket : Read data available

10.1.16.3 RtosObjectBreakWait

This is the generic function to break a waiting function.

UINT32 RtosObjectBreakWait (
RTOSLIB_HANDLE hObject)

Parameter
hObject
[in] Object handle returned from
RtosCreateEvent(), RtosNotificationExCreate(), RtosMsgQueueCreate(),
RtosPipeCreate(),RtosSocketCreate(),RtosFileCreate()

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
A thread could be waiting infinite for an event. If this thread should be shut down the RtosObjectBreakWait function can be used to break the wait. In this case the wait function will return the error RTE_ERROR_BREAK_WAIT.

10.1.16.4 RtosObjectClose

This is the generic function to close any RTOSLIB_HANDLE object.

UINT32 RtosObjectClose (
RTOSLIB_HANDLE hObject)

Parameter
hObject
[in] Object handle returned from
RtosCreateEvent(), RtosNotificationExCreate(), RtosMsgQueueCreate(),
RtosPipeCreate(),RtosSocketCreate(),RtosFileCreate()

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The handle becomes invalid and can’t be used any more – regardless of an returned error code like timout.

10.1.16.1 RtosObjectOptionSet

This is the generic function to configure a handle option. The option is object specific. For details check the comment.

UINT32 RtosObjectOptionSet (
RTOSLIB_HANDLE hObject,
UINT32 dwOptionId,
const UINT8 *pBuffer,
UINT32 dwBufferSize)

Parameter
hObject
[in] Object handle returned from RtosSocketCreate(), RtosFileCreate()
dwOptionId
[in] Object specific ID
pBuffer
[in] Buffer containing the data to be set
dwBufferSize
[in] Length of buffer in bytes

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
Possible options are object specific:

Object	Option ID	Type	Description
Socket	RTOSSOCKET_OPTION_RCVTIMEO	UINT32	Default Rx timeout in milliseconds
Socket	RTOSSOCKET_OPTION_SNDTIMEO	UINT32	Default Tx timeout in milliseconds
File	RTOSFILE_OPTION_ACKTIMEOUT	UINT32	Default acknowledge timeout in milliseconds

10.1.16.1 RtosObjectOptionGet

This is the generic function to query a handle option. The option is object specific. See “RtosObjectOptionSet” for details.

UINT32 RtosObjectOptionGet (
RTOSLIB_HANDLE hObject,
UINT32 dwOptionId,
const UINT8 *pBuffer,
UINT32 dwBufferSize)

Parameter
hObject
[in] Object handle returned from RtosSocketCreate(), RtosFileCreate()
dwOptionId
[in] Object specific ID
pBuffer
[out] Buffer for receiving the option data
dwBufferSize
[in] Length of buffer in bytes

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
See “RtosObjectOptionSet” for details.

10.1.17 RTOS Library – message queue functions

RtosLib contains message queue functionality based on shared memory communicaiton.

10.1.17.1 RtosMsgQueueCreateA

This function creates a message queue

```
UINT32 RtosMsgQueueCreateA (
    const CHAR*                 szName,
    PRTOSMSGQUEUE_OPTIONS       pOptions,
    RTOSLIB_HANDLE*             phObject )
```

Parameter

szName
[in] Name of the message queue

pOptions
[in] Message queue options. See comment.

phObject
[out] Pointer to receive a RTOSLIB_HANDLE object (message queue).

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

```
typedef struct _RTOSMSGQUEUE_OPTIONS
  {
    UINT32  dwSize;                 must be initialized with sizeof(RTOSMSGQUEUE_OPTIONS)
    UINT32  dwFlags;                can be
                                    - RTOSMSGQUEUE_OPTIONS_FLAG_ALLOWBROKEN
                                    to allow reading and writing the queue without counterpart
                                    being connected
                                    - RTOSMSGQUEUE_OPTIONS_FLAG_FORCE_CREATE
                                    to ensure the message queue didn't exist before
                                    - RTOSMSGQUEUE_OPTIONS_FLAG_FORCE_OPEN
                                    to ensure the message queue existed before
                                    -
                                    RTOSMSGQUEUE_OPTIONS_FLAG_FORCE_EXCLUSIVE
                                    to ensure being the first reader or writer (depending on
                                    bReadAccess)
    UINT32  dwNumMessages;          number of messages the queue should contain.
                                    0 uses the maximum available.
    UINT32  dwMsgDataSizeInBytes;   number of data bytes usable in each message
    BOOL    bReadAccess;            determines if the creator will be reader or writer to this queue.
  } RTOSMSGQUEUE_OPTIONS, *PRTOSMSGQUEUE_OPTIONS;
```

The message queue shared memory (named "RtosLibMsgQueue") will be divided into n equal sized parts. The shared memory size per queue can be configured via config file:

```
[MessageQueue\\RtosLibMsgQueue]
 "MaxShmUsagePerQueue"=dword:100000
```

Note that not the entire data can be used by user data since there is also queue administrative data.

The macro RtosMsgQueueCreate can be used to call RtosMsgQueueCreateW if UNICODE is defined and RtosMsgQueueCreateA if not.

Hint:
Because the queue has a fixed maximum size the dwNumMessages member could be set to 0 to gain the maximum number of packets.

10.1.17.2 RtosMsgQueueCreateW

See RtosMsgQueueCreateA

```
UINT32 RtosMsgQueueCreateW (
   const WCHAR*                wszName,
   PRTOSMSGQUEUE_OPTIONS       pOptions,
   RTOSLIB_HANDLE*             phObject )
```

10.1.17.1 RtosMsgQueueInfoGet

This function queries information about message queue

```
UINT32 RtosMsgQueueInfoGet (
   RTOSLIB_HANDLE          hObject
   PRTOSMSGQUEUE_INFO      pInfo )
```

Parameter

hObject

[in] Object handle returned from RtosMsgQueueCreate()

pInfo

[in] Information structure. See comment.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

```
typedef struct _RTOSMSGQUEUE_INFO
{
   UINT32  dwSize;                 must be initialized with sizeof( RTOSMSGQUEUE_INFO )
   UINT32  dwFlags;                reserved – should be 0.
   UINT32  dwNumMessages;          number of message containers
   UINT32  dwNumPending;           number of currently pending messages
   UINT32  dwNumPendingMax;        maximum number of pending messages
   UINT32  dwMsgDataSizeInBytes;   maximum data size per message in bytes
   UINT16  wNumReaders;            number of readers attached to this queue
   UINT16  wNumWriters;            number of writers attached to this queue
} RTOSMSGQUEUE_INFO, *PRTOSMSGQUEUE_INFO;
```

10.1.17.1 RtosMsgQueueRead

This is a synonym for RtosObjectRead. See RtosObjectRead for details.

```
UINT32 RtosMsgQueueRead (
   RTOSLIB_HANDLE          hObject,
   UINT8                   *pBuffer,
   UINT32                  dwBufferSize,
   UINT32                  *pdwBytesRead,
   UINT32                  dwTimeoutMs )
```

10.1.17.1 RtosMsgQueueWrite

This is a synonym for RtosObjectWrite. See RtosObjectWrite for details.

```
UINT32 RtosMsgQueueWrite (
    RTOSLIB_HANDLE          hObject,
    const UINT8             *pBuffer,
    UINT32                  dwBufferSize,
    UINT32                  *pdwBytesWritten,
    UINT32                  dwTimeoutMs )
```

10.1.17.1 RtosMsgQueueWait

This is a synonym for RtosObjectWait. See RtosObjectWait for details.

```
UINT32 RtosMsgQueueWait (
    RTOSLIB_HANDLE          hObject,
    UINT32                  dwTimeoutMs )
```

10.1.17.1 RtosMsgQueueBreakWait

This is a synonym for RtosObjectBreakWait. See RtosObjectBreakWait for details.

```
UINT32 RtosMsgQueueBreakWait (
    RTOSLIB_HANDLE          hObject )
```

10.1.17.2 RtosMsgQueueClose

This is a synonym for RtosObjectClose. See RtosObjectClose for details.

```
UINT32 RtosMsgQueueClose (
    RTOSLIB_HANDLE          hObject )
```

10.1.18 RTOS Library – pipe functions

RtosLib contains pipe functionality based on shared memory communicaiton.

10.1.18.1 RtosPipeCreateA

This function creates a message queue

UINT32 RtosPipeCreateA (
const CHAR* szName,
PRTOSPIPE_OPTIONS pOptions,
RTOSLIB_HANDLE* phObject)

Parameter

szName
[in] Name of the pipe

pOptions
[in] Pipe options. See comment.

phObject
[out] Pointer to receive a RTOSLIB_HANDLE object (pipe).

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

```
typedef struct _RTOSPIPE_OPTIONS
{
   UINT32  dwSize;          must be initialized with sizeof(RTOSPIPE_OPTIONS )
   UINT32  dwFlags;         can be
                            - RTOSPIPE_OPTIONS_FLAG_READ  for read access
                            - RTOSPIPE_OPTIONS_FLAG_WRITE for write access
                            - RTOSPIPE_OPTIONS_FLAG_READWRITE for both
   UINT32  dwAvgDataSize;   Should be set to the average message data size in bytes.
                            0 = default = 1500 bytes
} RTOSPIPE_OPTIONS, *PRTOSPIPE_OPTIONS;
```

A pipe contains two queues – one for reading and one for writing.
Only the queue(s) requested (read / write / read+write) will be created.

To establish a communication using a pipe one side must call RtosPipeCreate while the other side has to call RtosPipeOpen. This is required to open the correct message queues.

The first caller – regardless of using RtosPipeCreate or RtosPipeOpen – will initialize the pipe with its average data size. The second caller's average data size parameter will be ignored.

The macro RtosPipeCreate can be used to call RtosPipeCreateW if UNICODE is defined and RtosPipeCreateA if not.

10.1.18.2 RtosPipeCreateW

See RtosPipeCreateA

UINT32 RtosPipeCreateW(
const WCHAR* wszName,
PRTOSPIPE_OPTIONS pOptions,
RTOSLIB_HANDLE* phObject)

10.1.18.1 RtosPipeOpenA

This function opens a message queue. The counterpart has to use RtosPipeCreate. See RtosPipeCreateA for details.

```
UINT32 RtosPipeOpenA (
   const CHAR*              szName,
   PRTOSPIPE_OPTIONS        pOptions,
   RTOSLIB_HANDLE*          phObject )
```

10.1.18.1 RtosPipeOpenW

This function opens a message queue. The counterpart has to use RtosPipeCreate. See RtosPipeCreateA for details.

```
UINT32 RtosPipeOpenW (
   const WCHAR*             wszName,
   PRTOSPIPE_OPTIONS        pOptions,
   RTOSLIB_HANDLE*          phObject )
```

10.1.18.2 RtosPipeInfoGet

This function queries information about a pipe

```
UINT32 RtosPipeInfoGet (
   RTOSLIB_HANDLE           hObject
   PRTOSPIPE_INFO           pInfo )
```

Parameter

hObject

[in] Object handle returned from RtosPipeCreate()

pInfo

[in] Pointer to information structure. See comment.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

```
typedef struct _RTOSPIPE_INFO
{
   UINT32  dwSize;                  must be initialized with sizeof( RTOSPIPE_INFO )
   UINT32  dwFlags;                 see RTOSPIPE_OPTIONS_FLAG_...
   UINT32  dwNumMessagesRx;         number of message containers for Rx queue
   UINT32  dwNumMessagesTx;         number of message containers for Tx queue
   UINT32  dwNumPendingRx;          number of currently pending Rx messages
   UINT32  dwNumPendingTx;          number of currently pending Tx messages
   UINT32  dwNumPendingMaxRx;       maximum number of pending Rx messages
   UINT32  dwNumPendingMaxTx;       maximum number of pending Rx messages
   UINT32  dwNumWriterRx;           number of writers attached to Rx
   UINT32  dwNumReaderTx;           number of reades attached to Tx
   UINT32  dwMsgDataSizeInBytes;    maximum data size per message in bytes.
                                    Larger messages will be split into pakets.
} RTOSPIPE_INFO, *PRTOSPIPE_INFO;
```

10.1.18.3 RtosPipeRead

This is a synonym for RtosObjectRead. See RtosObjectRead for details.

```
UINT32 RtosPipeRead (
    RTOSLIB_HANDLE      hObject,
    UINT8               *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesRead,
    UINT32              dwTimeoutMs )
```

10.1.18.4 RtosPipeWrite

This is a synonym for RtosObjectWrite. See RtosObjectWrite for details.

```
UINT32 RtosPipeWrite (
    RTOSLIB_HANDLE      hObject,
    const UINT8         *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesWritten,
    UINT32              dwTimeoutMs )
```

10.1.18.5 RtosPipeWait

This is a synonym for RtosObjectWait. See RtosObjectWait for details.

```
UINT32 RtosPipeWait (
    RTOSLIB_HANDLE      hObject,
    UINT32              dwTimeoutMs )
```

10.1.18.6 RtosPipeBreakWait

This is a synonym for RtosObjectBreakWait. See RtosObjectBreakWait for details.

```
UINT32 RtosPipeBreakWait (
    RTOSLIB_HANDLE      hObject )
```

10.1.18.7 RtosPipeClose

This is a synonym for RtosObjectClose. See RtosObjectClose for details.

```
UINT32 RtosPipeClose (
    RTOSLIB_HANDLE      hObject )
```

10.1.19 RTOS Library – socket functions

RtosLib contains socket functionality based on shared memory communicaiton.

10.1.19.1 RtosSocketCreate

This function creates a socket

UINT32 RtosSocketCreate(
UINT32 dwFamily,
UINT32 dwType,
UINT32 dwProtocol,
RTOSLIB_HANDLE* phObject)

Parameter

dwFamily
[in] Socket family – must be RTOSSOCKET_FAMILY_RTE

dwType
[in] Socket type – currently only RTOSSOCKET_TYPE_STREAM is supported.

dwProtocol
[in] Protocol – can be RTOSSOCKET_PROTOCOL_TCP or RTOSSOCKET_PROTOCOL_UDP

phObject
[out] Pointer to receive a RTOSLIB_HANDLE object (socket).

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

-

10.1.19.1 RtosSocketBind

This function binds a socket

UINT32 RtosSocketBind(
RTOSLIB_HANDLE hObject,
UINT16 wPort)

Parameter

hObject
[in] Object handle returned from RtosSocketCreate()

wPort
[in] Port number to bind the socket to.

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

-

10.1.19.1 RtosSocketListen

This function configures a socket to listen

UINT32 RtosSocketListen(
RTOSLIB_HANDLE hObject)

Parameter
hObject
[in] Object handle returned from RtosSocketCreate()

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.19.1 RtosSocketAccept

This function (TCP) accepts a new connection

UINT32 RtosSocketAccept(
RTOSLIB_HANDLE hObject,
RTOSLIB_HANDLE* phObject,
PRTOSSOCKET_ADDR pAddrNew,
UINT32 dwTimeoutMs)

Parameter
hObject
[in] Object handle returned from RtosSocketCreate()
phObject
[out] Pointer to receive a RTOSLIB_HANDLE object (socket).
pAddrNew
[out] Pointer to a RTOSSOCKET_ADDR structure containing the address of the new socket. Its member 'bySize' must be initialized with sizeof(RTOSSOCKET_ADDR).
dwTimeoutMs
[in] Timeout in milliseconds

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
Before calling RtosSocketAccept pAddrNew→bySize must be initialized with sizeof(RTOSSOCKET_ADDR).

```
typedef struct _RTOSSOCKET_ADDR
{
   UINT8  bySize;              must be initialized with sizeof( RTOSSOCKET_ADDR )
   UINT8  byFamily;            see RTOSSOCKET_FAMILY_...
   UINT16 wPort;               port number
   union _RTOSSOCKET_ADDR_FAMILY
   {
      struct _RTOSSOCKET_ADDR_FAMILY_RAW
      {
         UINT8  abyData[12];
      } Raw;
      struct _RTOSSOCKET_ADDR_FAMILY_RTE
      {
         UINT32 dwOsId;        OS id
```

```
        UINT32 adwReserved[2];
      } Rte;
   } u;
} RTOSSOCKET_ADDR, *PRTOSSOCKET_ADDR;
```

10.1.19.1 RtosSocketConnect

This function (TCP) connects to a server

UINT32 RtosSocketConnect (
RTOSLIB_HANDLE hObject,
const PRTOSSOCKET_ADDR pAddr)

Parameter
hObject
[in] Object handle returned from RtosSocketCreate()
pAddr
[in] Pointer to a RTOSSOCKET_ADDR structure containing the address to connect to. Its member 'bySize' must be initialized with sizeof(RTOSSOCKET_ADDR).

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
Before calling RtosSocketConnect pAddr→bySize must be initialized with sizeof(RTOSSOCKET_ADDR).
See RtosSocketAccept for details of RTOSSOCKET_ADDR.

10.1.19.1 RtosSocketShutdown

This function does shutdown a connection.

UINT32 RtosSocketShutdown (
RTOSLIB_HANDLE hObject)

Parameter
hObject
[in] Object handle returned from RtosSocketCreate()

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
-

10.1.19.1 RtosSocketRecv

This is the (TCP) function to receive data into a buffer.

```
UINT32 RtosSocketRecv (
    RTOSLIB_HANDLE      hObject,
    UINT8               *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesRead )
```

Parameter

hObject
[in] Object handle returned from RtosSocketCreate()

pBuffer
[out] Buffer to receive the data read

dwBufferSize
[in] Length of string buffer in bytes

pdwBytesRead
[out] Number of bytes read into the buffer

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

If there is no data to be read the function will return after timeout elapsed.
If data was read the function will return as soon as the read buffer is full or there is no more data to be read.
The timeout can be configured - see RtosObjectOptionSet for details.

10.1.19.1 RtosSocketSend

This is the (TCP) function to send data from a buffer.

```
UINT32 RtosSocketSend (
    RTOSLIB_HANDLE      hObject,
    const UINT8         *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesWritten )
```

Parameter

hObject
[in] Object handle returned from RtosSocketCreate()

pBuffer
[out] Buffer to receive the data read

dwBufferSize
[in] Length of string buffer in bytes

pdwBytesWritten
[out] Number of bytes written

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The function will return after all data was written or the timeout elapsed.
If the timeout elapsed the number of bytes written will be returned in pdwBytesWritten.
The timeout can be configured - see RtosObjectOptionSet for details.

10.1.19.2 RtosSocketRecvFrom

This is the (UDP) function to receive data into a buffer and optionally get the source address.

```
UINT32 RtosSocketRecvFrom (
    RTOSLIB_HANDLE          hObject,
    UINT8                   *pBuffer,
    UINT32                  dwBufferSize,
    UINT32                  *pdwBytesRead,
    PRTOSSOCKET_ADDR        pAddr )
```

Parameter

hObject
[in] Object handle returned from RtosSocketCreate()

pBuffer
[out] Buffer to receive the data read

dwBufferSize
[in] Length of string buffer in bytes

pdwBytesRead
[out] Number of bytes read into the buffer

pAddr
[out] Pointer to a RTOSSOCKET_ADDR structure to return the source address. Its member 'bySize' must be initialized with sizeof(RTOSSOCKET_ADDR).

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

Before calling RtosSocketRecvFrom pAddr→bySize must be initialized with sizeof(RTOSSOCKET_ADDR).
If there is no data to be read the function will return after timeout elapsed.
If data was read the function will return as soon as the read buffer is full or there is no more data to be read.
The timeout can be configured - see RtosObjectOptionSet for details.

10.1.19.3 RtosSocketSendTo

This is the (UDP) function to send data from a buffer to a specific address.

```
UINT32 RtosSocketSendTo (
    RTOSLIB_HANDLE          hObject,
    const UINT8             *pBuffer,
    UINT32                  dwBufferSize,
    UINT32                  *pdwBytesWritten,
    const PRTOSSOCKET_ADDR  pAddr )
```

Parameter

hObject
[in] Object handle returned from RtosSocketCreate()

pBuffer
[out] Buffer to receive the data read

dwBufferSize
[in] Length of string buffer in bytes

pdwBytesWritten
[out] Number of bytes written

pAddr
[in] Pointer to a RTOSSOCKET_ADDR structure containing the destination address. Its member 'bySize' must be initialized with sizeof(RTOSSOCKET_ADDR).

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The function will return after all data was written or the timeout elapsed.
If the timeout elapsed the number of bytes written will be returned in pdwBytesWritten.
The timeout can be configured - see RtosObjectOptionSet for details.

10.1.19.4 RtosSocketReadFrom

This is the (UDP) function to receive data into a buffer and optionally get the source address.

UINT32 RtosSocketReadFrom (
RTOSLIB_HANDLE hObject,
UINT8 *pBuffer,
UINT32 dwBufferSize,
UINT32 *pdwBytesRead,
PRTOSSOCKET_ADDR pAddr,
UINT32 dwTimeoutMs)

Parameter
hObject
[in] Object handle returned from RtosSocketCreate()
pBuffer
[out] Buffer to receive the data read
dwBufferSize
[in] Length of string buffer in bytes
pdwBytesRead
[out] Number of bytes read into the buffer
pAddr
[out] Pointer to a RTOSSOCKET_ADDR structure to return the source address. Its member 'bySize' must be initialized with sizeof(RTOSSOCKET_ADDR).
dwTimeoutMs
[in] Timeout in milliseconds

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
Before calling RtosSocketReadFrom pAddr→bySize must be initialized with sizeof(RTOSSOCKET_ADDR).
If there is no data to be read the function will return after timeout elapsed.
If data was read the function will return as soon as the read buffer is full or there is no more data to be read.

10.1.19.5 RtosSocketWriteTo

This is the (UDP) function to send data from a buffer to a specific address.

```
UINT32 RtosSocketWriteTo (
    RTOSLIB_HANDLE              hObject,
    const UINT8                 *pBuffer,
    UINT32                      dwBufferSize,
    UINT32                      *pdwBytesWritten,
    const PRTOSSOCKET_ADDR      pAddr,
    UINT32                      dwTimeoutMs )
```

Parameter

hObject
[in] Object handle returned from RtosSocketCreate()

pBuffer
[out] Buffer to receive the data read

dwBufferSize
[in] Length of string buffer in bytes

pdwBytesWritten
[out] Number of bytes written

pAddr
[in] Pointer to a RTOSSOCKET_ADDR structure containing the destination address. Its member 'bySize' must be initialized with sizeof(RTOSSOCKET_ADDR).

dwTimeoutMs
[in] Timeout in milliseconds

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The function will return after all data was written or the timeout elapsed.
If the timeout elapsed the number of bytes written will be returned in pdwBytesWritten.

10.1.19.6 RtosSocketRead

(TCP) This is a synonym for RtosObjectRead. See RtosObjectRead for details.

```
UINT32 RtosSocketRead (
    RTOSLIB_HANDLE      hObject,
    UINT8               *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesRead,
    UINT32              dwTimeoutMs )
```

10.1.19.7 RtosSocketWrite

(TCP) This is a synonym for RtosObjectWrite. See RtosObjectWrite for details.

```
UINT32 RtosSocketWrite (
    RTOSLIB_HANDLE      hObject,
    const UINT8         *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesWritten,
    UINT32              dwTimeoutMs )
```

10.1.19.8 RtosSocketWait

This is a synonym for RtosObjectWait. See RtosObjectWait for details.

```
UINT32 RtosSocketWait (
    RTOSLIB_HANDLE          hObject,
    UINT32                  dwTimeoutMs )
```

10.1.19.9 RtosSocketBreakWait

This is a synonym for RtosObjectBreakWait. See RtosObjectBreakWait for details.

```
UINT32 RtosSocketBreakWait (
    RTOSLIB_HANDLE          hObject )
```

10.1.19.10 RtosSocketClose

This is a synonym for RtosObjectClose. See RtosObjectClose for details.

```
UINT32 RtosSocketClose (
    RTOSLIB_HANDLE          hObject )
```

10.1.19.11 RtosSocketOptionSet

This is a synonym for RtosObjectOptionSet. See RtosObjectOptionSet for details.

```
UINT32 RtosSocketOptionSet (
    RTOSLIB_HANDLE          hObject,
    UINT32                  dwOptionId,
    const UINT8             *pBuffer,
    UINT32                  dwBufferSize )
```

10.1.19.12 RtosSocketOptionGet

This is a synonym for RtosObjectOptionGet. See RtosObjectOptionGet for details.

```
UINT32 RtosSocketOptionGet (
    RTOSLIB_HANDLE          hObject,
    UINT32                  dwOptionId,
    const UINT8             *pBuffer,
    UINT32                  dwBufferSize )
```

10.1.20 RTOS Library – device functions

RtosLib contains device functionality for configuring host (Windows) devices.
This API is only available on host-side.

10.1.20.1 RtosDeviceA

This function allows device configuration.

UINT32 RtosDeviceA (
const CHAR* szParams)

Parameter
szParams
[in] Configuration parameters – see Comment for details

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The function does not require RtosLibInit to be called. In fact it must be called without RtosLibInit when installing RtosDrv.

Usage: RtosDevice("[<opt>...] <command> [<arg>...]")

<opt>... Zero or more options (see list below)
<command> Specifies a command (see list below)
<arg>... Zero or more arguments that modify a command.

Options:
-force Force operation
-noui Do not display user interface
-all Also include non-present devices (default is only present devices)

Commands:
rte_install -inf:<inf>
Install RtE device support. This will update and register the Class(Co)Installers.
-inf:<inf> Can specify a single inf file or an directory containing inf files

rte_uninstall [-deldp]
Remove RtE device support including all assigned devices (present and non-present), registry entries, services, inf's, class(co)installer, ...
-deldp Deletes installed driver packages for all RtE devices

rte_add [-slot] [-inf:<inf>] [<:n>] <id> [<id>...]
Add RtE device(s) assignment.
A registry entry will be written identifying this device as RtE device – and so only RtE drivers will be accepted.
Be careful specifying '-noui' because this might block an unsigned driver dialog and so cause assignment to fail.
-slot On <pciid> the PCI slot will be assigned and not the device.
-inf:<inf> Can specify a single inf file or an directory containing inf files
<:n> Specifies the n-th occurrence of a matching device
<id> Specifies the id of the devices.

```
rte_remove [-deldp] [-slot] [<:n>] <id> [<id>...]
rte_remove [-deldp] [-slot] [<:n>] =<class> [<id>...]
                Remove RtE device(s) assignment.
                The registry entry created by 'rte_add' will be removed.
                -deldp          Deletes installed driver packages for all RtE devices
                -slot           On <pciid> the PCI slot will be assigned and not the device.
                <:n>            Specifies the n-th occurrence of a matching device
                <id>            Specifies the id of the devices.
                =<class>        Specifies a device setup class.

rte_update -inf:<inf> <id> [<id>...]
                Update existing drivers. This can be used to update an existing driver.
                It is also possible to update a Windows device to become an RtE device.
                It is not possible to update a RtE device assigned using "rte_add" to become a
                Windows device again - this requires "rte_remove".
                -inf:<inf>      Can specify a single inf file or an directory containing inf files
                <id>            Specifies the id of the devices.

rte_configure -<prop:val> [-<prop:val>...] [<:n>] <id> [<id>...]
rte_configure -<prop:val> [-<prop:val>...] [<:n>] =<class> [<id>...]
                Configure RtE device(s) properties
                <prop:val>      Property and value to be set
                  -int_mode:0   Interrupt mode default (line interrupt)
                  -int_mode:1   Interrupt mode polling (requires specialized rt-driver)
                  -int_mode:2   Interrupt mode MSI     (only available on PCIe devices)
                  -osid:x       Assign device to OS x  (0=Rtos, 1=Rtos1, ..., 0xFFFFFFFE=Auto)
                  -name:x       Assign display name x to device. #2, #3, #4 will be appended case
multiple devices.
                <:n>            Specifies the n-th occurrence of a matching device
                <id>            Specifies the id of the devices.
                =<class>        Specifies a device setup class.

root_addorupdate -inf:<inf> <hwid>
                Updates a root enumerated driver or installs it when not found.
                -inf:<inf>      Specify a single inf file
                <hwid>          Specifies a hardware ID for the device.

root_add <inf> <hwid>
                Install root enumerated driver
                -inf:<inf>      Specifies an INF file with installation information for the device.
                <hwid>          Specifies a hardware ID for the device.

root_remove [-deldp] [<:n>] <id> [<id>...]
                Remove root enumerated driver
                -deldp          Deletes installed driver packages for all RtE devices
                <:n>            Specifies the n-th occurrence of a matching device
                <id>            Specifies the id of the devices.

find [<:n>] <id> [<id>...]
find [<:n>] =<class> [<id>...]
                List found devices
                <:n>            Specifies the n-th occurrence of a matching device
                <id>            Specifies the id of the devices.
                =<class>        Specifies a device setup class.

enable [<:n>] <id> [<id>...]
enable [<:n>] =<class> [<id>...]
                Enable found devices
                <:n>            Specifies the n-th occurrence of a matching device
                <id>            Specifies the id of the devices.
                =<class>        Specifies a device setup class.
```

disable [<:n>] <id> [<id>...]
disable [<:n>] =<class> [<id>...]

Disable found devices

<:n>	Specifies the n-th occurrence of a matching device
<id>	Specifies the id of the devices.
=<class>	Specifies a device setup class.

dp_add <inf>

Install driver package

-inf:<inf>	Specifies an INF file.

dp_delete <inf>

Remove driver package

-inf:<inf>	Specifies an Oem*.inf file.

ID Examples:

<pciid>	$5:2:0	PCI device with address bus 5 device 2 function 0
<hwid>	ISAPNP\PNP0501	Hardware ID
	'*PNP0501	Hardware ID with apostrophe (' prefixes literal match - matches exactly as typed, including the asterisk.)
<id>	*	All devices
	ISAPNP\PNP0501	Hardware ID
	PNP	Hardware ID with wildcards (* matches anything)
	@ISAPNP**	Instance ID with wildcards (@ prefixes instance ID)
	'*PNP0501	Hardware ID with apostrophe (' prefixes literal match - matches exactly as typed, including the asterisk.)
	=SYSTEM	All devices of class 'system'
	$5:2:0	PCI device with address bus 5 device 2 function 0
<:n> <id>	:2 '*PNP0501	2nd occurrence of Hardware ID with apostrophe

Calling RtosDevice() function:

- RtosDevice is provided by RtosLib32.dll or RtosLib64.dll. Please pay attention that on a 64bit system it is required to use RtosLib64.lib to succeed with device installation functions.
- Alternatively the Uploader (RtosUpload.exe) parameter '\device' can be used to forward a single string to RtosDevice(). To put multiple parameters into that string it has to be enclosed by quotation marks.
  This example will listing all COM devices:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-all find *PNP050*"<<

RtE Setup:

- During installation Setup will call
  >>RtosUpload.exe /nosleep /nowait /device "-noui rte_install -inf:\"$PATH_TO_RTE_RUNTIME$\Drivers\RTOS_Installer.inf\""<<
  to prepare for RtE device assignment.
- During uninstall Setup will call
  >>RtosUpload.exe /nosleep /nowait /device "-noui rte_uninstall -deldp"<<
  to assign all RtE devices back to Windows, Remove registrations and optionally delete all installed RtE driver packages, if "-deldp" was specified.

Assigning a Pro1000 to RtE

- Assigning all found instances:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "rte_add -inf:\"$PATH_TO_RTE_RUNTIME$\Drivers\" PCI\VEN_8086&DEV_10A7"<<
- Assign first occurrence only :
  >>C:\>RtosUpload.exe /nosleep /nowait /device "rte_add -inf:\"$PATH_TO_RTE_RUNTIME$\Drivers\" :1 PCI\VEN_8086&DEV_10A7"<<
- Assing by PCI address (Bus 3 Device 2 Function 0)
  >>C:\>RtosUpload.exe /nosleep /nowait /device "rte_add -inf:\"$PATH_TO_RTE_RUNTIME$\Drivers\" $3:2:0"<<
- Remove by PCI address (Bus 3 Device 2 Function 0)
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-noui rte_remove -deldp $3:2:0"<<
  This will also delete the driver package for this device.

Configuring a Pro1000

- Change interrupt to polling mode:
  This requires a specialized driver supporting polling mode. EC-Master LinkLayer for example are supporting this mode. Regular OS drivers will require an interrupt. If your driver requests an interrupt but the device is configured for polling mode probably an “unexpected interrupt id” message will appear when the driver starts.
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-noui rte_configure -int_mode:1 $3:2:0"<<
- Change interrupt to MSI mode:
  MSI is supported by most PCIe cards. Its useful to solve interrupt problems and can be configured calling:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-noui rte_configure -int_mode:2 $3:2:0"<<
- Assigning a device to another OS (Multi-RTOS):
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-noui rte_configure -osid:1 $3:2:0"<<
- Renaming a device:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-noui rte_configure -name:\"My New Device Name Pro1000\" $3:2:0"<<

Finding Pro1000

- Find all present Pro1000 on a system using Hardware ID:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-all find PCI\VEN_8086&DEV_10A7"<<
- Find all present Pro1000 on a system using Hardware ID and PCI addess B3-D0-F0:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "-all find $3:0:0"<<

Ensure a device is assigned to RTOS

- Ensure there are at least two Pro1000 assigned to RTOS:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "find :2 =RTOSDevices PCI\VEN_8086&DEV_10A7"<<
- Ensure there are at least 4 (unspecified) devices assigned to RTOS:
  >>C:\>RtosUpload.exe /nosleep /nowait /device "find :4 =RTOSDevices"<<

Assigning a PCI slot

This is usefull if you have a dedicated PCI slot being assigned to the RtE but different cards to be plugged in. It might also help if you’re using an OS imag on slightly different mainboards where device instance might be different.

As consequence of assigning a slot the device can be exchanged but will still be assigned to RtE automatically (in case the required drivers have been provided using for example ‘dp_add’ command).

- Assign PCI slot (Bus 3 Device 2 Function 0)
  >>C:\>RtosUpload.exe /nosleep /nowait /device "rte_add -slot -inf:\"$PATH_TO_RTE_RUNTIME$\Drivers\" $3:2:0"<<
- Remove PCI slot (Bus 3 Device 2 Function 0)
  >>C:\>RtosUpload.exe /nosleep /nowait /device "rte_remove -noui -slot $3:2:0"<<

10.1.20.1 RtosDeviceW

This function allows device configuration. See RtosDeviceA for details.

UINT32 RtosDeviceW (
const WCHAR* wszParams)

10.1.21 RTOS Library – memory reservation functions

RtosLib contains memory reservation functionality for reserving memory without starting RTOS. A setup can use this function to minimize the number of reboots required after installation to start a RTOS.

10.1.21.1 RtosSetMemoryConfigurationA

This function does install or remove memory reservation.

UINT32 RtosSetMemoryConfigurationA (
const CHAR* szParams
const CHAR* szConfigFileName)

Parameter
szParams
[in] Configuration parameter:
"-a" for install or update reservations (requires config file)
"-u" for uninstall reservations (will never ask for reboot)
"-ur" for uninstall reservations (will ask for reboot when required)
"-V" for validate reservations (requires config file)
szConfigFileName
[in] Config file – see comment for details

Return
RTE_SUCCESS on success and an error-code on failure.

Comment
The function does not require RtosLibInit to be called.

10.1.21.2 RtosSetMemoryConfigurationW

This function does install or remove memory reservation. See RtosSetMemoryConfigurationA for details.

UINT32 RtosSetMemoryConfigurationW (
const WCHAR* wszParams
const WCHAR* wszConfigFileName)

10.1.22 RTOS Library – virtual I/O (VIO) functions

RtosLib VIO functions allow reading and, if supported by the counterpart, writing to a virtual channel. Such a virtual channel is used by each OS for message output and (if supported) command input. The PuTTY based debug console is using this interface.

10.1.22.1 RtosVioCreate61

This function creates a handle to read or write to a VIO channel.

```
UINT32 RtosVioCreate61 (
    UINT32              dwChannelIndex
    BOOL                bIsPrimary
    RTOSLIB_HANDLE*     phObject )
```

Parameter

dwChannelIndex

[in] Channel index (0, 1, …) – default OS channel equals the OS id.

bIsPrimary

[in] Virtual I/O data are transferred between the primary OS, which usually is Windows, and the secondary OS (SOS), which usually is the RTOS.

phObject

[in] Pointer to receive a RTOSLIB_HANDLE object (VIO).

Return

RTE_SUCCESS on success and an error-code on failure.

Comment

The function does not require RtosLibInit to be called.

10.1.22.2 RtosVioClose

This is a synonym for RtosObjectClose. See RtosObjectClose for details.

```
UINT32 RtosVioClose (
    RTOSLIB_HANDLE      hObject )
```

10.1.22.3 RtosVioRead

This is a synonym for RtosObjectRead. See RtosObjectRead for details.

```
UINT32 RtosVioRead(
    RTOSLIB_HANDLE      hObject,
    UINT8               *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesRead,
    UINT32              dwTimeoutMs )
```

10.1.22.4 RtosVioWrite

This is a synonym for RtosObjectWrite. See RtosObjectWrite for details.

```
UINT32 RtosVioWrite(
    RTOSLIB_HANDLE      hObject,
    const UINT8         *pBuffer,
    UINT32              dwBufferSize,
    UINT32              *pdwBytesWritten,
    UINT32              dwTimeoutMs )
```

10.2 RTOS Library example applications

Shipped with VmfWin are some example applications for VxWorks and Windows CE which show how to use the RTOS library in a user application. The example applications may serve as a starting point.

The following examples are extracted from the ACONTIS CeWin product (Windows CE + Windows)
…\Examples\RtosLib\CeWin\WinCE
→ Windows CE example applications
…\Examples\RtosLib\CeWin\Windows
→ Windows example applications

The following examples are extracted from the ACONTIS VxWin product (VxWorks + Windows)
…\Examples\RtosLib\VxWin\VxWorks
→ VxWorks example applications
…\Examples\RtosLib\VxWin\Windows
→ Windows example applications

10.3 RTOS Library – compatibility issues for VxWin and CeWin 3.5

Most of the RTOS Library functions are compatible with VxWin 3.5 and CeWin 3.5.

10.3.1 Compatibility mode

To enable compatibility mode within existing applications some macros have to be defined prior to including RtosLib.h:

a) VxWin 3.5, CeWin 3.5 – Windows side of the application

```
#define RTOSLIB_API_VERSION   35
#define RTOSLIB_WIN
#include <RtosLib.h>
```

b) VxWin 3.5 – VxWorks side of the application

```
#define RTOSLIB_API_VERSION   35
#define RTOSLIB_VXWORKS
#include <RtosLib.h>
```

c) VxWin 3.5 – Windows CE side of the application

```
#define RTOSLIB_API_VERSION   35
#define RTOSLIB_WINCE
#include <RtosLib.h>
```

10.3.2 Initialization

Prior to using the RTOS Library it has to be initialized. See section 10.1.3 for more information. Existing applications have to be adjusted appropriately.

10.3.3 Time/date and timezone synchronization

- RtosSetClockMaster()
  Dynamically setting the clock master (time and date) is deprecated. Setting a clock master for an OS has to be done statically by configuration settings.
- RtosStartTimeSync()
  This function has been replaced by RtosTimeSyncStart().
  The priority of the started task can be set using system functions. The default is lowest priority.
- RtosStopTimeSync()
  This function has been replaced by RtosTimeSyncStop ().

10.3.4 Function SetOutputStream

The function SetOutputStream does not exist in the new RTOS Library. Instead the new function RtosSetOutputPrintf (see chapter 10.1.10.2) should be used.

11 Licensing

11.1 EC-Master (MAC-ID)

11.1.1 General

This product requires a valid license to be run. If your project also requires a MAC-ID licensed EC-Master it's possible to use the MAC-ID based license of EC-Master to get this product licensed. Finally one MAC-ID based licence is required to get both products (RTOS VM and EC-Master) licensed.

11.1.2 Required steps

Add the following function call of the EC-Master library o your project and recompile it.

- `ecatSetLicenseKey("__LICENSE_KEY__");`

No further actions are needed.
For additional information please check-out the specific EC-Master manual.

Hint: It's recommended that the call of `ecatSetLicenseKey` is done somewhere at start-up of the application.

11.2 CodeMeter

11.2.1 USB or virtual Dongle

CodeMeter supports a hardware solution based on different types of USB dongles and a software solution using a machine specific virtual dongle.
Aside from the first configuration is their handling equal.

CodeMeter requires the “CodeMeter Runtime-Kit” to recognize the licenses. This Kit will be automatically installed by our product setup.
It can alternatively be downloaded from “http://wibu.com/download_user.php”.

11.2.2 USB dongle already containing a License

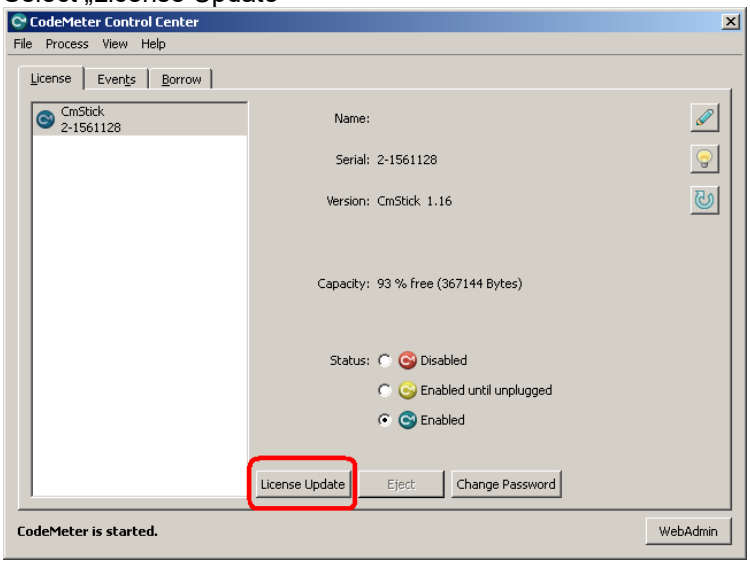
If you received an USB-Dongle including the license you can just plug the dongle into the PC and as soon as it is recognized the „CodeMeter Control Center“ will change its icon from grey to green.

11.2.3 USB dongle not yet containing a License

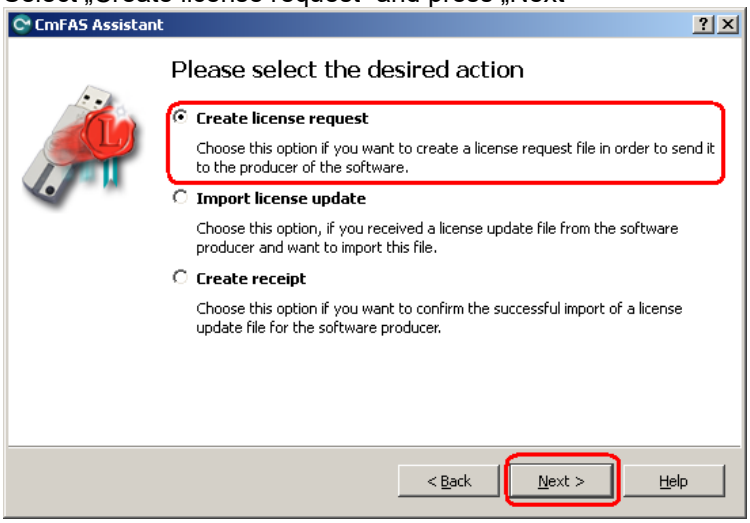
In case you already own an USB-Dongle and want to add a license you need to create a license request and send it to your support contact to receive a license update.

11.2.3.1 Generate license request

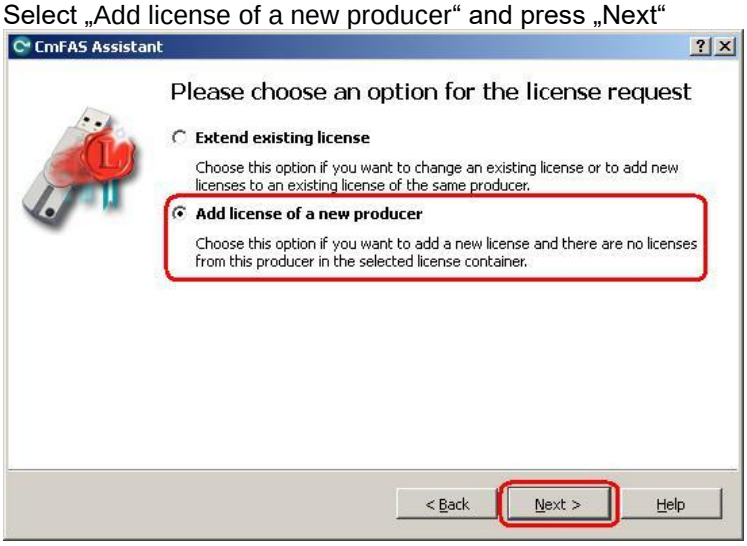
- Plug in your dongle
- Open „CodeMeter Control Center“ and select the dongle you want to receive a new license or a license update for.
- Select „License Update“



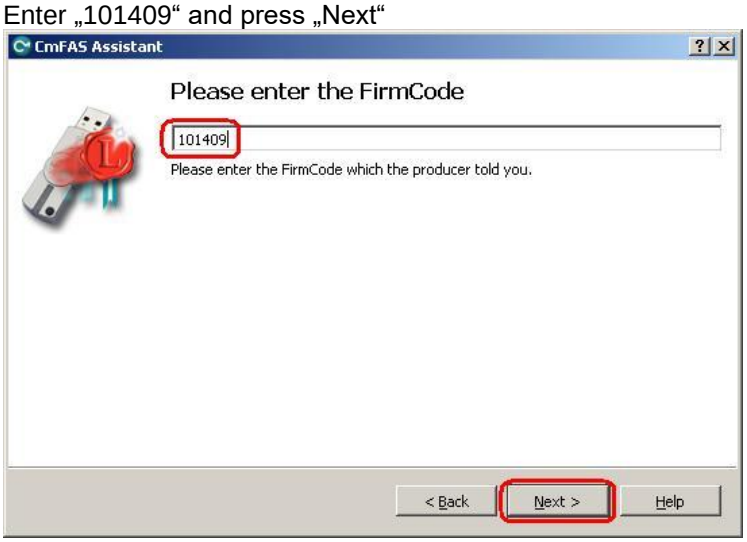
- Press „Next“
- Select „Create license request“ and press „Next“



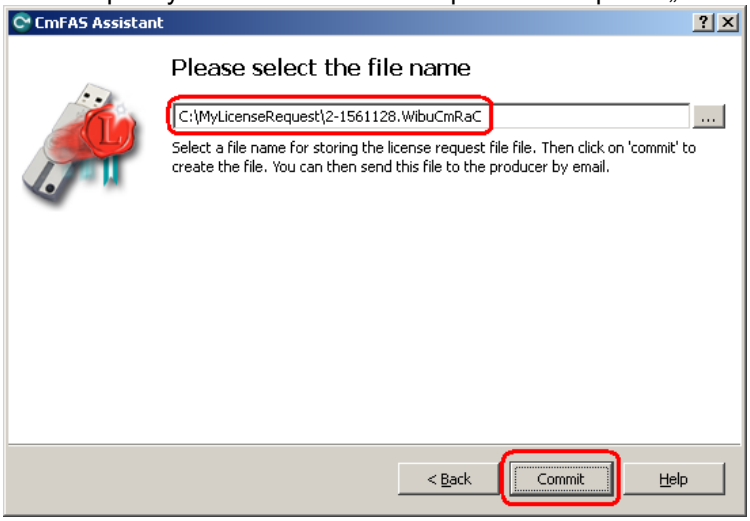
- Select „Add license of a new producer“ and press „Next“



- Enter „101409“ and press „Next“



- Select a path you want to save the request to and press „Commit“



Please send the created file to your support contact requesting a new license.

11.2.3.2 Import a new license or a license update

If your support contact sent you a license update file (“YourFilename.WibuCmRaU”) you may install it as described at “11.2.5.2

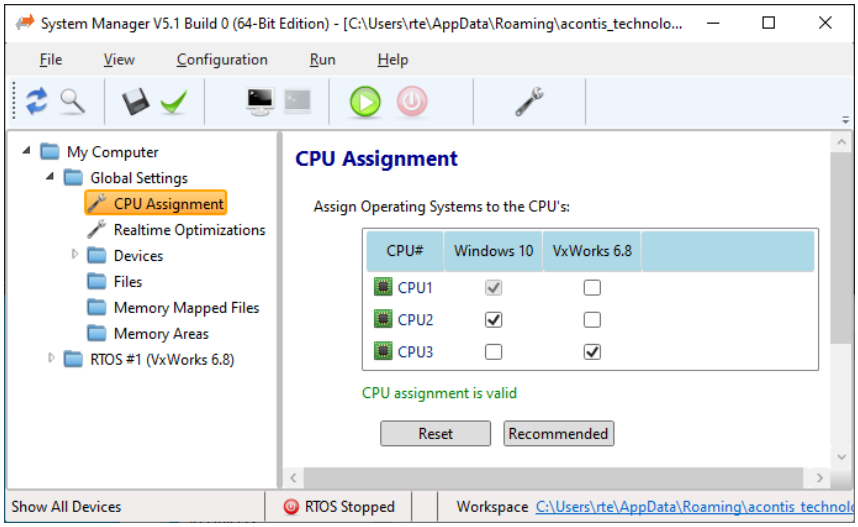
Import a license update”

11.2.4 Virtual Dongle

11.2.4.1 Virtual Machine (VM) usage

A Virtual Dongle license is bound to the hardware and a VM represents configurable, virtualized hardware, so attention must be paid not to break the license.
We are using the recommended configuration for our CmActLicense: SmartBind with a tolerance value of “2”.
CodeMeter documentation says:

> The behavior of CmActLicense with the binding scheme SmartBind for licenses in a VM is defined as follows:
> - If the VM is copied. i.e. the "I copied it" option has been selected, the license becomes invalid.
> - If the VM is moved, i.e. the "I moved it" option has been selected, then the license remains intact in case of the same CPU types.
>   However, if the CPU types differs, the license also becomes invalid except the tolerance level has been set to a value of "3" (loose).
> - If a previously created snapshot of the VM is reverted, the license becomes invalid.



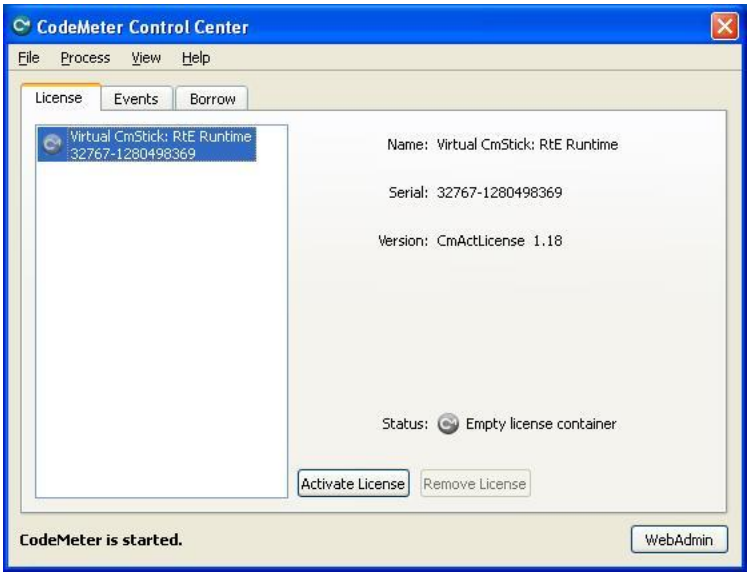
It is also required to configure the correct number of Windows CPUs before starting the following license activation.

Please do not change any configuration between generating the license request and installing the received license-update or the update might fail.

11.2.4.2 Import empty license container

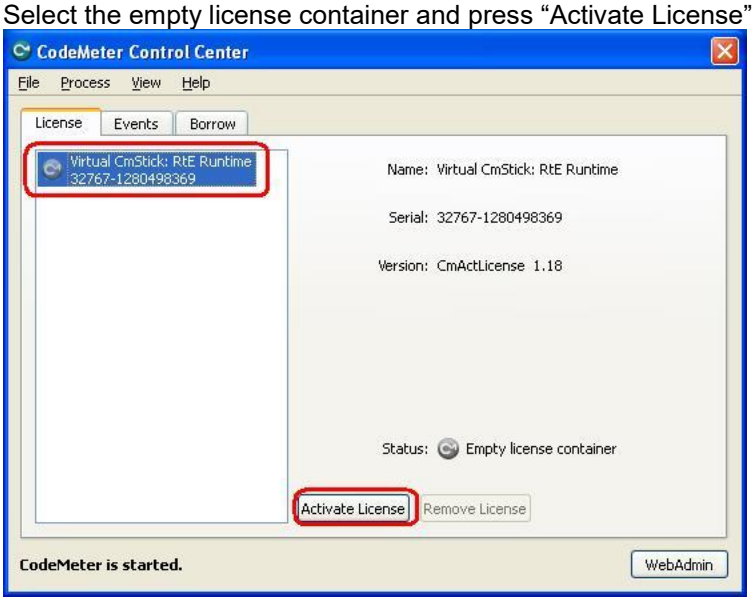
For the software based solution you need a "*.WibuCmLIF" file which can typically be found in your downloaded License Package .zip file. Please ask your sales contact to select the correct one.

- Open „CodeMeter Control Center“
- Drop the file "FileAsToldBySales.WibuCmLIF" from the File-Explorer into the “CodeMeter Control Center”



11.2.4.3 Activate License

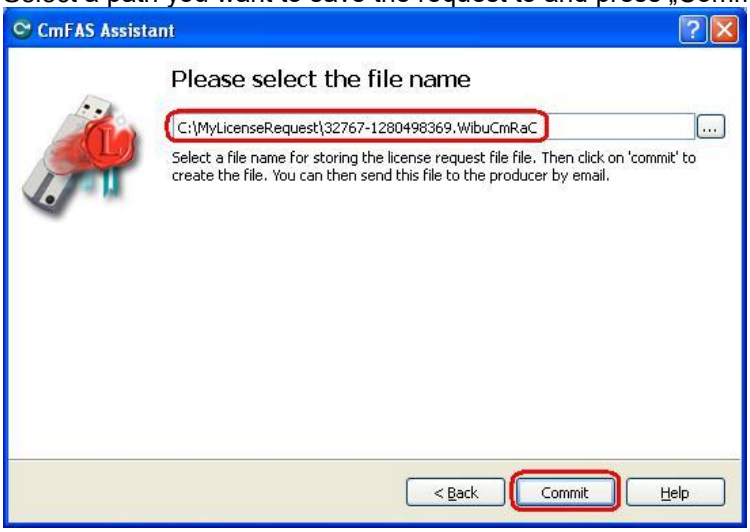
- Open „CodeMeter Control Center“
- Select the empty license container and press “Activate License”



- press “Next”

- Select “Create license request” and press “Next”

- Select a path you want to save the request to and press „Commit“



Please send the created file to your support contact requesting a new license.

11.2.4.4 Import a new license or a license update

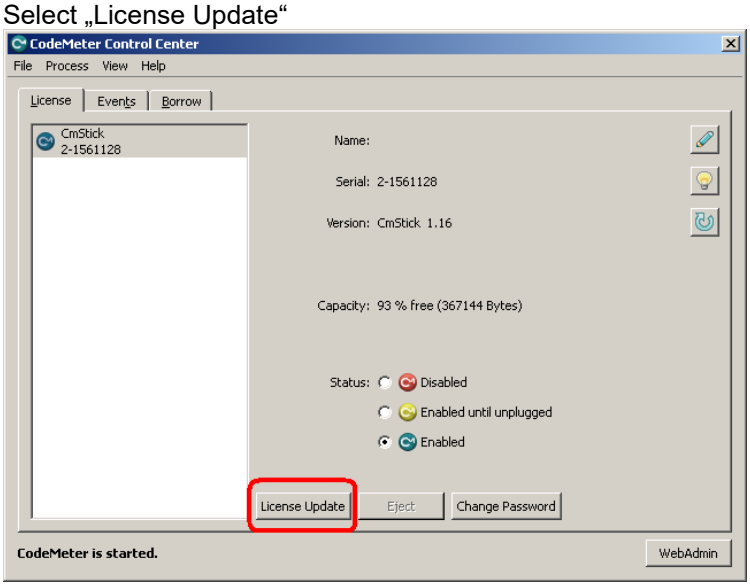
If your support contact sent you a license update file (“YourFilename.WibuCmRaU”) you may install it as described at “11.2.5.2 Import a license update”

11.2.5 Update a license

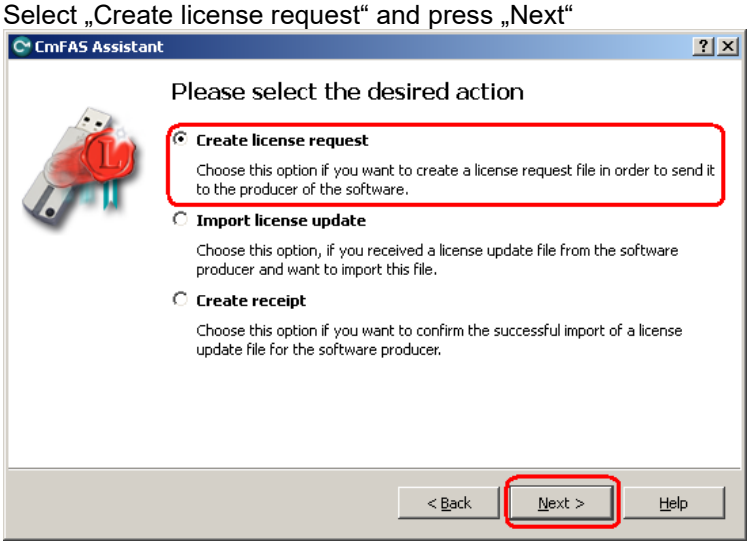
In this case you need to create a license request and send it to your support contact to receive a license update.

11.2.5.1 Generate license request

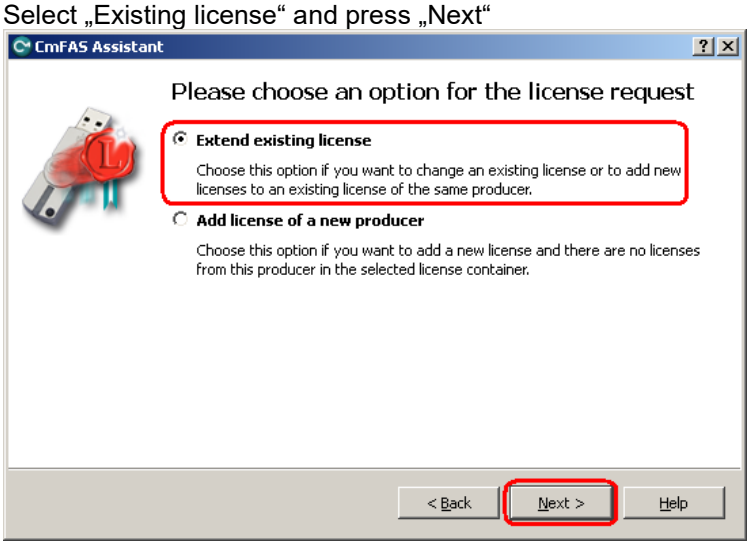
- Open „CodeMeter Control Center“ and select the dongle you want to receive a license update for.
- Select „License Update“



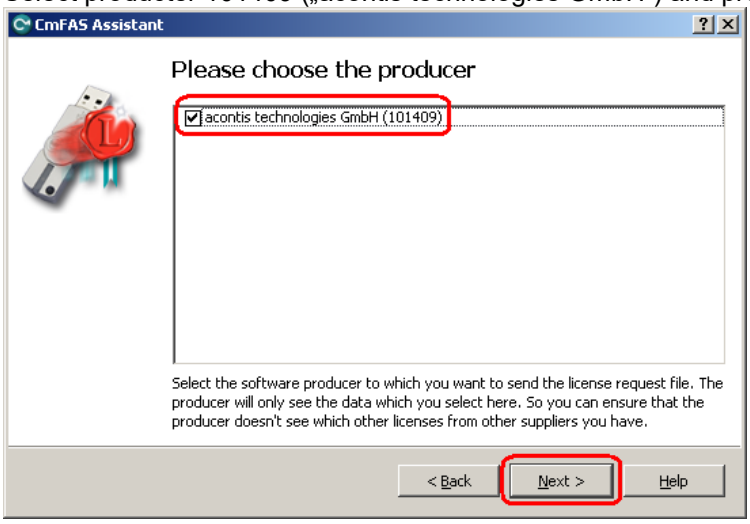
- Press „Next“
- Select „Create license request“ and press „Next“



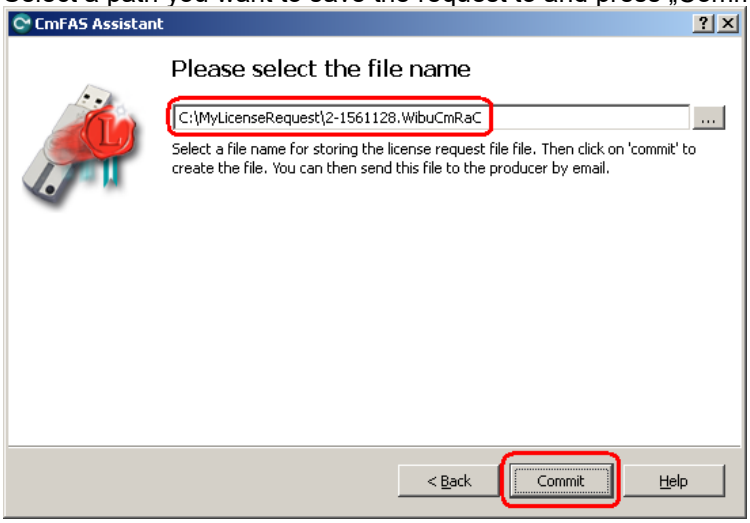
- Select „Existing license“ and press „Next“



- Select producter 101409 („acontis technologies GmbH“) and press „Next“



- Select a path you want to save the request to and press „Commit“

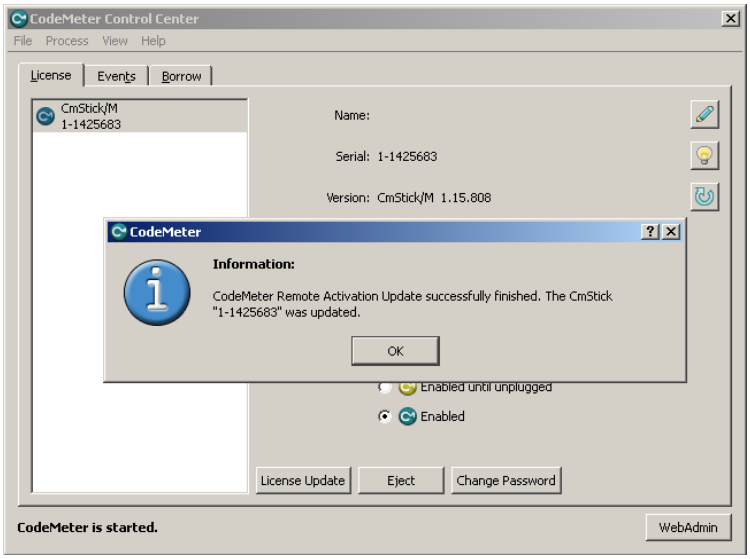


Please send the created file to your support contact requesting a new license.

11.2.5.2 Import a license update

If your support contact sent you a license update file (“YourFilename.WibuCmRaU”) you may install it using the “CodeMeter Control Center”.

- Open „CodeMeter Control Center“
- Drop the file “YourFilename.WibuCmRaU” from the File-Explorer into the “CodeMeter Control Center”



11.2.6 Sharing a License

Depending on your license it is possible to share it over a network. This allows to plug the dongle into a license server and use its license(s) from another PC over the network.

A license which can only be used locally:

Licenses which can be used over the network:

11.2.6.1 Single PC

The “CodeMeter Runtime-Kit” was installed by the product setup. You can just plug the dongle into the PC and as soon as it is recognized the „CodeMeter Control Center” will change its icon from grey to green.

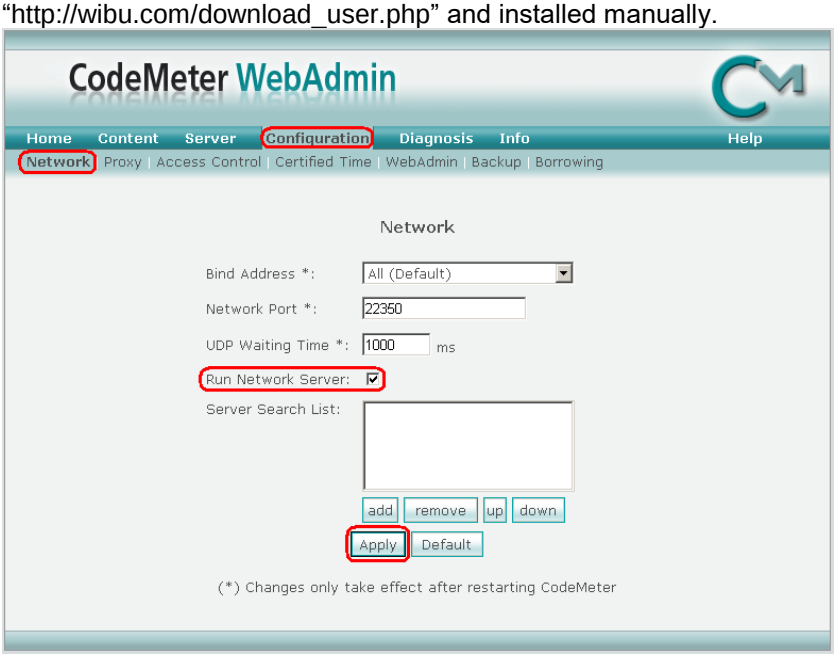
11.2.6.2 Two PCs with dongle on target

If you have a PC with the runtime environment (target) where you want to plug the dongle in and a development PC (host) you need the “CodeMeter Runtime-Kit” being installed on the target PC. This should already be done by the product setup. You can just plug the dongle into the target PC and as soon as it is recognized the „CodeMeter Control Center” will change its icon from grey to green.

11.2.6.3 Two PCs with dongle on host

If you have a PC with the runtime environment (target) and a development PC (host) where you want to plug the dongle in you need the “CodeMeter Runtime-Kit” being installed on both PC. This should already be done by the product setup if you used it to install runtime components on the target and

development components on the host.
Alternatively the “CodeMeter Runtime-Kit” can be downloaded from “http://wibu.com/download_user.php” and installed manually.



On your host PC you must configure the “CodeMeter Control Center” to act as license server:

- Open “CodeMeter Control Center”
- Click “WebAdmin”
- Select “Configuration” – “Network”
- Enable “Run Network Server”
- Press “Apply”

11.2.7 Troubleshooting

If a license error occurs in spite of a valid license possibly the Dongle has an incorrect time.
In this case the time has to be updated:

- Open „CodeMeter Control Center“
- Select „WebAdmin“
- Select „Content“ and „CmStick“

- Press “Update” to update the time. A connection to the internet will be required.

12 RTOSWin OEM Branding

12.1 General

By default the ACONTIS RTOS-VM runtime modules show up with ACONTIS product branding.
The RTOSWin solution provider or RTOSWin OEM customer may want to use his own brand labels instead of the ACONTIS branding.
The ACONTIS RTOS-VM runtime modules provide mechanisms to customize manufacturer specific product information. This can be achieved by some RTOS-VM specific functions and also by common Microsoft Windows configuration possibilities.

12.2 Module specific Branding

12.2.1 RtosDrv.sys

The driver RtosDrv.sys hosts several product information like company name, registry base path, product support internet address and product name. These informations are configured in the file “RtosDrv.inf” which is used to install the driver. After the installation these values are part of the driver registry values and provided by the RtosDrv to several RTOS-VM applications.

These values can either be modified in the “RtosDrv.inf” file or later in the registry.

Because the registry path (HKLM\SYSTEM\CurrentControlSet\Enum\Root\SYSTEM\xxxx\Device Parameters\Product , where xxxx is a system specific number) contains an computer specific element this way is only applicable on identical configured systems.

Within RtosDrv.inf the product specific information can be found in the last block at the end of the file. Additional information about the driver containing the company name (the second last block) might also be adapted.
Changing a file will invalidate the given driver signature and Windows will warn about an unsigned driver at installation time. This can be solved with a new signature. How to sign a driver and the limitations is not part of this document. Please contact ACONTIS support in case a new signature shall be generated.

12.2.2 RtosVnet.sys and RTOS_xxx.inf

Information about the driver manufacturer can be found in the the last block of the file and might be adapted. Changing a file will invalidate the given driver signature and Windows will warn about an unsigned driver at installation time. This can be solved with a new signature. How to sign a driver and the limitations is not part of this document.

12.2.3 RtosService.exe

Name and descriptions can be changed using the Windows Service Controller API to manually register / un-register the service instead of calling “RtosService.exe INSTALL” and “RtosService.exe UNINSTALL”. Additionally most Setup programs, like for example InstallShield, are providing functionalities to register and un-register services using custom name and description.
The application embedded icon (displayed in the Explorer) can be replaced using a binary resource editor tool.

12.2.4 RtosControl.exe

The application's embedded icon (displayed by the Windows Explorer) can be replaced using a binary resource editor tool. Additionally RtosControl.exe supports replacement of images shown in dialogs by adding a file to the applications directory:

Dialog	Description	Required filename
Taskbar / About dialog	Application icon	RTOSControl.ico
Evaluation dialog	Company logo	RTOSControl02.bmp
Evaluation dialog	Product logo	RTOSControl03.bmp

12.2.5 UploadRtos.exe (RTE <=4.x) or RtosUpload.exe (RTE >=5.x)

The application's embedded icon (displayed by the Windows Explorer) can be replaced using a binary resource editor tool. Most error message texts can be changed in
- UploadRtos.dll (RTE <=4.x)
- RtosLib32.dll and RtosLib64.dll (RTE >=5.x)

using a resource editor. As an alternative a customer written Uploader.exe could be used.

12.2.6 RtosPnp.sys

The Windows Device Manager shows an ACONTIS specific icon for the Rtos device class, which can be changed. This icon is part of the RtosPnpInstaller.dll which can be found in windows\system32 directory and the Rtos-Infs directory. There are several possibilities to change the icon:

1. Use an resource editor to edit the dll and change the icon
2. Use an resource editor to edit the dll and change add an additional icon + change the value of "Icon" which can be found twice in each RTOS_xxx.inf.
   A value of "0" represents the first icon of the dll, the value "1" is reserved.
3. Change the value of "Icon" which can be found twice in each RTOS_xxx.inf to a negative value.
   Negative values represent the system predefined icons. "-18" for example represents the "Unknown" icon (18).

Changing a file will invalidate the given driver signature and Windows will warn about an unsigned driver at installation time. This can be solved with a new signature. How to sign a driver and the limitations is not part of this document.

To update a system where RtosPnpInstaller.dll is already installed with a new icon number you must change the value of "Icon" in at least one of the RTOS_xxx.inf files, then right-click on the modified file and choose "install". After that the RTOS device class should use the new icon (perhaps a reboot might additionally be required).

13 Windows Update considerations

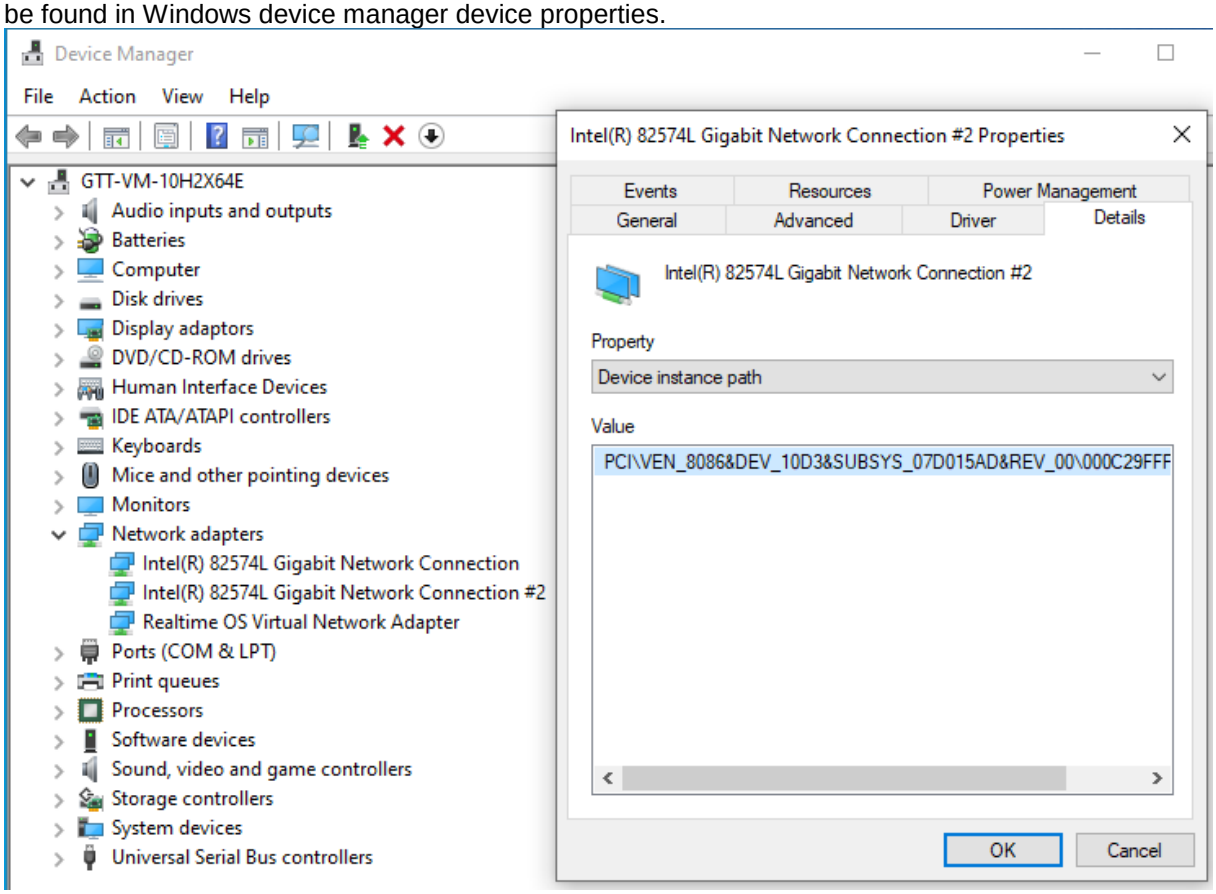
We strongly recommend using Windows LTS version to avoid feature update problems.

Nevertheless it is required to ensure the correct system configuration after updates are applied. Since this is often done during a (re)boot the check should be after booting, but before starting RTOS.

We provide the following example script for such a task. There are some configurations which must be adapted like for example

- Configuration path
- Image path
- Devices to be assigned

The “Device instance path”, as used by the script for RTOS device assignment and configuration, can be found in Windows device manager device properties.



Example code:

```
@ECHO OFF
SETLOCAL

REM -------------------------------------------------------------------------
REM  Function:
REM  To ensure a concrete system- / device- / memory- configuration
REM
REM  Requirements:
REM  This function must be called with administrator priviledges to work properly.
REM
REM  Recommendations:
REM  - Use a Windows LTS version to prevent unexpected behaviour caused by feature updates.
REM  - Config file entry:
REM    [Upload]
REM    "BootCodeReservationForce"=dword:1  ; prevent additional reboot
REM
REM  History:
REM  20201120,GTt New: Created
REM
REM -------------------------------------------------------------------------

REM Configuration settings
REM TODO: Change to meet your requirements.
REM
REM Reminder:
REM Variable 'WORKSPACE' is also required by SystemManager generated config files so it
REM should be valid when starting RTOS.
REM
SET /A "CPUCOUNTWIN=2"
SET    "WORKSPACE=C:\Users\rte\AppData\Roaming\acontis_technologies\workspaces\default"
SET    "RTECFG=%WORKSPACE%\config\startup.config"
SET    "RTEIMG=%WORKSPACE%\RtFiles\Loader.bin"

REM Global variables
SET /A "REBOOTREQUIRED=0"


REM -------------------------------------------------------------------------
REM Environment checks
REM -------------------------------------------------------------------------

REM Check for RTE_ROOT environment variable
IF NOT DEFINED RTE_ROOT (
  ECHO ERROR: Environment variable RTE_ROOT not defined
  GOTO ExitError
)

REM Check for Uploader
IF NOT EXIST "%RTE_ROOT%RtosUpload.exe" (
  ECHO ERROR: Could not find "%RTE_ROOT%RtosUpload.exe"
  GOTO ExitError
)
ECHO INFO: Using Uploader "%RTE_ROOT%RtosUpload.exe"
SET "RTEUPLOAD="%RTE_ROOT%RtosUpload.exe" -nosleep -nowait"

REM Check for driver directory
IF NOT EXIST "%RTE_ROOT%Drivers\RTOS_Installer.inf" (
  ECHO ERROR: Could not find "%RTE_ROOT%RtosUpload.exe"
  GOTO ExitError
)
ECHO INFO: Using drivers from "%RTE_ROOT%Drivers\"

REM Check for admin rights: "net.exe session" will fail without them
>NUL 2>&1 net.exe session
IF %ERRORLEVEL% NEQ 0 (
  ECHO ERROR: Administrator rights are required
  GOTO ExitError
)


REM -------------------------------------------------------------------------
REM Restore Device Configuration
REM -------------------------------------------------------------------------
REM TODO: Comment out or change to meet your requirements!

ECHO INFO: Devices - Stop any running RTOS before device configuration
>NUL %RTEUPLOAD% -x

ECHO INFO: Devices - ensuring RtE device support
%RTEUPLOAD% -device "-noui rte_install -inf:\"%RTE_ROOT%Drivers\RTOS_Installer.inf\""
CALL :CheckRteRetVal "%ERRORLEVEL%"
```

```
IF ERRORLEVEL 1 GOTO ExitError

ECHO INFO: Devices - ensuring assignment of COM1.
%RTEUPLOAD% -device "-noui rte_add -inf:\"%RTE_ROOT%Drivers\" @ACPI\PNP0501\1"
CALL :CheckRteRetVal "%ERRORLEVEL%"
IF ERRORLEVEL 1 GOTO ExitError

ECHO INFO: Devices - ensuring assignment of a network card.
%RTEUPLOAD% -device "-noui rte_add -inf:\"%RTE_ROOT%Drivers\"
@PCI\VEN_8086&DEV_10D3&SUBSYS_07D015AD&REV_00\000C29FFFF2C515C00"
CALL :CheckRteRetVal "%ERRORLEVEL%"
IF ERRORLEVEL 1 GOTO ExitError

ECHO INFO: Devices - ensuring polling mode for the network card.
%RTEUPLOAD% -device "-noui rte_configure -int_mode:1
@PCI\VEN_8086&DEV_10D3&SUBSYS_07D015AD&REV_00\000C29FFFF2C515C00"
CALL :CheckRteRetVal "%ERRORLEVEL%"
IF ERRORLEVEL 1 GOTO ExitError


REM -------------------------------------------------------------------------
REM Restore System Configuration
REM -------------------------------------------------------------------------
REM TODO: Comment out or change to meet your requirements!

REM Ensure Windows uses the correct number of processors {always required}.
CALL :CheckBcdVal "Current" "NumProc" "%CPUCOUNTWIN%"
IF ERRORLEVEL 1 GOTO ExitError

REM Ensure APIC is not used by host {required when 1st core is a shared core}
CALL :CheckBcdVal "Current" "UsePlatformTick" "Yes"
IF ERRORLEVEL 1 GOTO ExitError

REM Ensure BADMEMORY is not accessable {always required}
CALL :CheckBcdVal "Current" "BadMemoryAccess" "No"
IF ERRORLEVEL 1 GOTO ExitError
CALL :CheckBcdVal "BadMemory" "BadMemoryAccess" "No"
IF ERRORLEVEL 1 GOTO ExitError

REM Disable Virtualization based security {required when using RA reservation: Firmware!=UEFI
and OS requires "MemoryStartAddress"  }.
CALL :CheckRegVal "HKLM\System\CurrentControlSet\Control\Session Manager\Power"
"HiberbootEnabled" "0x0"
IF ERRORLEVEL 1 GOTO ExitError

REM Ensure APIC is not in unsupported x2 mode {always required}.
CALL :CheckBcdVal "Current" "x2ApicPolicy" "Disable"
IF ERRORLEVEL 1 GOTO ExitError

REM Ensure Hyper-V is disabled {always required}.
CALL :CheckBcdVal "Current" "HypervisorLaunchType" "Off"
IF ERRORLEVEL 1 GOTO ExitError

REM Disable Virtualization based security {always required}.
CALL :CheckRegVal "HKLM\System\CurrentControlSet\Control\DeviceGuard"
"EnableVirtualizationBasedSecurity" "0x0"
IF ERRORLEVEL 1 GOTO ExitError


REM -------------------------------------------------------------------------
REM Restore Memory Configuration
REM -------------------------------------------------------------------------

REM Start RTOS
REM
REM Known obstacles
REM - When Hyper-V is enabled, VMF VT-x is configured and RTOS requires "MemoryStartAddress"
Uploader will fail with 0x0531440A.
REM   To avoid this use memory configuration update instead of starting RTOS.
REM
IF %REBOOTREQUIRED% EQU 0 (
  REM Reboot not yet required. Try to start directly to save some time.
  ECHO INFO: Starting RTOS: %RTEUPLOAD% -config "'%RTECFG%'" "%RTEIMG%"
  %RTEUPLOAD% -config "'%RTECFG%'" "%RTEIMG%"
) ELSE (
  REM Reboot already required. Try to save another by checking only memory configration.
  ECHO INFO: Checking memory configuration: %RTEUPLOAD% -memcfg "-a" -config "'%RTECFG%'"
  %RTEUPLOAD% -memcfg "-a" -config "'%RTECFG%'"
)
CALL :CheckRteRetVal "%ERRORLEVEL%"
IF ERRORLEVEL 1 GOTO ExitError
```

```
REM -------------------------------------------------------------------------
REM DONE!
REM -------------------------------------------------------------------------
IF %REBOOTREQUIRED% NEQ 0 (
  GOTO ExitReboot
)
GOTO ExitOk


REM -------------------------------------------------------------------------
REM Sub programs
REM -------------------------------------------------------------------------

REM -------------------------------------------------------------------------
:CheckBcdVal
SETLOCAL
SET "TMP_Store=%~1"
SET "TMP_Property=%~2"
SET "TMP_Value=%~3"

ECHO INFO: Checking BCD "{%TMP_Store%}" "%TMP_Property%"
bcdedit.exe /enum {%TMP_Store%} |find /I "%TMP_Property%" |find /I "%TMP_Value%" >NUL
IF ERRORLEVEL 1 (
  bcdedit.exe /set {%TMP_Store%} %TMP_Property% %TMP_Value% >NUL
  IF ERRORLEVEL 1 (
    ECHO ERROR executing "bcdedit.exe /set {%TMP_Store%} %TMP_Property% %TMP_Value%"
    GOTO ExitError
  )
  ECHO UPDATE: SET "{%TMP_Store%}" "%TMP_Property%" to "%TMP_Value%"
  SET /A "REBOOTREQUIRED=1"
)
ECHO.
REM Use round brackets to get var value beyond 'endlocal'
(
  ENDLOCAL
  SET /A "REBOOTREQUIRED=%REBOOTREQUIRED%"
)
GOTO ExitOk


REM -------------------------------------------------------------------------
:CheckRegVal
SETLOCAL
SET "TMP_Key=%~1"
SET "TMP_ValName=%~2"
SET "TMP_ValData=%~3"

ECHO INFO: Checking registry "%TMP_Key%" "%TMP_ValName%"
reg.exe QUERY "%TMP_Key%" /v "%TMP_ValName%" |find /I "%TMP_ValData%" >NUL
IF ERRORLEVEL 1 (
  reg.exe ADD "%TMP_Key%" /v "%TMP_ValName%" /t REG_DWORD /d %TMP_ValData% /f >NUL
  IF ERRORLEVEL 1 (
    ECHO ERROR executing "reg.exe ADD '%TMP_Key%' /v '%TMP_ValName%' /t REG_DWORD /d
%TMP_ValData% /f"
    GOTO ExitError
  )
  ECHO UPDATE: SET "%TMP_Key%" "%TMP_ValName%" to "%TMP_ValData%"
  SET /A "REBOOTREQUIRED=1"
)
ECHO.
REM Use round brackets to get var value beyond 'endlocal'
(
  ENDLOCAL
  SET /A "REBOOTREQUIRED=%REBOOTREQUIRED%"
)
GOTO ExitOk


REM -------------------------------------------------------------------------
:CheckRteRetVal
SETLOCAL
SET /A "TMP_Error=%~1 & 0xFFFF"

IF %TMP_Error% EQU 0 (
  GOTO ExitOk
) ELSE IF %TMP_Error% EQU 260 (
  IF %REBOOTREQUIRED% NEQ 1 (
    ECHO ERROR : HiberbootEnabled set but not detected/corrected.
    GOTO ExitError
  )
) ELSE IF %TMP_Error% EQU 261 (
```

```
  IF %REBOOTREQUIRED% NEQ 1 (
    ECHO ERROR : BadMemoryAccess allowed but not detected/corrected.
    GOTO ExitError
  )
) ELSE IF %TMP_Error% EQU 262 (
  IF %REBOOTREQUIRED% NEQ 1 (
    ECHO ERROR : HypervisorLaunchTypeAuto set but not detected/corrected.
    GOTO ExitError
  )
) ELSE IF %TMP_Error% EQU 263 (
  IF %REBOOTREQUIRED% NEQ 1 (
    ECHO ERROR : EnableVirtualizationBasedSecurity set but not detected/corrected.
    GOTO ExitError
  )
) ELSE IF %TMP_Error% EQU 4226 (
  ECHO REBOOT : Required to update memory and/or device configuration"
  SET /A "REBOOTREQUIRED=1"
) ELSE IF %TMP_Error% EQU 14932 (
  IF %REBOOTREQUIRED% NEQ 1 (
    ECHO ERROR : LocalApic is in use by host but not detected/corrected.
    GOTO ExitError
  )
) ELSE IF %TMP_Error% EQU 14933 (
  IF %REBOOTREQUIRED% NEQ 1 (
    ECHO ERROR : LocalApic is running in unsupported x2APIC mode but not detected/corrected.
    GOTO ExitError
  )
) ELSE (
  EXIT /B %~1
)
REM Use round brackets to get var value beyond 'endlocal'
(
  ENDLOCAL
  SET /A "REBOOTREQUIRED=%REBOOTREQUIRED%"
)
GOTO ExitOk

REM --------------------------------------------------------------------------
REM Exits
REM --------------------------------------------------------------------------

:ExitReboot
ECHO INFO: Reboot required
EXIT /B 2

:ExitError
EXIT /B 1

:ExitOk
EXIT /B 0

REM --------------------------------------------------------------------------
REM End Of File
REM --------------------------------------------------------------------------
```

Exit codes::

- 0 = RTOS was successfully started
- 1 = an unknown error occurred and RTOS could not be stated.
- 2 = a reboot is required before RTOS can be started.

14 Appendix A – Platforms and performance

14.1 Real Time behavior and the RTOS-VM

When running on top of the RTOS-VM a RTOS can interrupt every Windows application and device driver at any time when running in shared mode. In exclusive mode the RTOS runs completely independent from and fully parallel to Windows.
This guarantees real-time performance and deterministic behavior for the RTOS.

However, one must nonetheless be careful about using PC cards that make long DMA (direct memory access) transfers, for DMA transfers can considerably increase interrupt latency time.

For example, consider a graphics card that wants to copy graphics data from PC memory into its own graphics memory. Normally, the CPU has access to the PC memory, but if the graphics card adapter requests a DMA transfer, the CPU gives up control of the bus. While the graphics card monopolizes the bus (to copy data into its own RAM), the CPU must wait until the DMA transfer has completed. While the CPU is waiting to reacquire the bus, it can neither respond to interrupts nor execute code in the usual fashion.

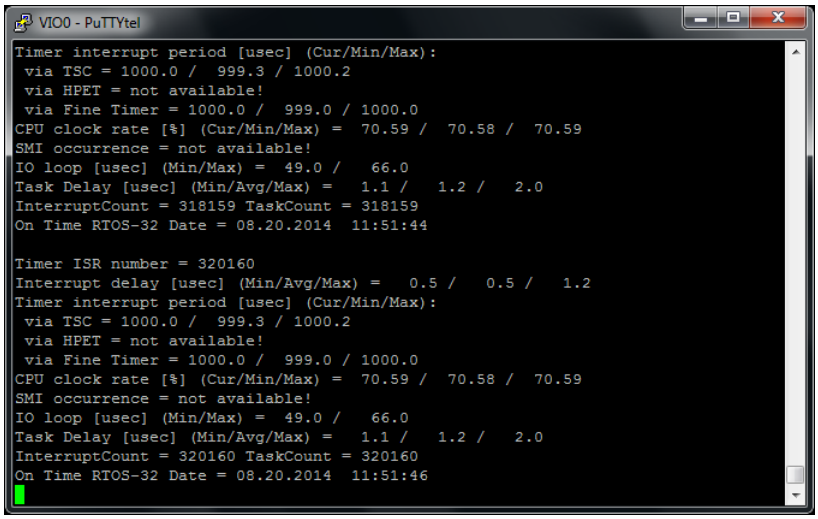
This problem is so tightly bound to an inflexible aspect of the hardware that the RTOS-VM can do nothing to effectively relieve the situation.

14.2 Platform Evaluation

Prior to using the RTOS-VM you have to verify that the PC platform where the RTOS is supposed to run will fulfill your real-time requirements. While keeping your real-time criteria in mind, you must determine that the interrupt latency times in your system are satisfactory. If it so happens that the latency is greater than you expect, you should investigate to determine if this is being caused by DMA operations. And if DMA is indeed the problem, you should then try to discover which hardware device is causing it, for in many cases the DMA-problem can be solved.
To evaluate the real-time behavior of your PC platform you need to use two types of tools: one to generate load on Windows and a second to measure real-time response in the RTOS.

Of the readily available tools for creating loads in Windows, a good one is PassMark's "BurnIn Test," a shareware tool. Refer to http://www.passmark.com/products/bit.htm. With this tool you can, for example, specify which hardware device to test, how long a test should last, and so on.
To measure real-time latency, you will have to use a test application running on the RTOS. Most RTOS-VM based solution will ship such a tool called "RealtimeDemo":

- RTOS-32: Start image "RealtimeDemo.bin"
- CE: Call "RealtimeDemo" from shell
- VxWorks: Call "demoStart" from shell



Even on slow Intel Atom or Celeron systems that run with a nominal of a 500 MHz CPU, the interrupt latency should never exceed approximately 30 to 40 microseconds. Using such a test application together with a tool like "BurnIn Test", you can evaluate your platform, disclosing any devices which may be detracting from your system's real-time capabilities.

14.3 Intel(R) Resource Director Technology (RDT)

14.3.1 Cache Allocation Technology (CAT)

14.3.1.1 How it works

RDT-CAT can be used to optimize processor cache usage by dividing the cache into partitions and selecting when to use which partition.
The partitions are configured at Class Of Service (COS) registers. These CAT-COS registers are shared among all cores that share the same cache.
Each CPU core can individually select the COS to be used. It has to be noted that this COS-selector is used for all supported COS-types;
this means, if CAT and Memory Bandwidth Allocation (MBA) are available it activates both, the CAT-COS **and** the MBA-COS.

The number of CAT-COS registers and the length of the settable bits are CPU specific and can be queried using CPUID.
Using the uploader utility, details about RDT availability and configuration can be determined:

```
"RtosUpload.exe /nosleep /nowait /idshow 6,0,8"
```

For more information, please contact your support.

14.3.1.2 CAT Default settings for all acontis real-time products

Without any configuration settings, the following default settings will be used:

- CAT is used when it is available.
- Two COS registers (0..1) are configured.
  COS0: CAT= Upper half of Cache, MBA=Limited Bandwidth
  COS1: CAT=Lower half of Cache, MBA=Unlimited Bandwidth
- Windows uses the configuration stored in register COS0
- The RTOS uses the configuration stored in register COS1
- If multiple independent caches/partitions exist, they will all be configured with the same default values above.

14.3.1.3 CAT Config-File settings

The default CAT settings can optionally be changed.
Below, the related CAT settings are described shortly.
The values used in this example correspond with the default settings that are used in case the respective configuration parameter does not exist.
In this example CPU 0..2 are used by Windows and 3 by RTOS.

```
[Vmf\RDT]
    "CatAllowed"=dword:1        ; 1=Enable (Default if value is omitted), 0=Disable

    ; Upper half of L2 cache; cache bit mask (Example for E3940 supporting 8 bits, each bit
corresponds to 1/8 of the whole cache)
    "CatMaskL2Cos0Cpu0"=dword:F0
    "CatMaskL2Cos0Cpu1"=dword:F0
    "CatMaskL2Cos0Cpu2"=dword:F0
    "CatMaskL2Cos0Cpu3"=dword:F0

    ; Lower half of L2 cache; cache bit mask (Example for E3940 supporting 8 bits, each bit
corresponds to 1/8 of the whole cache)
    "CatMaskL2Cos1Cpu0"=dword:0F
    "CatMaskL2Cos1Cpu1"=dword:0F
    "CatMaskL2Cos1Cpu2"=dword:0F
    "CatMaskL2Cos1Cpu3"=dword:0F

    ;... the maximum number of CAT-COS depends on CPU. E3940 supports 4.

[Host\RDT]
    "CosIdxCpu0"=dword:0        ; CPU0: COS0 - Upper half of Cache
    "CosIdxCpu1"=dword:0        ; CPU1: COS0 - Upper half of Cache
    "CosIdxCpu2"=dword:0        ; CPU2: COS0 - Upper half of Cache

[Rtos\RDT]
    "CosIdxCpu3"=dword:1        ; CPU3: COS1 - Lower half of Cache
```

14.3.1.4 Optimized CAT setting for Intel E3940

E3940 has 2 L2 caches shared between core 0-1 and 2-3.
Thus, the default settings above may not be optimal.
The settings below are recommended instead.
Only the differences to the default settings are listed.

- Using core 0..2 for Windows and 3 for RTOS:

```
 [Vmf\RDT]
    "CatMaskL2Cos0Cpu0"=dword:FF
    "CatMaskL2Cos0Cpu1"=dword:FF
```

- Using core 0,1 for Windows and 2,3 for RTOS:

```
[Vmf\RDT]
    "CatMaskL2Cos0Cpu0"=dword:FF
    "CatMaskL2Cos0Cpu1"=dword:FF
    "CatMaskL2Cos0Cpu2"=dword:FF
    "CatMaskL2Cos0Cpu3"=dword:FF
[Rtos\RDT]
    "CosIdxCpu2"=dword:0
    "CosIdxCpu3"=dword:0
```

14.3.1.5 CAT Code Data Prioritization (CDP)

A CPU might support CDP, which allows to split cache between code and data by using two separated masks. CDP will not be used on default and must be enabled by config entry.
In this example CPU 0..2 are used by Windows and 3 by RTOS.

```
[Vmf\RDT]
    "CatAllowed"=dword:1        ; 1=Enable (Default if value is omitted), 0=Disable
    "CatCdpAllowed"=dword:1     ; 1=Enable, 0=Disable (Default if value is omitted)

    ; Upper half of L3 cache; cache bit mask (Example for supporting 8 bits, each bit
corresponds to 1/8 of the whole cache)
    ;Settings to use without CPD:
    "CatMaskL3Cos0Cpu0"=dword:F0
    "CatMaskL3Cos0Cpu1"=dword:F0
    "CatMaskL3Cos0Cpu2"=dword:F0
    ;Settings to use with CPD:
    "CatMaskCodeL3Cos0Cpu0"=dword:30
    "CatMaskDataL3Cos0Cpu0"=dword:C0
    "CatMaskCodeL3Cos0Cpu1"=dword:30
    "CatMaskDataL3Cos0Cpu1"=dword:C0
    "CatMaskCodeL3Cos0Cpu2"=dword:30
    "CatMaskDataL3Cos0Cpu2"=dword:C0

    ; Lower half of L3 cache; cache bit mask (Example for supporting 8 bits, each bit
corresponds to 1/8 of the whole cache)
    ;Settings to use without CPD:
    "CatMaskL3Cos1Cpu3"=dword:0F
    ;Settings to use with CPD:
    "CatMaskCodeL3Cos1Cpu3"=dword:03
    "CatMaskDataL3Cos1Cpu3"=dword:0C

    ;... the maximum number of CAT-COS depends on CPU – currently up to 16. Enabling CDP cuts
them by half because each seting uses two masks.

[Host\RDT]
    "CosIdxCpu0"=dword:0        ; CPU0: COS0 - Upper half of Cache
    "CosIdxCpu1"=dword:0        ; CPU1: COS0 - Upper half of Cache
    "CosIdxCpu2"=dword:0        ; CPU2: COS0 - Upper half of Cache

[Rtos\RDT]
    "CosIdxCpu3"=dword:1        ; CPU3: COS1 - Lower half of Cache
```

14.3.2 Memory Bandwidth Allocation (MBA)

14.3.2.1 How it works

RDT-MBA can be used to limit the memory bandwidth being used by a CPU core.
In the same was as for CAT, if using MBA then different bandwidths can be configured at CPU core independent Class Of Service (COS) registers.
Each CPU core can individually select the COS to be used. It has to be noted that this COS-selector is used for all supported COS-types;
this means, if CAT and MBA are available it activates the CAT-COS **and** the MBA-COS.

The number of MBA-COS registers and its possible value are CPU specific and can be queried using CPUID.
Using the uploader utility, details about RDT availability and configuration can be determined:

```
"RtosUpload.exe /nosleep /nowait /idshow 6,0,8"
```

14.3.2.2 MBA Default settings for all acontis real-time products

- MBA is used when it is available.
- the memory bandwith for Windows is limited to 50% (using the configuration stored in register COS0)
- the memory bandwith for the RTOS is not limited (using the configuration stored in register COS1)

14.3.2.3 MBA Config-File settings

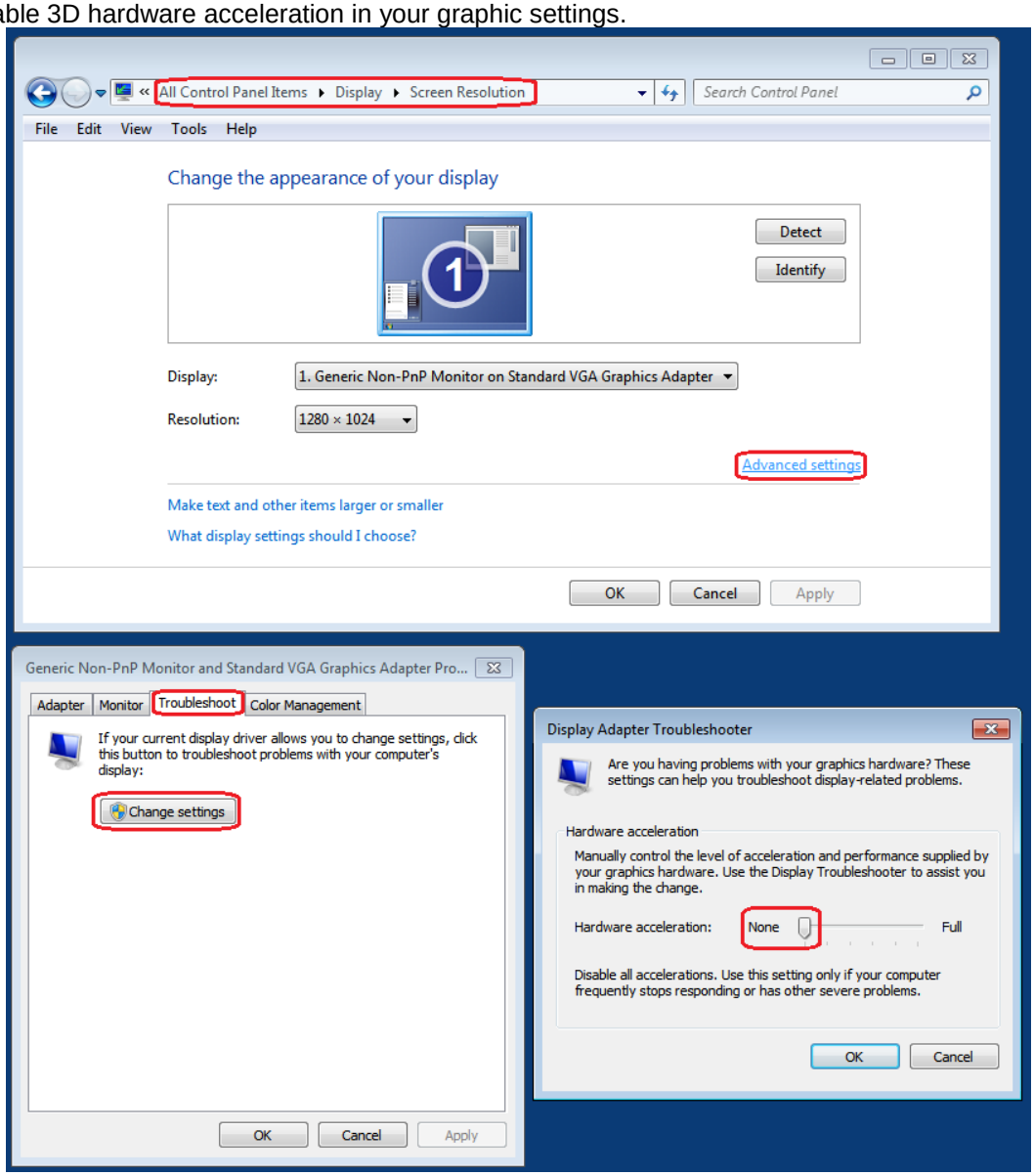
The default MBA settings can optionally be changed.
Below, the related MBA settings are described shortly.
The values used by default depend on the CPU type used.
How to set the value is described in the Intel Manuals, please ask acontis support for details.

```
[Vmf\RDT]
    "MbaAllowed"=dword:1        ; 1=Enable (Default if value is omitted), 0=Disable

    ; 50%: max/2 on linear and 1 on non-linear throttling; bandwith throttling value (the
value depends on the CPU type used)
    "MbaThrottleCos0Cpu0"=dword:1
    "MbaThrottleCos0Cpu1"=dword:1
    "MbaThrottleCos0Cpu2"=dword:1
    "MbaThrottleCos0Cpu3"=dword:1

    ; Unlimited
    "MbaThrottleCos1Cpu0"=dword:0
    "MbaThrottleCos1Cpu1"=dword:0
    "MbaThrottleCos1Cpu2"=dword:0
    "MbaThrottleCos1Cpu3"=dword:0

    ;... the maximum number of MBA-COS depends on CPU. (E3940 CPUs do not support MBA)

[Host\RDT]
    "CosIdxCpu0"=dword:0        ; CPU0: COS0 - Limited Bandwidth
    "CosIdxCpu1"=dword:0        ; CPU1: COS0 - Limited Bandwidth
    "CosIdxCpu2"=dword:0        ; CPU2: COS0 - Limited Bandwidth

[Rtos\RDT]
    "CosIdxCpu3"=dword:1        ; CPU3: COS1 - Unlimited Bandwidth
```

14.4 Reducing DMA latency problems

If you have determined that DMA is undermining your system's ability to serve as a real-time platform, the following list suggests a number of things you can do:

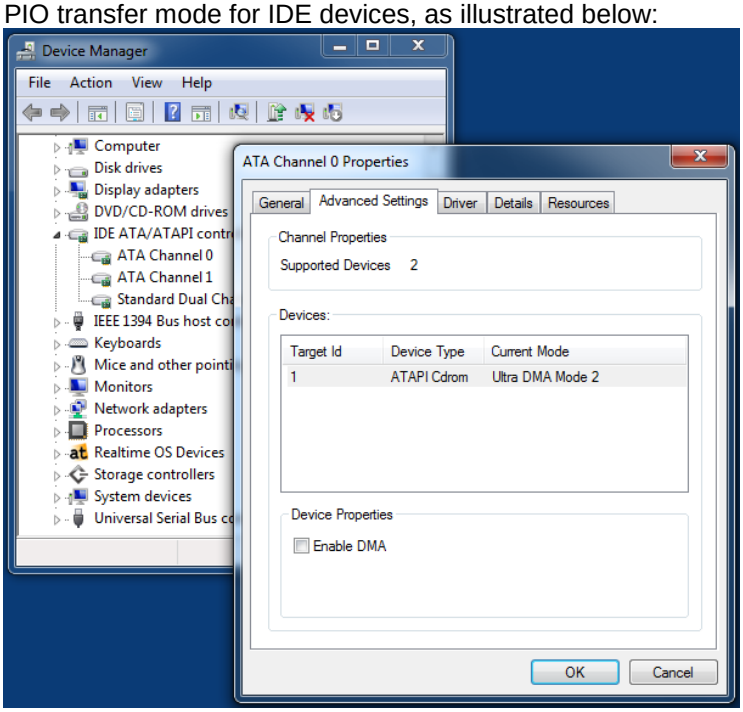
- Disable 3D hardware acceleration in your graphic settings.



W7:

- Change other settings of your graphics card, i.e., reduce the resolution and/or the number of displayed colors. In some cases, you may want to try a different graphics card or a different graphics card driver. You might try using a resolution of 640x480 and 8 bit colors, the least - demanding settings, to determine if a latency problem is truly related to the graphics card adapter.
- Try adjusting the advanced BIOS settings for the graphics card. Experiment with limiting the size or duration of DMA accesses.
- Try changing the settings of your network card adapter. If it uses DMA, try another network adapter that does not.
- Eliminate USB or IEEE 1394 devices that use extensive DMA transfers (e.g. USB hard disks or CDROM drives), or try changing their device driver settings.

- Use PIO transfer mode for IDE devices, as illustrated below:

W7: 

14.5 CPU throttling

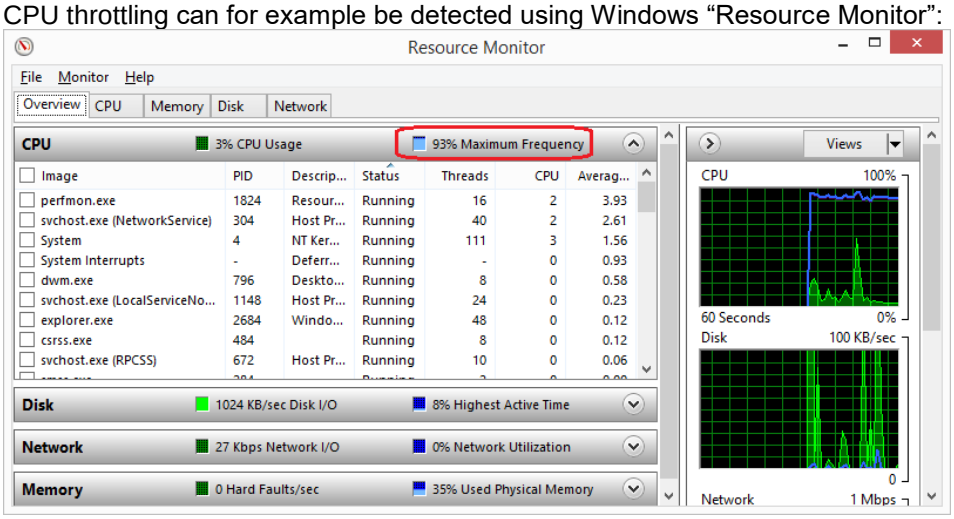
There are several CPU throttling mechanisms being used in modern CPUs for energy savings getting in conflict with realtime requirements:

- C1E (Enhanced Halt State)
  reduces the clock rate when the CPU goes idles.
- Intel® SpeedStep™ / “EIST” (“Enhanced Intel SpeedStep Technology”)
  changes the clock rate depending on the current configuration and workload.

14.5.1 Detection

If throtteling becomes active on a PC depends on its CPU, BIOS, OS and RTOS configuration.

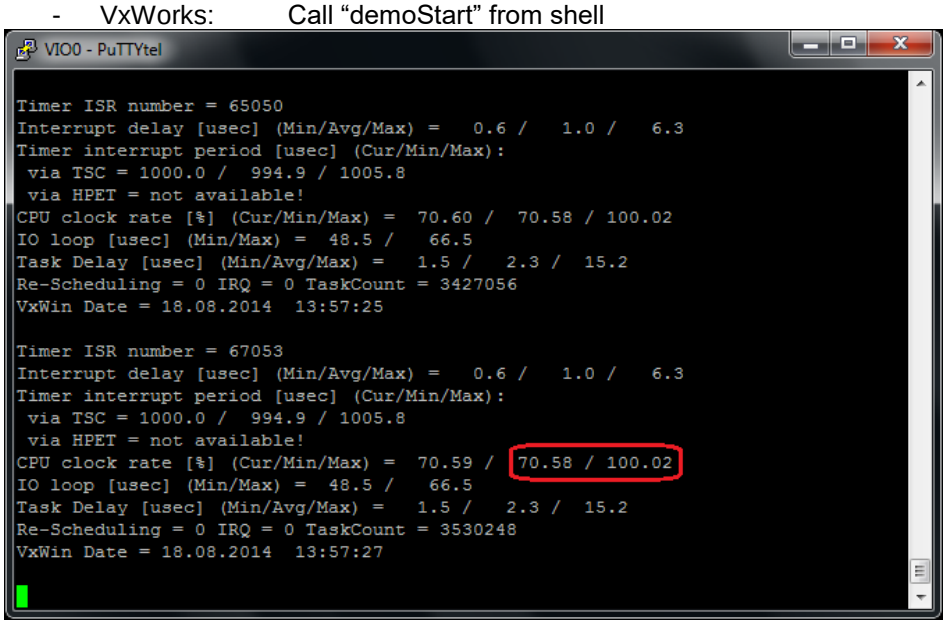
CPU throttling can for example be detected using Windows “Resource Monitor”:



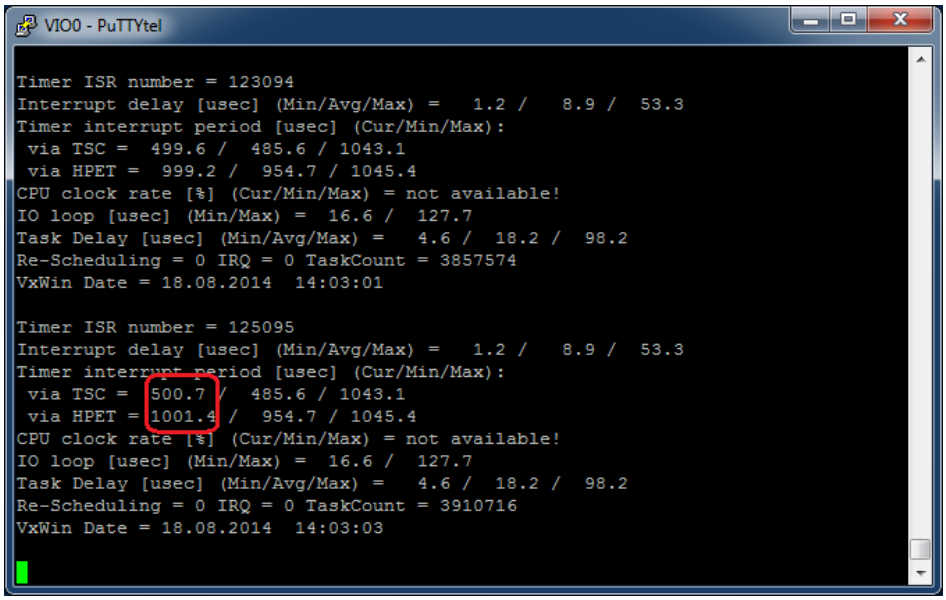
When throttling is enabled the maximum frequency is fluctuating.

Throttling settings may be processor specific so the check should be done on the realtime assigned processors. Therefor “RealtimeDemo” can be used which is part of RtE:

- RTOS-32: Start image “RealtimeDemo.bin”
- CE: Call “RealtimeDemo” from shell
- VxWorks: Call “demoStart” from shell



When throttling is enabled the CPU clock rate is fluctuating.



Another indicator for throttling is when TSC differs from HPET period up to 50%.

14.5.2 How to disable

Windows 7 and newer
includes a standard idle routine already using “hlt” - the optimized idle routine of the CPU driver uses the advanced “mwait” for throttling.
This means “Disable processor driver” is required and additionally one of the following actions:

- Disable Speed/Step and C1E by BIOS
- OR Disable Speed/Step and C1E by VMF

Please run RealtimeDemo again after changes to ensure throttling was successfully disabled.

14.5.2.1 PC BIOS

The BIOS may contain CPU configuration options called

- “C1E Support”
- “Intel® SpeedStep™” or “EIST” (“Enhanced Intel SpeedStep Technology”)
- Something containing “throttling”

These options should be disabled.

14.5.2.2 Processor Driver

The processor driver can be disabled in the Windows registry.

- Start “regedit”
- Navigate to “\HKLM\SYSTEM\CurrentControSet\services\Xxx” where “xxx” can be
  - o “Processor” (processr.sys)
  - o “intelppm” (intelppm.sys)
  - o “AmdK8” (amdk8.sys)
  - o “AmdPPM” (amdppm.sys)

  depending on the processor.
- Change the value of “Start” from to “4” to disable the driver.

A reboot is required to use the new configuration.

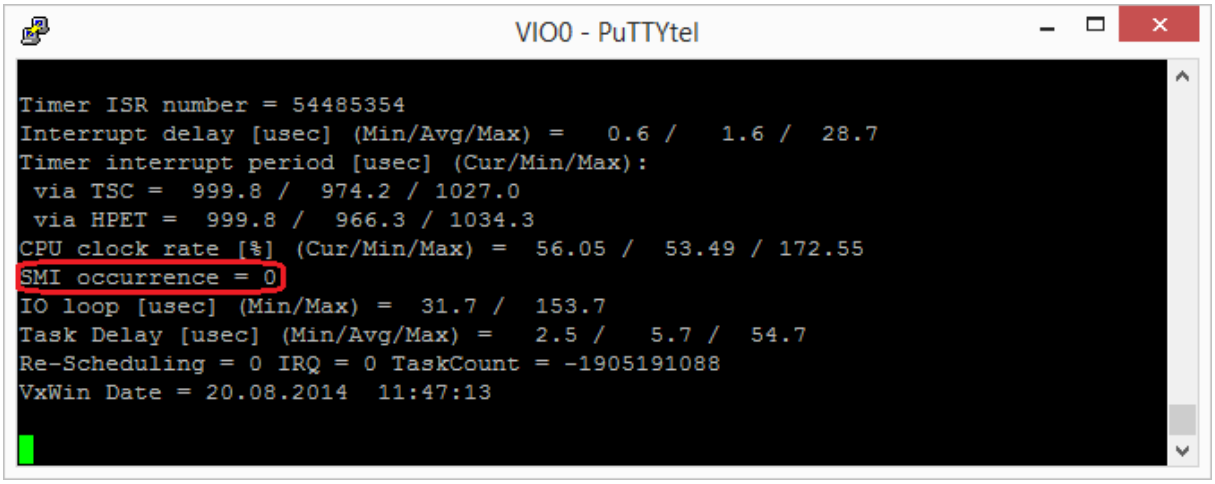
14.5.2.3 VMF

VMF can disable CPU throttling by reconfiguring each CPU used by RTOS. This will be done during RTOS startup. This feature is disabled on default but can be enabled using the following config file entry:

```
[Optimizations]
"ValueC1"=dword:1       ; omitted = 0 = disable, 1 = enable,
                        ; Other value = enable + force model (Exmpl: 0x617=CPU Family 6 Model 23)
                        ; Do no force a model without being prompted to do!
```

14.6 System Management Interrupt (SMI)

Another source of latency problems up to milliseconds are system management interrupts.
They are hardly to detect without an external clock reference.



Newer CPUs contain a SMI counter being evaluated by the RealtimeDemo.

Possible reasons for SMI's are:

- "USB Legacy support"
  → Can be disabled in most BIOS.
- Some Video driver use SMI.
  → Use another driver for example Standard VGA.

14.6.1 VMF

In combination with Hardware Virtualization support (see "VtAllowed" in chapter 5.5) there is another option to suppress software SMIs:

```
[Optimizations]
"ValueD1"=dword:1       ; omitted = 0 = disable, 1 = enable
```

15 Appendix B – Troubleshooting

A variety of common errors can occur when starting up the RTOS for the first time. A few are mentioned below:

15.1 Setup fails

Setup creates a log-file in the Windows. Its name depends on the product and version.
For example EC-Win(RTOS-32) might create the logfile “C:\Windows\EC-Win(RTOS-32) 6.0.00.07.LOG”. Please check this file for additional information.

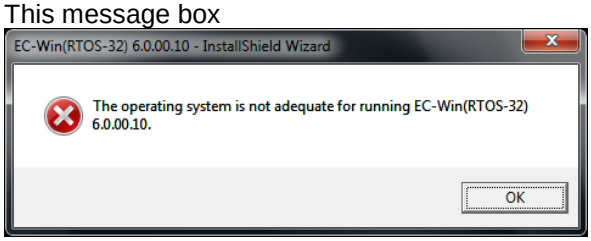
- Check– especially on a new platform – if you’re using the latest RtE version.

- If installing from network or inside VMWare, first copy all files locally and run setup locally.

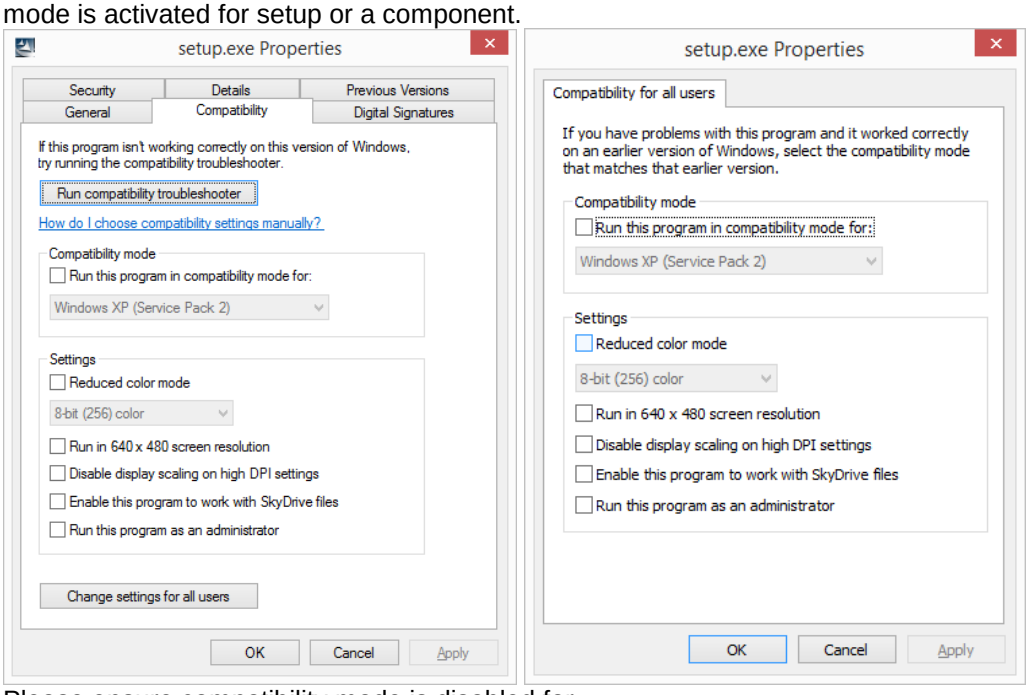
- On InstallScript engine errors sometimes it needs to be updated. RtE Setup requires version 10:
  http://support.installshield.com/kb/files/Q108158/IsScript101.zip
  http://consumerdocs.installshield.com/selfservice/viewContent.do?externalId=Q108158&sliceId=1

- Another InstallShield Scripting Runtime error might be soled by:
  http://consumerdocs.installshield.com/selfservice/viewContent.do?externalId=Q108340&sliceId=1

- This message box



can appear when running Setup on an OS not supported or when application compatibility mode is activated for setup or a component.



Please ensure compatibility mode is disabled for
- Setup.exe
- C:\Program Files (x86)\Common Files\InstallShield\Driver\10\Intel 32\IDriver.exe (64bit OS)
- C:\Program Files\Common Files\InstallShield\Driver\10\Intel 32\IDriver.exe (32 bit OS)

15.2 System does not boot

1) First it should be checked if system can start in Safe Mode.
   If this is possible probably a configuration change caused the problem.
   For example when multiple large shared memories are configured it is possible the system has not enough memory remaining to boot. Such a situation can be solved this way:
   - Start the system in Safe Mode
   - Change the SharedMemory configuration
   - Start the RTOS to update with the new configuration
   - Reboot the system

   The same can be done in case a memory configuration change caused the problem.

2) If Safe Mode also can't boot the Windows "repair console" should be used to rename the driver RtosDrv to prevent it from being loaded:
   "ren c:\Windows\System32\drivers\RtosDrv.sys RtosDrv_org.sys"
   The repair console can started from the repair boot menu or when booting from the installation disk. After renaming the driver the console can be left by calling "exit" to reboot the system.
   Please contact support in case this solved the problem.

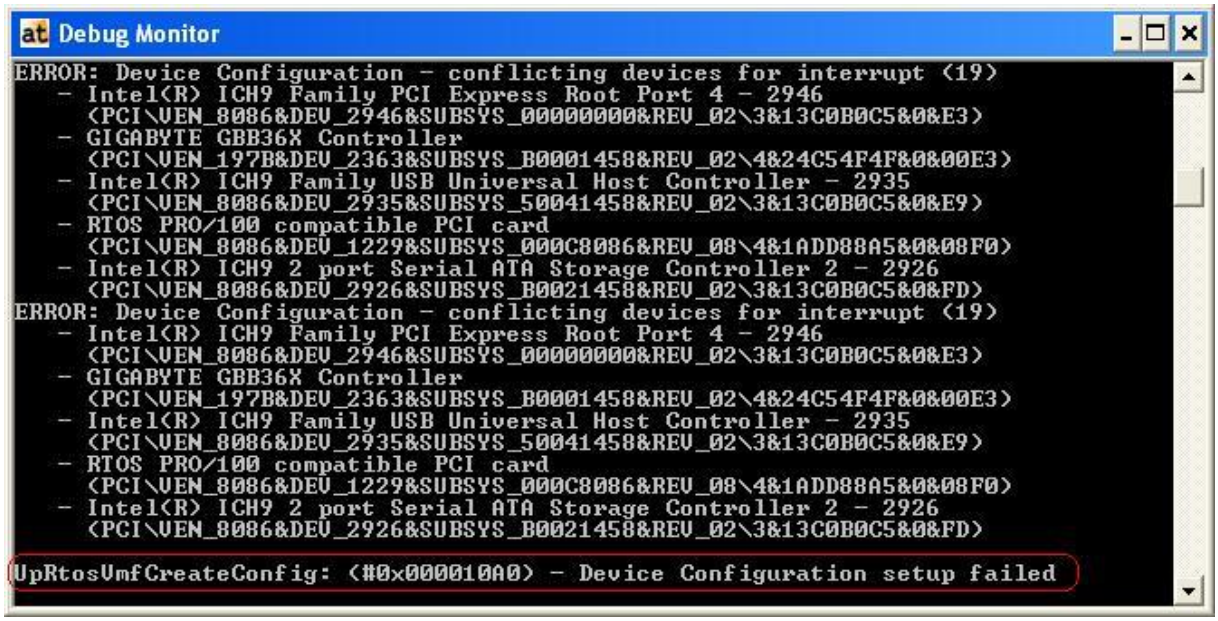
3) If renaming the driver did not help call "bcdedit /enum {default}" from the repair console:
   When it shows a huge "badmemorylist" over multiple pages then please call
   "bcdedit /deletevalue {default} badmemorylist".
   When it contains "firstmegabytepolicy = UseAll" then please call
   "bcdedit /deletevalue {default} firstmegabytepolicy".
   After the call(s) succeeded the console can be left by calling "exit" to reboot the system.

4) In case nothing was helpful a startup repair should be done.
   On Windows 7 or newer run "Startup Repair". Sometimes this can be selected from the repair boot menu and sometimes it is required to boot from the Installation DVD.

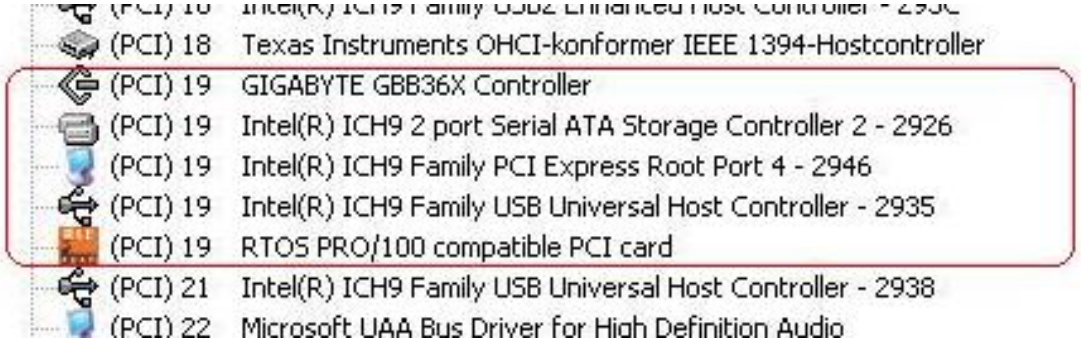
15.3 Common startup problems

A variety of common errors can occur when starting up the RTOS for the first time. A few are mentioned below:

15.3.1 IRQ sharing with Windows (10A0)



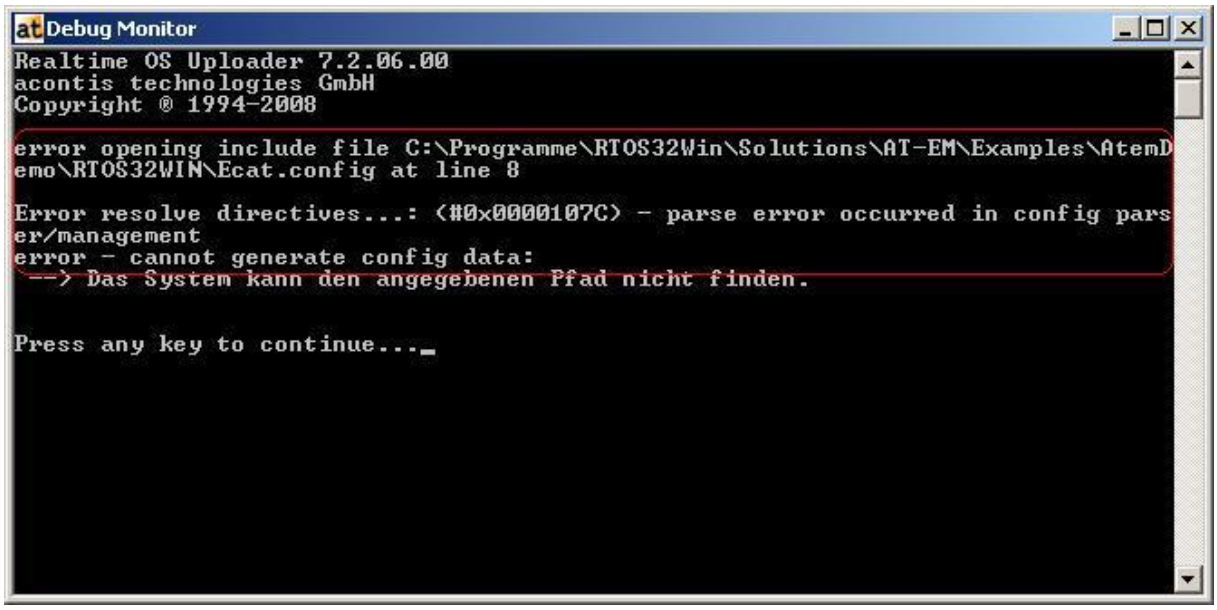
Causes:
The IRQ of the Rtos-Device is shared with a Windows-Device. Rtos-Devices need an exlusive IRQ.



There are several alternatives to solve the problem:

- Put the PCI card into another slot to use another interrupt line, which hopefully doesn't conflict.
- A PCI express card supporting MSI's can be configured to use MSI.
- If the RTOS device will be polled the interrupt can be disabled.
  Attention: Every normal RTOS driver will require an interrupt. This is only an option in combination with driver software known not to require the interrupt.
- When the conflicting Windows device is not required it can be disabled by BIOS or Windows device manager.
- When it is known that the Windows device will never use its interrupt in can be added to the interrupt ignore list.
  Attention: This will lead to unpredictable behaviour case the device anyway uses the interrupt.

15.3.2 Error opening include file (107C)



Causes:
The path or filename is not correct. The include filename is invalid or it is not located in the selected path.

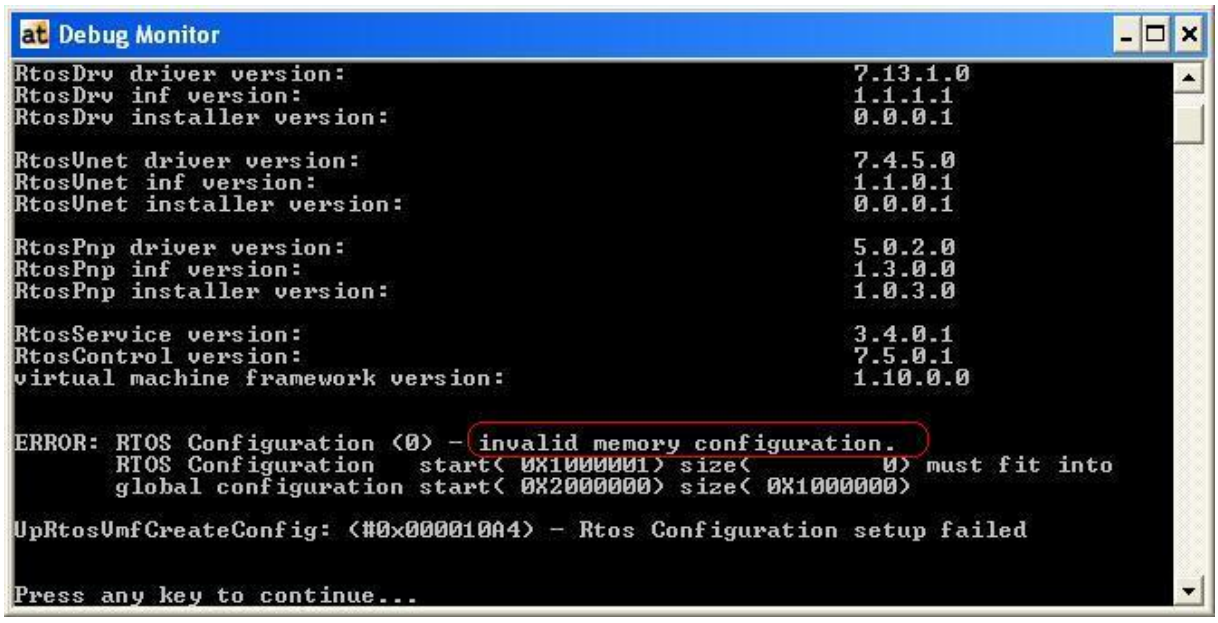
15.3.3 Configured RTE memory range not available

When updating from an older version it is possible the currently configured memory range will not be detected correctly. In this case please

- Remove the current configuration by calling
  “RtosUpload.exe /memcfg /u” from a DOS box.
- Reboot the PC
- Start RTOS again (should tell about required reboot)
- Reboot
- Start RTOS (should work now)

Before manually (means not using Setup) updating from one version to another the memory reservation should be removed first.

15.3.4 Invalid memory configuration (10A4)



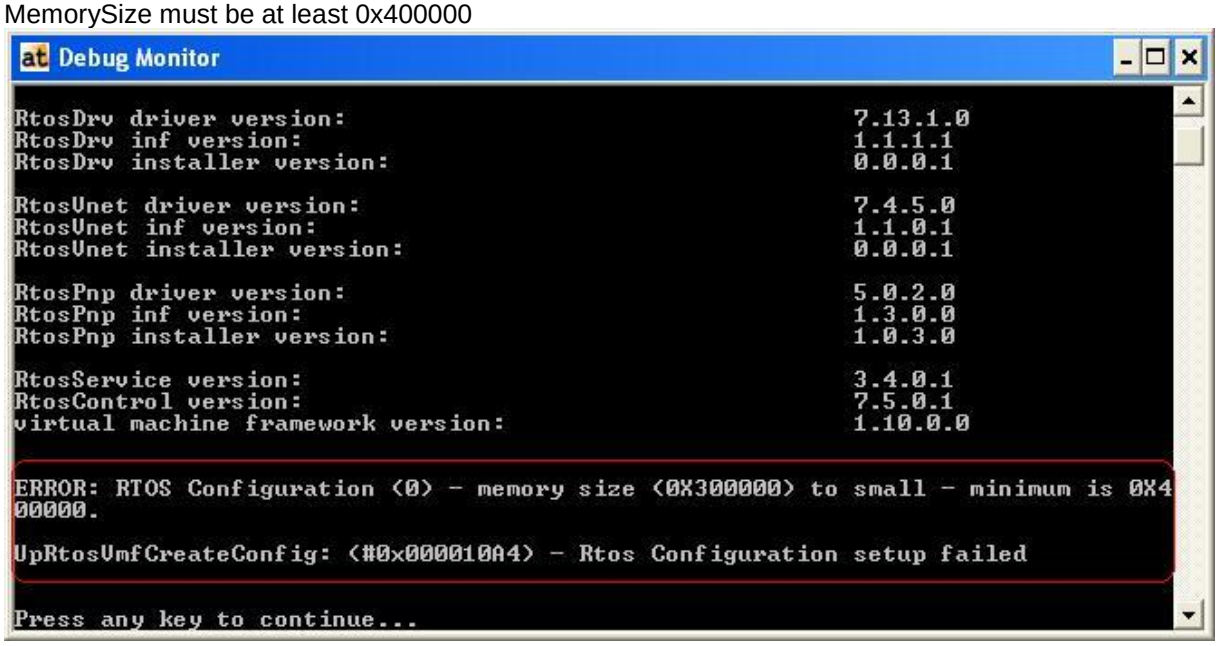
Causes:

MemoryStartAddress isn't in the range of the RteMemory.
(RteMemoryStartAddress >= **MemoryStartAddress** <= (RteMemorySize+RteMemoryStartAddress))

MemorySize is too high
MemorySize > RteMemorySize
Or MemorySize+Offset > RteMemorySize

Image is too big
MemorySize < Image Size

Memory size is too small
MemorySize must be at least 0x400000



15.4 Windows Clock Delay

In case the Windows clock seems to be delayed
- Using SharedCore check if the clock correction is enabled
- Using ExclusiveCore check if disabling the clock correction solves the problem.

See chapter "8.1Clock Correction" for configuration details.

15.5 Windows Network Stack

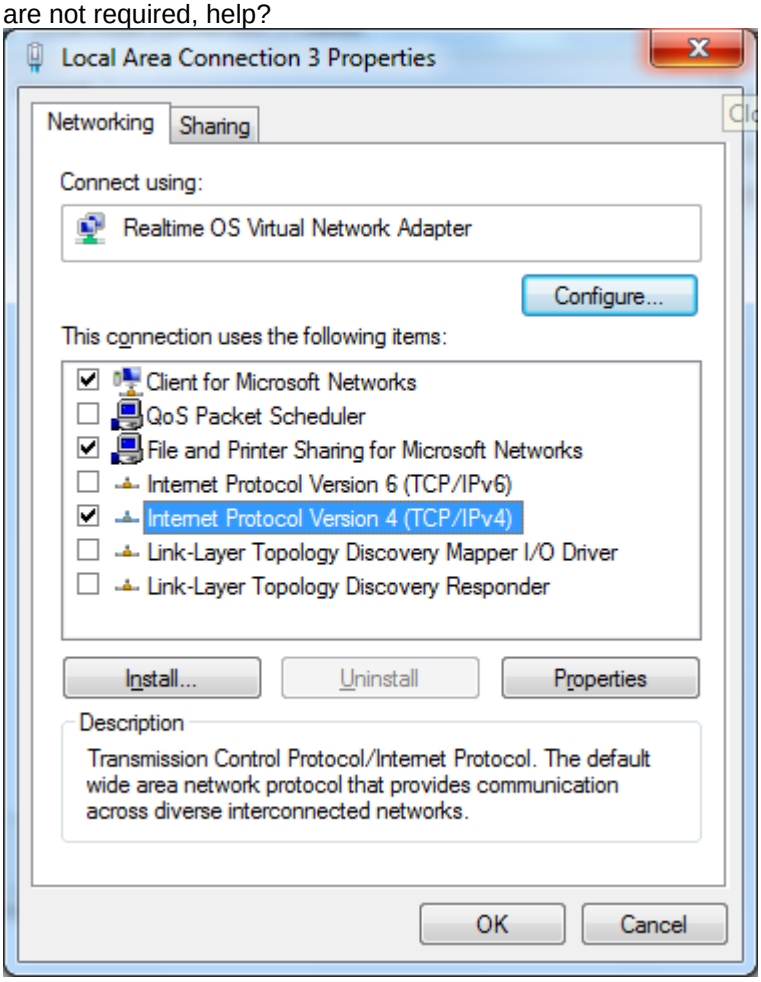
In some circumstances it is possible the Windows netwok IP stack becomes corrupt.
This can be identified for example
- If opening TCP/IP parameters of a network connection results in an error message
- If "ipconfig -all" shows another IP address than TCP/IP configuration dialog

When the stack is corrupted it can be reset by calling
"netsh int ip reset c:\resetlog.txt"
from an administrator command line.
After a reboot all IP settings will be reset. All manual settings have to be configured again.

15.6 Network Share access

In case the network share can't be accessed by RTOS please check the following:

- Can the network folder be accessed from the same and also from another PC?
- Can RTOS ping the PC using the computer name (not the IP)?
- Is the config file entry for network share and password correct?
- Does disabling of all protocols and services of "Realtime OS Virtual Network Adapter", which are not required, help?



15.7 Timer frequency

All VMF timer are depending on the Local APIC timer. Its input frequency is normally measured by VMF itself during startup.

15.7.1 Setting a dedicated frequency

Under rare circumstances, when a very exact timer interrupt period is required, it might be required to manually configure the Local APIC input frequency on a PC.

The currently used processor input frequency can be displayed calling:
“RtosUpload.exe /idshow 11,0,1”

The frequency can be set for each processor using a config file entry:
[Processors]
“LocalApicTimerInputFrequency0”=hex:…
“LocalApicTimerInputFrequency1”=hex:…
The values are 64 Bit values and have to be provided in “Little Endian” format.
e.g.: hex:00,CA,9A,3B,00,00,00,00 for 1 GHz
e.g.: hex:B4,BE,F9,0B,00,00,00,00 for 200916660 Hz

15.7.2 Frequency measure error

While VMF determines the Local APIC frequency it checks the quality of this measurement.
If measure time exceeds a limit the error code 0x270B =
RTE_ERROR_TIMER_MEASUREFREQUENCY_DELAYLIMIT will be returned.

This error indicates that the measured frequency will probably not be very accurate and reliable.
This might be acceptable in case no Realtime is required.
The limit can be configured using config-file entry

[Vmf]
"TimerMeasureDelayLimit"=dword:X

See chapter “5.5 Section [Vmf]” for details.

15.8 Interrupt / Timer Latency

Please check chapter “14 Appendix A – Platforms and performance” for possible reasons and solutions.

15.9 RtosLib Event / MsgQueue / Pipe / Socket Performance

On default the events are configured using polling mode. In case the performance is not sufficient the system can be configured for using interrupt mode.
See chapter “5.8.2 Enable / Disable Comm Interrupt” for details.

15.10 Using RTOSVM inside a Hypervisor

It is not officially supported to run an RTOSVM inside a Hypervisor because realtime behavior is undetermined.
Nevertheless it might be usefull during development.
Because such a system runs very slow Local APIC timer frequency measure will fail - see chapter “15.7.2 Frequency measure error” for details.

15.11 Reasons for required Reboots

After product installation or updates or Windows updates it may be desired to minimize the number of required reboots. This list contains typical and untypical reasons requiring a reboot.

Reason	Setting
Memory reservation has changed (size, limit, alignment, type)	RtosUpload: RtosUpload.exe /nosleep /nowait /memcfg "/a" /config "CfgFile"
Windows is already using LocalAPIC (Sharing 1st core only)	BCD-store: Bcdedit.exe /set "{current}" useplatformtick yes
Exclusive-Core configuration	BCD-store: Bcdedit.exe /set "{current}" numproc $ReplaceWithNumOfProcs$
Bootcode reservation failed (using ExclusiveCore only)	Config: [Upload] "BootCodeReservationForce"=dword:1
BCD Memory reservation failed because functionality was disabled	BCD-store: Bcdedit.exe /deletevalue "{current}" badmemoryaccess OR Bcdedit.exe /set "{current}" badmemoryaccess no
Windows is running in x2APIC mode	BCD-store: Bcdedit.exe /set "{current}" x2apicpolicy disable
Windows Hypervisor is enabled	BCD-store: Bcdedit.exe /set "{current}" hypervisorlaunchtype off
Windows Kernel DMA protection is enabled	Turn off at Windows Security: → Device Security →Core isolation details →Memory integrity
Windows Device based security is enabled	Registry: Set values to ‘0’ at HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\DeviceGuard OR Policy Editor: Disable “Turn On Virtualization Based Security”
Hiberboot is enabled	Registry: Set ‘HiberbootEnabled‘ to ‘0’ at HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Power

16 Appendix C – Installation

16.1 OEM Installation

To simplify the installation of the required RtE runtime components a Microsoft installer packet (.msi) is available starting with version 7.0:

- “RteRuntime_x86.msi” for x86 installations
- “RteRuntime_x64.msi” for x64 installations

An OEM installation requires the following components to be installed:

- “CodeMeterRuntime32.msi” or “CodeMeterRuntime64.msi” (requirement depends on license)
- “vcredist_x86.msi” or “vcredist_x64.msi”
- “RteRuntime_x86.msi” or “RteRuntime_x64.msi”
- An RTOS image to be started and the corresponding .config files

Command line parameters and options for installing .msi files can be found at multiple online ressources. Some of them will be presented down at RtE Runtime descpription.

16.1.1 CodeMeter User Runtime

The CodeMeter User Runtime .msi files are included in our SDK at “…\SDK\OemSetup”. The latest versions can be downloaded from “http://codemeter.com”.
Further information regarding these modules should be taken from CodeMeter documentation.

16.1.2 RtE Runtime

The RtE Runtime .msi file contains several features and some properties, which can be used to individualize the installation.
Additional information about MSI installing and configuration options can be found in the internet.

16.1.2.1 MSI Feature list

- Feature.RtosDrv (includes RtosLib)
- Feature.RtosVnet
- Feature.RtosPnp
- Feature.RtosService
- Feature.RtosControl
- Feature.RtosUpload
- Feature.RtosLibDotNet
- Feature.RteRegistry (some registry settings)

16.1.2.2 MSI Properties

- VNETIP (default value "192.168.0.1")
- VNETMASK (default value "255.255.255.0")

16.1.2.3 Installation by Setup.exe

Please check your setups documentation how to install additional .msi packets.

16.1.2.4 Installation by script

The examples refer to RteRuntime_x64.msi, but for RteRuntime_x86.msi it is equal.

Install:
msiexec.exe /i "RteRuntime_x64.msi"

Uninstall:
msiexec.exe /x "RteRuntime_x64.msi"

Install with LogFile (also usable on uninstall):
*msiexec.exe /i "RteRuntime_x64.msi" /l*v "%USERPROFILE%\RteRuntimeInstall.log"*

Silent install with LogFile (also usable on uninstall):
*msiexec.exe /i "RteRuntime_x64.msi" /qn /l*v "%USERPROFILE%\RteRuntimeInstall.log"*

Silent install using non-default IP with LogFile:
*msiexec.exe /i "RteRuntime_x64.msi" VNETIP="192.168.10.1" /qn /l*v "%USERPROFILE%\RteRuntimeInstall.log"*

Silent install using non-default IP without installing RtosUpload with LogFile:
*msiexec.exe /i "RteRuntime_x64.msi" VNETIP="192.168.10.1" ADDLOCAL=ALL REMOVE=Feature.RtosUpload /qn /l*v "%USERPROFILE%\RteRuntimeInstall.log"*

Because the msiexec.exe call will return immediately and not wait until install/uninstall finished, an alternative is using PowerShell. Special attention is required creating the correct parameter list.
PowerShell Silent install using non-default IP without installing RtosUpload with LogFile:
*PowerShell; Start-Process -Wait -FilePath msiexec -ArgumentList /i, "RteRuntime_x64.msi", VNETIP="192.168.10.1", ADDLOCAL=ALL, REMOVE=Feature.RtosUpload, /qn, /l*v, "%USERPROFILE%\RteRuntimeInstall.log"*

16.2 Manual Installation

There are several elements required or optional to be installed.
The automatic equivalent of Setup.exe the component “Runtime Files” installs all of them.

- “Realtime OS Driver”
  Required driver for loading and accessing VMF and OS

- “Realtime OS Uploader”
  Required application to communicate with “Realtime OS Driver”

- “Virtual Machine Framework”
  Required file containing the code shared between all OS.

- “Configuration Files”
  Configuration files ae required to control the behaviour of the Uploader and VMF.

- “Realtime OS Service”
  Optional Service for handling RtosLib functionality.
  It is required if at least of this features should be usable by Windows:
  SharedMemory, Events, TimeSync, TimeZoneSync
  If not installed the config file entry "WaitForRtosCommSubsystems" must be set to “0”

- “Realtime OS Control”
  Optional task bar application for showing message boxes in case of errors.
  If not installed the config file entry “LaunchRtosControl” must be set to “0”

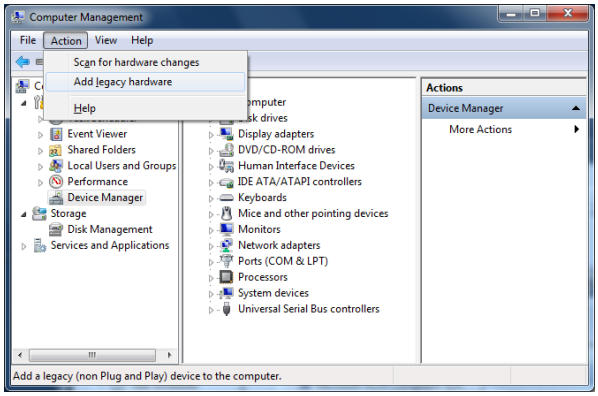
- “Realtime OS Virtual Network Driver”
  Optional network driver for accessing virtual network

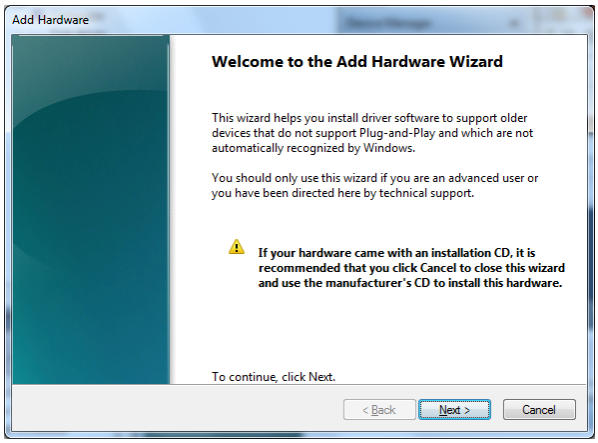
- “Debug Console”
  Optional application to show information, debug messages and – depending on the product – gain access to a console for accessing an OS.

The following steps are described for Windows 7 but the procedure is similar for previous versions.

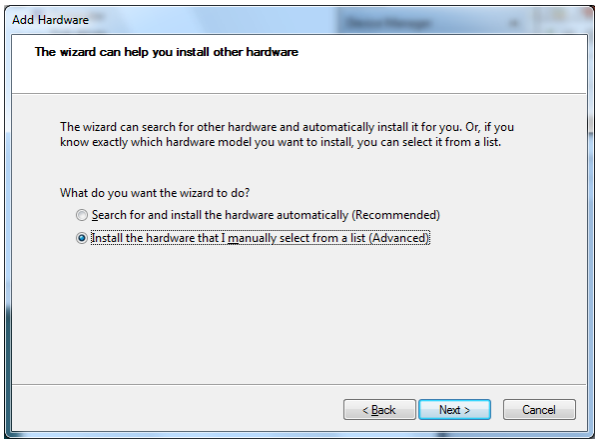
16.2.1 Realtime OS Driver

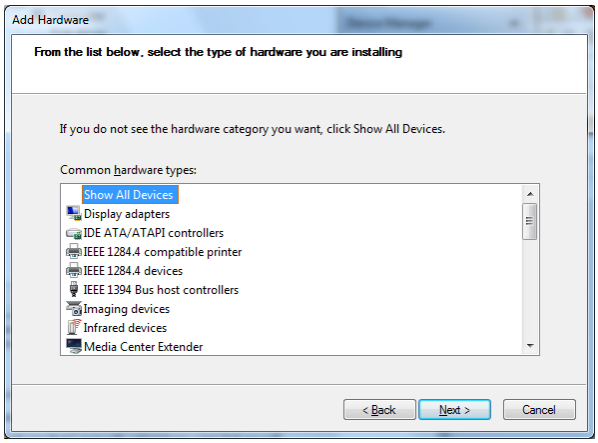
The driver has to be installed using the “Add Hardware Wizard”.
On Windows 7 it can be accessed through the “Device Manager”.



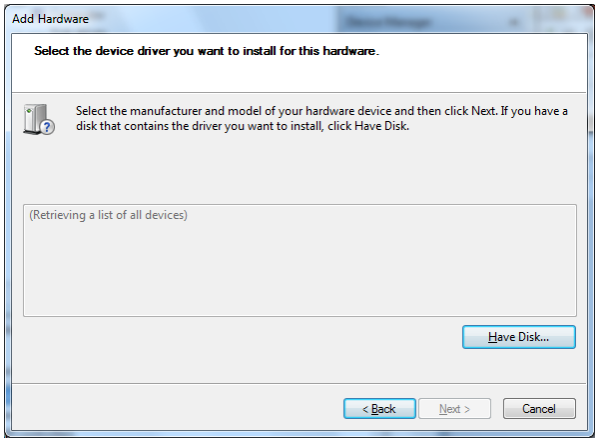


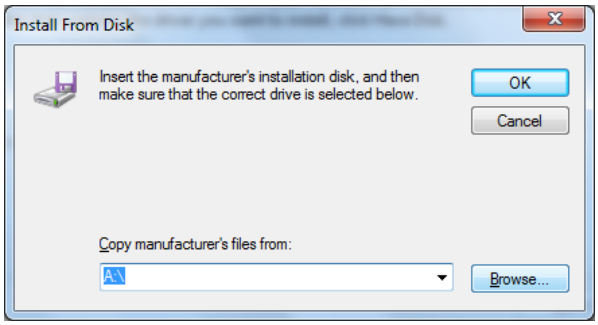
First start the “Add Hardware Wizard”.



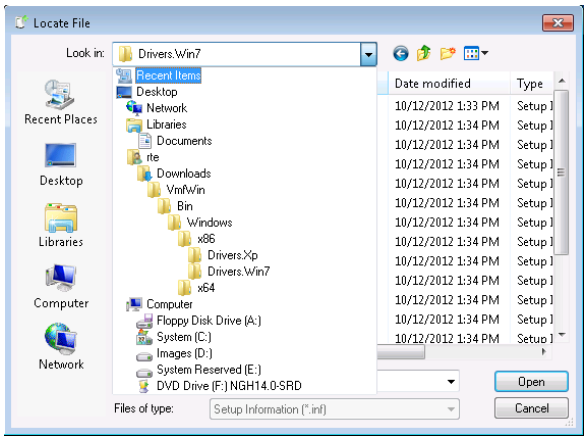


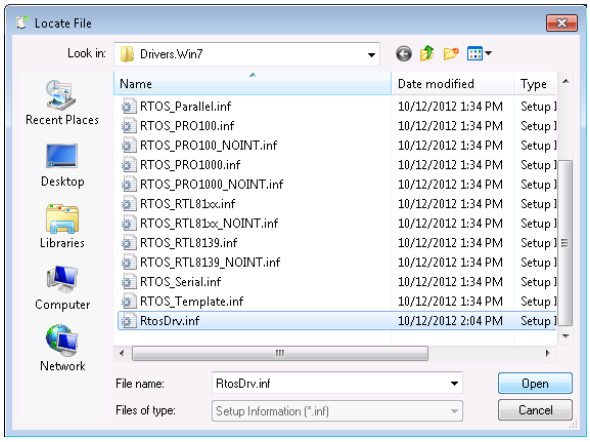
Select manual selection of the hardware to be added.





Add a new device driver from…

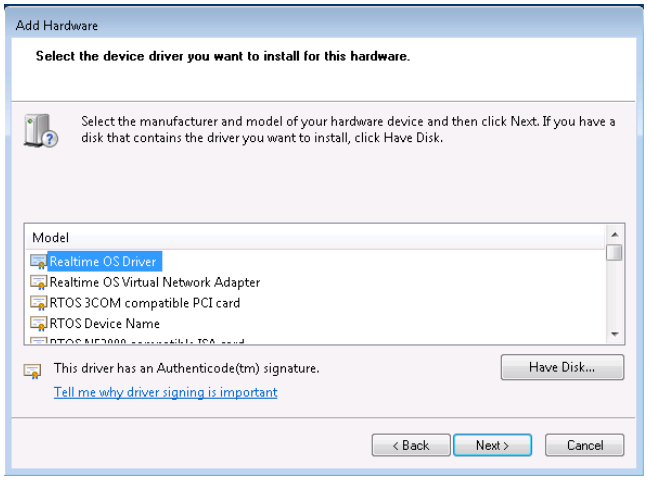


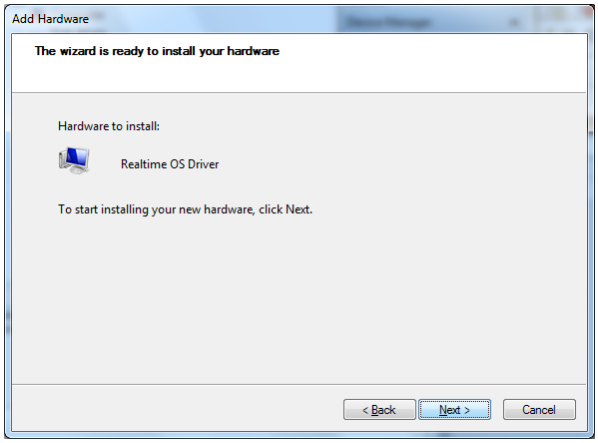


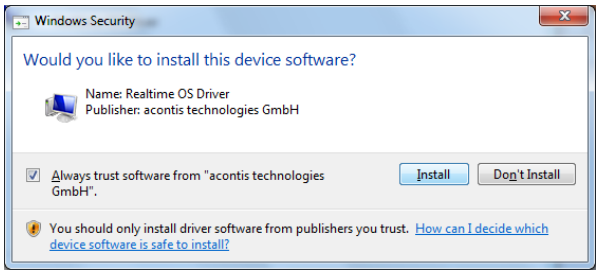
… the appropriate directory. Use

- “x86\Drivers.Win7” for Windows 7, 32 Bit
- “x64\Drivers” for Windows 7, 64 Bit

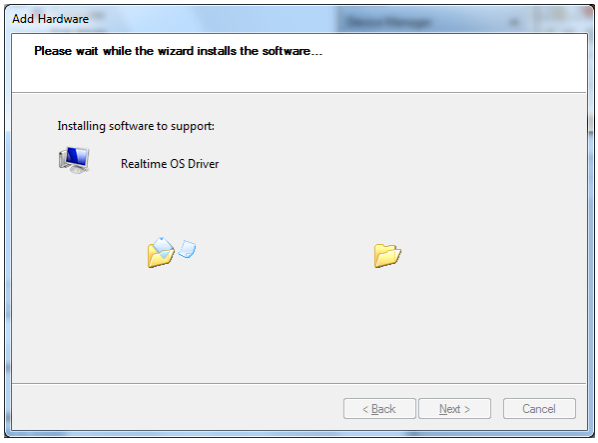
The supported Windows versions are depending on your RTE version. Support for 64 Bit for example is starting with RTE 5.0

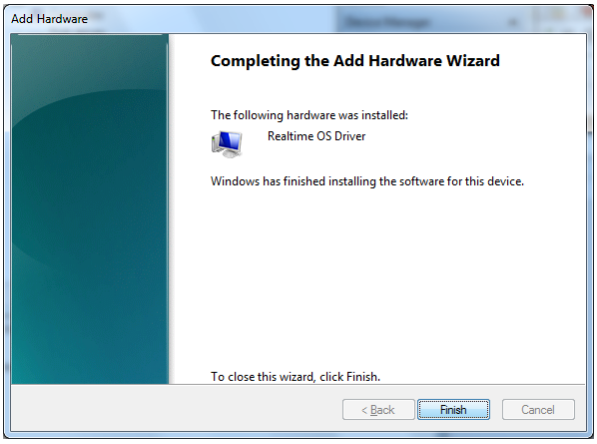


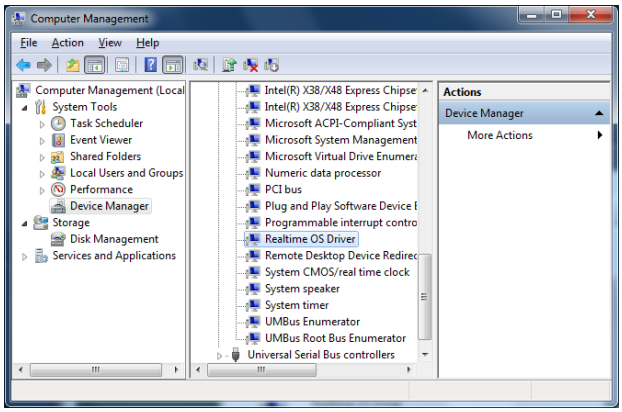




Depending on your Windows version and driver signing policies you may see different dialogs.



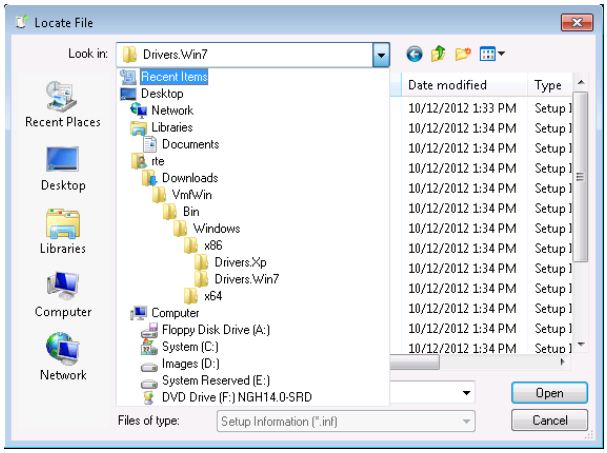




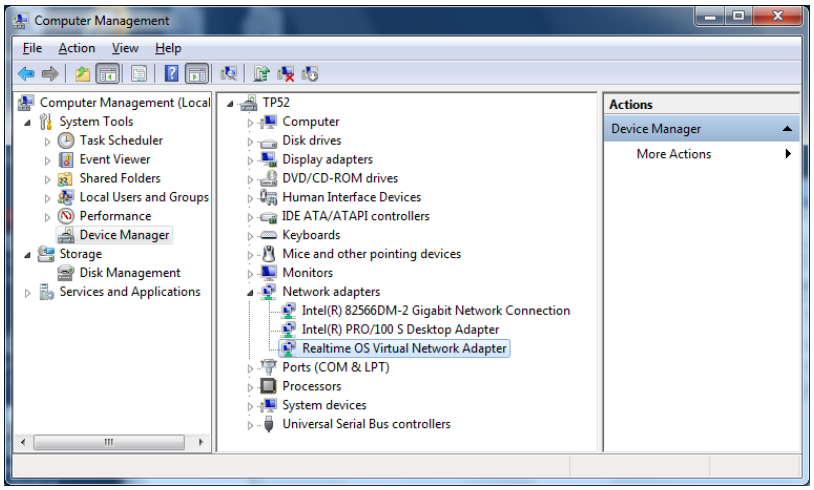
After successful installation you should be able to see “Realtime OS Driver” in the list of “System Devices” in the Windows Device Manager.

16.2.2 Realtime OS Virtual Network Driver

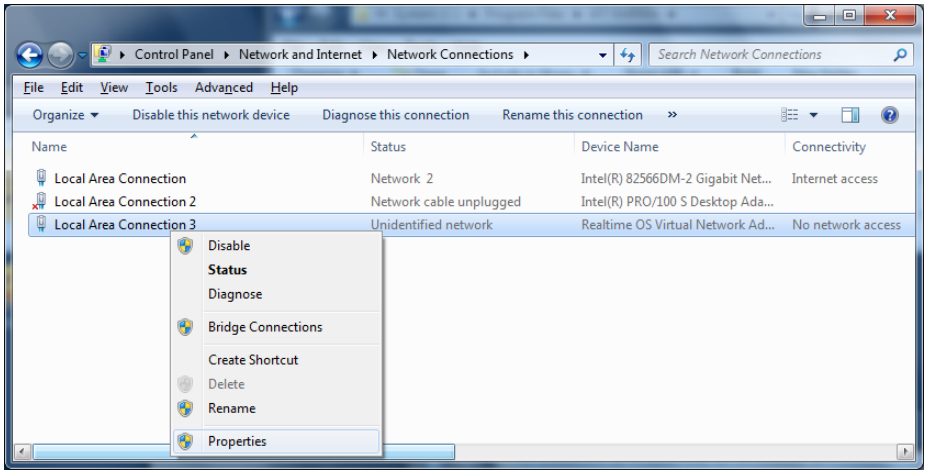
The “Realtime OS Virtual Network Driver” installation is similar to the previous “Realtime OS Driver” installation.

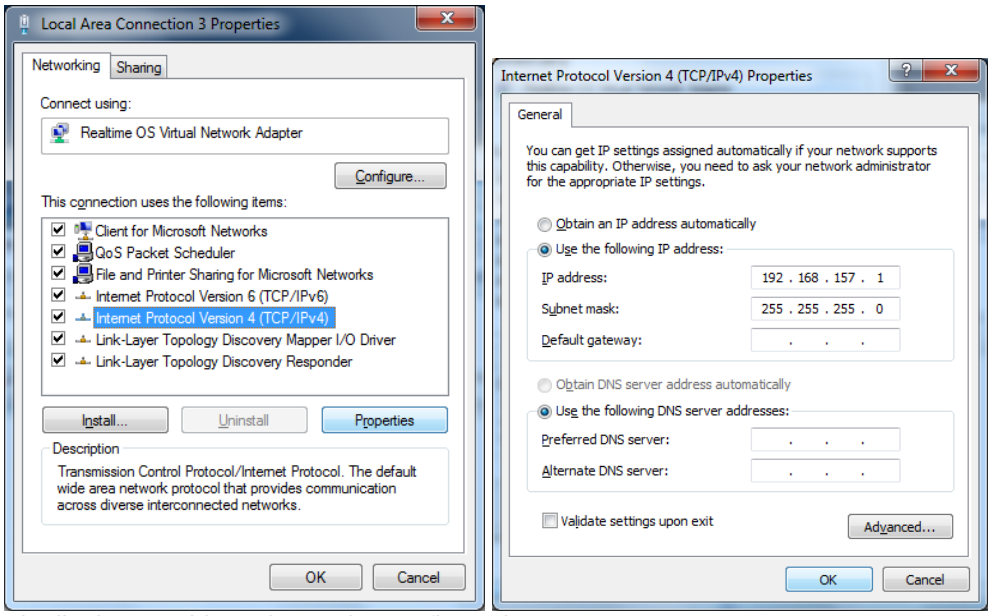


The main difference is that you have to select the “Realtime OS Virtual Network Driver”. All other steps are equal.



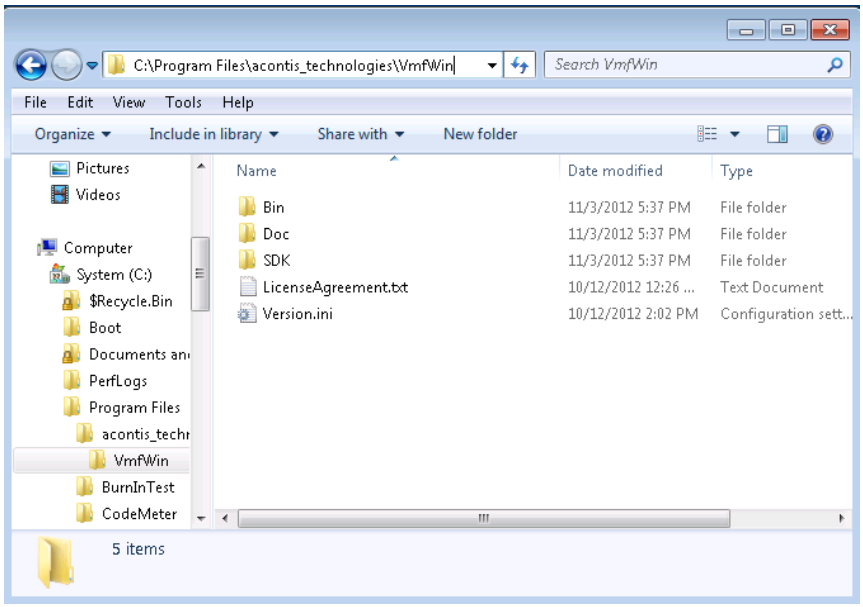
After the installation finished you the Device Manager should show the new network device.





Finally the IP address has to be configured.

16.2.3 Product Files

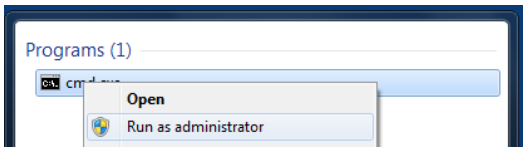


Create a new folder where the product should be installed to and copy all files from your installation directory into that folder.(without “Setup.exe”, “ProductIcon.ico” and “autorun.inf”)
The number of files will depend on your product.

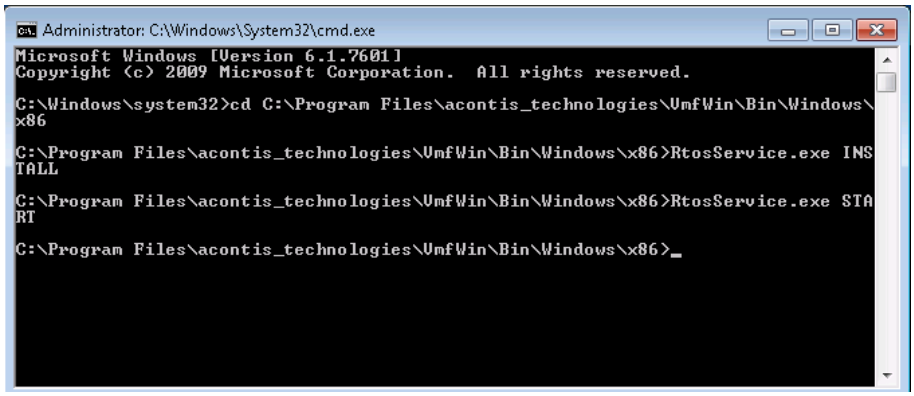
16.2.3.1 Virtual Machine Framework

The VMF file “vmf.bin” requires no special installation.

16.2.3.2 Realtime OS Service

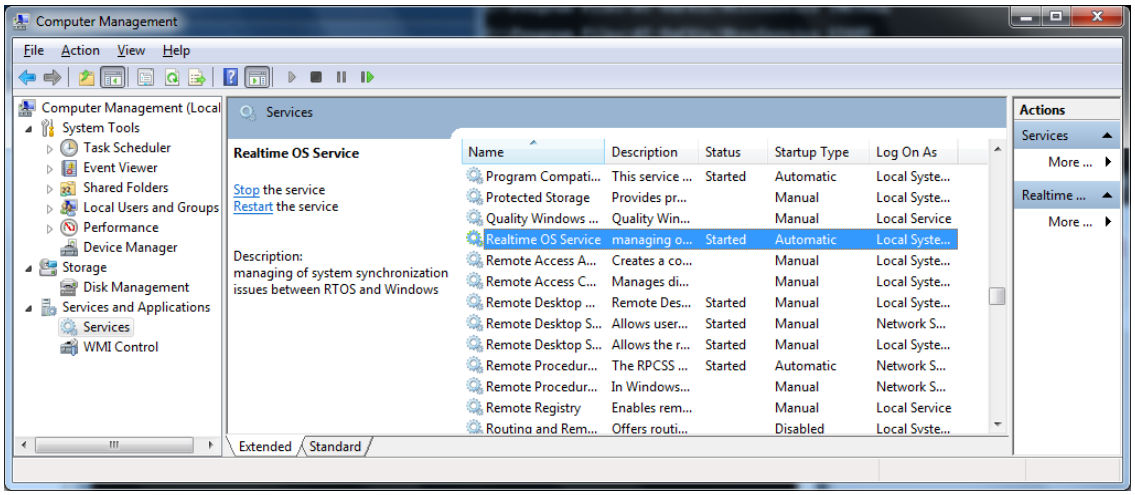


Start a command shell with administrator rights.



Change to de directory “C:\Program Files\acontis_technologies\RteRuntime” and then type in “RtosService.exe INSTALL” followed by “RtosService.exe START”

The service can be removed using the commands “STOP” and “UNINSTALL”.



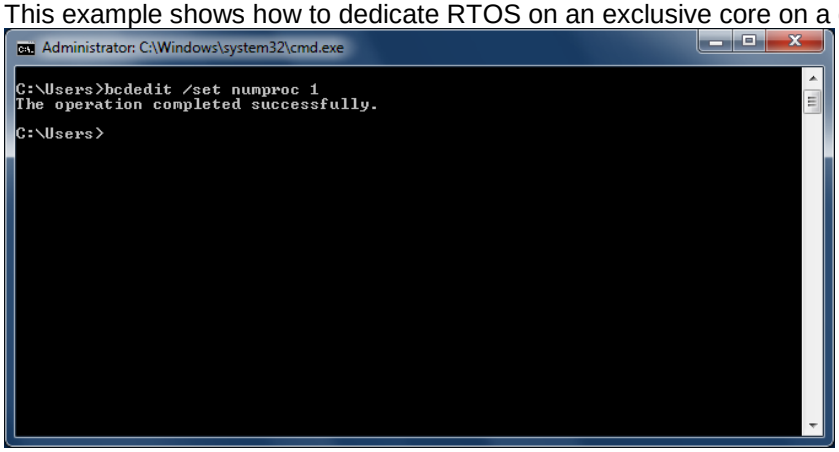
After the installation the Windows Servics should show the new “Realtime OS Service”.

16.2.3.3 Realtime OS Control

RtosControl.exe requires no special installation.

16.2.3.4 Configuration Files

If SharedCore is not required or technically not possible ExclusiveCore can be used.
This example shows how to dedicate RTOS on an exclusive core on a dual core PC.

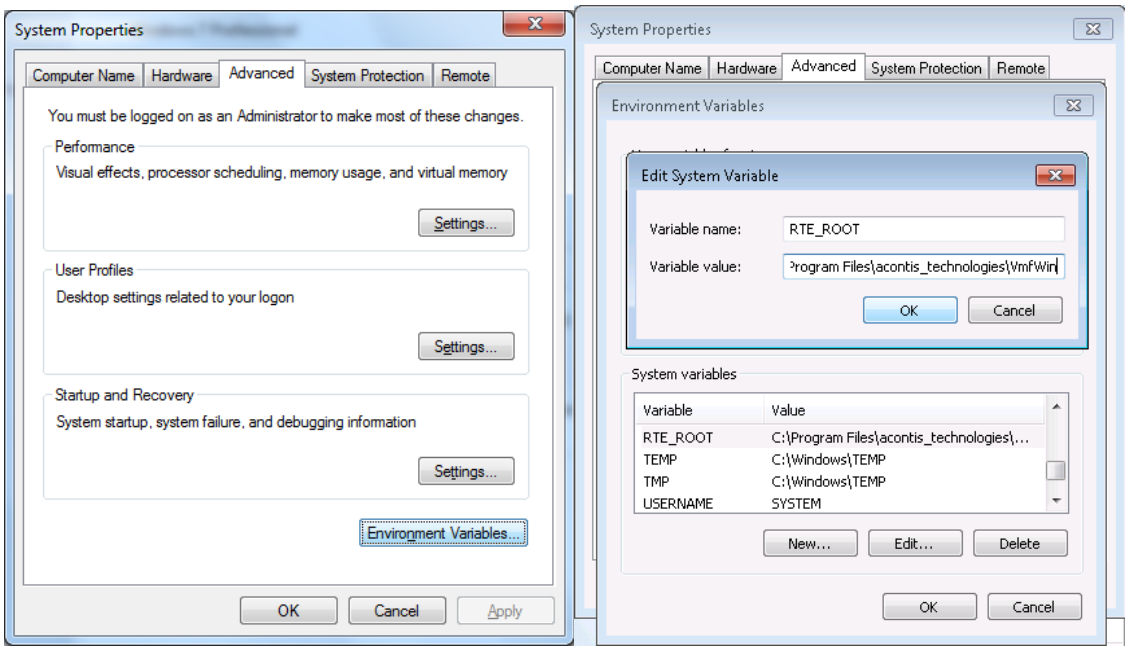


Windows must be limited in its processor usage.

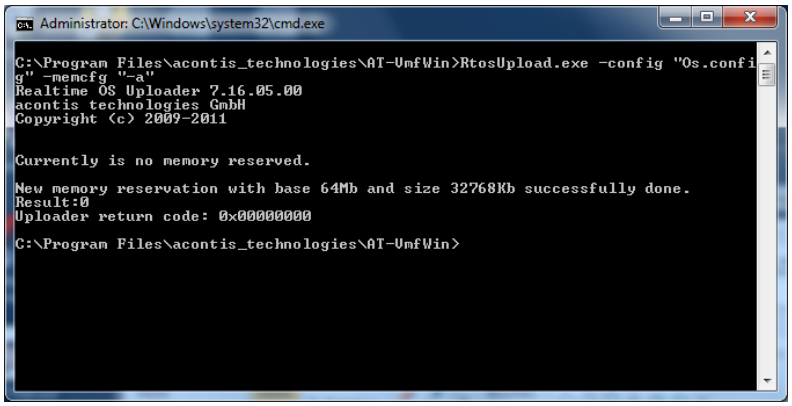
- Win7: call “bcdedit /set numproc X” from the command shell – started with administrator rights. (remove: “bcdedit /deletevalue numproc”)

A reboot is required to activate the new setting.
In this example Windows is limited to one processor so the second is available.
The config file “general.config” should contain the section “[Rtos]” with the value "ProcessorMask".
“ProcessorMask” must be set to the value 2 to use the second processor.

16.2.3.5 Realtime OS Uploader



The environment variable “RTE_ROOT” has to be set in the Windows system properties.
“Realtime OS Uploader” requires the variable “RTE_ROOT” to have the value of the product installation directory – for example “C:\Program Files\acontis_technologies\VmfWin”.



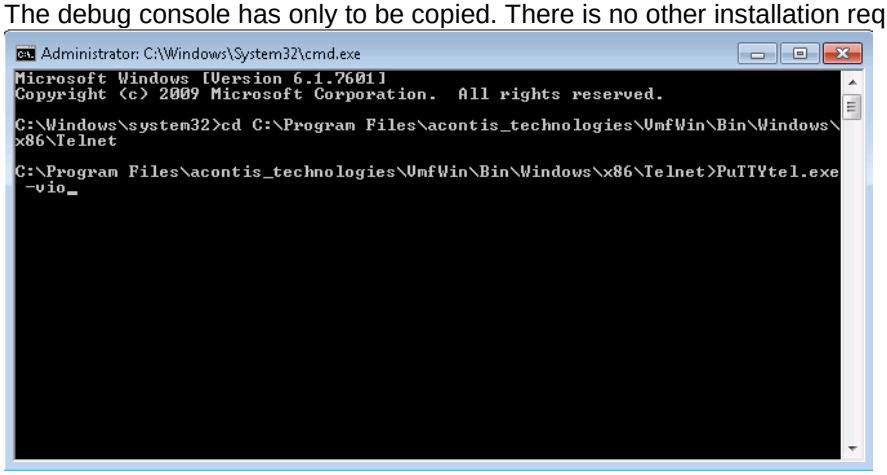
Memory has to be reserved from Windows for loading a RTOS.
The screenshot shows how memory reservation can be updated (values are taken from the given config file) without loading an OS image.
Depending on the product the name of the config file may vary.

Additionally the memory reservation is checked each time VMF is started and reconfigured automatically if the settings in the config file had changed.

A reboot is required after the memory configuration has been updated.

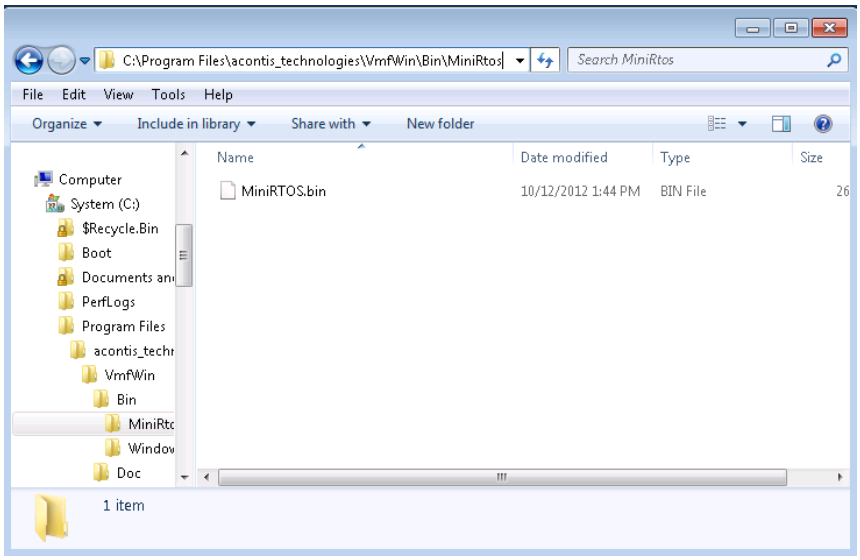
16.2.4 Debug Console

The debug console has only to be copied. There is no other installation required.



To start the debug console the parameter “-vio” is required.

16.2.5 Os Image

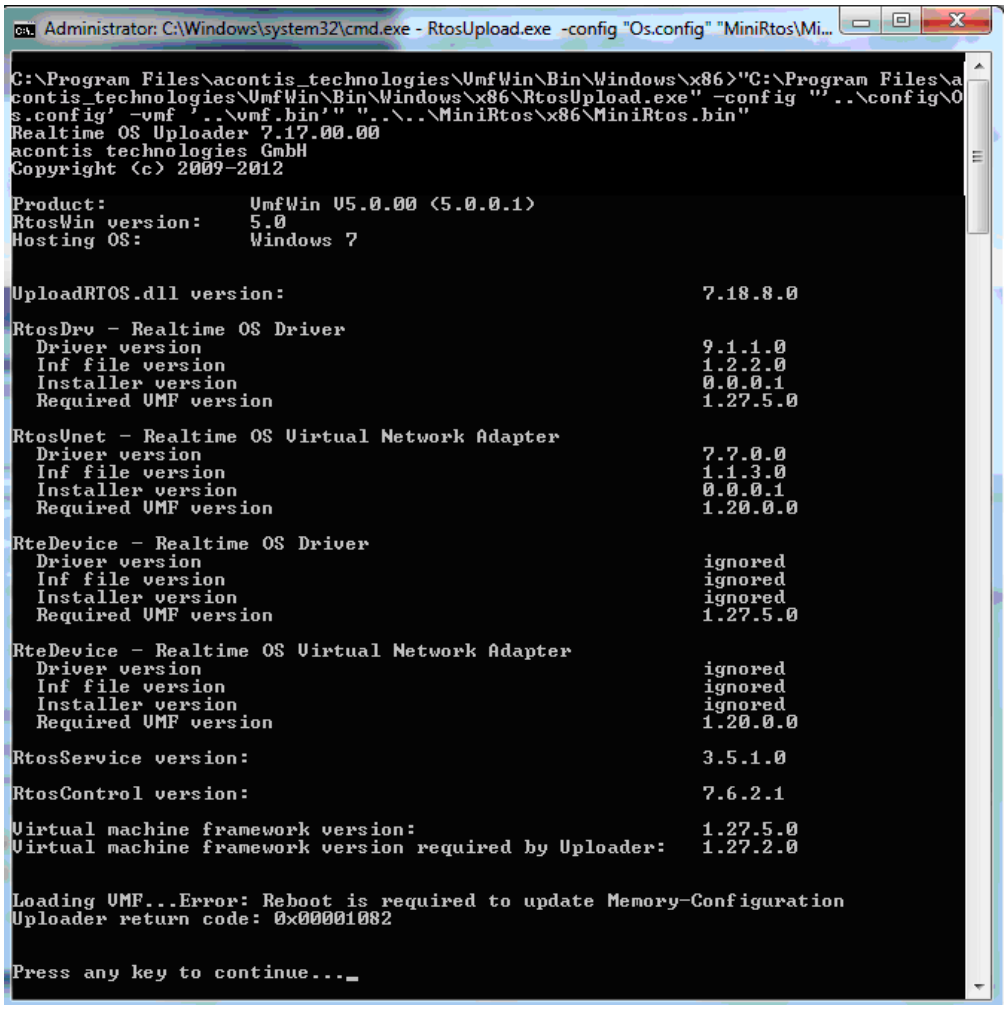


Copy the OS image to the desired directory.
The name and directory of the OS image file are product depending. This example shows VfmWin so please adapt this step to the product you’re using.

16.2.6 CodeMeter Runtime Environment

If your version is bound to a Software or USB license the WIBU “CodeMeter Runtime for Windows” has to be installed to verify the license.
If no license was found – because there is no license or then “CodeMeter Runtime for Windows” is missing – a “license not found” error message will occur during start of an OS.
The latest version of “CodeMeter Runtime for Windows” can be downloaded from http://www.wibu.com (Support & Downloads → User → User Software).

16.2.7 First Start of an OS

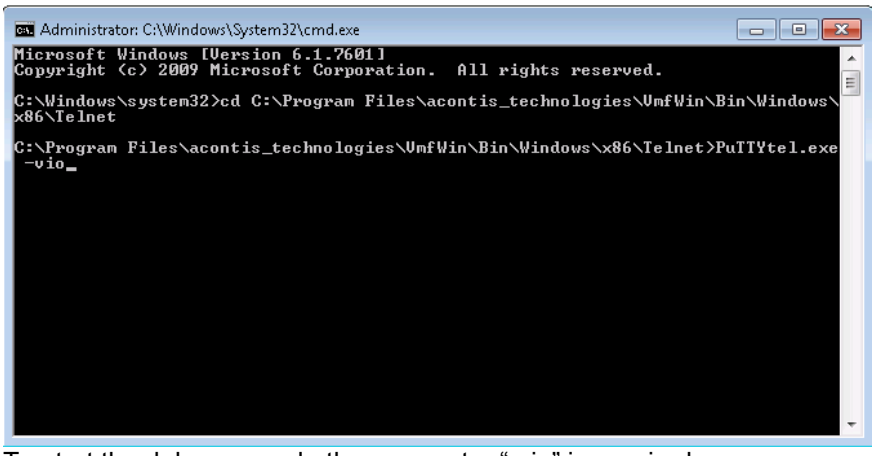


To start an OS the config file and OS image must be passed as parameters to the Uploder.
In this case the complete parameter is:

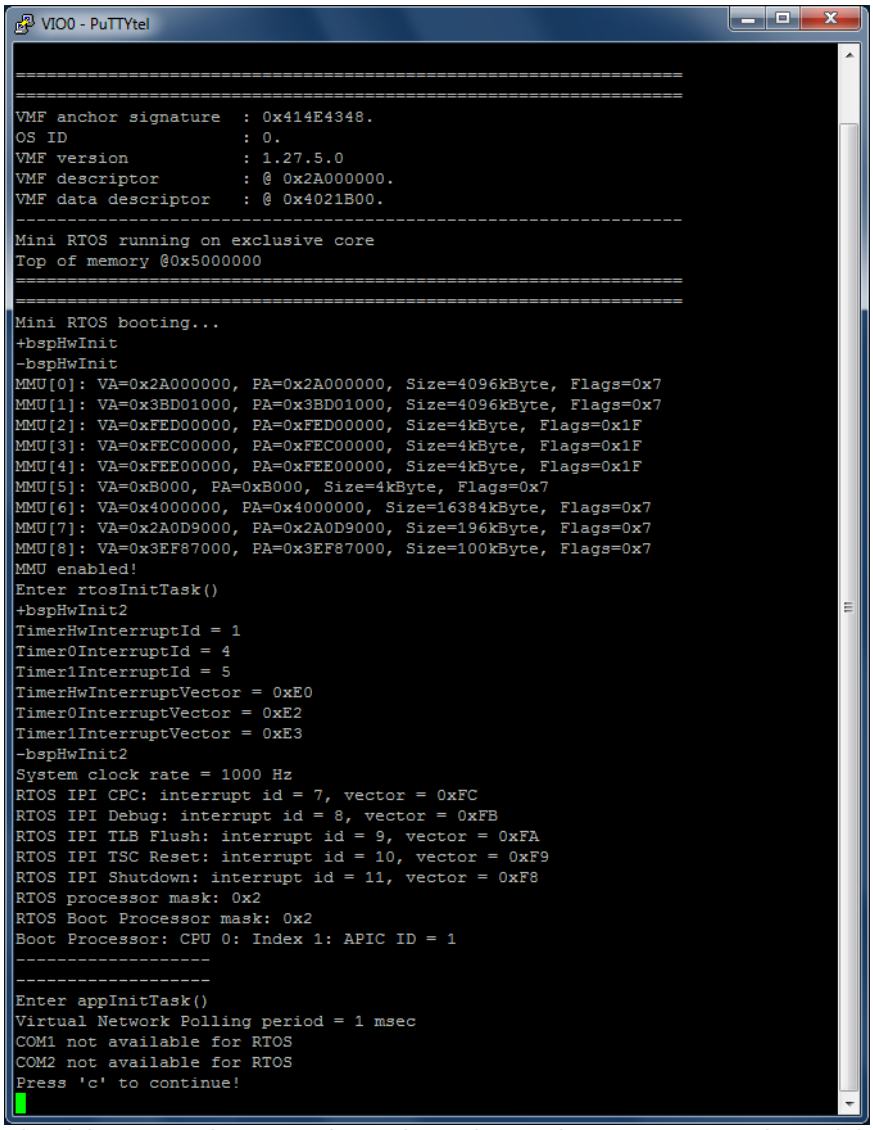
"C:\Program Files\acontis_technologies\RteRuntime\RtosUpload.exe" -config
"'..\VmfWin\Cfg\Os.config' -vmf '.\vmf.bin'" "..\VmfWin\Bin\MiniRtos\x86\MiniRtos.bin"

After first time installation the Memory-Configuration might require a second reboot.
The name of the config file and OS image file are product depending. This example uses VfmWin so please adapt this step to the product you're using.

Finaly it should start successfully.



To start the debug console the parameter “-vio” is required.



The debug console output depends on the product. In some products debug console implements an entire shell to access the OS.

16.2.8 Product specific additionals steps

If a product requires additional installation steps they will be described in the “Manual Installation” section of the product specific manual.

17 Version History

A general version history containing information about new features, migration hints and improvements can be found in the release notes file “ReleaseHistory.txt”.