System Configuration Guide

Release 1.3.9

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Chapter 1.About this Guide

This chapter contains the following topics:

Objectives

This manual contains instructions on how to get started with the Mapusoft products. The intention of the document is to guide the user to install, configure, build and execute the applications using Mapusoft products.

Audience

This manual is designed for anyone who wants to port applications to different operating systems, create projects, and run applications. This manual is intended for the following audiences:

- Customers with technical knowledge and experience with the Embedded Systems
- Application developers who want to migrate their application to different RTOSs
- Managers who want to minimize the cost and leverage on their existing code

Document Conventions

Table 1_1 defines the notice icons used in this manual.

Table 1_1: Notice Icons

Icon	Meaning	Description
☞	Informational note	Indicates important features or icons.
⚠	Caution	Indicates a situation that might result in loss of data or software damage.

Table 1_2 defines the text and syntax conventions used in this manual.

Table 1_2: Text and Syntax Conventions

Convention	Description
Courier New	`Identifies Program listings and Program examples.`
Italic text like this	`Introduces important new terms.` • `Identifies book names` • `Identifies Internet draft titles.`
COURIER NEW, ALL CAPS	`Identifies File names.`
Courier New, Bold	`Identifies Interactive Command lines`

MapuSoft Technologies and Related Documentation

Reference manuals can be provided under NDA. Click http://mapusoft.com/contact/ to request for a reference manual.

The document description table lists MapuSoft Technologies manuals.

Table 1_3: Document Description Table

User Guides	Description
	•
AppCOE Quick Start Guide	Provides detailed description on how to become familiar with AppCOE product and use it with ease. This guide: • Explains how to quickly set-up AppCOE on Windows/Linux Host and run the demos that came along AppCOE
Application Common Operating Environment Guide	Provides detailed description of how to do porting and abstraction using AppCOE. This guide: • Explains how to port applications • Explains how to import legacy applications • Explains how to do code optimization • Explains how to generate library packages • Explains on Application profiling and platform profiling
OS Abstractor Interface Reference Manual	Provides detailed description of how to use OS Abstraction. This guide: • Explains how to develop code independent of the underlying OS • Explains how to make your software easily support multiple OS platforms
POSIX Interface Reference Manual	Provides detailed description of how to get started with POSIX interface support that MapuSoft provides. This guide: • Explains how to use POSIX interface, port applications
micron-ITRON Interface Reference Manual	Provides detailed description of how to get started with micron-ITRON interface support that MapuSoft provides. This guide: • Explains how to use micron-ITRON interface, port applications
pSOS Interface Reference Manual	Provides detailed description of how to get started with pSOS interface support that MapuSoft provides. This guide: • Explains how to use pSOS interface, port applications
pSOS Classic Interface Reference Manual	Provides detailed description of how to get started with pSOS Classic interface support that MapuSoft provides. This guide • Explains how to use pSOS Classic interface, port applications
Nucleus Interface Reference Manual	Provides detailed description of how to get started with Nucleus interface support that MapuSoft provides. This guide:

	• Explains how to use Nucleus interface, port applications
ThreadX Interface Reference Manual	Provides detailed description of how to get started with ThreadX interface support that MapuSoft provides. This guide: Explains how to use ThreadX interface, port applications
VxWorks Interface Reference Manual	Provides detailed description of how to get started with VxWorks Interface support that MapuSoft provides. This guide: Explains how to use VxWorks Interface, port applications
Windows Interface Reference Manual	Provides detailed description of how to get started with Windows interface support that MapuSoft provides. This guide: • Explains how to use Windows interface, port applications
Release Notes	Provides the updated release information about MapuSoft Technologies new products and features for the latest release. This document: • Gives detailed information of the new products • Gives detailed information of the new features added into this release and their limitations, if required

Requesting Support

Technical support is available through the MapuSoft Technologies Support Centre. If you are a customer with an active MapuSoft support contract, or covered under warranty, and need post sales technical support, you can access our tools and resources online or open a ticket at http://www.mapusoft.com/support.

Registering a New Account

To register:

From http://www.mapusoft.com/main page, select **Support**.
Select **Register** and enter the required details.
After furnishing all your details, click **Submit**.

Submitting a Ticket

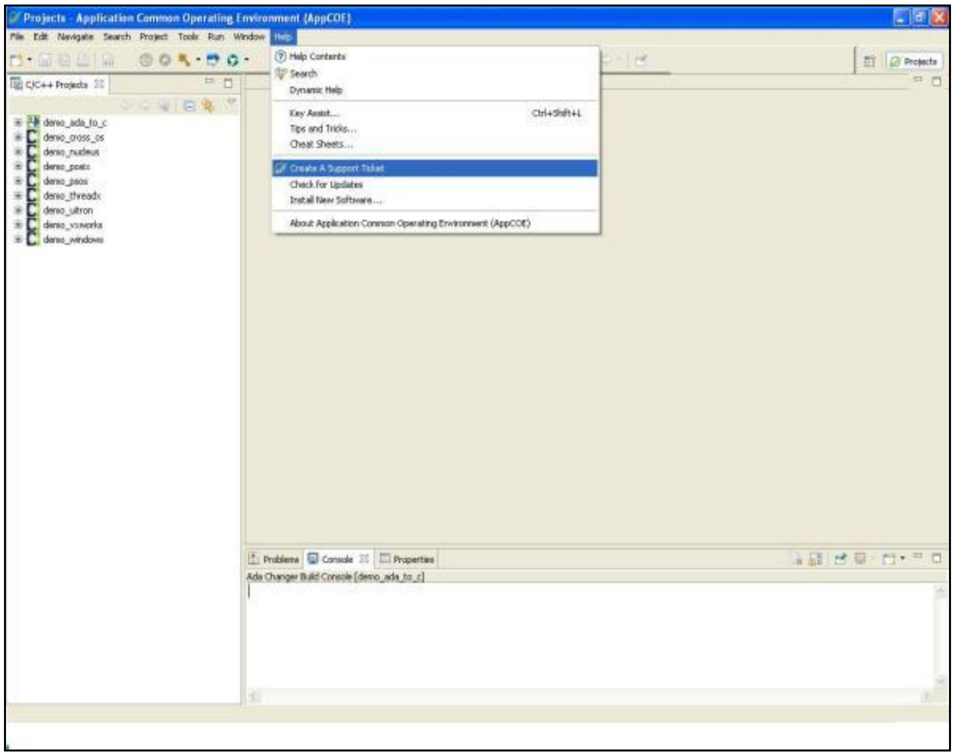
1. To submit a ticket:
    1. From http://www.mapusoft.com/main page, select **Support > Submit a Ticket**
    2. Select a department according to your problem, and click **Next.**
    3. Fill in your details and provide detailed information of your problem.
    4. Click **Submit.**

MapuSoft Support personnel will get back to you within 48 hours with a valid response.

2. To submit a ticket from AppCOE

    1. From AppCOE main menu, Select Help > Create a Support Ticket as shown in below Figure

Figure: Create a Support Ticket from AppCOE



2. Using the Existing Email and Password for login into Mapusoft Support Suite.
3. Select the department according to your problem, and click **Next.**
4. Fill in your details and provide detailed information of your problem.
5. Click **Submit.**

MapuSoft Support personnel will get back to you within 48 hours with a valid response.

Live Support Offline

MapuSoft Technologies also provides technical support through Live Support offline.
To contact live support offline:

1. From http://www.mapusoft.com/main page, select **Support** > **Live Support Offline**.
2. Enter your personal details in the required fields. Enter a message about your technical query. One of our support personnel will get back to you as soon as possible.
3. Click **Send**.

You can reach us at our toll free number: 1-877-627-8763 for any urgent assistance.

Documentation Feedback

Send Feedback on Documentation: http://www.mapusoft.com/support/index.php/

Chapter 2.System Configuration

This chapter contains the information about the System Configuration with the following topics:

- System Configuration
- Target OS Selection
- OS HOST Selection
- Target 64 bit CPU Selection
- User Configuration File Location
- OS Changer Components Selection
- POSIX Interface Selection
- OS Abstractor Interface Process Feature Selection
- OS Abstractor Interface Task-Pooling Feature Selection
- OS Abstractor Interface Profiler Feature Selection
- OS Abstractor Interface Output Device Selection
- OS Abstractor Interface Debug and Error Checking
- OS Abstractor Interface ANSI API Mapping
- OS Abstractor Interface Resource Configuration
- OS Abstractor Interface Minimum Memory Pool Block Configuration
- OS Abstractor Interface Application Shared Memory Configuration
- OS Abstractor Interface Clock Tick Configuration
- OS Abstractor Interface Device I/O Configuration
- OS Abstractor Interface Target OS Specific Notes
- Runtime Memory Allocations
- OS Abstractor Process Feature
- Simple (single-process) Versus Complex (multiple-process) Applications

System Configuration

The user configuration is done by setting up the appropriate value to the pre-processor defines found in the cross_os_usr.h.

NOTE: Make sure the OS Abstractor Interface libraries are re-compiled and newly built whenever configuration changes are made to the os_target_usr.h when you build your application. In order to re-build the library, you would actually require the full-source code product version (not the evaluation version) of OS   Abstractor Interface.

Applications can use a different output device as standard output by modifying the appropriate functions defines in os_target_usr.h along with modifying os_setup_serial_port.c module if they choose to use the format Input/output calls provided by the OS AbstractorInterface.

Target OS Selection

Based on the OS you want the application to be built, set the pre-processor definition in your project setting or make files by using the Table 2_1.

Table 2_1: Set the Pre-processor Definition For Selected Target OS

Flag and Purpose	Available Options
OS_TARGET To select the target operating system.	The value of the OS_Target should be for the OS Abstractor Interface product that you have purchased. For Example, if you have purchased the license for : **OS_NUCLEUS** – Nucleus PLUS® from ATI **OS_THREADX** – ThreadX® from Express Logic **OS_VXWORKS** – VxWorks® from Wind River Systems **OS_ECOS** – eCOS standards from Red Hat **OS_MQX** - Precise/MQX® from ARC International **OS_UITRON** – micro-ITRON standard based OS **OS_LINUX** - Open-source/commercial Linux® distributions **OS_WINDOWS** – Windows 2000, Windows XP®, Windows CE, Windows Vista from Microsoft. If you need to use the OS Abstractor Interface both under Windows and Windows CE platforms, then you will need to purchase additional target license. **OS_TKERNEL** – Japanese T-Kernel® standards based OS **OS_LYNXOS** - LynxOS® from LynuxWorks **OS_QNX** – QNX operating system from QNX **OS_LYNXOS** – LynxOS from Lynuxworks **OS_SOLARIS** – Solaris from SUN Microsystems **OS_ANDROID** – Mobile Operating System running on Linux Kernel **OS_NETBSD** – UNIX like Operating System **OS_µCOS** – µCOS® from Micrium For example, if you want to develop for ThreadX, you will define this flag as follows: OS_TARGET = OS_THREADX PROPRIETARY OS: If you are doing your own porting of OS Abstractor Interface to your proprietary OS, you could add your own define for your OS and include the appropriate OS interface files within os_target.h file. MapuSoft can also add custom support and validate the OS Abstraction solution for your proprietary OS platform

OS HOST Selection

The flag has to be false for standalone generation.

Table 2_2: Select the host operating system

Flag and Purpose	Available Options
OS_HOST To select the host operating system	This flag is used only in AppCOE environment. It is not used in the target environment. In Standalone products, this flag should be set to OS _FALSE.

Target 64 bit CPU Selection

Based on the OS you want the application to be built, set the following pre-processor definition in your project setting or make files:

Table 2_3: Select the Target CPU type

Flag and Purpose	Available Options
OS_CPU_64BIT To select the target CPU type.	The value of OS_CPU_64BIT can be any ONE of the following: • OS_TRUE – Target CPU is 64 bit type CPU • OS_FALSE – Target CPU is 32 bit type CPU **NOTE**: This value cannot be set in the cross_os_usr.h, instead it needs to be passed to compiler as –D macro either in command line for the compiler or set this pre-processor flag via the project settings. If this macro is not used, then the default value used will be OS_FALSE.

Select the OS Changer components for your application use as follows:

Table 2_4: OS Changer components for your application

Compilation Flag	Meaning
MAP_OS_ANSI_FMT_IO	Maps ANSI Formatted I/O functions to the OS Abstractor equivalent
MAP_OS_ANSI_IO	Maps ANSI I/O functions to the OS Abstractor equivalent
INCLUDE_OS_PSOS_CLASSIC	set to OS_TRUE to build for use with the OS Changer for pSOS Classic product

Select the following definition if you want OS Changer to enable error checking for debugging purposes:

Table 2_5: Set the Pre-processor Definition For error checking

Compilation Flag	Meaning
OS_DEBUG_INFO	Enable error checking for debugging

User Configuration File Location

The default directory location of the cross_os_usr.h configuration file is given below:

Table 2_6: Cross_os_usr.h Configuration File

Target OS	Configuration Files Directory Location
OS_NUCLEUS	`\mapusoft\cros_os_nucleus\include`
OS_THREADX	`\mapusoft\cross_os_threadx\include`
OS_VXWORKS	`\mapusoft\cross_os_vxworks\include` Please make sure you specify the appropriate target OS versions that you use in the osabstractor_usr.h
OS_MQX	`\mapusoft\cross_os_mqx\include`
OS_UITRON	`\mapusoft\cross_os_uitron\include`
OS_LINUX	`\mapusoft\cross_os_linux\include` Please make sure you specify the appropriate target OS versions that you use in the cross_os_usr.h **NOTE**: RT Linux, for using RT Linux you need to select this option.
OS_SOLARIS	`\mapusoft\cross_os_solaris\include`
OS_WINDOWS	`\mapusoft\cross_os_windows\include` Any windows platform including Windows CE platform. If you use OS Abstractor Interfaceunder both Windows and Windows CE, then you would require additional target license. **NOTE**: Windows 2000, Windows XP®, Windows CE, Windows Vista from Microsoft
OS_ECOS	`\mapusoft\cross_os_ecos\include`
OS_LYNXOS	`\mapusoft\cross_os_lynxos\include`
OS_QNX	`\mapusoft\cross_os_qnx\include`
OS_TKERNEL	`\mapusoft\cross_os_tkernel\include`
OS_ANDROID	`\mapusoft\cross_os_android\include`
OS_NETBSD	`\mapusoft\cross_os_netbsd\include`
OS_µCOS	`\mapusoft\cross_os_µCOS\include`

If you have installed the MapuSoft's products in directory location other than mapusoft then refer the corresponding directory instead of \mapusoft for correct directory location.

OS Changer Components Selection

OS Abstractor optional comes with various OS Changer API solutions in addition to its BASE and POSIX API offerings. OS Changer APIs are used to port legacy code base from one OS to another. Select one or more OS Changer components depending on the type of code that you needed to port to one or more new operating system platforms. Set the pre-processor flag below to select the components needed by your application:

Table 2_7: OS Changer Components Selection

Flag and Purpose	Available Options
INCLUDE_OS_VXWORKS To include VxWorks Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE
INCLUDE_OS_POSIX/LINUX To include POSIX/LINUX Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE
INCLUDE_OS_PSOS To include pSOS Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE
INCLUDE_OS_PSOS_CLASSIC To include a very old version of pSOS Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support for pSOS 4.1 rev 3/10/1986 OS_FALSE – do not include pSOS 4.1 support The default is OS_FALSE
INCLUDE_OS_UITRON To include UITRON Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE
INCLUDE_OS_NUCLEUS To include Nucleus PLUS Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE.
INCLUDE_OS_NUCLEUS_NET To include Nucleus NET Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE.
INCLUDE_OS_THREADX To include ThreadX Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE
INCLUDE_OS_FILE To include ANSI file system API compliance for the vendor provided File Systems. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE. This option is only available for Nucleus PLUS target OS
INCLUDE_OS_WINDOWS To include Windows Interface product. Refer to the appropriate Interface manual for more details.	OS_TRUE – Include support OS_FALSE – Do not include support The default is OS_FALSE This option is not available on Windows operating system host or target environment

NOTE: For additional information regarding how to use any specific Interface product, refer to the appropriate reference manual or contact www.mapusoft.com.

POSIX OS Abstractor Selection

OS Abstractor Interface optionally comes with POSIX support as well. Set the pre-processor flag provided below to select the POSIX component for application use as follows:

Table 2_8: POSIX component for application

Flag and Purpose	Available Options
INCLUDE_OS_POSIX To include POSIX Interface product component.	**OS_TRUE** – Include support. You will need this option turned ON either if the underlying OS does not support POSIX (or) you need to POSIX provided by OS Abstractor Interface instead of the POSIX provided natively by the target OS OS_FALSE – Do not include support The default is OS_FALSE.

NOTE: The above component can be used across POSIX based and non-POSIX based target OS for gaining full portability along with advanced real-time features. POSIX Interface library will provide the POSIX functionality instead of application using POSIX functionalities directly from the native POSIX from the OS and as a result this will ensure that your application code will work across various POSIX/UNIX based target OS and also its various versions while providing various real-time API and performance features. In addition, OS Abstractor Interface will allow the POSIX application to take advantage of safety critical features like task-pooling, fixing boundary for application's heap memory use, self recovery from fatal errors, etc. (these features are defined elsewhere in this document). For added flexibility, POSIX applications can also take advantage of using OS Abstractor Interface APIs non-intrusively for additional flexibility and features.

OS Abstractor Process Feature Selection

Table 2_9: OS Abstractor Process Feature Selection

Flag and Purpose	Available Options
INCLUDE_OS_PROCESS	OS_TRUE – Include OS Abstractor process support APIs and track resources under each process and also allow multiple individually executable applications to use OS Abstractor OS_FALSE – Do not include process model support. Use this option for optimized OS Abstractor performance The default is OS_FALSE

The INCLUDE_OS_PROCESS option is useful when there are multiple developers writing components of the applications that are modular. The resource created by the process is automatically tracked and when the process goes away they also go away. One process can use another process resource, only if that process is created with "system" scope. A process cannot delete a resource that it did not create.

The INCLUDE_OS_PROCESS feature can also be used on target OS like VxWorks 5.x a non-process based operating system. In this case, the OS Abstractor provides software process protection. Under process-based OS like Linux, the processes created by the OS Abstractor will be an actual native system processes.

The INCLUDE_OS_PROCESS feature is also useful to simulate complex multiple embedded controller application on x86 single processor host platform. In this case, each individual process /application will represent individual controllers, which uses a shared memory region for inter-communication. This application could then be ported to the real multiple embedded controller environments with shared physical memory.

Process Feature use within OS Changer

It is possible for legacy applications to use the process feature along with OS Changer and take advantage of process protection mechanism and also have the ability to break down the complex application into multiple manageable modules to reduce complexity in code development. However, when porting legacy code, we recommend that the application be first ported to a single process successfully. Once this is completed, then the application can be modified to move the global data to shared memory and can be made to easily reside into individual process and or multiple executables.

To allow the legacy applications to be broken down into process modules and /or multiple applications the flag INCLUDE_OS_PROCESS needs to be set to OS_TRUE. Also the application needs to use OS_Create_Process envelopes to move the resources to appropriate processes. Legacy application can also make in multiple applications which then compile separately and can continue to use Interface APIs for inter-process communication. Interface APIs provides transparency to the application and allows the application to use the API among resources within a single process or multiple processes /applications.

OS Abstractor Task-Pooling Feature Selection

Task-Pooling feature enhances the performances and reliability of application. Creating a task (thread) at run-time require considerable system overhead and memory. The underlying OS thread creation function call can take considerable amount of time to complete the operation and could fail if there is not enough system memory. Enabling this feature, Applications can create OS Abstractor tasks during initialization and be able to re-use the task envelope again and again. To configure task-pooling, set the following pre-processor flag as follows:

Table 2_10: OS Abstractor Task-Pooling Feature Selection

Flag and Purpose	Available options
INCLUDE_OS_TASK_POOLING	OS_TRUE – Include OS Abstractor task pooling feature to allow applications to re-use task envelops from task pool created during initialization to eliminate run-time overhead with actual resource creation and deletion OS_FALSE – Do not include task pooling support The default is OS_FALSE

Except for the performance improvement, this behavior will be transparent to the application. Each process /application will contain its own individual task pool. Any process, which requires a task pool, must successfully add tasks to the pool before it can be used. Tasks can be added to (via OS_Add_To_Task_Pool function) or removed (via OS_Remove_From_Task_Pool function) from a task pool at anytime.

When an application makes a request to use a pool task, OS Abstractor will first search for a free task in the pool with an exact match based on stack size. If it does not find a match, then a free task with the next larger stack size that is available will be used. If there are multiple requests pending, a search will be made in FIFO order on the request list when a task is freed to the pool. The first request that matches or fulfills the stack requirement will then be fulfilled.

Refer to the MapuSoft supplied os_application_start.c file that came with the MapuSoft's demo application. The demo application pre-creates a bunch of fixed-stack-size (using STACK_SIZE as defined in cross_os_def.h) task-pool-task as shown below:

```
#if (INCLUDE_OS_TASK_POOLING == OS_TRUE)
       for(i = 0; i < Max_Threads; i++)
       {
       OS_Add_To_Task_Pool(STACK_SIZE); /*this is a portion of code in
       init.c,
                                         STACK_SIZE should be changed
                                         according to the desired stack size
       }
#endif
```

Typically, applications would need a variety of threads with different stack size. If you would like to modify the demo application to use threads with larger or differing stack size, make sure you modify the `os_application_start.c` file according to your needs.

The OS_Create_Task function will be used to retrieve a task from the task pool. This will be accomplished by passing one of the flags OS_POOLED_TASK_WAIT or `OS_POOLED_TASK_NOWAIT` as a parameter to `OS_Create_Task`. When a task has completed and either exits, falls through itself or gets deleted by another task using the `OS_Delete_Task` function, the task will automatically be freed to be used again by the task pool. For further details, please refer to the `OS_Create_Task` specification defined in the following pages.

An Application can add or remove tasks with a specified stack size to the task pool at any time. The task pool will grow or shrink depending on each addition or deletion of tasks in the task pool. The Application cannot remove a valid task, which does not belong to the task pool. `OS_Get_System_Info` function can be used to retrieve the system configuration and run-time system status including information related to task pool.

If `OS_TASK_POOLING` is enabled, then all tasks POSIX threads created using the POSIX Interface POSIX APIs provided by POSIX Interface with POSIX and/or any task creation created using task create functions in any Interface products will automatically use the task pool mechanism with the flag option set to `OS_POOLED_TASK_NOWAIT`.

Warning: Your application will fail during task creation if OS_TASK_POOLING is enabled and you have not added any tasks to the task pool. Make sure you add tasks (via `OS_Add_To_Task_Pool` function) with all required stack sizes prior to creating pooled tasks (via OS_Create_Task function).

Special Notes: Task Pooling feature is not supported in ThreadX, µCOS, and Nucleus targets.

OS Abstractor Profiler Feature Selection

The following are the user configuration options that can be set in the cross_os_usr.h:

Table 2_11: OS Abstractor Profiler Feature Selection

Flag and Purpose	Available Options
OS_PROFILER Profiler feature allows applications running on the target to collect valuable performance data regarding the application's usage of the OS Abstractor APIs. Using the AppCOE tool, this data can then be loaded and analyzed in graphical format. You can find out how often a specific OS Abstractor API is called across the system or within a specific thread. You can also find out how much time the functions took across the whole system as well as within a specific thread Profiler feature uses high resolution clock counters to collect profiling data and this implementation may not be available for all target CPU and OS platforms. Please contact MapuSoft for any custom high resolution timer implementation required for the profiler for your target/OS environment. Refer to `OS_Get_Hr_Clock_Freq`() and `OS_Read_Hr_Clock()` for additional details on what target/OS platforms are currently supported by the profiler. If profiler feature is turned ON, then it needs to use the open/read/write calls to write to profiler data file. If you set OS_MAP_ANSI_IO to OS_TRUE then make sure you install the appropriate file device and driver.	Can either be: OS_TRUE – Profiler feature will be included. Profiling takes place with each OS Abstractor API call. If profiler is turned on, also set the value for the following defines: **PROFILER_TASK_PRIORITY** The priority level (0 to 255) of the profiler thread. The profiler thread starts picking up the messages in the profiler queue, formats them into XML record and write to file. If the priority is set to the lowest (i.e, 255), then the profiler thread may not have an opportunity to pick the message from the queue in time and as such the queue gets filled up and as such the profiler will stop. The default profiler task priority value is set to 200. **NUM_OF_MSG_TO_HOLD_IN_MEMORY** This will be the depth of the profiler queue. The bigger the number, the more the memory is needed. A maximum of 30,000 profiler records can be created. Please make sure you increase you application's heap size by NUM_OF_MSG_TO_HOLD_IN_MEMORY times PROFILER_MSG_SIZE in the OS_Application_Init call. **PROFILER_DATAFILE_PATH** This will be the directory location where the profiler file will be created. For Linux,The default location set is "/root". OS_FALSE – Profiler code will be excluded and the feature will be turned off. The default value is OS_FALSE**.**

The profiler starts as soon as the application starts and will continue to collect performance data until the memory buffers in the profiler queue gets filled up. After, this the profiling stops and data is dumped into *.pal files at the user specified location. It is recommended that the profiler feature be turned off for the production release of your application.

If the profiler feature is turned OFF, then the profiler hooks disappear within the OS Abstractor and as such there are no impacts to the OS Abstractor API performance.

Special Notes: Profiler feature is not supported in ThreadX and Nucleus targets.

OS Abstractor Output Device Selection

The following are the user configuration options and their meanings:

Table 2_12: OS Abstractor Output Device Selection

Flag and Purpose	Available options
OS_STD_OUTPUT	Output device to print. OS_SERIAL_OUT – Print to serial OS_WIN_CONSOLE – Print to console User can print to other devices by modifying the appropriate functions within os_setup_serial_port.c in the OS Abstractor “source” directory and use OS Abstractor’s format Input/Output calls. The default value is OS_WIN_CONSOLE

OS Abstractor Debug and Error Checking

Table 2_13: OS Abstractor Debug and Error Checking

Flag and Purpose	Available Options
OS_DEBUG_INFO	**OS_DEBUG_MINIMAL** – print debug info, fatal and compliance errors **OS_DEBUG_VERBOSE** –print the debug information, Fatal Error & Compilation Error elaborately. **OS_DEBUG_DISABLE** -do not print debug info The default value is **OS_DEBUG_MINIMAL**
OS_ERROR_CHECKING	OS_TRUE – Check for API usage errors OS_FALSE – do not check for errors. Use this option to increase performance and reduce code size The default value is OS_TRUE

OS Abstractor ANSI API Mapping

OS Abstractor APIs can be mapped to exact ANSI names by turning on these features:

Table 2_14: OS Abstractor ANSI API Mapping

Flag and Purpose	Available options
MAP_OS_ANSI_MEMORY	OS_TRUE – map ANSI malloc() and free() to OS Abstractor equivalent functions OS_FALSE – do not map functions. Also, when you call OS_Application_Free in this case, the memory allocated via malloc() calls will NOT be automatically freed. The default value is OS_TRUE **NOTE**: Refer to OS_USE_EXTERNAL_MALLOC define, if you want to connect your own memory management solution for use by OS Abstractor
MAP_OS_ANSI_FMT_IO	OS_TRUE – map ANSI printf() and sprintf() to OS Abstractor equivalent functions OS_FALSE – do not map functions The default value is OS_FALSE
MAP_OS_ANSI_IO	OS_TRUE – map ANSI device I/O functions like open(), close(), read(), write, ioctl(), etc. to OS Abstractor equivalent functions **NOTE:** If your target OS is NOT a single-memory model based (e.g. Windows, Linux, QNX, etc.), then the OS Abstractor I/O functions are to be used within one single process/application.. If you need to use the I/O across multiple process, then set this define to OS_FALSE so that your application can use the native I/O APIs from the OS OS_FALSE – do not map functions The default value is OS_FALSE

NOTE: When you set MAP_OS_ANSI_IO to OS_TRUE, OS Abstractor automatically replaces open() calls to `OS_open()` during compile time when you include os_target.h in your source code. If you set MAP_OS_ANSI_IO to OS_FALSE, then in your source code when you include os_target.h, application can actually use both OS_open() and open() calls, where the `OS_open` will come from OS Abstractor library and open() will come from the native OS library. Given that OS Abstractor I/O APIs are similar to ANSI I/O, you probably can use the third option so that you eliminate some performance overhead going through OS Abstractor I/O wrappers if necessary. But, it is always recommended that application use OS Abstractor or POSIX APIs instead of directly using native API calls from OS libraries for maximum portability.

OS Abstractor External Memory Allocation

OS Abstractor APIs can be mapped to exact ANSI names by turning on these features:

Table 2_15: OS Abstractor External Memory Allocation

Flag and Purpose	Available options
OS_USE_EXTERNAL_MALLOC	OS_TRUE – OS Abstractor can be configured to use an application defined external functions to allocate and free memory needed dynamically by the process. In this case, the OS Abstractor will use these function for allocating and freeing memory within `OS_Allocate_Memory` and `OS_Deallocate_Memory` functions These external functions needs to be similar to `malloc()` and free() and should be defined within cross_os_usr.h in order for OS Abstractor to successfully use them. This feature is useful if the application has its own memory management schemes far better than what the OS has to offer for dynamic allocations. OS_FALSE – OS Abstractor will directly use the target OS system calls for allocating and freeing the memory The default value is OS_FALSE

OS Abstractor Resource Configuration

In addition to OS Abstractor resources used by application, there may be some additional resources required internally by OS Abstractor. The configuration should take into account of these additional resources while configuring the system requirements. All or any of the configuration parameters set in cross_os_usr.h configuration file can be altered by OS_Application_Init function .

The following are the OS Abstractor system resource configuration parameters:

Table 2_16: OS Abstractor system resource configuration parameters

Flag and Purpose	Default Setting
OS_TOTAL_SYSTEM_PROCESSES The total number of processes required by the application	100 One control block will be used by the OS_Application_Init function when the INCLUDE_OS_PROCESS option is true
OS_TOTAL_SYSTEM_TASKS The total number of tasks required by the application	100 One control block will be used by the OS_Application_Init function when the INCLUDE_OS_PROCESS option is true.
OS_TOTAL_SYSTEM_PIPES The total number of pipes for message passing required by the application	100
OS_TOTAL_SYSTEM_QUEUES	100

The total number of queues for message passing required by the application	
OS_TOTAL_SYSTEM_MUTEXES The total number of mutex semaphores required by the application	100
OS_TOTAL_SYSTEM_SEMAPHORES The total number of regular (binary/count) semaphores required by the application	100
OS_TOTAL_SYSTEM_DM_POOLS The total number of dynamic variable memory pools required by the application	100 One control block will be used by the OS_Application_Init function when the INCLUDE_OS_PROCESS option is true.
OS_TOTAL_SYSTEM_PM_POOLS The total number of partitioned (fixed-size) memory pools required by the application	100
OS_TOTAL_SYSTEM_TM_POOLS The total number of Tiered memory pools required by the application	100
OS_TOTAL_SYSTEM_TSM_POOLS The total number of Tiered shared memory pools required by the application	100
OS_TOTAL_SYSTEM_EV_GROUPS The total number of event groups required by the application	100
OS_TOTAL_SYSTEM_TIMERS The total number of application timers required by the application	100
OS_TOTAL_SYSTEM_HANDLES The total number of system Handles required by the application	100

NOTE: The first control block of Task, Queue, Dynamic Memory and Semaphore is reserved for internal use in the OS Abstractor Interface.

The following are the additional resources required internally by OS Abstractor:

Table 2_17: Additional resources required internally by OS Abstractor

Resources	Linux /POSIX ,Vxworks, pSOS ,Windows, µCOS, QNX, MQX, ThreadX, Nucleus, uITRON, NetBSD, Solaris, LynxOS, Android Targets
TASK	• 2 Semaphore required if application uses µitron Interface for above mentioned target • 1 Event Group required by OS Abstractor for signaling support in posix for above mentioned target • 1 Event group required if application uses POSIX Interface and/or VxWorks Interface and/or pSOS Interface for above mentioned target • 1 Event Group required by OS Abstractor if application uses task pooling for above mentioned target
DYNAMIC_POOL	• 1 Event Group required by OS Abstractor for above mentioned target but not for MQX Target
QUEUE	• 2 Semaphores used by OS Abstractor for above mentioned target • 1 Semaphore used by POSIX Interface for above mentioned target • Additional Queues required by OS Abstractor if application uses profiler for above mentioned target
PIPE	• 1 Additional Semaphore required by OS Abstractor
MUTEX	• Additional Protection Structure required by OS Abstractor for above mentioned target
PROCESS	• 1 DM_POOL used by OS Abstractor for above mentioned target • 1 Event Group required by OS Abstractor for above mentioned target • 1 Additional Task required by OS Abstractor for above mentioned target • 2 Protection Structures required by OS Abstractor for above mentioned target **Note:** Every process needs a memory pool only for µCOS Target
NON_PROCESS	• 1 Event Group required by OS Abstractor for Linux, Windows, MQX Target • 2 Event Group required by OS Abstractor µCOS Target
PARTITION_POOL	• 1 Semaphore is used by OS Abstractor for above mentioned target
PROTECTION_STRUCTURE	• 1 Protection Structures required by os_key_list_protect if application uses POSIX Interface for above mentioned target • 14 Additional Protection Structure required by OS Abstractor for above mentioned Targets except LynxOS Target, Vxworks & QNX Target

	• 13 Additional Protection Structure required by OS Abstractor for LynxOS Target, Vxworks &QNX Target
Posix Condition Variable	1 Event Group required by POSIX Interface for above mentioned target
Posix R/W Lock	1 Event Group required by POSIX Interface for above mentioned target 1 Semaphore required by POSIX Interface for above mentioned target

If INCLUDE_OS_PROCESS feature is set to OS_FALSE, then the memory will be allocated from the individual application/process specific pool, which gets created during the OS_Application_Init function call.

If INCLUDE_OS_PROCESS is set to OS_TRUE, then the memory is allocated from a shared memory region to allow applications to communicate across multiple processes. Please note that in this case, the control block allocations cannot be done from the process specific dedicated memory pool since the control blocks are required to be shared across multiple applications.

OS Abstractor Minimum Memory Pool Block Configuration

Table 2_18: OS Abstractor Minimum Memory Pool Block Configuration

Flag and Purpose	Default Setting
OS_MIN_MEM_FROM_POOL Minimum memory allocated by the malloc() and/or OS_Allocate_Memory() calls. This will be the memory allocated even when application requests a smaller memory size	4 (bytes) **NOTE**: Increasing this value further reduces memory fragmentation at the cost of more wasted memory.

OS Abstractor Application Shared Memory Configuration

Table 2_19: OS Abstractor Application Shared Memory Configuration

Flag and Purpose	Default Setting
OS_USER_SHARED_REGION1_SIZE Application defined shared memory region usable across all process-based OS Abstractor processes/applications. Process-based applications are required to be built with OS_INCLUDE_PROCESS feature set to OS_TRUE	1024 (bytes)

OS Abstractor includes this shared user region in the memory area immediately following all the OS Abstractor control block allocations. Applications can access the shared memory via the `System_Config->user_shared_region`1 global variable. Also, access to shared memory region must be protected (i.e. use mutex locks prior to read/write by the application).

NOTE: The actual virtual address of the shared memory may be different across processes/application; however the OS Abstractor initialized the `System_Config` pointer correctly during OS_Application_Init function call. Applications should not pass the shared memory region address pointer from one process to another since the virtual address pointing to the shared region may differ from process to process (instead use the above global variable defined above for shared memory region access from each process/applications).

OS Abstractor Clock Tick Configuration

Table 2_20: OS Abstractor Clock Tick Configuration

Flag and Purpose	Default Setting
OS_TIME_RESOLUTION This will be the system clock ticks (not hardware clock tick). For example, when you call OS_Task_Sleep(5), you are suspending task for a period (5* OS_TIME_RESOLUTION). See **NOTES** in this table.	10000 µ second (= 10milli sec) Normally this value is derived from the target OS. If you cannot derive the value then refer to the target OS reference manual and set the correct per clock tick value
OS_DEFAULT_TSLICE Default time slice scheduling window width among same priority pre-emptable threads when they are all in ready state.	10 Number of system ticks. If system tick is 10ms, then the threads will be schedule round-robin at the rate of every 100ms. **NOTE**: On Linux operating system, the time slice cannot be modified per thread. OS Abstractor ignores this setting and only uses the system default time slice configured for the Linux kernel. **NOTE**: Time slice option is NOT supported under micro-ITRON. **NOTE**: If the time slice value is non-zero, then under Linux the threads will use Round-Robin scheduling using the system default time slice value of Linux. If the Linux kernel support LINUX_ADV_REALTIME then the time slice value will be set accordingly.

NOTE: Since the system clock tick resolution may vary across different OS under different target. It is recommended that the application use the macro `OS_TIME_TICK_PER_SEC` to derive the timing requirement instead of using the raw system tick value in order to keep the application portable across multiple OS.

OS Abstractor Device I/O Configuration

Table 2_21: OS Abstractor Device I/O Configuration

Flag and Purpose	Default Setting
NUM_DRIVERS Maximum number of drivers allowed in the OS Abstractor driver table structure	20 **NOTE**: This excludes the native drivers the system, since they do not use the OS Abstractor driver table structure.
NUM_FILES Maximum number of files that can be opened simultaneously using the OS Abstractor file control block structure.	30 **NOTE**: One control block is used when an OS Abstractor driver is opened. These settings do not impact the OS setting for max number of files.
EMAXPATH Maximum length of the directory path name including the file name for OS Abstractor use excluding the null char termination	255 **NOTE**: This setting does not impact the OS setting for the max path/file name.
MAX_FILENAME_LENGTH	(EMAXPATH + 1) /* max chars in filename + EOS*/

SMP Flags

The following is the compilation defines that can be set when building the OS Abstractor library for SMP kernel target OS:

Table 2_23: Compilation Flag for SMP

Compilation Flag	Meaning
OS_BUILD_FOR_SMP Support for Symmetric Multi-Processors **(SMP)**	Specify the SMP or non-SMP kernel. The value can be: **OS_TRUE** SMP enabled **OS_FALSE** SMP disabled

Warning: If you fail to set SMP flag to OS_TRUE and use Mapusoft products on an SMP enabled machine, you will get the result in an unpredictable behavior due to failure of internal data protection mechanism.

Now MapuSoft provides SMP support to the following OS's:

- Linux
- Windows XP/Vista/Mobile/CE/7
- VxWorks

Limitations:

In VxWorks there is a limitation to set affinity to a single core only. Hence in OS_Application_Init.c and OS_Create_Process.c, the affinity mask in the respective init_info structures should be passed accordingly.

SMP is not supported on the following OSs:

- µCOS
- Nucleus
- ThreadX
- MQX
- uITRON
- Android
- T-Kernel
- uITRON
- QNX
- Solaris
- NetBSD
- LynxOS

OS Abstractor Target OS Specific Notes

Nucleus PLUS Target

The following is the compilations define that has to be set when building the Nucleus PLUS library in order for the OS Abstractor to perform correctly:

Table 2_21: Compilation Flag For Nucleus PLUS Target

Compilation Flag	Meaning
NU_DEBUG	Regardless of the target you build, the OS Abstractor library always requires this flag to be set in order to be able to access OS internal data structures. Without this flag, you will see a lot of compiler errors.

ThreadX Target

The ThreadX port for Win32 has a user defined memory ceiling which has a default value of 64K. If you run into issues with memory not being available, you will need to increase the memory limit. This define is called TX_WIN32_MEMORY_SIZE and is located in tx_port.h.

Precise/MQX Target

The following are the compilation defines that has to be set if you are using Precise/MQX as your target OS:

Table 2_22: Compilation Flag for Precise/MQX Target

Compilation Flag	Meaning
MQX_TASK_DESTRUCTION	Set this macro to zero to allow OS Abstractor to manage destruction of MQX kernel objects such as semaphores.
BSP_DEFAULT_MAX_MSGPOOLS	Set this macro to match the maximum number of message queues and pipes required by your application at a given time. For example, if your application would need a max of 10 message queues and 10 pipes, then this macro needs to be set to 20.

The MQX_TASK_DESTRUCTION macro is located in source\include\mqx_cnfg.h in your MQX installation. Set it to zero as shown below (or pass it to compiler via pre-processor setting in your project make files):

```
#ifndef MQX_TASK_DESTRUCTION
#define MQX_TASK_DESTRUCTION 0
#endif
```

The BSP_DEFAULT_MAX_MSGPOOLS macro is located in source\bsp\bspname\bspname.h in your MQX installation, where bspname is the name of your BSP. Set the required value as follows:

```
#define BSP_DEFAULT_MAX_MSGPOOLS (20L)
```

Linux Target

User Vs ROOT Login

OS Abstractor internally checks the user ID to see if the user is ROOT or not. If the user is ROOT, then it will automatically utilize the Linux real time policies and priorities. It is always recommended that OS Abstractor application be run under ROOT user login. In this mode:

- OS Abstractor task priorities, time slice, pre-emption modes and critical region protection features will work properly.
- OS Abstractor applications will have better performance and be more deterministic behavior since the Linux scheduler is prevented to alter the tasks priorities behind the scenes.
- Also, when you load other Linux applications (that uses the default SCHED_OTHER policies), they will not impact the performance of the OS Abstractor applications that are running under real-time priorities and policies.

Under non-ROOT user mode, the task scheduling is fully under the mercy of the Linux scheduler. In this mode, the OS Abstractor does not utilize any real-time priorities and/or policies. It will use the SCHED_OTHER policy and will ignore the application request to set and/or change scheduler parameters like priority and such. OS Abstractor applications will run under the non-ROOT mode, with restrictions to the following OS Abstractor APIs:

- OS_Create_Task: The function parameters *priority, time-slice* and OS_NO_PREEMPT flag options are ignored
- OS_Set_Task_Priority: This function will have no effect and will be ignored
- OS_Set_Task_Preemption: Changing the task pre-emption to OS_NO_PREEMPT has no effect and will be ignored
- OS_Protect: Will offer NO critical region data protection and will be ignored. If you need protection, then utilize OS Abstractor mutex features
- OS_Create_Driver: The OS Abstractor driver task will NOT be run at a higher priority level that the OS Abstractor application tasks.

  Though OS Abstractor applications may run under non-ROOT user mode, it is highly recommended that the real target applications be run under ROOT user mode.

System Resource Configuration

Linux has a limit on the sysv system resources. Typically, OS Abstractoris able to adjust these limits as required. But, if the CAP_SYS_RESOURCE capability is disabled, OS Abstractorwill not have the proper access privileges to do so. In this case, the values will need to be adjusted manually using an account with the proper capabilities enabled, or the kernel will need to be modified and rebuilt with the increased number of resources set as a default.

Time Resolution

The value of the system clock ticks is defined by OS_TIME_RESOLUTION, which is retrieved from the Linux system. Under Red Hat®/GNU® Linux, this is actually 100 (this means every tick equals to 10ms). However, the OS_TIME_TICK_PER_SEC could be different under other real-time or proprietary Linux distributions.

Also, make sure you modify OS_DEFAULT_TSLICE value to match with your application needs if necessary. By default, this value is set for the time slice to be 100ms. If the Linux Advanced

Real Time Feature is present (i.e the Linux kernel macro LINUX_ADV_REALTIME == 1), then OS Abstractor automatically takes advantage of this feature if present and uses the `sched_rr_set_interval()` function and sets the application required round-robin thread time-slice for the OS Abstractor thread. If this feature is not present, the time-slice value for round-robin scheduling will be whatever the kernel is configured to.

Memory Heap

OS Abstractor uses the system heap directly to provide the dynamic variable memory allocation. The Memory management for the variable memory is best left for the Linux kernel to be handled, so OS Abstractor only does boundary checks to ensure that the application does not allocate beyond the pool size. The maximum memory the application can get from these pools will depend on the memory availability of the system heap.

Priority Mapping Scheme

The OS Abstractor uses priorities 0~255 plus one more for exclusivity which results in a total of 257 priorities. If the Linux that you use provides less than 257 priority values, then OS Abstractor maps its priority in a simple window-mapping scheme where a window of OS Abstractor priorities gets mapped to each individual Linux priority. If the Linux that you use provides more than 257 priority values, then the OS Abstractor maps it priority one-on-one somewhere in the middle of the range of Linux priorities. Please modify the priority scheme as necessary if required by your application. If you want to minimize the interruption of the external native Linux applications then you would want the OS Abstractor priorities to map to the higher end of the Linux priority window.

OS Abstractor priority value of 257 is reserved internally by OS Abstractor to provide the necessary exclusivity among the OS Abstractor tasks when they request no preemption or task protection. The exclusivity and protections are not guaranteed if the external native Linux application runs at a higher priority.

It is recommended that the Linux kernel be configured to have a priority of 512, so that the OS Abstractor priorities will use the window range in the middle and as such would not interfere with some of core Linux components. If your Linux kernel is configured to have less than 257 priorities, the OS Abstractor will automatically configuring a windowing scheme, where multiple number of OS Abstractor priorities will map to a single Linux priority. Because of this, the reported priority value could be slightly different than what was used during the task creating process. If your application uses the pre-processor called OS_DEBUG_INFO, then all the priority values and calculations will be printed to the standard output device.

Memory and System Resource Cleanup

OS Abstractor uses shared memory to support multiple OS Abstractor and OS Changer application processes that are built with OS_INCLUDE_PROCESS mode set to OS_TRUE.

Single-process Application Exit

This will apply to application that does not use the OS_PROCESS feature. Each application needs to call OS_Application_Free to unregister and free OS Abstractor resources used by the application. Under circumstances where the application terminates abnormally, the applications need to install appropriate signal handler and call OS_Application_Free within them.

Multi-process Application Exit

This will be the case where the applications are built with OS_PROCESS feature set to OS_TRUE. When the first multi-process application starts, shared memory is created to accommodate all the shared system resources for all the multi-process application. When subsequent multi-process application gets loaded, they will register and OS Abstractor will create all the local resources (memory heap) necessary for the application. Application's can also spawn new applications using OS_Create_Process and will result the same as if a new application get's loaded. Each application needs to call OS_Application_Free to unregister and free OS Abstractor resources used by the application. Under circumstances where the application terminates abnormally, the applications need to install appropriate signal handler and call OS_Application_Free within them. When the last application calls OS_Application_Free, then OS Abstractor frees the resources used by the application and also deletes the shared memory region.

Manual Clean-up

If application terminates abnormally and for any reason and it was not possible to call OS_Application_Free, then it is recommended that you execute the provide **cleanup.pl** script manually before starting to load applications. Users can query the interprocess shared resources status by typing ipcs in the command line.

Multi-process Zombie Cleanup

There are circumstances where a multi-process application terminates abnormally and was not able to call OS_Application_Free. In this case, the shared memory region would be left with a zombie control block (i.e there is no native process associated with the OS Abstractor process control block). Whenever, a new multi-process application get's loaded, OS Abstractor automatically checks the shared memory region for zombie control blocks. If it finds any, it will take the following action:
Free and initialize all the control blocks that belong to the zombie process (this could even be the zombie process of the same application currently being loaded but was previously terminated abnormally).

Task's Stack Size

The stack size has to be greater than PTHREAD_STACK_MIN defined by Linux, otherwise, any OS Abstractor or OS Changer task creation will return success, but the actual task (pthread) will never get launched by the target OS. It is also safe to use a value greater than or equal to OS_MIN_STACK_SIZE defined in cross_os_def.h. OS Abstractor ensures that OS_STACK_SIZE_MIN is always greater that the minimum stack size requirement set by the underlying target OS.

Windows Target

`OS_Relinquish_Task` API uses Window's sleep() to relinquish task control. However, the sleep() function does not relinquish control when stepping through code in the debugger, but behaves correctly when executed. This is a problem inherent in the OS itself.

If you have windows interface turned ON (i.e OS_INCLUDE_WINDOWS = OS_TRUE) along with other interface libraries in your project, make sure the project is build with process mode flag is turned ON (i.e INCLUDE_OS_PROCESS = OS_TRUE). If you build one interface library with process mode flag turned OFF and other interface libraries with process mode flag ON then segmentation fault will occur due to mismatch all libraries not being built with the current process feature.

Android Target

Installing and Building the Android Platform

Prerequisites:

To install and build Android requires the following packages:

- JDK 5.0 update 12 or higher. Java 6 will not work. – Download from http://java.sun.com
- Android 1.5 SDK – Download from http://developer.android.com/sdk/1.5_r3/index.html
- Android 1.5 NDK – Download from http://developer.android.com/sdk/ndk/1.5_r1/index.html

Refer to the Android website for instructions on how to properly install and configure the SDK and the NDK.

It is very important that JDK 6 is not used. JDK 6 will cause compiler errors. If you have both JDK's installed confirm that JDK 5.0 is the one that will be used by using the command:

```
$ which java
```

Adding Mapusoft Products to the Android Platform

To add Mapusoft products to Android Platform:

1. Add the Mapusoft project into the ~/android-ndk-1.5_r1/sources directory. This directory is referred to as <MAPUSOFT_ROOT>.
2. Run the setup.sh script located in <MAPUSOFT_ROOT>/cross_os_android. This creates symbolic links for the demo applications.

   The command used to build the applications is

```
$ make APP=<app_name>
```

For instance, to build the OS Abstractor demo the command would be

```
$ make APP=demo_cross_os
```

Running the Demos from the Android Emulator

To run the demos from Android Emulator:

1. Follow the steps documented on the Android developer site on how to create an AVD for the emulator.
2. Launch the emulator with the command:
   ```
   $ emulator -avd <avd_name>
   ```
3. Open another terminal and enter the command:
   ```
   $ adb logcat
   ```
   This will capture the log output from the emulator.
4. After the emulator launches click on the menu button to unlock the phone.
5. Click on the popup arrow on the screen.
6. The demos should be listed in the list of applications. Click on one to launch it. The demo output will be piped into the adb terminal window.

QNX Target

User Vs ROOT Login

OS Abstractor internally checks the user ID to see if the user is ROOT or not. If the user is ROOT, then it will automatically utilize the Linux real time policies and priorities. It is always recommended that OS Abstractor application be run under ROOT user login. In this mode:

- OS Abstractor task priorities, time slice, pre-emption modes and critical region protection features will work properly.
- OS Abstractor applications will have better performance and be more deterministic behavior since the Linux scheduler is prevented to alter the tasks priorities behind the scenes.
- Also, when you load other Linux applications (that uses the default SCHED_OTHER policies), they will not impact the performance of the OS Abstractor applications that are running under real-time priorities and policies.

Under non-ROOT user mode, the task scheduling is fully under the mercy of the Linux scheduler. In this mode, the OS Abstractor does not utilize any real-time priorities and/or policies. It will use the SCHED_OTHER policy and will ignore the application request to set and/or change scheduler parameters like priority and such. OS Abstractor applications will run under the non-ROOT mode, with restrictions to the following OS Abstractor APIs:

OS_Create_Task: The function parameters priority, time-slice and OS_NO_PREEMPT flag options are ignored

- OS_Set_Task_Priority: This function will have no effect and will be ignored
- OS_Set_Task_Preemption: Changing the task pre-emption to OS_NO_PREEMPT has no effect and will be ignored
- OS_Protect: Will offer NO critical region data protection and will be ignored. If you need protection, then utilize OS Abstractor mutex features
- OS_Create_Driver: The OS Abstractor driver task will NOT be run at a higher priority level that the OS Abstractor application tasks.

Though OS Abstractor applications may run under non-ROOT user mode, it is highly recommended that the real target applications be run under ROOT user mode.

Time Resolution

The value of the system clock ticks is defined by `OS_TIME_RESOLUTION`, which is retrieved from the Linux system. Under Red Hat®/GNU® Linux, this is actually 100 (this means every tick equals to 10ms). However, the `OS_TIME_TICK_PER_SEC` could be different under other real-time or proprietary Linux distributions.

Also, make sure you modify `OS_DEFAULT_TSLICE` value to match with your application needs if necessary. By default, this value is set for the time slice to be 100ms.

Memory Heap

OS Abstractor uses the system heap directly to provide the dynamic variable memory allocation. The Memory management for the variable memory is best left for the Linux kernel to be handled, so OS Abstractor only does boundary checks to ensure that the application does not allocate beyond the pool size. The maximum memory the application can get from these pools will depend on the memory availability of the system heap.

Priority Mapping Scheme

QNX native priority value of 255 will be reserved for OS Abstractor Exclusivity. The rest of the 255 QNX priorities will be mapped as follows:

0 to 253 OS Abstractor priorities -> 254 to 1 QNX priorities
254 and 255 OS Abstractor priorities -> 0 QNX priority
The OS Abstractor uses priorities 0~255 plus one more for exclusivity which results in a total of 257.

Memory and System Resource Cleanup

Please refer to the same section under target specific notes for Linux operating system.

Task's Stack Size

The stack size has to be greater than PTHREAD_STACK_MIN defined by Linux, otherwise, any OS Abstractor or OS Changer task creation will return success, but the actual task (pthread) will never get launched by the target OS. It is also safe to use a value greater than or equal to OS_STACK_SIZE_MIN defined in def.h. OS Abstractor ensures that OS_STACK_SIZE_MIN is always greater that the minimum stack size requirement set by the underlying target OS.

Dead Synchronization Object Monitor

Use OS_Monitor_Register function to register a process as a dead synchronization object monitor. A dead synchronization object situation can occur if a process is terminated while it owns a synchronization object such as a mutex or a pthread_spinlock. When this happens any other processes suspended on that object will never be able to acquire it. This situation can only occur if the synchronization object is shared between processes. For further information about OS_Monitor_Register function, refer to the OS Abstractor Interface Reference Manual.

VxWorks Target

Version Flags

The following is the compilation defines that has to be set when building the OS Abstractor library for VxWorks target OS:

Table 2_24: Version Flags for VxWorks Target

Compilation Flag	Meaning
OS_VERSION	Specify the VxWorks version. The value can be: **OS_VXWORKS_5X** – VxWorks 5.x or older **OS_VXWORKS_6X** – Versions 6.x or higher
OS_USER_MODE	Set this value to **OS_TRUE** if the OS Abstractor is required to run as a application module. Under OS_VXWORKS_5X, the OS_KERNEL_MODE flag is ignored. The library is built to run as application module. Under OS_VXWORKS_6X, you have the option to create the library for either as a kernel module or a user application as below: OS_USER_MODE = OS_TRUE for application module OS_USER_MODE =OS_FALSE for kernel module.
OS_KERNEL_MODE	Set this value to **OS_TRUE** if the OS Abstractor is required to run as a kernel module. Under OS_VXWORKS_5X, the OS_KERNEL_MODE flag is ignored. The library is built to run as a kernel module. Under OS_VXWORKS_6X, you have the option to create the library for either as a kernel module or a user application as below: OS_KERNEL_MODE = OS_TRUE for kernel module OS_KERNEL_MODE = OS_FALSE for user application.
OS_VXWORKS_TARGET	Select your appropriate Target platform. The value can be: OS_VXWORKS_PPC OS_VXWORKS_PPC_604 OS_VXWORKS_X86 OS_VXWORKS_ARM OS_VXWORKS_M68K OS_VXWORKS_MCORE OS_VXWORKS_MIPS OS_VXWORKS_SH OS_VXWORKS_SIMLINUX OS_VXWORKS_SIMNT OS_VXWORKS_SIMSOLARIS OS_VXWORKS_SPARC

Unsupported OS Abstractor APIs

The following OS Abstractor APIs are not supported as shown below:

Table 2_25: Unsupported OS Abstractor APIs for VxWorks Target

Compilation Flag	Unsupported APIs
OS_VERSION = OS_VXWORKS_5X	OS_Delete_Partion_Pool OS_Delete_Memory_Pool OS_Get_Semaphore_Count
OS_VERSION = OS_VXWORKS_6X and OS_KERNEL_MODE = OS_TRUE	OS_Set_Clock_Ticks
OS_VERSION = OS_VXWORKS_6X and OS_KERNEL_MODE = OS_FALSE	OS_Get_Semaphore_Count

Application Initialization

Once you have configured the OS Abstractor (refer to chapter OS Abstractor Configuration), now you are ready to create a sample demo application.

Application needs to initialize the OS Abstractor library by calling the OS_Application_Init() function prior to using any of the OS Abstractor function calls. Please refer to subsequent pages for more info on the usage and definition of OS_Application_Init function.

The next step would be is to create the first task and then within the new task context, application needs to call other initializations functions if required. For example, to use the POSIX Interface component, application need to call OS_Posix_Init() function within an OS Abstractor task context prior to using the POSIX APIs. The OS_Posix_Init() function initializes the POSIX library and makes a function call to px_main() function pointer that is passed along within OS_Posix_Init() call. Please note that the px_main() function is similar to the main() function that is typically found in posix code. Please refer to the example initialization code shown at the end of this section.

If the application also uses OS Changer components, then the appropriate OS Changer library initialization calls need to be made in addition to POSIX initialization. Please refer to the appropriate Interface reference manual for more details.

Please refer to the init.c module provided with the sample demo application for the specific OS, tools and target for OS Abstractor initialization and on starting the application.

If you need to re-configure your board differently or would like to use a custom board, or would like to re-configure the OS directly, then refer to the appropriate documentations provided by the OS vendor.

Example: OS Abstractor for Windows Initialization

```
int main(int   argc,
         LPSTR argv[])
{
    OS_Main();

    return (OS_SUCCESS);
} /* main */


#if (OS_HOST == OS_TRUE)
/* The below defines are the system settings used by the OS_Application_Init()
function. Use these to modify the settings when running on the host.  A value of -1
for any of these will use the default values located in cross_os_usr.h.
   When you optimize for the target side code, the wizard will create a custom
cross_os_usr.h  using the settings you specify at that time so these defines will no
longer be necessary. */
#define HOST_TASK_POOLING                    OS_FALSE  /* to use task pooling, set
this to OS_TRUE, and make sure
                                                         add tasks to pool using
OS_Add_To_Pool apis */
#define HOST_DEBUG_INFO                      2
#define HOST_TASK_POOL_TIMESLICE             -1
#define HOST_TASK_POOL_TIMEOUT               -1
#define HOST_ROOT_PROCESS_PREEMPT            -1
#define HOST_ROOT_PROCESS_PRIORITY           -1
```

```
#define HOST_ROOT_PROCESS_STACK_SIZE         -1
#define HOST_ROOT_PROCESS_HEAP_SIZE          -1
#define HOST_DEFAULT_TIMESLICE               0
#define HOST_MAX_TASKS                       8
#define HOST_MAX_TIMERS                      5
#define HOST_MAX_MUTEXES                     5
#define HOST_MAX_PIPES                       5
#define HOST_MAX_PROCESSES                   8
#define HOST_MAX_QUEUES                      4
#define HOST_MAX_PARTITION_MEM_POOLS         9
#define HOST_MAX_DYNAMIC_MEM_POOLS           8
#define HOST_MAX_EVENT_GROUPS                4
#define HOST_MAX_SEMAPHORES                  7
#define HOST_MAX_PROTECTION_STRUCTS          5
#define HOST_USER_SHARED_REGION1_SIZE        2
#define HOST_ROOT_PROCESS_AFFINITY                   0
#endif

    /* set the OS_APP_INIT_INFO structure with the actual number of resources
we will use.  If we set all the Variables to -1, the default values would be
used. On ThreadX and Nucleus, we must pass an OS_APP_INIT_INFO structure with
at least first_available set to the first unused memory. Other OS's can pass
NULL to OS_Application_Init and all defaults would be used.  */

VOID OS_Main()
{
    STATUS           sts        = OS_SUCCESS;
    OS_APP_INIT_INFO info       = OS_APP_INIT_INFO_INITIALIZER;
    UNSIGNED         process_id = 0;

#if (OS_HOST == OS_TRUE)

    /* Initialize the info structure. During the optimization process the wizard will
       create a custom cross_os_usr.h with these values set to the values you specify
       at that time so this structure will not be necessary on the target system. */
    info.debug_info                = HOST_DEBUG_INFO;
    info.task_pool_timeslice       = HOST_TASK_POOL_TIMESLICE;
    info.task_pool_timeout         = HOST_TASK_POOL_TIMEOUT;
    info.root_process_preempt      = HOST_ROOT_PROCESS_PREEMPT;
    info.root_process_priority     = HOST_ROOT_PROCESS_PRIORITY;
    info.root_process_stack_size   = HOST_ROOT_PROCESS_STACK_SIZE;
    info.root_process_heap_size    = HOST_ROOT_PROCESS_HEAP_SIZE;
    info.default_timeslice         = HOST_DEFAULT_TIMESLICE;
    info.max_tasks                 = HOST_MAX_TASKS;
    info.max_timers                = HOST_MAX_TIMERS;
    info.max_mutexes               = HOST_MAX_MUTEXES;
    info.max_pipes                 = HOST_MAX_PIPES;
    info.max_processes             = HOST_MAX_PROCESSES;
    info.max_queues                = HOST_MAX_QUEUES;
    info.max_partition_mem_pools   = HOST_MAX_PARTITION_MEM_POOLS;
    info.max_dynamic_mem_pools     = HOST_MAX_DYNAMIC_MEM_POOLS;
    info.max_event_groups          = HOST_MAX_EVENT_GROUPS;
    info.max_semaphores            = HOST_MAX_SEMAPHORES;
    info.max_protection_structs    = HOST_MAX_PROTECTION_STRUCTS;
    info.user_shared_region1_size = HOST_USER_SHARED_REGION1_SIZE;
    info.task_pool_enabled        = HOST_TASK_POOLING;
    info.affinity_mask                   =    HOST_ROOT_PROCESS_AFFINITY;
#endif
#if ((OS_TARGET == OS_THREADX) || (OS_TARGET == OS_NUCLEUS))
    info.pool = pool;
#endif
    sts = OS_Application_Init(&process_id,
                              "Demo",
                              "/",
                              HEAP_SIZE,
                              &info);
      if ((sts != OS_SUCCESS)&&(sts != OS_SUCCESS_ATTACHED))
    {
        OS_Fatal_Error("OS_Main",
                       "os_init.c",
                       "OS_ERR_SYSTEM_NOT_INITIALIZED",
                       "There was an error while initializing Cross OS",
                       OS_ERR_SYSTEM_NOT_INITIALIZED,
                       sts);
        return;
    }

    OS_Library_Init();
    /* Wait for Application termination */
    OS_Application_Wait_For_End();
}


VOID OS_Application_Start(UNSIGNED argv)
{
/*User application code*/
}
```

Example: POSIX Interface for Windows Target Initialization

```
int main(int   argc,
         LPSTR argv[])
{
    OS_Main();

    return (OS_SUCCESS);
} /* main */

#if (OS_HOST == OS_TRUE)
/* The below defines are the system settings used by the OS_Application_Init()
function.
   Use these to modify the settings when running on the host.  A value of -1 for any
of these
   will use the default values located in cross_os_usr.h.
   When you optimize for the target side code, the wizard will create a custom
cross_os_usr.h
   using the settings you specify at that time so these defines will no longer be
necessary. */
#define HOST_TASK_POOLING                    OS_FALSE  /* to use task pooling, set
this to OS_TRUE, and make sure
                                                         add tasks to pool using
OS_Add_To_Pool apis */
#define HOST_DEBUG_INFO                      -1
#define HOST_TASK_POOL_TIMESLICE             -1
#define HOST_TASK_POOL_TIMEOUT               -1
#define HOST_ROOT_PROCESS_PREEMPT            -1
#define HOST_ROOT_PROCESS_PRIORITY           -1
#define HOST_ROOT_PROCESS_STACK_SIZE         -1
#define HOST_ROOT_PROCESS_HEAP_SIZE          -1
#define HOST_DEFAULT_TIMESLICE               -1
#define HOST_MAX_TASKS                       5
#define HOST_MAX_TIMERS                      0
#define HOST_MAX_MUTEXES                     0
#define HOST_MAX_PIPES                       0
#define HOST_MAX_PROCESSES                   1
#define HOST_MAX_QUEUES                      2
#define HOST_MAX_PARTITION_MEM_POOLS         0
#define HOST_MAX_DYNAMIC_MEM_POOLS           0
#define HOST_MAX_EVENT_GROUPS                0
#define HOST_MAX_SEMAPHORES                  1
#define HOST_MAX_PROTECTION_STRUCTS          1
#define HOST_USER_SHARED_REGION1_SIZE        -1
#define HOST_ROOT_PROCESS_AFFINITY                   0
#endif

VOID OS_Main()
{
        STATUS          sts        = OS_SUCCESS;
    OS_APP_INIT_INFO info       = OS_APP_INIT_INFO_INITIALIZER;
    UNSIGNED         process_id = 0;

    /* set the OS_APP_INIT_INFO structure with the actual
     * number of resources we will use.  If we set all the
     * variables to -1, the default values would be used.
     * On ThreadX and Nucleus, we must pass an OS_APP_INIT_INFO
     * structure with at least first_available set to the first
     * unused memory.  Other OS's can pass NULL to OS_Application_Init
     * and all defaults would be used */
#if (OS_HOST == OS_TRUE)

    /* Initialize the info structure. During the optimization process the wizard will
       create a custom cross_os_usr.h with these values set to the values you specify
       at that time so this structure will not be necessary on the target system. */
    info.debug_info                = HOST_DEBUG_INFO;
    info.task_pool_timeslice       = HOST_TASK_POOL_TIMESLICE;
    info.task_pool_timeout         = HOST_TASK_POOL_TIMEOUT;
    info.root_process_preempt      = HOST_ROOT_PROCESS_PREEMPT;
    info.root_process_priority     = HOST_ROOT_PROCESS_PRIORITY;
    info.root_process_stack_size   = HOST_ROOT_PROCESS_STACK_SIZE;
    info.root_process_heap_size    = HOST_ROOT_PROCESS_HEAP_SIZE;
    info.default_timeslice         = HOST_DEFAULT_TIMESLICE;
    info.max_tasks                 = HOST_MAX_TASKS;
    info.max_timers                = HOST_MAX_TIMERS;
    info.max_mutexes               = HOST_MAX_MUTEXES;
    info.max_pipes                 = HOST_MAX_PIPES;
    info.max_processes             = HOST_MAX_PROCESSES;
    info.max_queues                = HOST_MAX_QUEUES;
    info.max_partition_mem_pools   = HOST_MAX_PARTITION_MEM_POOLS;
    info.max_dynamic_mem_pools     = HOST_MAX_DYNAMIC_MEM_POOLS;
    info.max_event_groups          = HOST_MAX_EVENT_GROUPS;
    info.max_semaphores            = HOST_MAX_SEMAPHORES;
    info.max_protection_structs    = HOST_MAX_PROTECTION_STRUCTS;
    info.user_shared_region1_size  = HOST_USER_SHARED_REGION1_SIZE;
    info.task_pool_enabled         = HOST_TASK_POOLING;
    info.affinity_mask                    =    HOST_ROOT_PROCESS_AFFINITY;
#endif
#if ((OS_TARGET == OS_THREADX) || (OS_TARGET == OS_NUCLEUS))
    info.pool = pool;
#endif


sts = OS_Application_Init(&process_id,
                              “Demo”,
                              "/",
                              HEAP_SIZE,
                              &info);
      if ((sts != OS_SUCCESS)&&(sts != OS_SUCCESS_ATTACHED))
    {
        OS_Fatal_Error("OS_Main",
                       "os_init.c",
                       "OS_ERR_SYSTEM_NOT_INITIALIZED",
                       "There was an error while initializing Cross OS",
                       OS_ERR_SYSTEM_NOT_INITIALIZED,
                       sts);
        return;
    }

    OS_Library_Init();
    /* Wait for Application termination */
    OS_Application_Wait_For_End();
}

VOID OS_Application_Start(UNSIGNED argv)
{
    pthread_t task;

/* posix compatibility initialization.  create the main process
    *  and pass in the osc posix main entry function px_main.*/
    OS_Posix_Init();

    pthread_create(&task, NULL, (void*)px_main, NULL);
    pthread_join(task, NULL);

    OS_Application_Free(OS_APP_FREE_EXIT);
} /* OS_Application_Start */

int px_main(int   argc,
            char* argv[])
{
            /*User application code*/
}
```

Runtime Memory Allocations

OS Abstractor Interface

Some of the allocations for this product will be dependent on the native OS. Some of these may be generic among all products. The thread stacks should come from the process heap. This is only being done on the OS Abstractor for QNX product at the moment.

- Message in int_os_send_to_pipe
- Device name in os_creat
- Partitions in os_create_partition_pool
- Device name in os_device_add
- File structures in os_init_io
- Driver structures in os_init_io
- Device header for null device in os_init_io
- Device name for the null device in os_init_io
- Device name in os_open
- Environment structure in os_put_environment
- Environment variable in os_put_environment
- Memory for profiler messages if profiler feature is turned ON
- Thread stack (only under QNX)

POSIX Interface

All of the following allocations use OS_Allocate_Memory using the System_Memory pool. Thus, all these allocations come from the calling processes memory pool:

- Pthread key lists and values
- Stack item in pthread_cleanup_push
- Sem_t structures created by sem_open.
- Timer_t structures created by timer_create.
- mqueue_t structures created by mq_open.
- Message in mq_receive. This is deallocated before leaving the function call.
- Message in mq_send. This is deallocated before leaving the function call.
- Message in mq_timedreceive. This is deallocated before leaving the function call.
- Message in mq_timedsend. This is deallocated before leaving the function call.

All of the following are specific to the TKernel OS and use the SMalloc api call. These will not be accounted for in the process memory pool:

- Parameter list for execve
- INT_PX_FIFO_DATA structure in fopen

All of the following are specific to the TKernel OS and use os_malloc_external API call. These will not be accounted for in the process memory pool.

- Buffer for getline
- Globlink structure in int_os_glob_in_dir
- Globlink name in int_os_glob_in_dir
- Directory in int_o_prepend_dir

micro-ITRON Interface

All of the following allocations use OS_Allocate_Memory using the System_Memory pool. Thus, all these allocations come from the calling processes memory pool.

- Message in snd_dtq. This is deallocated before leaving the function call.
- Message in psnd_dtq. This is deallocated before leaving the function call.
- Message in tsnd_dtq. This is deallocated before leaving the function call.
- Message in fsnd_dtq. This is deallocated before leaving the function call.
- Message in rcv_dtq. This is deallocated before leaving the function call.
- Message in prcv_dtq. This is deallocated before leaving the function call.
- Message in trcv_dtq. This is deallocated before leaving the function call.
- Message in snd_mbf. This is deallocated before leaving the function call.
- Message in psnd_mbf. This is deallocated before leaving the function call.
- Message in tsnd_mbf. This is deallocated before leaving the function call.
- Message in rcv_mbf. This is deallocated before leaving the function call.
- Message in prcv_mbf. This is deallocated before leaving the function call.

- Message in trcv_mbf. This is deallocated before leaving the function call.

VxWorks Interface

All of the following allocations use OS_Allocate_Memory using the System_Memory pool. Thus, all these allocations come from the calling processes memory pool.

- Wdcreate allocates memory for an OS_TIMER control block .
- Message in msgqsend. This is deallocated before leaving the function call.
- Message in msgqreceive. This is deallocated before leaving the function call

pSOS Interface

All of the following allocations use OS_Allocate_Memory using the System_Memory pool. Thus, all these allocations come from the calling processes memory pool.

- Rn_getseg will allocate from the System_Memory if a pool is not specified.
- Message in q_vsend. This is deallocated before leaving the function call.
- Message in q_vrecieve. This is deallocated before leaving the function call.
- Message in q_vurgent. This is deallocated before leaving the function call.

All of the following allocations use malloc. Depending on the setting of OS_MAP_ANSI_MEM these may or may not be accounted for in the process memory pool.

- IOPARMS structure in de_close
- IOPARMS structure in de_cntrl
- IOPARMS structure in de_init
- IOPARMS structure in de_open
- IOPARMS structure in de_read

Nucleus Interface

All of the following allocations use OS_Allocate_Memory using the System_Memory pool. Thus, all these allocations come from the calling processes memory pool.

- Message in nu_receive_from_pipe. This is deallocated before leaving the function call
- Message in nu_receive_from_queue. This is deallocated before leaving the function call
- Message in nu_send_to_front_of_pipe. This is deallocated before leaving the function call
- Message in nu_send_to_front_of_queue. This is deallocated before leaving the function call
- Message in nu_send_to_pipe. This is deallocated before leaving the function call
- Message in nu_send_to_queue. This is deallocated before leaving the function call

ThreadX Interface

All of the following allocations use OS_Allocate_Memory using the System_Memory pool. Thus, all these allocations come from the calling processes memory pool.

- Message in tx_queue_receive. This is deallocated before leaving the function call
- Message in tx_queue_send. This is deallocated before leaving the function call
- Message in tx_queue_front_send. This is deallocated before leaving the function call

OS Abstractor Process Feature

An OS Abstractor process or an application ("process") is an individual module that contains one or more tasks and other resources. A process can be looked as a container that provides encapsulation from other process. The OS Abstractor processes only have a peer-to-peer relationship (and not a parent/child relationship).

An OS Abstractor process comes into existence in two different ways. Application registers a new OS Abstractor process when it calls OS_Application_Init function. Application also launches a new process when it calls the OS_Create_Process function. In the later case, the newly launched process does not automatically inherit the open handles and such; however they can access the resources belonging to the other process if they are created with "system" scope.

Under process-based operating system like Linux, this will be an actual process with virtual memory addressing. As such the level of protection across individual application will be dependent on the underlying target OS itself.

Under non-process-based operating system like Nucleus PLUS, a process will be a specialized task (similar to a main() thread) owning other tasks and resources in a single memory model based addressing. The resources are protected via OS Abstractor software. This protection offered by OS Abstractor is software protection only and not to be confused with MMU hardware protection in this case.

OS Abstractor automatically tracks all the resources (tasks, threads, semaphores, etc.) and associates them with the process that created them. All the memory requirements come from its own process dedicated memory pool called "process system pool". Upon deletion of the process, all these resources will automatically become freed.

Depending on whether the resource needs to be shared across other processes, they can be created with a scope of either OS_SCOPE_SYSTEM or OS_SCOPE_PROCESS. The resources with system scope can be accessible or usable by the other processes. However, the process that creates them can only do deletion of these resources with system scope.

A new process will be created as a "new entity" and not a copy of the original. As such, none of the resources that are open becomes immediately available to the newly created process. The new created process can use the resources which were created with system scope by first retrieving their ID through their name. For this purpose, the application should create the resources with unique names. OS Abstractor will all resource creation with duplicate names, however the function that returns the resource ID from name will provide the ID of only the first entry.

Direct access to any OS Abstractor resource control blocks are prohibited by the application. In other words, the resource Ids does not directly point to the addresses of the control blocks.

Simple (single-process) Versus Complex (multiple-process) Applications

An OS Abstractor application can be simple (i.e. single-process application) or complex (multi-process application). Complex and large applications will greatly benefit in using the OS_INCLUDE_PROCESS feature support offered by OS Abstractor.

Table 2_26: Simple (single-process) Versus Complex (multiple-process) Applications

OS_INCLUDE_PROCESS = OS_FALSE (Simple OR Single-process Application)	**OS_INCLUDE_PROCESS = OS_TRUE (Complex OR multi-process Application)**
OS Abstractor applications are independent from each other and are complied and linked into a separate executables. There is no need for the OS Abstractor and/or OS Changer APIs to work across processes.	OS Abstractor applications can share the OS Abstractor resources (as long as they are created with system scope) between them even though they may be complied and linked separately. The OS Abstractor and/or OS Changer APIs works across processes.
Many independent or even clones of OS Abstractor single-process applications can be hosted on the OS platform.	In addition to independent single-process applications, the current release of OS Abstractor allows to host one multi-process application.
OS Abstractor applications do NOT spawn new processes via the OS_Create_Process function. In fact, any APIs with the name “process” in them are not available for a single-process application.	OS Abstractor applications can spawn new processes via the OS_Create_Process function.
Each application uses its own user configuration parameters set in the cross_os_usr.h file.	Each application has to have the same set of shared resources defined in the cross_os_usr.h (e.g. max number of tasks/threads across all multi-process applications). When the first multi-process application gets loaded, the OS Abstractor uses the values defined in cross_os_usr.h or the over-ride values passed along its call to OS_Application_Init function to create all the shared system resources. When subsequent multi-process application gets loaded, OS Abstractor ignores the values defined in the cross_os_usr.h or the values passed in the OS_Application_Init call. Please note that the shared resources are only gets created during the load time of the first application and they gets deleted when the last multi-process application exits.
OS Abstractor creates all the resource control blocks within the process memory individually for each application.	OS Abstractor creates all the resource control blocks in shared memory during the first OS_Application_Init function call. In other words, when the first application gets loaded, it will initialize the OS Abstractor library. After this, every subsequent OS_Application_Init call

	will register and adds the application as a new OS Abstractor process and also creates the memory pool for the requested heap memory. An application can delete or free or re-start itself with a call to OS_Application_Free. An application can delete or re-start another application via OS_Delete_Process. Also, it is up to the application to provide the necessary synchronization during loading individual applications so that the complex application will start to run only in the preferred sequence.

Memory Usage

The memory usage depends on whether your application is built in single process mode (i.e OS_INCLUDE_PROCESS set to false) or multi-processes mode (i.e OS_INCLUDE_PROCESS set to true).

The memory usage also depends on whether the target OS supports single memory model or a virtual memory model. Operating systems such as LynxOS, Linux, Windows XP, etc. are based on virtual memory model where each application are protected from each other and run under their own virtual memory address space. Operating systems like Nucleus PLUS, ThreadX, MQX, etc. are based on single memory model where each application shares the same address space and there is no protection from each other.

In general, OS Abstractor applications require memory to store the system configuration and also to meet the application heap memory needs.

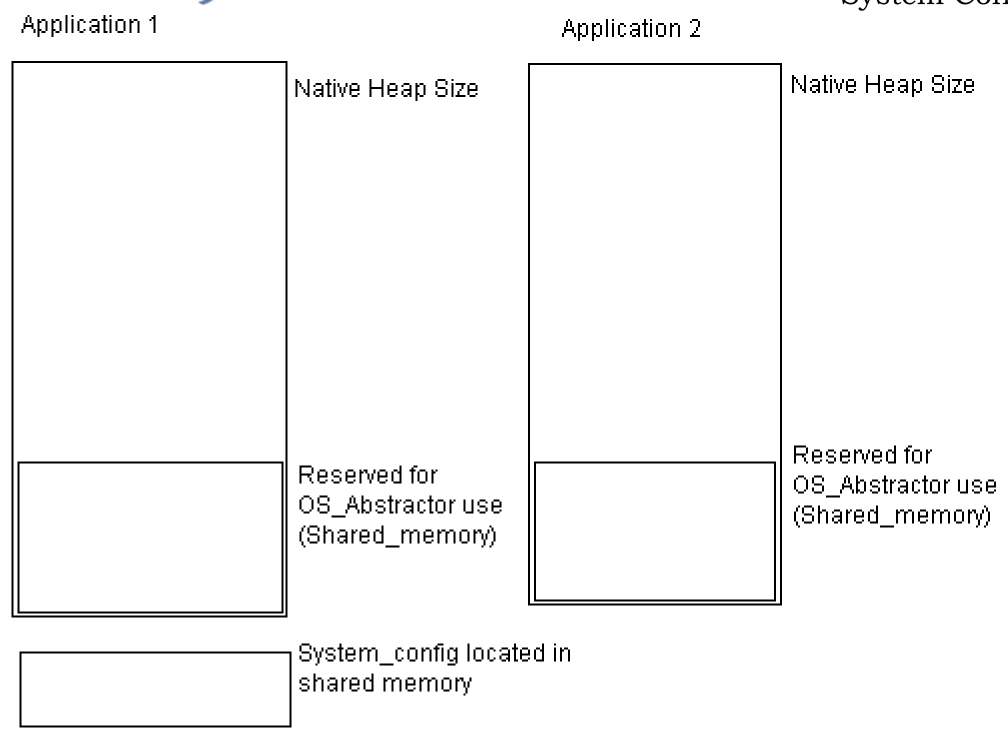
Memory Usage under Virtual memory model based OS

Multi-process Application

System_Config: The system config structure will be allocated from shared memory. The size will be returned to the user for informational use via the OS_SYSTEM_OVERHEAD macro.

OS_Application_Init: the memory value passed into this API by memory_pool_size will be the heap size for this particular process. In this type of system, it is possible to have multiple applications, all of which will call this API. This API will create an OS Abstractor dynamic memory pool the size of the heap. The global variable System_Memory will be set to the id of this pool.
OS_Create_Process: The memory value passed into this API by process_heap_size will be the heap size for this particular process. This API will create an OS Abstractor dynamic memory pool the size of the heap. The global variable System_Memory will be set to the id of this pool.

System_Memory: This will be set to the pool id of the process memory pool.

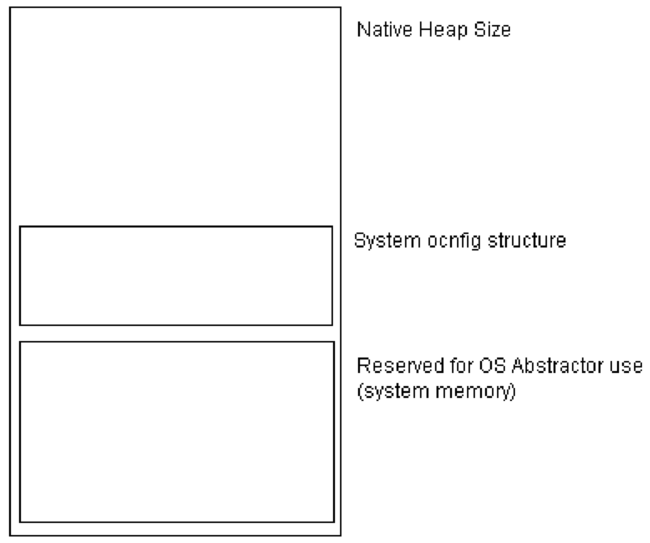

Application 1
Application 2
Native Heap Size
Native Heap Size
Reserved for OS_Abstractor use (Shared_memory)
Reserved for OS_Abstractor use (Shared_memory)
System_config located in shared memory

Single-process Application

System_Config: The system config structure will be allocated from the process heap. The size will be returned to the user for informational use only by calling OS_System_Overhead();

OS_Application_Init: the memory value passed into this API by memory_pool_size will be the amount of memory available to the system. This API will create an OS Abstractor dynamic memory pool this size. The memory for System_Config does not come from this pool. So the total memory requirements will be OS_SYSTEM_OVERHEAD + memory_pool_size.

System_Memory: This will be set to 0. Since there are no processes, the first pool will always be the system memory pool.



Native process heap size: We are not adjusting the native process heap size, so it could be possible that there is an inconsistency between the amount of memory reserved by OS Abstractor and the amount of memory reserved for the actual heap of the native process.
There is no upper bounds limit to the system wide memory use while in process mode. We will create processes without regard to the actual size of the physical memory.

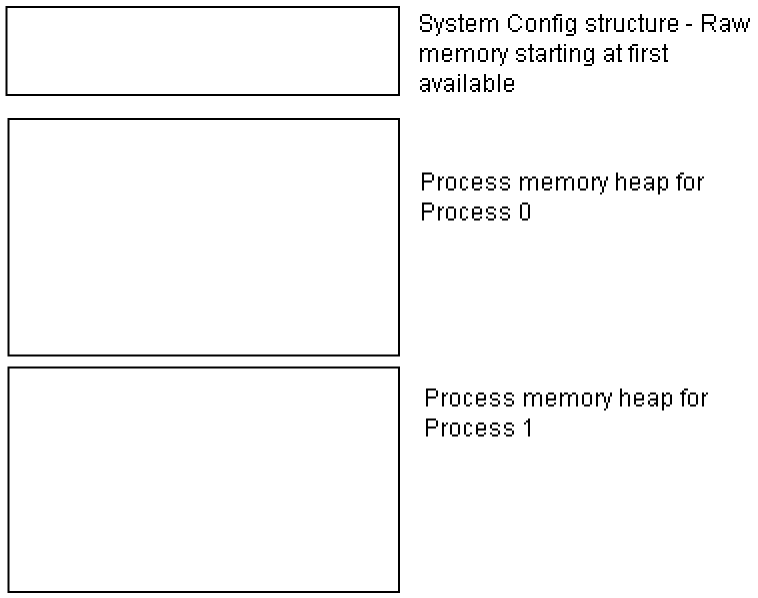
Memory Usage under Single memory model based OS

Multi-process Application

System_Config: The first available memory will be set in the OS_APP_INFO structure and will be adjusted the size of the system_config structure.

OS_Application_Init: The memory value passed into this API by memory_pool_size will be the heap size for this particular process. This API can only be called once since it is not possible to have multiple applications natively. This API will create an OS Abstractor dynamic memory pool the size of the heap.

OS_Create_Process: The memory value passed into this API by process_heap_size will be the heap size for this particular process. This API will create an OS Abstractor dynamic memory pool the size of the heap.
System_Memory: This will always be set to 0. When we get a pool id of 0 in any of the allocation APIs we will know to allocate from the current process memory pool. This means that the dynamic memory pool control block at index 0 is not to be used.

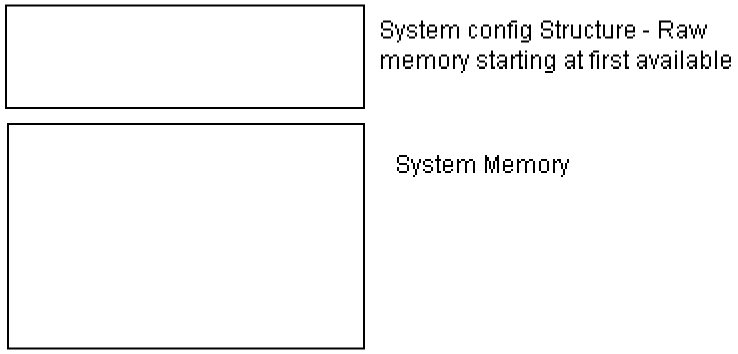

System Config structure - Raw memory starting at first available
Process memory heap for Process 0
Process memory heap for Process 1

Single-process Application

System_Config: The first available memory will be set in the OS_APP_INFO structure and will be adjusted the size of the system_config structure.

OS_Application_Init: the memory value passed into this API by memory_pool_size will be the amount of memory available to the system. This API will create an OS Abstractor dynamic memory pool this size. The memory for System_Config does not come from this pool. So the total memory requirements will be OS_SYSTEM_OVERHEAD + memory_pool_size.

System_Memory: This will always be set to 0. Since we are not in process mode, there should not be any other OS Abstractor memory pools created.


System config Structure - Raw memory starting at first available
System Memory

There is no upper bounds limit to the system wide memory use while in process mode. Also, it cannot be guaranteed that there will be enough memory to create all the processes of the application since there is no total memory being reserved.

Chapter 3: Ada System Configuration

Interfacing to C and Machine

Code

This section explains how to interface between Ada code and C and machine code. The Ada compiler generates C code, which is compiled by the C compiler into machine language. Therefore, most machine-level details require some understanding of the conventions used by the C compiler.

Before reading this section, please read the sections of the C compiler manual that refer to interfacing between C and assembly language. You will need to understand the calling conventions, data layout conventions, and so forth documented there. In order to write machine code inserts, you need to understand your target's hardware architecture.

Data Layout

Ada types are converted into corresponding C types. In most cases, the correspondence is simple:

An Ada array becomes a C array (starting at zero).An Ada record becomes a C struct with the fields in the same order. Ada Integer becomes int, modular becomes unsigned, Character becomes char, and enumerations become enum. See the C compiler documentation for information about the layout of these types.

Packed Arrays

The effect of Pragma Pack on an array type is to cause packing of discrete type array elements into 8-bit bytes. The component size used is the smallest divisor of 8 which is greater than or equal to the component size with any leftover bits spread evenly into each component. For example, if the component size is 3, each component, when packed in the array, is 4 bits. Note that pragma Pack has no effect on the layout of the component type.

Packed Records

The effect of pragma Pack on a record type is to cause scalar components (other than floating point) to be compressed so that they occupy the smallest number of bits appropriate to values of those types. Sub-word sized items will be combined into a single word, packed starting at the next available bit, but never to extend across a word boundary. If an item is word sized or larger, it will start and end on a word boundary. Bit numbering starts with zero at the low-order end of words.

Interface to C

Since the compiler generates C, it is relatively straightforward to interface to C. Refer to RM-B.3 for information about the language-defined mechanisms. An example version of package Interfaces.C may be found in the distribution, in the RTS or RTL subdirectory.

You can use the -ke switch to tell the Ada compiler to keep the C code after compiling it, and you can look at the C code to determine what names and so forth were chosen.

Machine Code Inserts

Ada provides two mechanisms for doing machine code inserts: Code statements and Intrinsics.

AdaMagic supports the more powerful of the two mechanisms— intrinsics. Code statements and the corresponding package System, Machine_Code are not supported.

The C compiler supports machine code inserts using the “asm” and “asm_volatile” operations.

These operations have a special syntax that is a mixture of strings, colons, and parenthesized C variable names.

This is supported in Ada as follows:

```
procedure <Ada subp name>(<formal_parameter_list>);
pragma Import(Inline_Asm[_Volatile], <Ada subp name>,
"<instruction1>;<instruction2>;...:<output constraint1>(Ada OUT
param):" &
"<input constraint1>(Ada IN param),...:<clobberreg1>,<clobberreg2,...")
```

This has the same format as the C inline asm operation except:

- everything is enclosed in a single level of quotes
- the names used are the Ada formal parameter names

OUT parameters may appear only in the output section. IN parameters may appear only in the input section. IN OUT parameters must appear in both, with an appropriate digit in the input section. After giving the pragma Import with the Inline_Asm convention, each call to that procedure will be expanded by the compiler into an inline sequence of instructions; the instructions are given in the string literal that is the second argument of the pragma.

In addition, there is a package System.Machine_Intrinsics, which contains two special procedures:

```
procedure Asm(Instruction : String);
procedure Asm_Volatile(Instruction : String);
```

A call to Asm turns into the corresponding “asm” statement in C; similarly for Asm_Volatile. The string must of course be known at compile time—for example, a double-quoted string literal, or (if that won’t fit on a line), several string literals concatenated together with "&".

The string literals may include assembler directives, macro calls, #include statements, and so forth, in addition to actual machine code instructions.

Example:

```
with System.Machine_Instructions;
package body ... is
...
procedure Disable_Interrupts is
use System.Machine_Instructions;
begin
asm("#include <def21060.h>");
asm("bit clr MODE1 IRPTEN;");
end Disable_Interrupts;
```

Implementation-Defined Conventions

As explained above, the following implementation-defined conventions may be used in pragmas Convention, Import, and Export:

- C
- C_Pass_By_Copy
- Inline_Asm
- Inline_Asm_Volatile
- Program_Memory: The entity mentioned in the pragma must be a library-level object (it must not be nested in any subprogram). It must not be aliased. The generated C code must represent the object as a static or extern variable; for example, the object cannot be dynamic-sized, because that requires an extra indirection in the generated C code. If you specify convention Program_Memory, then the Ada compiler generates "pm" in the C code. This causes the C back end to allocate the object in program memory rather than the default data memory. See the C compiler manual for more details.

Interrupt Handling

This section explains how to write interrupt handlers. The basic Ada mechanisms for interrupt handling are described in RM-C.3; please read that first. You will also need to read the interrupt-related parts of your target's hardware manual.

NOTE: If you want to write an interrupt handler that does not do any Ada tasking-related operations (such as protected procedure calls), then you can use your target's RTOS mechanisms directly, instead of the mechanisms described here.

The basic idea is that a protected procedure can be attached as an interrupt handler. If the procedure should be permanently attached throughout the execution of the program, use pragma Attach_Handler to attach it. If the procedure needs to be attached and detached and reattached from time to time during execution, then first use pragma Interrupt_Handler to mark that procedure as a potential interrupt handler. Then use operations in package Ada.Interrupts to attach and detach the procedure.

The example hardware (the Analog Devices SHARC) supports 32 interrupts. These are given names in package Ada.Interrupts.Names, which is shown here:

package Ada.Interrupts.Names is

```
      -- Hardware interrupts
      -- If interested in further detail on this example, see page F-1 of the
      -- ADSP-2106x SHARC User's Manual, Second Edition,
      Reserved_0 : constant Interrupt_ID := 0;
      RSTI : constant Interrupt_ID := 1; -- (reserved) Reset (read-only, non-
      maskable)
      Reserved_2 : constant Interrupt_ID := 2;
      SOVFI : constant Interrupt_ID := 3; -- Status stack or loop stack
      overflow of PC stack full
      . . .
      SFT2I : constant Interrupt_ID := 30; -- User software interrupt 2
      SFT3I : constant Interrupt_ID := 31; -- User software interrupt 3
      -- Useful constants
      First_Interrupt : constant Interrupt_ID := 0;
      Last_Interrupt : constant Interrupt_ID := 31;
      end Ada.Interrupts.Names;
```

These interrupt names can be used in a pragma Attach_Handler, or in the operations defined in Ada.Interrupts. For example, to attach a handler permanently:

```
protected PO is

      procedure Handler;
      pragma Attach_Handler(Handler, Ada.Interrupts.Names.IRQ0I);
end PO;
```

Or, in a more dynamic situation:

```
protected PO is

      procedure Handler;
      pragma Interrupt_Handler(Handler);
end PO;
```

And then, from time to time:

```
      Ada.Interrupts.Attach_Handler
      (New_Handler => PO.Handler'Access,
      Interrupt => Ada.Interrupts.Names.IRQ0I);
```

The interrupts marked above as "(reserved)" are reserved for the Ada run-time system or the real-time kernel. The Reserved_n interrupts are reserved by the hardware. You cannot attach handlers to reserved interrupts. (If you try, Program_Error will be raised.)

Exceptions in Interrupt Handlers

If an exception is propagated out of an interrupt handler, it is ignored. So, if you have a bug that causes an unhandled exception, the exception is lost, and you will be confused as to why your program doesn't work. To help in debugging, you can write your interrupt handlers like this:

```
protected body Handler_PO is

      procedure Handler is
      -- Nothing here.
   begin
      declare
      ... -- If you want local variables, put them here,
      -- so if their elaboration raises an exception,
      -- it will be handled below.
      begin
      ...
      end;
   exception
      when X: others =>
            Put_Line(Exceptions.Exception_Name(X)
            & " raised in interrupt handler.");
      end handler;
```

The exception handler can log the error and/or take some other appropriate action. Here, it just prints something like "Constraint_Error raised in interrupt handler." to standard output.

NOTE: There is some time overhead associated with having the exception handler.

Priorities

Interrupt handlers run at interrupt priority, which means they are higher priority than normal tasks.

More precisely, the ceiling priority of the protected object containing the interrupt handler is an interrupt-level priority. Thus, not only does the interrupt handler run at interrupt level, but so do all other operations of the same protected object. In the examples below, procedure Handler and entry

Await_Interrupt will both execute at interrupt level (locking out other tasks).

Package System has:

```
      subtype Priority is Integer range 1 .. 30;
      subtype Interrupt_Priority is Integer range 31 .. 31;
      subtype Any_Priority is Integer range
      Priority'First .. Interrupt_Priority'Last;

      Default_Priority : constant Priority := (Priority'First +
      Priority'Last)/2;
```

Interrupts are masked when an interrupt hander is executing, and when a task is executing at a priority in Interrupt_Priority, because it called a protected operation of an interrupt-level protected object.

Example 1

We show three examples of interrupt handling below. The first example shows how to attach a simple interrupt handler. The second example shows how to communicate information from the interrupt handler to Ada tasks using protected entries. The third example shows how to use suspension objects (see RM-D.10) to notify a task from an interrupt handler that the event has occurred.

The first example prints the following:

```
        Hello from Simple_Interrupt_Test main procedure.
        0 interrupts so far.
        1 interrupts so far.
        2 interrupts so far.
        . . .
        9 interrupts so far.
        10 interrupts.
---------------------------------------------------------------
        -- This is a simple example of interrupt handling using

        -- protected procedures as interrupt handlers

        -- We attach an interrupt handler that just counts up the number

        -- of times it is called. We then simulate some interrupts,

        -- and print out the count.

---------------------------------------------------------------

with Ada.Interrupts.Names; use Ada.Interrupts.Names;

        -- This is where the names of all the hardware interrupts
        -- are declared.
with Ada_Magic.DBG; use Ada_Magic.DBG;

        -- We could use Text_IO instead, but Ada_Magic.DBG is much smaller,
        -- so it's better if memory is tight.
package Simple_Interrupt_Test is

        -- This is the root package of the example.
end Simple_Interrupt_Test;

---------------------------------------------------------------
package Simple_Interrupt_Test.Handlers is

        -- This package creates an interrupt handler for the SFT0I
        -- interrupt. The interrupt handler is the protected
        -- procedure Handler inside the protected object Handler_PO.
        -- This interrupt handler simply counts the number of
        -- interrupts; this number is returned by Number_Of_Interrupts.
pragma Elaborate_Body;

        protected Handler_PO is
        procedure Handler; -- The interrupt handler.
        pragma Attach_Handler(Handler, SFT0I);
```

```
          function Number_Of_Interrupts return Natural;
          -- Return number of interrupts that have
          -- occurred so far.
private

          Count: Natural := 0;
          end Handler_PO;
          end Simple_Interrupt_Test.Handlers;
-----------------------------------------------------------------
package body Simple_Interrupt_Test.Handlers is

   protected body Handler_PO is
          procedure Handler is
          begin
             Count := Count + 1;
          end Handler;
          function Number_Of_Interrupts return Natural is
          begin
             return Count;
          end Number_Of_Interrupts;
          end Handler_PO;
   end Simple_Interrupt_Test.Handlers;
-----------------------------------------------------------------
with System.Machine_Intrinsics;

with Simple_Interrupt_Test.Handlers; use Simple_Interrupt_Test.Handlers;

procedure Simple_Interrupt_Test.Main is

          -- This is the main procedure. It simulates an external interrupt 10

          -- times by calling Generate_Interrupt, and prints out the number

-- each time.

procedure Generate_Interrupt(Interrupt : Ada.Interrupts.Interrupt_ID) is

          -- This uses machine code intrinsics to simulate a hardware

          -- interrupt, by generating an interrupt in software.

use System.Machine_Intrinsics;
          -- This sets the N'th bit in IRPTL, where N is the interrupt number,

          -- which causes the interrupt to happen; see page 3-26 of the

          -- ADSP-2106x SHARC Users' Manual, Second Edition.

          -- We want to use the BIT SET instruction, so it's atomic,

          -- but that instruction requires an immediate value;

          -- we can't calculate 2**N and use that as the mask;

          -- hence the rather repetitive code below.


procedure Gen_0 is

    pragma Inline(Gen_0);

begin
```

```
   Asm("BIT SET IRPTL 0x00000001;");
end Gen_0;

procedure Gen_1 is
   pragma Inline(Gen_1);
begin
   Asm("BIT SET IRPTL 0x00000002;");
end Gen_1;
. . .
procedure Gen_31 is
   pragma Inline(Gen_31);
begin
   Asm("BIT SET IRPTL 0x80000000;");
end Gen_31;

subtype Handleable_Range is Ada.Interrupts.Interrupt_ID
   range 0..31; -- These are the only interrupts that
    -- actually exist in the hardware.
begin
   case Handleable_Range'(Interrupt) is
when 0 => Gen_0;
when 1 => Gen_1;
when 2 => Gen_2;
. . .
when 31 => Gen_31;
   end case;
   end Generate_Interrupt;
begin
   Put_Line("Hello from Simple_Interrupt_Test main procedure.");
   for I in 1..10 loop
Put_Line(Integer'Image(Handler_PO.Number_Of_Interrupts)
& " interrupts so far.");
   Generate_Interrupt(SFT0I);
   end loop;
```

Put_Line(Integer'Image(Handler_PO.Number_Of_Interrupts)

& " interrupts.");

    end Simple_Interrupt_Test.Main;

Example 2

The second example prints the following:

```
Hello from Interrupt_Test_With_Entries main procedure.

Generating interrupt.

Waiting_Task: Got interrupt.

Generating interrupt.

Waiting_Task: Got interrupt.

. . .

Generating interrupt.

Goodbye from Interrupt_Test_With_Entries main procedure.

Waiting_Task: Got interrupt.

Goodbye from Waiting_Task.
```

-- This example illustrates how an interrupt handler (a protected procedure) may communicate with a task using an entry. The interrupt handler is called when the interrupt occurs, and it causes the entry's barrier to become True. The task waits by calling the entry; it is blocked until the barrier becomes True.

In this example, we simulate 10 interrupts, and we have a task

-- (Waiting_Task) that waits for 10 interrupts by calling the entry.

-- Each interrupt triggers one call to the entry to proceed. In this

-- example, the only information being transmitted back to the waiting

-- task is the fact that the interrupt has occurred.

-- In a real program, the protected object might have additional

-- operations to do something to some external device (e.g. initiate

-- some I/O). This might cause the device to generate an interrupt.

-- The interrupt would not be noticed until after this operation

-- returns, even if the device generates the interrupt right away;

-- that's because of the priority rules. Also, the interrupt handler

-- might get some information from the device, save it locally in the

-- protected object, and then the entry body might pass this information

-- back to the task via an 'out' parameter.

-- In other words, a protected object used in this way acts as a "device

```
-- driver", containing operations to initiate I/O operations, to wait
-- for operations to complete, and to handle interrupts. Anything that
-- needs to be done while masking the interrupt of the device should be
-- part of the protected object.
-- Note that if multiple device drivers are needed for similar devices,
-- it is convenient to declare a protected type, and declare multiple
-- objects of that type. Discriminants can be used to pass in
-- information specific to individual devices.
----------------------------------------------------------------
with Ada.Interrupts.Names; use Ada.Interrupts.Names;
with Ada_Magic.DBG; use Ada_Magic.DBG;
package Interrupt_Test_With_Entries is
-- Empty.
end Interrupt_Test_With_Entries;
----------------------------------------------------------------
package Interrupt_Test_With_Entries.Handlers is
pragma Elaborate_Body;
protected Handler_PO is
procedure Handler; -- The interrupt handler.
pragma Attach_Handler(Handler, SFT0I);
entry Await_Interrupt;
-- Each time Handler is called,
-- this entry is triggered.
private
Interrupt_Occurred: Boolean := False;
end Handler_PO;
end Interrupt_Test_With_Entries.Handlers;
----------------------------------------------------------------
package body Interrupt_Test_With_Entries.Handlers is
protected body Handler_PO is
procedure Handler is
begin
Interrupt_Occurred := True;
end Handler;
entry Await_Interrupt when Interrupt_Occurred is
begin
```

```
Interrupt_Occurred := False;

end Await_Interrupt;

end Handler_PO;

end Interrupt_Test_With_Entries.Handlers;
```

```
package Interrupt_Test_With_Entries.Waiting_Tasks is

pragma Elaborate_Body; -- So the body is allowed.

end Interrupt_Test_With_Entries.Waiting_Tasks;
```

```
with              Interrupt_Test_With_Entries.Handlers;              use
Interrupt_Test_With_Entries.Handlers;

package body Interrupt_Test_With_Entries.Waiting_Tasks is

task Waiting_Task;

task body Waiting_Task is

begin

for I in 1..10 loop

Handler_PO.Await_Interrupt;

Put_Line("Waiting_Task: Got interrupt.");

end loop;

Put_Line("Goodbye from Waiting_Task.");

end Waiting_Task;

end Interrupt_Test_With_Entries.Waiting_Tasks;
```

```
with System.Machine_Intrinsics;

with Interrupt_Test_With_Entries.Waiting_Tasks;

-- There are no references to this package; this with_clause is here

-- so that task Waiting_Task will be included in the program.

procedure Interrupt_Test_With_Entries.Main is

procedure  Generate_Interrupt(Interrupt  :  Ada.Interrupts.Interrupt_ID)
is

... -- as in previous example

end Generate_Interrupt;

begin

-- Generate 10 simulated interrupts, with delays in between.

Put_Line("Hello from Interrupt_Test_With_Entries main procedure.");

for I in 1..10 loop
```

```
        delay 0.01;
        Put_Line("Generating interrupt.");
        Generate_Interrupt(SFT0I);
        end loop;
        Put_Line("Goodbye from Interrupt_Test_With_Entries main procedure.");
        end Interrupt_Test_With_Entries.Main;
```

Example 3

The third example prints the following:

```
Hello from Suspension_Objects_Test main procedure.
Generating interrupt.
Waiting_Task: Got interrupt.
Generating interrupt.
Waiting_Task: Got interrupt.
Generating interrupt.
Waiting_Task: Got interrupt.
Generating interrupt.
Waiting_Task: Got interrupt.
Goodbye from Waiting_Task.
Generating interrupt.
Generating interrupt.
Generating interrupt.
Generating interrupt.
Generating interrupt.
Generating interrupt.
Goodbye from Suspension_Objects_Test main procedure.
```

```
-- This example illustrates how an interrupt handler
-- (a protected procedure) may communicate with a task
-- using a suspension object. A suspension object allows a
-- task or interrupt handler to notify another task that some
-- event (in our case, an interrupt) has occurred.
-- Each time the interrupt occurs, the suspension object is set to True.
-- The task waits for this event by calling Suspend_Until_True.
-- In this example, we simulate some interrupts,
-- and we have a task (Waiting_Task) that waits for them
-- using a suspension object called Interrupt_Occurred.
-- Note that if the task is already waiting (the usual case) when the
-- interrupt occurs, Interrupt_Occurred is only set to True momentarily;
-- Suspend_Until_True automatically resets it to False. If the task is
-- not waiting, then the True state will be remembered, and when the
-- task gets around to waiting, it will reset it to False and proceed
-- immediately.
-- Note that only one task can wait on a given suspension object; it's
-- sort of like a protected object with an entry queue of length one,
-- which allows it to be implemented more efficiently. This means that
-- the programmer using suspension objects has to know which task will
-- do the waiting; it's as if that task has a kind of ownership of that
-- particular suspension object.
--------------------------------------------------------------
with Ada.Interrupts.Names; use Ada.Interrupts.Names;
with Ada_Magic.DBG; use Ada_Magic.DBG;
package Suspension_Objects_Test is
-- Empty.
end Suspension_Objects_Test;
--------------------------------------------------------------
with Ada.Synchronous_Task_Control; use Ada.Synchronous_Task_Control;
package Suspension_Objects_Test.Handlers is
pragma Elaborate_Body;
protected Handler_PO is
procedure Handler; -- The interrupt handler.
pragma Attach_Handler(Handler, SFT0I);
end Handler_PO;
Interrupt_Occurred: Suspension_Object;
-- Default-initialized to False.
-- Set to True for each interrupt.
end Suspension_Objects_Test.Handlers;
--------------------------------------------------------------
package body Suspension_Objects_Test.Handlers is
protected body Handler_PO is
procedure Handler is
```

```
        begin
        Set_True(Interrupt_Occurred);
        end Handler;
        end Handler_PO;
        end Suspension_Objects_Test.Handlers;
--------------------------------------------------------------
        package Suspension_Objects_Test.Waiting_Tasks is
        pragma Elaborate_Body; -- So the body is allowed.
        end Suspension_Objects_Test.Waiting_Tasks;
--------------------------------------------------------------
        with Suspension_Objects_Test.Handlers; use Suspension_Objects_Test.Handlers;
        with Ada.Synchronous_Task_Control; use Ada.Synchronous_Task_Control;
        package body Suspension_Objects_Test.Waiting_Tasks is
        task Waiting_Task;
        task body Waiting_Task is
        begin
        for I in 1..4 loop
        Suspend_Until_True(Interrupt_Occurred);
        Put_Line("Waiting_Task: Got interrupt.");
        end loop;
        Put_Line("Goodbye from Waiting_Task.");
        end Waiting_Task;
        end Suspension_Objects_Test.Waiting_Tasks;
--------------------------------------------------------------
        with System.Machine_Intrinsics;
        with Suspension_Objects_Test.Waiting_Tasks;
        -- There are no references to this package; this with_clause is here
        -- so that task Waiting_Task will be included in the program.
        procedure Suspension_Objects_Test.Main is
        procedure Generate_Interrupt(Interrupt : Ada.Interrupts.Interrupt_ID) is
        ... -- as in previous example
        end Generate_Interrupt;
        begin
        -- Generate some simulated interrupts, with delays in between.
        Put_Line("Hello from Suspension_Objects_Test main procedure.");
```

```
for I in 1..10 loop
delay 0.01;
Put_Line("Generating interrupt.");
Generate_Interrupt(SFT0I);
end loop;
Put_Line("Goodbye from Suspension_Objects_Test main procedure.");
end Suspension_Objects_Test.Main;
```

Implementation-Defined Pragmas

The following implementation-defined pragmas are supported:

```
pragma Assert(boolean_expression[, static_string_expression]);
```

This pragma is allowed wherever a declaration or a statement is allowed. The boolean_expression is evaluated, and Program_Error is raised if the value is not True. The string expression is currently ignored. At some future date, we intend to add a separate package to support the pragma Assert, and raise an Assert_Error exception instead. Note that the check associated with a pragma Assert can be suppressed with a pragma Suppress (Assertion_Check) or a pragma Suppress(All_Checks).

```
pragma C_Pass_By_Copy([Max_Size =>] static_integer_expression);
```

This is a configuration pragma. The expression may be of any integer type. This pragma affects the parameter passing conventions of structs in subprograms whose convention is C. Any struct whose size is less than or equal to that specified by this pragma will be passed by copy; larger structs will be passed by reference. The Max_Size is measured in storage elements. Without this pragma,all structs are passed by reference (for interface-C subprograms), unless the convention is specified explicitly with a pragma Convention(C_Pass_By_Copy, ...).

```
pragma Revision(static_string_expression);
```

This pragma is allowed wherever any pragma is allowed. The static_string_expression is intended to contain a revision number for the current compilation unit. This pragma currently has no effect. At some future date, it will include the revision as a string in the generated code.

```
pragma Suppress_Aggregate_Temps;
```

This pragma causes compiler-generated temporary variables to be suppressed in an assignment statement where the right-hand side is an aggregate, such as “X := (...);”. The generated code will build the aggregate directly in the target, which is more efficient than using a temp.

Note: This pragma is dangerous. In particular, if the right-hand side overlaps the target, as in this example: “X := (This => X.That, That => X.This);” the compiler will generate incorrect code.

Without the pragma, the compiler can *sometimes* avoid the temp, but only in those cases where the compiler is smart enough to prove the absence of overlapping.

This pragma is a configuration pragma, which means that you may place it at the top of a source file, in which case it applies to the units in that file, or you may place it in a pragmas-only file, in which case it applies to the entire program library.
In addition, there is a compiler switch -suppress_aggregate_temps, which has the same effect as the pragma.

```
pragma Unchecked_Union([Entity =>] first_subtype_local_name);
```

This is a representation pragma. It causes the discriminant to be omitted from an Ada variant record type, in order to interface to a C union type. The discriminant can be (and in fact must be) specified in aggregates, but it is not allocated any space at run time.

Pragma Interface:

This pragma is a synonym for pragma Import. It is provided for backward compatibility; new code should use pragma Import instead.

```
Pragmas Memory_Size, Storage_Unit, System_Name:
```

These pragmas are ignored. They are provided for compatibility with Ada 8

Debugging Ada Programs

This section contains advice for debugging using a C debugger.

Source File Display in a C debugger

The AdaMagic Compiler generates optimized ANSI C as its intermediate language, which is then compiled by an ISO/ANSI C compiler to produce object modules. When given the "-ga" flag ("-g" for debugger, "a" for Ada source display), the AdaMagic compiler will generate "#line" directives in the generated C source which will allow a typical C debugger (e.g. gdb) to trace the generated object code back to the original Ada source file and line that produced it. Alternatively, when given the "-gc" flag ("-g" for debugger, "c" for C source display), the generated intermediate C will be saved, with C comments identifying the original Ada source line, and the target debugger will show the generated C source, rather than the original Ada source, when stepping through an AdaMagic program.

Local Ada Variable Display in a C debugger

When either the -ga or -gc flag is given, information on all Ada local variables is carried forward into the debugger symbol information included in the generated object modules. Because Ada ignores upper/lower case, whereas a typical C debugger distinguishes between upper and lower case, it is important to understand the "canonical" upper/lower case conventions used in the generated debugger symbol information. In particular, the original upper/lower case in the Ada name is ignored – the name in the debugger symbol table always starts with an upper case letter, and then the remaining letters are in lower case. For example, an Ada local variable called "My_Local_Variable"would appear in the debugger as "My_local_variable."

Global Ada Variable Display in a C debugger

For Ada variables (or subprograms) declared inside packages, a concatenated name appears in the debugger symbol table. The concatenated name consists of the package name, canonicalized so that the first letter is upper case, followed by an underscore ('_'), followed by the name of the variable (or subprogram) inside the package, again with the first letter capitalized. For example, an Ada variable whose full name is "My_Package.My_Global" would appear in the debugger as "My_package_My_global". Effectively every "." in the full expanded name has been converted to "_" with the next letter in upper case.

If the Ada variable (or subprogram) is declared in the package body rather than in the package spec, then two underscores separate the package name from the variable (or subprogram) name. Hence, a variable from the body such as "My_Package.My_Hidden_Global"would appear in the debugger as "My_package__My_hidden_global".

Nested Subprograms and Up-level References

If a variable is declared in a subprogram that has nested subprograms, and at least one of those nested subprograms makes an "up-level" reference to the variable, then the variable is moved into a "frame record" and the whole frame record is passed to each of the nested subprograms to support up-level access.

The frame record of the current subprogram (if any) is called "this_frame" in the debugger, and the frame record of the enclosing subprogram (if any) is pointed to by a parameter called "parent_frame." If you can't "find" a local variable you expected to see, and the current subprogram has nested subprograms, then take a look in the local variable called "this_frame." If it exists, it might contain the local variable you were looking for.

Similarly, if you are looking for a variable from an enclosing subprogram, look through the "parent_frame" parameter. If the variable is multiple levels up in the hierarchy of enclosing subprograms, then look for another "parent_frame" component in the frame record pointed to by the "parent_frame" parameter, and keep following the chain. For example, a variable called "My_Up_Level", which is two levels up in the hierarchy, would be accessible via "this_frame->parent_frame->My_up_level".

Setting Break Points

When viewing a source file in the debugger, you can set a break point by double clicking on the line of interest. This should work whether looking at Ada source, C source, or disassembly. Disassembly is most reliable if you want to stop at a very specific instruction. With Ada or C source, there is some imprecision in the setting of the break point.

Watch points generally work with the simulator, and don't seem to slow it down significantly (given that the simulator is already quite slow).

Stopping when an Exception is raised

By setting a break point at the symbol "rts_raise" the debugger will stop when any exception is raised. To set a breakpoint when a run-time check fails causing a language-defined exception to be raised, you can set a break point at "rts_raise_constraint_error," "rts_raise_program_error," or "rts_raise_storage_error."

Note that rts_raise_storage_error is only used for "primary" stack overflow, and it bypasses "rts_raise" itself because of the intricate processing required when the primary stack overflows. Other storage overflows go through rts_raise directly, and bypass rts_raise_storage_error.

To stop when an exception is re-raised (e.g. via the "raise;" statement in Ada), set a break point at "rts_raise_occurrence." When rts_raise is called, the only parameter is the address of a string containing the full name of the exception being raised. When rts_raise_occurrence is called, the only parameter is the address of an "exception_occurrence" record, which contains as its first word a pointer to the string name of the exception being re-raised.

Generics and Inlines

It is not generally possible to set a breakpoint in an instance of a generic or an inline expansion of a subprogram call. However, line number information is included which should allow the C debugger to step through instances and inlines.

Tasking-related Symbols and Breakpoints

To determine the current task, the global variable per_thread_ptr points to the task control block for the current task. The global variable main_thread is the task control block for the environment (main) thread of the program.

More information on the Ada task is described in the following fields:

Table 3_1: Symbols and Breakpoints Fields related about Ada task

Position in Record	Field Name	Meaning
2	highwater_mark	Secondary stack pointer
3	Ss_last_chunk	Secondary stack limit
4	Ss_Priority	Current task priority
5	Name	(null terminated)
7	Suspended_On	!= null means thread is suspended
8	Defer_count	> 0 means is abort-deferred
9	Pending_abort_level	Normally 2**31-1

The field Suspended_On contains a non-null address when the corresponding Ada task is suspended. The target of the pointer is the "Suspension Object" on which the task is suspended.

To set a breakpoint for when a task is about to suspend, set it at:

> **`System_Rts_Tgt_Kernel_Threads_Suspend_until_true_or_timeout`**
> (**NOTE**: This is case sensitive)

The parameters to this routine are the pointer to the Suspension Object, and the maximum time in ticks the task will wait. To set a breakpoint for when a task ends, set it at:

> **`System_Rts_Task_termination_pkg_Terminate_task`**

The only parameter to this routine is the completion status, which is either Completed_normally(=1) or Unhandled_exception(=4).

To set a breakpoint for when a task is aborted, set it at:

> **`System_Rts_Master_pkg_Abort_self`**

The only parameter to this routine is the abort "level" where zero means abort completely, and > 0 means abort to the asynchronous select statement at the corresponding level of dynamic nesting. To set a breakpoint for when the main subprogram ends, either because it is complete, or because of an unhandled exception, set it at:

> **`ada_fini`**

This routine performs any necessary finalization and then returns, allowing the target program to exit.

Tracing the Call Stack

The debugger's stack trace back command is generally useful. However, sometimes it is necessary to track the stack manually. To do that, you will need to know the target calling conventions. In an interrupt handler, there may be different calling conventions used by the target hardware or operating system.

Revision History

Document Title: System Configuration Guide
Release Number: 1.3.9

Release	Revision	Orig. of Change	Description of Change
1.3.5	0.1	VV	• New document • Updated UITRON with micro-ITRON • Added revision history • Renamed Getting started to Programmers Guide • Changed the Programmers Guide description on page 8
1.3.6	0.1	VV	• Modified the Release number • Added the SMP Flag information • Added Android Specific notes • Added Ada System Configuration
1.3.7	0.1	VV	• Modified the Release number
1.3.8	0.1	VV	• Modified the Release number
1.3.9	0.1	VV	• Added the Threadx Interface • Added the Threadx Target • Added SMP Flag Limitation