smxUSBH™ User's Guide

USB Host Stack

Version 2.55
September 19, 2016

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1. Overview

smxUSBH™ is a full-featured USB host stack for the SMX® RTOS. If offers a clean, modular design that allows embedded system developers to easily add USB host capabilities. Low-cost USB devices such as a keyboard or a USB flash drive can then be integrated with the system. smxUSBH is written in C and can be easily ported to another RTOS (see Appendix A. Porting smxUSBH to Another OS).

The reader should be familiar with the USB 2.0 specification, "Universal Serial Bus Specification, Revision 2.0". All USB specifications can be found at http://www.usb.org/.

smxUSBH has four layers:

1. **Class Driver Layer**: Provides support for different USB class drivers, such as mouse, keyboard and mass storage drivers.
2. **USB Driver Layer (USBD)**: Provides the common USB Device framework. See chapters 5, 8 and 9 in the USB 2.0 specification for details.
3. **Host Controller Driver (HCD) Layer**: Provides a driver for the Host Controller and also contains Root Hub support. This layer supports devices based on the OHCI/UHCI/EHCI, NXP ISP host controllers, and those on many embedded processors, such as ARM and ColdFire. See chapters 5, 8, and 10 of the USB 2.0 specification for details.
4. **Porting Layer**: Provides functions related to the hardware, operating system and compiler. Detailed in chapter 6. Hardware Porting Notes.

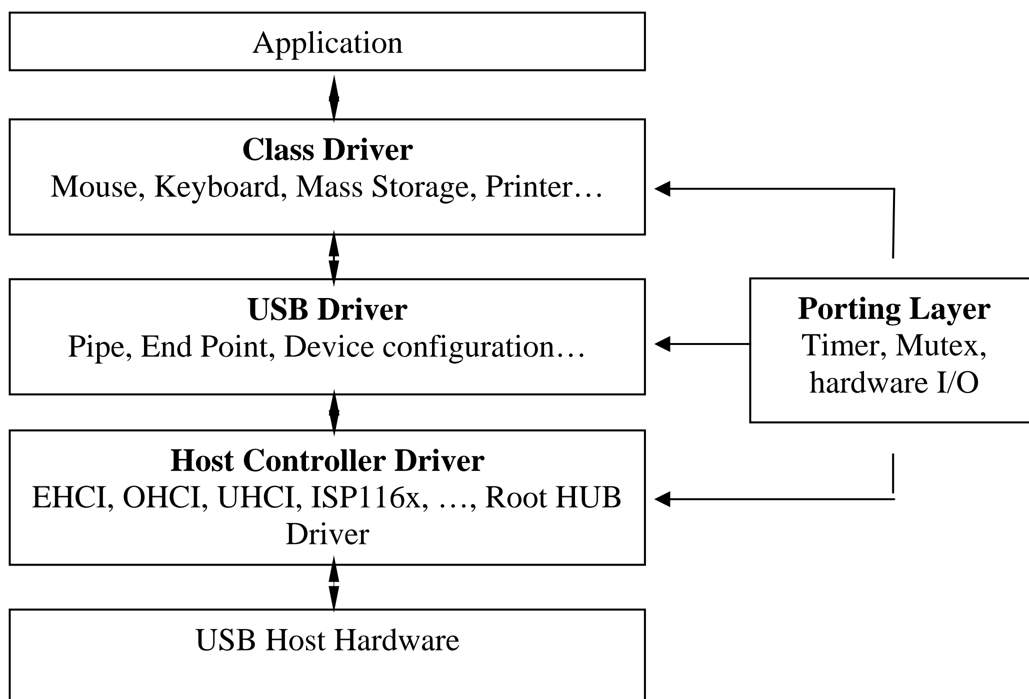


Figure1 smxUSBH Structure

smxUSBH supports processors that can only do 16-bit memory addressing, such as some Texas Instruments DSPs. See discussion of SB_CPU_MEM_ADDR_8BIT and SB_PACKED_STRUCT_SUPPORT in the smxBase User's Guide. This has only been tested for the core code, mass storage and printer class drivers, and ISP1362 host controller driver. Other class drivers and host controller drivers have not been tested, and some may require modification.

v2.30 adds the capability to support multiple host controllers of different types.
v2.40 adds the capability to support multiple host controllers of the same (and different) types.
v2.50 changes the porting layer to smxBase.

2. Files

Like other SMX RTOS products, all source code for smxUSBH is stored in its own directory, named "XUSBH", under the main SMX directory. Below is a summary of the directory structure.

2.1 Directory Structure

```
SMX
   APP
      DEMO      usbhdemo.c (for SMX)
      NORTOS    Build directory for standalone (non-SMX) releases. Has demo too.
   XUSBH        Configuration and porting layer files.
      XX.YY     Build directory for SMX releases
      Audio     Audio class driver
      CDC       Communication Device Class driver (serial, ACM (modem), Ethernet)
      CTempl    Class driver template
      EHCI      EHCI host controller driver
      HCD       Simple Host Controller Drivers such as ISP116x, ISP1362, and ISP176x
      HID       Human Interface Device class drivers (keyboard, mouse, generic HID)
      Hub       Hub driver
      MassStor  Mass Storage class driver
      OHCI      OHCI host controller driver
      Printer   Printer class driver
      UHCI      UHCI host controller driver
      USBD      USB Driver
      Video     Video class driver
```

2.2 Files

2.2.1 Main Files

FILE	DESCRIPTION
smxusbh.h	smxUSBH API header file. Use in application files.
ucfg.h	smxUSBH configuration file. Allows enabling/disabling main components of smxUSBH.
uinit.c,h	Initialization of the USB host stack, including the hub, selected host controller, and selected devices.
uintern.h	Main internal header file. Included by smxUSBH files rather than including individual header files, in order to ensure files are included in the proper order.

2.2.2 Porting Layer

FILE	DESCRIPTION
uport.c,h	Porting functions. OS and compiler porting is based on smxBase.
uheap.c,h	Memory allocation/free related functions. Includes support for specifying the alignment of the allocated memory.

2.2.3 USB Driver

FILE	DESCRIPTION
udrvinit.h	USB driver initialization function prototypes.
ubase.c,h	Utility functions for the USB host stack. Includes linked list functions and macros for handling USB pipes.
udesc.c,h	Utility functions for USB device configuration.
udriver.c,h	USB host stack protocol functions. Handles events associated with discovering and removing USB devices, and requests data.
udevice.h	Data structure definitions and macros for the device framework.

2.2.4 Hub Driver

FILE	DESCRIPTION
uhubinit.h	USB hub initialization function prototypes.
uhubbase.c,h	USB root hub functions.
uhubdrv.c,h	USB external hub class driver.
uhubthrd.c,h	Contains task that polls for hub status change and enumerates the new device.

2.2.5 Host Controller Driver

FILE	DESCRIPTION
uehcinit.c,h	EHCI Controller initialization function.
uehcdrv.c,h	EHCI related functions. Includes Device Configuration, Resource Management, and Data Transfers
uehcthrd.c,h	Thread for EHCI interrupt handler. Processes the completed asynchronous or periodic list.
uohcinit.c,h	OHCI Controller initialization function.
uohcdrv.c,h	OHCI related functions. Includes Device Configuration, Resource Management, and Data Transfers
uohcthrd.c,h	Thread for OHCI interrupt handler. Processes the completed transfer descriptor list.
uuhcinit.c,h	UHCI Controller initialization function.
uuhcdrv.c,h	UHCI related functions. Includes Device Configuration, Resource Management, and Data Transfers
uuhcreg.h	UHCI register definitions.
uuhcthrd.c,h	Thread for UHCI interrupt handler. Processes the completed frame list.
uisp116x.c,h	NXP ISP116x host controller driver.
uisp1362.c,h	NXP ISP1362 host controller driver.
uisp176x.c,h u176xdrv.c,h	NXP ISP176x host controller driver.
u720150.c,h	NEC uPD720150 host controller driver.
upd720150.c,h	NEC uPD720150 low-level register access routines. May need to be built into the BSP code instead of the USBH library.
ublkfn.c,h	Analog Devices Blackfin USB host controller driver.
ucf522xx.c,h	Freescale Coldfire 52223/52211/52259 host controller driver.
ulm3s.c,h	TI LM3Sxxxx host controller driver.
umax3421.c,h	Maxim MAX3421 host controller driver.
urenesas.c,h	Renesas USB host controller driver.
usyndwc.c,h	Synopsys DWC host controller driver.
uhctempl.c,h	Host Controller Driver template.

2.2.6 Audio Class Device Driver

FILE	DESCRIPTION
uaudio.c,h	USB Audio Class support.

2.2.7 Communication Device Class (CDC) Device Driver

FILE	DESCRIPTION
ucdcacm.c,h	USB CDC ACM (modem) support.
uftdi232.c,h	FTDI FT232B/LC/R Serial Converter support.
upl2303.c,h	Prolific 2303HXD Serial Converter support.
userial.c,h	USB serial support.
uwceser.c,h	Windows CE non-CDC/ACM USB serial support.
usierra.c,h	Sierra Wireless Dongle support.
uk4510.c,h	Huawei K4510 3G Wireless Dongle support.
uobid.c,h	FEIG OBID-iscan RFID Reader support.
urt250x.c,h	Ralink RT250x WiFi dongle support.
urt2870.c,h	Ralink RT2870 WiFi dongle support.
urt3070.c,h	Ralink RT3070 WiFi dongle support.
urt3572.c,h	Ralink RT3572 WiFi dongle support.
urt5370.c,h	Ralink RT5370 WiFi dongle support.
urt5572.c,h	Ralink RT5572 WiFi dongle support.
umt7601.c,h	MediaTek MT7601 WiFi dongle support.
unet.c,h unetchip.h unetchip_asix.c	USB to Ethernet Adapter support. ASIX88772 chip support

2.2.8 Human Interface Device (HID) Class Device Driver

FILE	DESCRIPTION
ukbd.c,h	USB keyboard support.
umouse.c,h	USB mouse support.
uhid.c,h	USB generic HID support.

2.2.9 Mass Storage Class Device Driver

FILE	DESCRIPTION
umsinit.c,h	Initialization function that registers the mass storage device with USBD.
umscmd.c,h	Build mass storage request for QIC, UFI, and ATAPI protocol devices.
umscmdt.c,h	Send mass storage request for QIC, UFI, and ATAPI protocol devices.
umsdrv.c,h	Mass storage device functions (USBDI).
umsintf.c.h	File IO interface and implementation.
umsscmd.c,h	Send mass storage request for SCSI protocol devices.

2.2.10 Printer Class Device Driver

FILE	DESCRIPTION
uprinter.c,h	USB printer support.
uuf8000.c,h	Panasonic UF 8000 USB facsimile transceiver support

2.2.11 Video Class Device Driver

FILE	DESCRIPTION
uvideo.c,h	USB video camera support.
uv20k13.c,h	Videology 20K13 camera support.

2.2.12 Class Device Driver Template

FILE	DESCRIPTION
uctempl.c,h	USB class driver template.

3. smxUSBH Library and Demos

This section documents details of configuration and building the library and demos.

3.1 smxUSBH Configuration

3.1.1 ucfg.h

smxUSBH can be configured so that it includes support for a specific set of USB devices, thus saving code space. The following sections describe the settings.

Operating System Selection

Operating system selection uses the smxBase configuration in bcfg.h.

Controller Selection

SU_EHCI

> Set to “1” or more to indicate the maximum number of EHCI host controllers to support in your system. Set to “0” to exclude support. su_EHCIGetHCNum() can be called to get the number of detected and enabled EHCI controllers.

SU_OHCI

> Set to “1” or more to indicate the maximum number of OHCI host controllers to support in your system. Set to “0” to exclude support. su_OHCIGetHCNum() can be called to get the number of detected and enabled OHCI controllers.

SU_UHCI

> Set to “1” or more to indicate the maximum number of UHCI host controllers to support in your system. Set to “0” to exclude support. su_UHCIGetHCNum() can be called to get the number of detected and enabled UHCI controllers.

SU_ISP116X

> Set to “1” or more to indicate the maximum number of NXP ISP116x host controllers to support in your system. Set to “0” to exclude support.

SU_ISP1362

> Set to “1” or more to indicate the maximum number of NXP ISP1362 host controllers to support in your system. Set to “0” to exclude support.

SU_ISP176X

> Set to “1” or more to indicate the maximum number of NXP ISP176x host controllers to support in your system. Set to “0” to exclude support.

SU_BLACKFIN

Set to “1” to include support for an Analog Devices Blackfin USB host controller. Set to “0” to exclude support.

SU_CF522XX

Set to “1” to include support for a Freescale MCF52211/MCF52223/MCF52259 host controller. Set to “0” to exclude support.

SU_LM3S

Set to “1” to include support for a TI LM3Sxxxx host controller. Set to “0” to exclude support.

SU_MAX3421

Set to “1” to include support for a Maxim MAX3421 host controller. Set to “0” to exclude support.

SU_PD720150

Set to “1” to include support for a NEC uPD720150 host controller. Set to “0” to exclude support.

SU_RENESAS

Set to “1” to include support for a Renesas USB host controller. Set to “0” to exclude support.

SU_SYNOPSYS

Set to “1” to include support for a Synopsys DWC host controller. Set to “0” to exclude support.

Note: Starting with smxUSBH v2.40, multiple host controller drivers of the same (or different) type may be enabled simultaneously. (v2.30 only supported enabling multiple controllers of different types.) For example, smxUSBH supports use of multiple OHCIs and one EHCI or even multiple OHCIs and multiple EHCIs. It supports shared interrupts used by different host controllers, whether they are the same type or not.

Class Driver Selection

SU_AUDIO

Set to “1” or more to indicate the maximum number of Audio devices. Set to “0” to exclude support.

SU_CCID

Set to “1” or more to indicate the maximum number of SmartCard CCID devices. Set to “0” to exclude support.

SU_CDCACM

Set to “1” or more to indicate the maximum number of CDC ACM (modem) devices. Set to “0” to exclude support.

SU_FTDI232

Set to “1” or more to indicate the maximum number of FTDI FT232B/LC/R Serial Converter devices. Set to “0” to exclude support. This is not a standard USB class driver.

SU_HID

Set to “1” or more to indicate the maximum number of generic HID devices. Set to “0” to exclude support.

SU_HUB

Set to “1” or more to indicate the maximum number of external hub devices. Set to “0” to exclude support. External hubs are NOT supported for low-end host controllers such as MAX3421.

SU_K4510

Set to “1” or more to indicate the maximum number of Huawei K4510 3G Wireless Dongle devices. Set to “0” to exclude support. This is not a standard USB class driver.

SU_KBD

Set to “1” or more to indicate the maximum number of keyboard devices. Set to “0” to exclude support.

SU_MOUSE

Set to “1” or more to indicate the maximum number of mouse devices. Set to “0” to exclude support.

SU_MSTOR

Set to “1” or more to indicate the maximum number of Mass Storage class devices. Set to “0” to exclude support.

SU_MT7601

Set to “1” or more to indicate the maximum number of MediaTek MT7601 WiFi dongles. Set to “0” to exclude support.

SU_NET

Set to “1” to or more to indicate the maximum number of USB to Ethernet converter devices. Set to “0” to exclude support. This is not a standard USB class driver. You may need to add some code to support a specific USB to Ethernet converter chip. You also need a TCP/IP stack, such as smxNS.

SU_NOVATEL

Set to “1” or more to indicate the maximum number of Novatel Wireless Dongle devices. Set to “0” to exclude support.

SU_OBID

Set to “1” or more to indicate the maximum number of FEIG OBID-iscan RFID Reader devices. Set to “0” to exclude support.

SU_PL2303

Set to “1” or more to indicate the maximum number of Prolific 2303HXD-based serial converter devices. Set to “0” to exclude support.

SU_PRINTER

Set to “1” to or more to indicate the maximum number of printer devices. Set to “0” to exclude support.

SU_RT250X

Set to “1” or more to indicate the maximum number of Ralink RT250x WiFi dongles. Set to “0” to exclude support.

SU_RT2870

Set to “1” to or more to indicate the maximum number of Ralink RT2870 WiFi dongles. Set to “0” to exclude support.

SU_RT3070

Set to “1” or more to indicate the maximum number of Ralink RT3070 WiFi dongles. Set to “0” to exclude support.

SU_RT3572

Set to “1” or more to indicate the maximum number of Ralink RT3572 WiFi dongles. Set to “0” to exclude support.

SU_RT5370

Set to “1” or more to indicate the maximum number of Ralink RT5370 WiFi dongles. Set to “0” to exclude support.

SU_RT5572

Set to “1” or more to indicate the maximum number of Ralink RT5572 WiFi dongles. Set to “0” to exclude support.

SU_SERIAL

Set to “1” or more to indicate the maximum number of serial devices. Set to “0” to exclude support. This is not a standard USB class driver.

SU_SIERRA

Set to “1” or more to indicate the maximum number of Sierra Wireless Dongle devices. Set to “0” to exclude support. This is not a standard USB class driver.

SU_UF8000

Set to “1” or more to indicate the maximum number of Panasonic UF-8000 Facsimile transceiver devices. Set to “0” to exclude support. This is not a standard USB class driver.

SU_V20K13

Set to “1” or more to indicate the maximum number of Videology V20K13 camera devices. Set to “0” to exclude support. This is not a standard USB class driver.

SU_VIDEO

Set to “1” or more to indicate the maximum number of Video camera devices. Set to “0” to exclude support.

SU_WCESERIAL

Set to “1” or more to indicate the maximum number of Windows Mobile non-CDC/ACM serial devices. Set to “0” to exclude support. This is not a standard USB class driver.

SU_CTEMPL

Set to “1” to include support for a generic class driver template. Set to “0” to exclude support.

On the Go support

SU_OTG

Set to “1” if smxUSBH is being used with smxUSBO to support OTG feature. You must also enable smxUSBO in your project at the same time. Set to “0” to disable this feature.

Debug Settings

SU_DEBUG_LEVEL

Specifies the debug level. The following values are supported:

0 disables all debug output and debug statements are null macros
1 only output fatal error information
2 output additional warning information
3 output additional status information
4 output additional device change information
5 output additional data transfer information
6 output interrupt information

SU_MS_DEBUG

Set to “1” to provide additional mass storage debug information.

Miscellaneous Settings

SU_HUB_RESET_TWICE

Set to "1" to reset the hub twice. Set to "0" for once. Some devices may need to reset the hub port twice before they can be enumerated. You don't need to enable this feature in most cases. Contact MDI if you have any question about this.

SU_DEV_ADDR_INCREASE

Set to "1" to always increase the device address. Set to "0" to re-use any smaller available address first.

SU_ENUMERATION_RETRY

Number of times to retry for the enumeration GetDescriptorInfo request.

SU_SAFETY_CHECKS

Set to "1" to enable special run time checking operations. Set to "0" to disable. These extra checks add extra run-time overhead so this should be disabled normally and only enabled to help diagnose a problem.

SU_NEED_NC_MEMORY

Set to "1" if the host controller requires non-cacheable memory for data transfer. Set to "0" if the host controller does not require it. Currently, of the controllers supported by smxUSBH, only OHCI, UHCI, and EHCI require non-cacheable memory.

SU_USE_C_HEAP

Set to "1" if your system has C library heap function (malloc()/free()) support. Set to "0" to enable the internal heap functions within smxUSBH. smx users may set this to 1, since it translates malloc()/free() calls to smx heap routines.

SU_HEAPSIZE

Sets the size of internal heap memory in smxUSBH. Heap size is the sum of USBD heap size, host controller heap size, and class driver heap size.

SU_COPY_DATA

Set to "1" if your system's CPU memory space is different than the USB Host Controller's memory space. This will increase the memory requirement.

SU_SPLIT_TRANSFER

Set to "1" if your host controller limits the size of a data buffer of a mass storage device. This splits the request into smaller ones.

SU_SPLIT_TRANSFER_SIZE

The maximum data transfer size (KB) per request for a mass storage device when **SU_SPLIT_TRANSFER** is set.

3.1.2 uport.h

General interrupt-related hardware porting interface is defined by smxBase. Please see smxBase User's Guide for details. The following are the smxUSBH-specific macros.

SU_HC_TASK_STACK, SU_HUB_TASK_STACK

Stack sizes of the USB host stack tasks. There are two tasks for multitasking environment. One is host controller interrupt processing task; another is the hub task for the enumeration of devices.

SU_EHCI_BASE, SU_OHCI_BASE, SU_UHCI_BASE, SU_ISP116X_BASE, SU_ISP1362_BASE, SU_ISP176X_BASE, SU_SYNOPSYS_BASE, SU_BLACKFIN_BASE, SU_RENESAS_BASE

SU_OHCI_IRQ, SU_UHCI_IRQ, SU_EHCI_IRQ, SU_ISP116X_IRQ, SU_ISP1362_IRQ, SU_ISP176X_IRQ, SU_MAX3421_IRQ, SU_SYNOPSYS_IRQ, SU_BLACKFIN_IRQ, SU_RENESAS_IRQ, SU_LM3S_IRQ, SU_PD720150_IRQ

Set to the base address and IRQ number for your host controller. These do not need to be set for x86 PCI systems because this information is retrieved from the PCI BIOS. The exception is SU_OHCI_BASE for x86 real mode. In that case set it to a low memory address in the range 0xC8000 to 0xF0000 and see if it works for your system. Run our OHCIBASE utility from DOS to see what addresses will work, if any. See 5.5.1 OHCI for x86 Real Mode for more information.

SU_NC_MEM_START

Set the non-cacheable memory start address. Separate non-cacheable memory is needed for OHCI/UHCI/EHCI host controllers if you enabled data cache on your system.

SU_FREESCALE_EHCI_FS_LS, SU_FREESCALE_EHCI_ULPI, SU_FREESCALE_EHCI_UTMI

Set Freescale EHCI-compatible host controller transceiver types. Check the processor's manual to determine which one should be enabled.

SU_USB_INT_DISPATCHER

Set to 1 if the USB host controller's interrupt needs a special dispatcher. Currently, of the processors we have supported, this is only needed to be 1 for NXP LPC17xx and LPC24XX.

3.2 Building the Library

After configuring ucfg.h (see 3.1.1 ucfg.h), build the library with the makefile or project file supplied in the build directory (e.g. MC.P3). It is built like other SMX module libraries, as documented in the SMX Quick Start (see E.10 Referenced Documents). If a makefile is provided, run the mak.bat file to invoke it. Run mak.bat without arguments for syntax help.

3.3 Building and Running the Demos

For non-SMX releases, a simple demo is provided in \SMX\APP\NORTOS\usbhdemo.c

For SMX releases, the demos are stored in \SMX\APP\DEMO. They are:

usbhdemo.c	main USB Host demo
fdemo.c	demonstrates smxFile USB disk driver
fsdemo.c	demonstrates smxFS USB disk driver

The demos are integrated with the smx Protosystem. They are enabled just like all other SMX module demos, as documented in the SMX Quick Start (E.10 Referenced Documents). For makefile builds, simply uncomment the macros **susbh** in pro.mak and **susbhdm or sfsdm** in demodefs.mki.

Each class driver demo is enabled when that class is enabled in ucfg.h (e.g. **SU_MOUSE**). Multiple demos can run at the same time, for example, mouse and mass storage device. Micro Digital recommends that you run the mouse demo first since it is the simplest.

The following is a summary of what each class driver demo does:

Mouse This demo shows the mouse movement and/or click events. The display format is:

L M R X:xx Y:xx W:U/D

If left button is pressed then L will be displayed. M is displayed for middle button and R for right button. X and Y indicate movement of the mouse and W is the wheel of the mouse, Up or Down.

Keyboard This demo shows which key is pressed. For example if the user presses the U key it will display "*U*" on the terminal or screen. Some shift keys will also be displayed such as *Alt*, *Ctrl*, *Shift*, *Num Lock*, *Caps Lock*.

HID This demo shows events from a generic HID device such as a Joystick or Multimedia keyboard. The information includes the event's type, for example, key or relative, the event's code, for example, *Key 0* or *Mouse Left button*, the event value, for example 1 or pressed and 0 for released.

Mass Storage This demo reads all the sectors of the flash disk that is plugged in. It shows the sector number it is reading, for example: *Testing Reading... 12345*

Net This demo calls Portinit() for smxNS, after the USB to Ethernet device is configured by the host stack. smxNS or another TCP/IP stack does the remaining work for the data transfer.

Printer This demo sends data to the printer to print information such as "*This is a USB printer*". Because different printers use different print control languages, the demo only supports HP LaserJet or HP Desktop 3500 printers. For other printers, you may need to encode the print data yourself.

Serial This demo sends data to a serial device and then reads back the data, comparing the result to see if it matches. It assumes the serial device is in the loop back test mode and sends back any received data. This demo shows the data length it has written, for example: "*WrittenData: 12345*"

CDC ACM This demo sends AT commands to the CDC ACM device. Normally it is a USB modem and it displays the response for the AT command to the terminal or screen. After that it tries to dial a number, logs on to an Intenet Service Provider (ISP), and then hangs up. You need to configure the ISP's phone number and username/password by setting the macros DIAL_PHONE_NUM, DIAL_USER_NAME and DIAL_PASSWORD at the top of usbhdemo.c.

FTDI232 This demo receives data from the USB to serial converter and then sends that data back. You can connect the converter to a PC serial port and use a terminal emulator program (e.g. TeraTerm) to input a message, and then you will see the echo returned by this demo.

Audio This demo records about 10 seconds voice data from a USB microphone and then plays it back through a USB speaker. (Typically a headset is used which has both.) When the demo shows "Testing Recording", talk into the microphone. Then the demo shows "Testing Playback", playing the voice just recorded.

PL2303 This demo receives data from the USB to serial converter and then sends that data back. You can connect the converter to a PC serial port and use a terminal emulator program to input a message. You will see the message echoed by this demo.

WiFi Dongle Refer to the smxWiFi User's Guide for more information about the smxWiFi demo.

Video This demo capture data from the video camera. If we don't have a display driver for the board, the demo will not display the image in this demo. We also do not have JPEG decoder so the demo will not display MJPEG format video data on the display even if we have display driver.

V20K13 This demo receives data from the V20K13 camera we don't have the display driver here so we will not display the image in this demo, just show the number of byte we get.

3.4 Initialization

smxUSBH is automatically initialized by an SMX application, if SMXUSBH is defined by the application makefile or project file. This is done by smxusbh_init(), which is called by smx_modules_init(). For non-SMX applications, call su_Initialize() from your initialization code.

Note that the hardware initialization requires delays. These are done with a polling loop (see sb_OS_WAIT_USEC_POLL() and sb_OS_WAIT_MSEC_POLL ()). For SMX these macros map onto BSP delay loops. These are implemented using the constant **BSP_CPU_MHZ**. Check bsp.h (in BSP) to ensure this is configured properly for your target. Otherwise, the delays could be much longer (or shorter) than expected.

4. USB Class Drivers

4.1 Class Driver API Overview

This section describes the general class driver structure and class driver API for each device that smxUSBH supports.

The overall structure of the application interface to a device depends upon the type of device. For a mouse or a keyboard, the interface is rather simple. The application simply registers a callback function, and then receives information on mouse movement or key presses when the callback function is called. The application can also check to see if a mouse or keyboard has been connected by using a specific status function.

For mass storage devices or printers, the application must ensure that the device is connected before attempting to use the device. Ideally a task should be created that monitors the connection state of the device. Alternatively, the device event callback function can be used. Once a status call indicates that the device is connected, the application can start making calls to set up and use the device. If a device returns an error while it is being used, the connection status should be rechecked to make sure that the device was not unplugged.

The following sections provide detailed descriptions of the class driver APIs.

4.2 Class Driver Interface (USBDI)

This section describes important interfaces used in a class driver.

4.2.1 Register the Class Driver with the USB Driver

A Class Driver must first be registered with the USB Driver (USBD). When the USB Driver detects that a new device has been plugged in, it searches through a list of registered devices to find an appropriate driver. To register the class driver with the USB Driver, perform the following steps:

1. Declare a global structure of type SU_DRV_DRIVERINFO_T. The structure is declared as follows in the file udriver.h:

    ```
    typedef struct SU_DRV_DriverInfo_T
    {
       SU_LISTHEADER_T driverHeaderList;
       const char * deviceName;
       void *(*deviceConn)(SU_DRV_DEVICEINFO_T * pDeviceInfo, uint intf,
                                  const SU_DRV_CHECKDEVICEINFO_T *id);
       void (*deviceClose)(SU_DRV_DEVICEINFO_T *, void *);
       const SU_DRV_CHECKDEVICEINFO_T *deviceArray;
       SU_SEMA_HANDLE  mutexDriver;
    } SU_DRV_DRIVERINFO_T;
    ```

    You only need to fill in the following members:

deviceName

This is the driver's name, such as "usb-mouse". The name has no special meaning so you can name it anything you like.

deviceConn

USBD calls this function when it finds a new device and finds that this class driver can handle the new device. You can indicate which kind of device this class driver can handle in deviceArray, documented below.

When this function is called, the device has already been configured by the USB driver through the device's default pipe. This function can perform initialization. For example, this function may retrieve the manufacturer, product, and serial number for the device, retrieve an additional endpoint descriptor according to device specific requirements, and allocate data transfer buffers which will be used for the device.

This function should also allocate a device specific driver information structure and return it as void *. The driver information structure can be considered as a handler for this device and it should maintain appropriate device state information to allow for the proper operation of the device.

deviceClose

USBD calls this function when it finds that a device has been removed from the USB system. This function typically performs clean up operations, such as removing pending requests and freeing allocated data buffers and internal data structures. The second parameter of this function is the driver information structure returned by deviceConn function.

deviceArray

This is a list of devices you want this class driver to handle. Each item in this array is a structure of type SU_DRV_CHECKDEVICEINFO_T. This structure is defined as:

```
typedef struct
{
   u16   checkMask;
   u16   vendor;
   u16   product;
   u8    deviceClass;
   u8    deviceSubClass;
   u8    deviceProtocol;
   u8    interfaceClass;
   u8    interfaceSubClass;
   u8    interfaceProtocol;
} SU_DRV_CHECKDEVICEINFO_T;
```

checkMask

This bitmap indicates which members of USB_DRV_CHECKDEVICEINFO_T structure need to match the values reported by a device in order for this device driver to be

associated with the device. The default setting is for the device class, device subclass, and device protocol to match. Mask definitions are in the file udriver.h.

vendor

Vendor ID to be checked by the driver. 0 indicates don't care.

product

Product ID to be checked by the driver. 0 indicates don't care.

deviceClass

Device Class to be checked by the driver. 0 indicates don't care.

deviceSubClass

Device Sub Class to be checked by the driver. 0 indicates don't care.

deviceProtocol

Device Protocol to be checked by the driver. 0 indicates don't care.

interfaceClass

Interface Class to be checked by the driver. 0 indicates don't care.

interfaceSubClass

Interface Sub Class to be checked by the driver. 0 indicates don't care.

interfaceClass

Interface Class to be checked by the driver. 0 indicates don't care.

interfaceProtocol

Interface Protocol to be checked by the driver. 0 indicates don't care.

2. Call function su_DrvAddDriverInfoToList() to register your driver with USBD.

4.2.2 Transfer of Data between the Class Driver and the USB Driver

Transfer data via the Default Control Pipe:

Call the function su_DrvSendControlInquiryInfo() to transfer data through the Default Control Pipe. You may use this method to set up a device specific feature. The request's parameter is passed in the function's parameter list. Check your device specification and standard USB request values to find out which value you should use.

Transfer data via another pipe:

Call the function su_DrvSendRequestStruct() to transfer data via another pipe. To cancel the request, call the function su_DrvUnlinkRequestStruct().

Before you call su_DrvSendRequestStruct(), you should set up a SU_DRV_INQUIRY_INFO_T structure and initialize appropriate members within this structure. These may include:

pDevice

The SU_DRV_DEVICEINFO_T structure pointer. Usually this is passed by the USBD when calling the deviceConn function and you should keep it in your own driver information structure.

pipe

A bitmap indicating the transfer direction, transfer type and endpoint number for this request.

pTransferBuf

The data buffer for the request.

transferBufLen

The data buffer's length.

completeFunc

The callback function used when the request is done. You may use it to inform your driver.

pContext

Your own class driver information structure pointer.

4.3 Audio

4.3.1 API

The application level interface is defined in **uaudio.h**. Normally, this kind of device is a USB headset, speaker or microphone. The interface includes:

BOOLEAN **su_AudioInserted**(uint iID);

Record

int **su_AudioRecGetChannelNum**(uint iID);
int **su_AudioRecGetChannelInfo**(uint iID, uint iChannel, SU_AUDIO_CHAN_INFO *pInfo);
int **su_AudioRecGetCurChannel**(uint iID, uint *piChannel);
int **su_AudioRecGetCurVolume**(uint iID, uint iChannel, uint *piVolume, uint *piMax, uint *piMin, uint *piRes);
int **su_AudioRecGetCurMute**(uint iID, uint iChannel, uint *piMute);
int **su_AudioRecSelectChannel**(uint iID, uint iChannel);
int **su_AudioRecSetVolume**(uint iID, uint iChannel, uint iVolume);
int **su_AudioRecSetMute**(uint iID, uint iChannel, uint iMute);
int **su_AudioRecGetFormatNum**(uint iID);
int **su_AudioRecGetFormat**(uint iID, uint iIndex, SU_AUDIO_FORMAT_INFO *pFormat);
int **su_AudioRecSetFormat**(uint iID, uint wFormat, u32 dwSamRate, uint iBits, uint Channel);
int **su_AudioRecOpen**(uint iID);
int **su_AudioRecClose**(uint iID);
int **su_AudioRecRead**(uint iID, u8 *pData, uint iLen);

Playback

int **su_AudioPlaybackGetChannelNum**(uint iID);
int **su_AudioPlaybackGetChannelInfo**(uint iID, uint iChannel, SU_AUDIO_CHAN_INFO *pInfo);
int **su_AudioPlaybackGetCurVolume**(uint iID, uint iChannel, uint *piVolume, uint *piMax, uint *piMin, uint *piRes);
int **su_AudioPlaybackGetCurMute**(uint iID, uint iChannel, uint *piMute);
int **su_AudioPlaybackSetVolume**(uint iID, uint iChannel, uint iVolume);
int **su_AudioPlaybackSetMute**(uint iID, uint iChannel, uint iMute);
int **su_AudioPlaybackGetFormatNum**(uint iID);
int **su_AudioPlaybackGetFormat**(uint iID, uint iIndex, SU_AUDIO_FORMAT_INFO *pFormat);
int **su_AudioPlaybackSetFormat**(uint iID, uint wFormat, u32 dwSamRate, uint iBits, uint Channel);
int **su_AudioPlaybackOpen**(uint iID);
int **su_AudioPlaybackClose**(uint iID);
int **su_AudioPlaybackWrite**(uint iID, u8 *pData, uint iLen);

MIDI

BOOLEAN **su_MIDIInserted**(uint iID);
int **su_MIDIPackEvent**(u8 *pData, SU_AUDIO_MIDI_EVENT *pEvent);
int **su_MIDIUnpackEvent**(u8 *pData, SU_AUDIO_MIDI_EVENT *pEvent);
int **su_MIDIRead**(uint iID, u8 *pData, uint iLen, uint iTimeout);
int **su_MIDIWrite**(uint iID, u8 *pData, uint iLen);
void **su_MIDISetDataReadyNotify**(MIDIDATAREADYFUNC handler);
int **su_MIDIStartReadTask**(uint iID);
int **su_MIDIStopReadTask**(uint iID);

BOOLEAN **su_MIDIReadTaskStarted**(uint iID);
int **su_MIDIOutCableNum**(uint iID)

int **su_AudioRecGetChannelNum** (uint iID)

Summary Get the number of recording channels.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.
If the USB audio device is a USB speaker then this function will return 0. You can use this function to decide if this device supports recording function.

Parameters iID Index of the device. Should be less than SU_AUDIO.

Returns

> 0	Number of audio recording channels.
== 0	This device has no recording channel.
< 0	An error occurred.

int **su_AudioRecGetChannelInfo**(uint iID, uint iChannel, SU_AUDIO_CHAN_INFO *pInfo)

Summary Get a recording channel's information based on the index.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver. Call **su_AudioRecGetChannelNum()** to get the total number of recording channels and then retrieve the channel information one by one.

Parameters

iID	Index of the device. Should be less than SU_AUDIO.
iChannel	Index of the channel, from 1 to **su_AudioRecGetChannelNum().**
pInfo	The structure pointer for the channel

The information for the channel is defined as:

```
typedef struct
{
   uint iID;
   uint iFeature;
   char szName[32];
}SU_AUDIO_CHAN_INFO;
```

iID is the internal ID of this channel
iFeature is the bitmap of this channel. Valid bits include:

SU_AUDIO_MUTE_PRESENT
SU_AUDIO_VOLUME_PRESENT
SU_AUDIO_BASS_PRESENT
SU_AUDIO_MID_PRESENT

SU_AUDIO_TREBLE_PRESENT
SU_AUDIO_GRAPHIC_EQUALIZER_PRESENT
SU_AUDIO_AUTOMATIC_GAIN_PRESENT
SU_AUDIO_DELAY_PRESENT
SU_AUDIO_BASS_BOOST_PRESENT
SU_AUDIO_LOUDNESS_PRESENT

szName is the name of this channel

Returns == 0 Function executed successfully.
< 0 An error occurred.

int **su_AudioRecGetCurChannel**(uint iID, uint *piChannel)

Summary Get the currently selected recording channel.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device. Should be less than SU_AUDIO.
piChannel	Index of the currently selected recording channel

Returns == 0 Function executed successfully.
< 0 An error occurred.

int **su_AudioRecGetCurVolume**(uint iID, uint iChannel, uint *piVolume, uint *piMax, uint *piMin, uint *piRes)

Summary Get a recording channel's volume information.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iChannel	Index of the channel for which you want to get the volume information, from 1 to **su_AudioRecGetChannelNum().**
piVolume	Pointer to current volume
piMax	Pointer to maximum volume
piMin	Pointer to minimum volume
piRes	Pointer to volume resolution

Returns == 0 Function executed successfully.
< 0 An error occurred.

int **su_AudioRecGetCurMute**(uint iID, uint iChannel, uint *piMute)

Summary Get a recording channel's mute status.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iChannel	Index of the channel for the mute status inquiry, from 1 to **su_AudioRecGetChannelNum().**
piMute	Pointer to mute status

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioRecSelectChannel**(uint iID, uint iChannel)

Summary Select a recording channel.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iChannel	Index of the channel for the recording selection.

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioRecSetVolume**(uint iID, uint iChannel, uint iVolume)

Summary Set the recording volume.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iChannel	Index of the channel for the volume setting.
iVolume	The volume value.

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioRecSetMute**(uint iID, uint iChannel, uint iMute)

Summary Set the recording mute status.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iChannel	Index of the channel for the mute status setting.
iMute	Mute or not. 1 for mute and 0 for unmute

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioRecGetFormatNum**(uint iID)

Summary Get the supported recording format number.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters iID Index of the device.

Returns

>= 0	Supported format number.
< 0	An error occurred.

int **su_AudioRecGetFormat**(uint iID, uint iIndex, SU_AUDIO_FORMAT_INFO *pFormat)

Summary Set the detailed supported recording format

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iIndex	Index of the format. It should be less than **su_AudioRecGetFormatNum()**.
pFormat	Pointer to the format information structure. The structure is defined as:

```
typedef struct
{
   u16  wFormatTag;
   u8   bChannels;
   u8   bBits;
   uint iSamRateNum;
   u32  SamRate[SU_AUDIO_MAX_FREQ];
}SU_AUDIO_FORMAT_INFO;
```

wFormatTag is the data format:

- SU_AUDIO_FORMAT_PCM
- SU_AUDIO_FORMAT_PCM8
- SU_AUDIO_FORMAT_IEEE_FLOAT
- SU_AUDIO_FORMAT_ALAW
- SU_AUDIO_FORMAT_MULAW

bChannels is the channel number of the data, 1 or 2.
bBits is the number of bits per sample, 8 or 16
iSamRateNum is the supported sample rate number
SamRate is the array of supported sample rate values, for example, 22050, 44100 or 48000

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioRecSetFormat**(uint iID, uint wFormat, u32 dwSamRate, uint iBits, uint iChannel)

Summary Set the recording data format.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver. Call this function at least one time before calling **su_AudioRecOpen**(). The format must be supported by the device. Call **su_AudioRecGetFormat()** to get all the supported formats.

Parameters

iID	Index of the device.
wFormat	Data format macro. For example SU_AUDIO_FORMAT_PCM.
dwSamRate	Sample rate. For example, 44100.
iBits	Number of bits per sample. For example, 16.
iChannel	The channel number to sample. For example 1.

Returns

== 0	Function executed successfully.
< 0	Format is not supported or an error occurred.

int **su_AudioRecOpen**(uint iID)

Summary Open and start the recording channel for recording.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver. Call **su_AudioRecSetFormat()** at least once before calling this function.

Parameters iID Index of the device.

Returns
== 0 Function executed successfully.
< 0 Could not open the device.

int **su_AudioRecClose**(uint iID)

Summary Close and stop the recording channel.

Details This function must be called **after** you call **su_AudioRecOpen()** and you want to stop the recording.

Parameters iID Index of the device.

Returns
== 0 Function executed successfully.
< 0 Could not close the device.

int **su_AudioRecRead**(uint iID, u8 *pData, uint iLen)

Summary Get the recorded data.

Details This function must be called **after** calling **su_AudioRecOpen()** and **before** calling **AudioRecClose()**.

Parameters
iID Index of the device.
pData Buffer pointer to the recorded data.
iLen Length of the data buffer.

Returns
>= 0 Length of data recorded.
< 0 An error occurred.

int **su_AudioPlaybackGetChannelNum** (uint iID)

Summary Get the playback channel number of the audio device.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.
If the USB audio device is a USB Microphone then this function will return 0. Use this function to decide if this device supports playback function.

Parameters iID Index of the device. Should be less than SU_AUDIO.

Returns
> 0 Channel number for audio playback.
== 0 This device has no playback channel.
< 0 An error occurred.

int **su_AudioPlaybackGetChannelInfo**(uint iID, uint iChannel, SU_AUDIO_CHAN_INFO *pInfo)

Summary Get a playback channel's information based on the index.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver. Call **su_AudioPlaybackGetChannelNum()** to get the total number of recording channels and then retrieve the channel information one by one.

Parameters
iID Index of the device. Should be less than SU_AUDIO.
iChannel Index of the channel, from 1 to **su_AudioPlaybackGetChannelNum().**
pInfo The structure pointer for the channel

The information of the channel is defined as:

```
typedef struct
{
   uint iID;
   uint iFeature;
   char szName[32];
}SU_AUDIO_CHAN_INFO;
```

iID is the internal ID of this channel
iFeature is the bitmap of this channel.. Valid bits include:
SU_AUDIO_MUTE_PRESENT
SU_AUDIO_VOLUME_PRESENT
SU_AUDIO_BASS_PRESENT
SU_AUDIO_MID_PRESENT
SU_AUDIO_TREBLE_PRESENT

SU_AUDIO_GRAPHIC_EQUALIZER_PRESENT
SU_AUDIO_AUTOMATIC_GAIN_PRESENT
SU_AUDIO_DELAY_PRESENT
SU_AUDIO_BASS_BOOST_PRESENT
SU_AUDIO_LOUDNESS_PRESENT

szName is the name of this channel

Returns

> 0	Audio playback channel number.
== 0	This device has no playback channel.
< 0	An error occurred.

int **su_AudioPlaybackGetCurVolume**(uint iID, uint iChannel, uint *piVolume, uint *piMax, uint *piMin, uint *piRes)

Summary Get current playback volume information.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iChannel	Index of the channel to get the volume information
piVolume	Pointer to current volume
piMax	Pointer to maximum volume
piMin	Pointer to minimum volume
piRes	Pointer to volume resolution

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioPlaybackGetCurMute**(uint iID, uint iChannel, uint *piMute)

Summary Get current playback mute status.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iChannel	Index of the channel to get the mute status.
piMute	Pointer to current mute status.

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioPlaybackSetVolume**(uint iID, uint iChannel, uint iVolume)

Summary	Set the playback volume.	
Details	This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.	
Parameters	iID	Index of the device.
	iChannel	Index of the channel to set the volume.
	iVolume	Volume value.
Returns	== 0	Function executed successfully.
	< 0	An error occurred.

int **su_AudioPlaybackSetMute**(uint iID, uint iChannel, uint iMute)

Summary	Set the playback mute status.	
Details	This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.	
Parameters	iID	Index of the device.
	iChannel	Index of the channel to set the mute status.
	iMute	Mute or not.
Returns	== 0	Function executed successfully.
	< 0	An error occurred.

int **su_AudioPlaybackGetFormatNum**(uint iID)

Summary	Get the supported playback format number.	
Details	This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.	
Parameters	iID	Index of the device.
Returns	>= 0	Supported format number.
	< 0	An error occurred.

int **su_AudioPlaybackGetFormat**(uint iID, uint iIndex, SU_AUDIO_FORMAT_INFO *pFormat)

Summary Set the detailed supported playback format.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver.

Parameters

iID	Index of the device.
iIndex	Index of the format. It should be less than **su_AudioPlaybackGetFormatNum()**.
pFormat	Pointer of the format information structure. The structure is defined as:

```
typedef struct
{
   u16  wFormatTag;
   u8   bChannels;
   u8   bBits;
   uint iSamRateNum;
   u32  SamRate[SU_AUDIO_MAX_FREQ];
}SU_AUDIO_FORMAT_INFO;
```

wFormatTag is the data format which is one of the following macro:

SU_AUDIO_FORMAT_PCM
SU_AUDIO_FORMAT_PCM8
SU_AUDIO_FORMAT_IEEE_FLOAT
SU_AUDIO_FORMAT_ALAW
SU_AUDIO_FORMAT_MULAW

bChannels is the channel number of the data, 1 or 2.
bBits is the number of bits per sample, 8 or 16
iSamRateNum is the supported sample rate number
SamRate is the array of supported sample rate values, for example, 22050, 44100 or 48000

Returns

== 0	Function executed successfully.
< 0	An error occurred.

int **su_AudioPlaybackSetFormat**(uint iID, uint wFormat, u32 dwSamRate, uint iBits, uint iChannel)

Summary Set the playback data format.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver. Call this function at least one time before calling **su_AudioPlaybackOpen**(). The format must be supported by the device. Call **su_AudioPlaybackGetFormat()** to get all the supported formats.

Parameters	iID	Index of the device.
	wFormat	Data format macro such as SU_AUDIO_FORMAT_PCM.
	dwSamRate	Sample rate.
	iBits	Number of bits per sample.
	iChannel	Number of channels for each sample.

Returns == 0 Function executed successfully.
< 0 Format is not supported or an error occurred.

int **su_AudioPlaybackOpen**(uint iID)

Summary Open and start the playback channel for recording.

Details This function must be called **after** the USB Audio device has been connected to the USB and configured by the device driver. Call **su_AudioPlaybackSetFormat()** at least once before you call this function.

Parameters iID Index of the device.

Returns == 0 Function executed successfully.
< 0 Could not open the device.

int **su_AudioPlaybackClose**(uint iID)

Summary Close and stop the playback channel.

Details Call **su_AudioPlaybackOpen()** before calling this function.

Parameters iID Index of the device.

Returns == 0 Function executed successfully.
< 0 Could not close the device.

int **su_AudioPlaybackWrite**(uint iID, u8 *pData, uint iLen)

Summary Send the playback data

Details Call **su_AudioPlaybackOpen()** before calling this function. Call this function **before** calling **AudioPlaybackClose()**.

Parameters	iID	Index of the device.
	pData	Pointer to playback data buffer.
	iLen	Length of the data buffer.

Returns >= 0 Length of data sent to the audio device's internal buffer.
< 0 An error occurred.

BOOLEAN **su_MIDIInserted**(uint iID)

Summary Check if a USB MIDI device is inserted.

Details Before any MIDI operations, this function must be called to assure a USB MIDI device is connected.

Parameters iID Index of the device.

Returns TRUE A USB MIDI device has been connected to the USB and initialized by the device driver.
FALSE No USB MIDI device has been connected.

int **su_MIDIPackEvent**(u8 *pData, SU_AUDIO_MIDI_EVENT *pEvent)

Summary Pack a MIDI event structure into a memory space

Details MIDI devices accept data in a format of MIDI event defined in the "Universal Serial Bus Device Class Definition for MIDI device" document. Please refer to Figure 8: 32-bit USB-MIDI Event Packet for details. When sending data to a MIDI device, call this function to convert to this format.

Parameters *pData The memory where a MIDI event structure will be packed to.
*pEvent The MIDI event structure used to pack to memory. The structure is defined as:

```
typedef struct
{
   u8 iCN;           /* Cable Number */
   u8 iCIN;          /* Code Index Number */
   u8 iMIDI_0;       /* MIDI data byte 0 */
   u8 iMIDI_1;       /* MIDI data byte 1 */
   u8 iMIDI_2;       /* MIDI data byte 2 */
}SU_MIDI_EVENT;
```

Returns >= 0 Data have been packed sucessfully.
< 0 An error occurred.

int **su_MIDIUnPackEvent**(u8 *pData, SU_AUDIO_MIDI_EVENT *pEvent)

Summary Unpack a MIDI event from memory to an event structure.

Details MIDI devices send data in a format of MIDI event defined in the "Universal Serial Bus Device Class Definition for MIDI device" document. Please refer to Figure 8: 32-bit USB-MIDI Event Packet for details. When receiving data from a MIDI device call this function to convert to a MIDI event structure.

Parameters

***pData**	The memory pointer to data to convert into a MIDI event.
*pEvent	The MIDI event structure where data is unpacked. The structure is defined as:

```
typedef struct
{
   u8 iCN;          /* Cable Number */
   u8 iCIN;         /* Code Index Number */
   u8 iMIDI_0;      /* MIDI data byte 0 */
   u8 iMIDI_1;      /* MIDI data byte 1 */
   u8 iMIDI_2;      /* MIDI data byte 2 */
}SU_MIDI_EVENT;
```

Returns

>= 0	Data have been unpacked sucessfully.
< 0	An error occurred.

int **su_MIDIRead**(uint iID, u8 *pData, uint iLen, uint iTimeout)

Summary Read data from the MIDI device.

Details This function tries to read some data from the MIDI device. If there is no data within timeout milliseconds, it returns 0. Note: this function should not be called when the polling read task has been started.

Parameters

iID	Index of the device. Should be less than SU_AUDIO.
pData	Pointer to the data buffer.
iLen	Length of the data buffer.
iTimeout	The timeout value for this operation, in milliseconds.

Returns

> 0	Length of the data read from the device.
= 0	An error occurred or there is no data.

int **su_MIDIWrite**(uint iID, u8 *pData, uint iLen)

Summary Sends data to the MIDI device.

Details This function can be called once a MIDI device has been connected to the USB and initialized by the device driver. It tries to write some data to that device.

Parameters

	iID	Index of the device. Should be less than SU_AUDIO
	pData	Pointer to the data buffer.
	iLen	Length of the data buffer.

Returns

	> 0	Length of the data written to the device.
	= 0	An error occurred.

int **su_MIDIOutCableNum**(uint iID)

Summary Get the cable number associated with the MIDI device BULK OUT endpoint.

Details Cable number is used to assemble the MIDI event packet when the host needs to send data to the MIDI device. Please refere to Figure 8: 32-bit USB-MIDI Event Packet in "Universal Serial Bus Device Class Definition for MIDI devices" document.

Parameters

	iID	Index of the device. Should be less than SU_AUDIO

Returns

	> =0	The cable number
	< 0	An error occurred.

void **su_MIDISetDataReadyNotify**(MIDIDATAREADYFUNC handler)

Summary Register a callback function to handle the event that incoming data is ready.

Details This function can be called any time after smxUSBH has started.
The callback function is defined as:
typedef void (*MIDIDATAREADYFUNC)(uint iID, u8 *pData, uint iLen);
You should only call this when you choose to use the polling task to poll for incoming data. Note: The callback function will be directly called from the USBH interrupt handler. To avoid long interrupt delay, the application should not put long data processing code in the callback function; it should be placed in another task.

Parameters

	handler	Callback function pointer.

Returns None

int **su_MIDIStartReadTask**(uint iID)

Summary	Start the read polling task.	
Details	This function will start a task to keep polling the incoming data. You should not call su_MIDIRead() to get the data in your application after the task is started.	
Parameters	iID	Index of the device. Should be less than SU_AUDIO.
Returns	0	Task started.
	-1	Failed to start the task.

int **su_MIDIStopReadTask**(uint iID)

Summary	Stop the read polling task.	
Details	This function will stop the read polling task.	
Parameters	iID	Index of the device. Should be less than SU_AUDIO.
Returns	0	Task stopped.
	-1	Task has not been started yet.

BOOLEAN **su_MIDIReadTaskStarted** (uint iID)

Summary	Check if the read polling task is started.	
Details	This function will indicate whether the polling task has been started or not.	
Parameters	iID	Index of the device. Should be less than SU_AUDIO.
Returns	TRUE	Task started.
	FALSE	Task has not been started yet.

4.3.2 Audio Device Limitations

There are some limitations for this audio class device driver:

1. It does not support selecting the playback channel.
2. It does not support multiple microphones or speakers in the same device.
3. It is not tested for compressed data format recording and playback, such as MPEG or AC-3.
4. It does not support Processing Units such as Dolby Prologic Processing Unit.
5. It does not support multiple MIDI stream intrefaces in the same devices.

6. It does not support MIDI element units.
7. It does not support MIDI dedicated transfer bulk endpoints.

4.4 Communication (CDC)

4.4.1 ACM (Modem)

4.4.1.1 API

The application level interface is defined in **ucdcacm.h**. Normally, this kind of device is used for a modem or ISDN adapter. The interface includes:

```
int        su_CDCACMOpen (uint iID)
int        su_CDCACMClose (uint iID)
BOOLEAN    su_CDCACMInserted (uint iID)
int        su_CDCACMRead (uint iID, u8 * pData, int len, uint timeout)
int        su_CDCACMWrite (uint iID, u8 * pData, int len)
int        su_CDCACMGetLineState(int port, uint *piState);
int        su_CDCACMGetLineCoding(int port, u32 *pdwDTERate, u8 *pbParityType,
                                  u8 *pbDataBits, u8 *pbStopBits);
int        su_CDCACMSetLineState(int port, uint iState);
int        su_CDCACMSendLineBreak(uint iID, u16 ms);

int        su_CDCACMSetCommFeature(uint iID, u16 wSelector, u16 wStatus);
int        su_CDCACMGetCommFeature(uint iID, u16 wSelector, u16 *pwStatus);

void       su_CDCACMRegisterStateChangeNotify(PHOSTCDCACMFUNC handler);
```

int **su_CDCACMOpen** (uint iID)

Summary Open the CDC ACM device.

Details This function must be called **after** the USB CDC ACM device has been connected to the USB and configured by the device driver and **before** any CDCACMRead/CDCACMWrite functions. It sets the line coding information such as baud rate and number of data bits. It also sets the DCD and DTR signals of the CDC ACM device.

Parameters iID Index of the device. Should be less than SU_CDCACM.

Returns

== 0	The device has been opened and the line coding and line state have also been set up.
< 0	An error occurred.

int **su_CDCACMClose** (uint iID)

Summary Close the CDC ACM device.

Details This function must be called **after** you finish any CDCACMRead/CDCACMWrite function calls. It clears the DCD and DTR signals of the serial port.

Parameters

iID Index of the device. Should be less than SU_CDCACM.

Returns

== 0 The device has been closed.
< 0 An error occurred.

BOOLEAN **su_CDCACMInserted** (uint iID)

Summary Returns status indicating if a USB CDC ACM device has been connected.

Details This function can be called at any time to determine if a CDC ACM device has been connected to the USB port.

Parameters

iID Index of the device. Should be less than SU_CDCACM.

Returns

TRUE A USB CDC ACM device has been connected to the USB and initialized by the device driver.
FALSE No USB CDC ACM device has been connected.

int **su_CDCACMRead** (uint iID, u8 * pData, int len, uint timeout)

Summary Reads data from the serial device.

Details This function tries to read some data from the serial port. If there is no data within timeout milliseconds, it returns 0.

Parameters

iID Index of the device. Should be less than SU_CDCACM.
pData Pointer to the data buffer.
len Length of the data buffer.
timeout The timeout value for this operation, in milliseconds.

Returns

> 0 Length of the data read from the device.
= 0 An error occurred or there is no data.

int **su_CDCACMWrite** (uint iID, u8 * pData, int len)

Summary	Sends data to the CDC ACM device.	
Details	This function can be called once a CDC ACM device has been connected to the USB and configured by the device driver. It tries to write some data to that device.	
Parameters	iID	Index of the device. Should be less than SU_CDCACM
	pData	Pointer to the data buffer.
	len	Length of the data buffer.
Returns	> 0	Length of the data written to the device.
	= 0	An error occurred.

int **su_CDCACMGetLineState** (uint iID, uint *piState)

Summary Get the current Line State.

Details This function can be called once a CDC ACM device has been connected to the USB and configured by the device driver, or after getting a line state change notification. It returns the current Line State bitmap. The bitmap is compatible with USB CDC Class Specification. Values include:

SU_CDCACM_LINE_IN_DCD
SU_CDCACM_LINE_IN_DSR
SU_CDCACM_LINE_IN_BRK
SU_CDCACM_LINE_IN_RI
SU_CDCACM_LINE_IN_FRAMING
SU_CDCACM_LINE_IN_PARITY
SU_CDCACM_LINE_IN_OVERRUN

Parameters	iID	Index of the device. Should be less than SU_CDCACM.
	piState	Pointer to the line state bitmap.
Returns	1	Got the line state bitmap
	= 0	An error occurred or no device is connected.

int **su_CDCACMGetLineCoding** (uint iID, u32 *pdwDTERate, u8 *pbParityType,
u8 *pbDataBits, u8 *pbStopBits)

Summary Get the current Line Coding information.

Details This function can be called once a CDC ACM device has been connected to the USB and configured by the device driver. It returns the current device configuration, such as baud rate and number of data bits. **The default setting for the line coding is 115200 N 8 1**.

Parameters

iID Index of the device. Should be less than SU_CDCACM.

pdwDTERate Pointer to the baud rate value, if the baud rate is 115200 then it will return 115200.

pbParityType Pointer to the parity value. Valid values include:
- SU_CDCACM_PARITY_NONE
- SU_CDCACM_PARITY_ODD
- SU_CDCACM_PARITY_EVEN
- SU_CDCACM_PARITY_MARK
- SU_CDCACM_PARITY_SPACE

pbDataBits Pointer to the number of data bits value. May be 7 or 8.

pbStopBits Pointer to the number of stop bits value. Valid values include:
- SU_CDCACM_STOP_BITS_1
- SU_CDCACM_STOP_BITS_1_5
- SU_CDCACM_STOP_BITS_2

Returns

1 Got the line coding value.

= 0 An error occurred or the device is not connected.

int **su_CDCACMSetLineState** (uint iID, uint *piState)

Summary Change the current Line State.

Details This function can be called once a CDC ACM device has been connected to the USB and configured by the device driver. This function sets the current Line State bitmap. This bitmap is compatible with USB CDC Class Specification. Valid values include:
- SU_CDCACM_LINE_OUT_RTS
- SU_CDCACM_LINE_OUT_DTR

Parameters

iID Index of the device. Should be less than SU_CDCACM.

piState Pointer to the line state bitmap.

Returns

1 Got the line state bitmap

= 0 An error occurred or no device is connected.

int **su_CDCACMSendLineBreak** (uint iID, uint ms)

Summary Send an RS-232 style break.

Details This function can be called once a CDC ACM device has been connected to the USB and configured by the device driver. Some CDC ACM devices may not support this feature.

Parameters

iID	Index of the device. Should be less than SU_CDCACM.
ms	Duration of the break.

Returns

1	Break has been sent out.
= 0	An error occurred. Device does not support this feature or no device is connected.

int **su_CDCACMGetCommFeature** (uint iID, u16 wSelector, u16 *pwStatus)

Summary Return the current settings for the selected communication feature.

Details This function can be called once a CDC ACM device has been connected to the USB and configured by the device driver. Some CDC ACM devices may not support this feature. Valid selectors include:

SU_CDCACM_FEATURE_ABSTRACT_STATE
SU_CDCACM_FEATURE_COUNTRY_SETTING

Parameters

iID	Index of the device. Should be less than SU_CDCACM.
wSelector	Feature selector.
pwStatus	Pointer to the returned status.

Returns

1	Got the feature.
= 0	An error occurred, device does not support this feature, or no device is connected.

int **su_CDCACMSetCommFeature** (uint iID, u16 wSelector, u16 wStatus)

Summary Change the current settings for the communication feature as selected.

Details This function can be called once a CDC ACM device has been connected to the USB and configured by the device driver. Some CDC ACM devices may not support this feature.Valid selectors include:

SU_CDCACM_FEATURE_ABSTRACT_STATE
SU_CDCACM_FEATURE_COUNTRY_SETTING

Parameters

iID	Index of the device. Should be less than SU_CDCACM.
wSelector	Feature selector.
wStatus	The new status.

Returns

1	Feature has been set.
= 0	An error occurred, device does not support this feature, or no device is connected.

void **su_CDCACMRegisterStateChangeNotify**(PHOSTCDCACMFUNC handler)

Summary Register a callback notification function for device state changes.

Details This function can be called any time smxUSBH has started.
The callback function is defined as:
typedef void (* PHOSTCDCACMFUNC)(uint iID, uint wNotifyType, u16 wParam);
Values for wNotifyType include:

SU_CDCACM_CONNECT_CHANGED
SU_CDCACM_LINE_STATE_CHANGED
SU_CDCACM_RESPONSE_READY

If the type is SU_CDCACM_CONNECT_CHANGED, then wParam = 1 means connected; 0 means disconnected.
If the type is SU_CDCACM_LINE_STATE_CHANGED, then wParam contains the current line state.
wParam is not used for SU_CDCACM_RESPONSE_READY.

Parameters

iID	Index of the device. Should be less than SU_CDCACM.
wNotifyType	The notification type. Some device may not support SU_CDCACM_CONNECT_CHANGED type notification
wParam	Parameter for the notification.

Returns None

4.4.2 Serial (Windows Mobile 5 Device, CDC/ACM-like)

4.4.2.1 API

There are two ways to get the incoming data: Keep calling su_SerialRead() in the application, or call su_SerialStartPollingTask()/su_SerialStopPollingTask() to use the built-in polling task and use the data ready callback function.

Please see section 4.4.2.2 Limitations for important information about this driver.

Micro Digital provides separate USB to serial adapter drivers for FTDI FT232 and Prolific 2303HXD chips. If using one of these, select it in ucfg.h, and see the corresponding section below: 4.4.3 Serial Converter FTDI FT232B or 4.4.4 Serial Converter Prolific 2303HXD.

The application level interface is defined in **userial.h**. This interface includes:

int	**su_SerialOpen** (uint iID)
int	**su_SerialClose** (uint iID)
BOOLEAN	**su_SerialInserted** (uint iID)
int	**su_SerialRead** (uint iID, u8 * pData, int len, uint iTimeout)
int	**su_SerialWrite** (uint iID, u8 * pData, int len)
int	**su_SerialGetLineState**(int port, uint *piState);
int	**su_SerialGetLineCoding**(int port, u32 *pdwDTERate, u8 *pbParityType, u8 *pbDataBits, u8 *pbStopBits);
void	**su_SerialRegisterStateChangeNotify**(PHOSTSERIALFUNC handler);
void	**su_SerialDataReadyNotify**(PSERIALDATAREADYFUNC handler);
int	**su_SerialStartPollingTask**(uint iID);
int	**su_SerialStopPollingTask**(uint iID);
BOOLEAN	**su_SerialPollingTaskStarted**(uint iID);

int **su_SerialOpen** (uint iID)

Summary Open the serial port.

Details This function must be called **after** the USB serial device has been connected to the USB and configured by the device driver and **before** any SerialRead/SerialWrite functions. It sets the line coding information such as baud rate and number of data bits. It also sets the DCD and DTR signals of the serial port.

Parameters iID Index of the serial device. Should be less than SU_SERIAL.

Returns

- == 0 The device has been opened and the line coding and line state have also been set up.
- < 0 An error occurred.

int **su_SerialClose** (uint iID)

Summary Close the serial port.

Details This function must be called **after** finishing any SerialRead/SerialWrite function calls. It clears the DCD and DTR signals of the serial port.

Parameters iID Index of the serial device. Should be less than SU_SERIAL.

Returns

== 0	The device has been closed.
< 0	An error occurred.

BOOLEAN **su_SerialInserted** (uint iID)

Summary Returns status indicating if a USB serial device has been connected.

Details This function can be called at any time to determine if a supported serial device has been connected to the USB.

Parameters iID Index of the serial device. Should be less than SU_SERIAL.

Returns

TRUE	A supported USB serial device has been connected to the USB and initialized by the device driver.
FALSE	No USB serial device has been connected.

int **su_SerialRead** (uint iID, u8 * pData, int len, uint iTimeout)

Summary Reads data from the serial device.

Details This function tries to read some data from the serial port. If there is no data within iTimeout milliseconds, this function returns 0.

You should not call this function if you use the built-in polling task.

Parameters

iID	Index of the serial device. Should be less than SU_SERIAL.
pData	Pointer to the data buffer.
len	Length of the data buffer.
iTimeout	Timeout value (millisecond) for the read operation.

Returns

> 0	Length of the data read from the serial device.
= 0	An error occurred or there is no data during the timeout period.

int **su_SerialWrite** (uint iID, u8 * pData, int len)

Summary Sends data to the serial device.

Details This function can be called once a serial device has been connected to the USB and configured by the device driver. It tries to write some data to the serial device.

Parameters

iID	Index of the serial device. Should be less than SU_SERIAL
pData	Pointer to the data buffer.
len	Length of the data buffer.

Returns

> 0	Length of the data written to the serial device.
= 0	An error occurred.

int **su_SerialGetLineState** (uint iID, uint *piState)

Summary Get the current Line State.

Details This function can be called after a serial device has been connected to the USB and configured by the device driver, or it can be called after a line state change notification. It returns the current Line State bitmap. This bitmap is compatible with USB CDC Class Specification. Values include:

SU_SERIAL_LINE_IN_DCD
SU_SERIAL_LINE_IN_DSR
SU_SERIAL_LINE_IN_BRK
SU_SERIAL_LINE_IN_RI
SU_SERIAL_LINE_IN_FRAMING
SU_SERIAL_LINE_IN_PARITY
SU_SERIAL_LINE_IN_OVERRUN

Parameters

iID	Index of the serial device. Should be less than SU_SERIAL.
piState	Pointer to the line state bitmap.

Returns

1	Got the line state bitmap
= 0	An error occurred or no serial device is connected.

int **su_SerialGetLineCoding** (uint iID, u32 *pdwDTERate, u8 *pbParityType,
u8 *pbDataBits, u8 *pbStopBits)

Summary Get the current Line Coding information.

Details This function can be called after a serial device has been connected to the USB and configured by the device driver. It returns the current serial device configuration such as baud rate and number of data bits. **The default setting for the line coding is 115200 N 8 1**.

Parameters

iID	Index of the serial device. Should be less than SU_SERIAL.
pdwDTERate	Pointer to the baud rate value. For example, 115200.
pbParityType	Pointer to the parity value. Valid values include: SU_SERIAL_PARITY_NONE SU_SERIAL_PARITY_ODD SU_SERIAL_PARITY_EVEN SU_SERIAL_PARITY_MARK SU_SERIAL_PARITY_SPACE
pbDataBits	Pointer to the number of data bits value. May be 7 or 8.
pbStopBits	Pointer to the number of stop bits value. Valid values include: SU_SERIAL_STOP_BITS_1 SU_SERIAL_STOP_BITS_1_5 SU_SERIAL_STOP_BITS_2

Returns

1	Got the line coding value.
= 0	An error occurred or the serial device is not connected.

void **su_SerialRegisterStateChangeNotify**(PHOSTSERIALFUNC handler)

Summary Register a callback notification function for line state changes.

Details This function can be called any time after smxUSBH has started.
The callback function is defined as:
typedef void (* PHOSTSERIALFUNC)(uint iID, u16 wNewLineState);

Parameters

iID	Index of the device. Should be less than SU_SERIAL.
wNewLineState	New Line State.

Returns None

void **su_SerialDataReadyNotify**(PSERIALDATAREADYFUNC handler)

Summary Register a callback function to handle the event that incoming data is ready.

Details This function can be called any time after smxUSBH has started.
The callback function is defined as:
typedef void (* PSERIALDATAREADYFUNC)(uint iID, u8 *pData, uint iLen);
You should only call this when you choose to use the built-in polling task to poll the incoming data.

Parameters handler Callback function pointer.

Returns None

int **su_SerialStartPollingTask** (uint iID)

Summary Start the built-in polling task.

Details This function will start a built-in task to keep polling the incoming data. Only call this function after you call su_SerialOpen(). You can not call su_SerialRead() to get the data in your application after the task is started.

Parameters iID Index of the device. Should be less than SU_SERIAL.

Returns

0	Task started.
-1	Failed to start the task.

int **su_SerialStopPollingTask** (uint iID)

Summary Stop the built-in polling task.

Details This function will stop the built-in task. Only call this function after you call su_SerialOpen() and before su_SerialClose().

Parameters iID Index of the device. Should be less than SU_SERIAL.

Returns

0	Task stopped.
-1	Task has not been started yet.

BOOLEAN **su_SerialPollingTaskStarted** (uint iID)

Summary Check if the built-in polling task is started.

Details This function will indicate whether the built-in polling task has been started or not.

Parameters iID Index of the device. Should be less than SU_SERIAL.

Returns	TRUE	Task started.
	FALSE	The task is not started yet.

4.4.2.2 Limitations

Universal Serial Bus Device Class Definition for Communication Devices (www.usb.org/developers/defined_class) defines a set of communication devices such as modems and LAN cards. It does not define a USB serial device but it can be used to implement one, which Micro Digital has done and which has been done in Windows.

The USB Serial device may be a USB to RS232 adapter that connects to another RS232 port through a serial cable. It can also be an embedded device that uses the USB port to communicate with a USB host. In this case, there is no RS232 link. In our testing, Windows Mobile 5 devices use this kind of device to connect to a USB host. For the smxUSBH serial class driver the connection type is not relevant.

A USB Serial device that follows the Communication Devices specification can be supported by Windows 2000, XP, Vista, and 7 without any special driver. Only an .inf file is needed. However, there are many products in the market that require a special driver to work under Windows, which do not follow the existing well-defined specification. They define their own proprietary interface. smxUSBH serial follows the USB specification so **it cannot automatically support serial devices that need a special driver for Windows**. It can support any serial device that has the following features:

1. Its Interface Class number is 2 and/or 10, which means it is a CDC Communication class device or CDC Data class device.
2. It has three endpoints (one BULK IN, one BULK OUT, and one INT IN for notification) in one or two interfaces:
   a. CDC COMM interface contains only INT IN endpoint, and CDC Data interface contains BULK IN and BULK OUT endpoints.
   b. CDC COMM interface contains all three endpoints.
3. It uses the Abstract Control Mode request SET_LINE_CODING, GET_LINE_CODING, and SET_CONTROL_LINE_STATE to set/get the serial device's DTE rate, parity, data bits, stop bits, and number-of-character bits. See the CDC specification v1.1 table 4 for the details.
4. It uses the Abstract Control Mode Notification SERIAL_STATE to notify the host through the INT IN endpoint that the RS232 Control line state has changed.
5. The LINE_CODING data format is compatible with CDC specification v1.1 table 50.
6. The Control Line State data format is compatible with CDC specification v1.1 table 51

For serial adapters and other types of serial devices that don't follow the CDC specification, additional code must be written in the smxUSBH serial driver, which could take some effort. Source code that may be provided on the CD that comes with the adapters (e.g. Linux driver) will show what is necessary to communicate with the adapter. If there is no source code, use a USB packet analyzer to study the details of messages sent while in use by a Windows application to see what is required. This could take a lot of time.

4.4.3 Serial Converter FTDI FT232B/LC/R

4.4.3.1 API

The application level interface is defined in **uftdi232.h**. This interface includes:

int	**su_FTDIOpen**(uint iID)
int	**su_FTDIClose** (uint iID)
BOOLEAN	**su_FTDIInserted** (uint iID)
int	**su_FTDIReadData** (uint iID, u8 * pData, int len)
int	**su_FTDIWriteData** (uint iID, u8 * pData, int len)
int	**su_FTDISetModemCtrl**(uint iID, uint Data)
int	**su_FTDISetFlowCtrl**(uint iID, uint Data)
int	**su_FTDISetLineCoding**(uint iID, u32 dwDTERate, u16 wbParityType, u16 wDataBits, u16 wStopBits);
int	**su_FTDIGetModemStatus**(uint iID);
int	**su_FTDIGetStatus**(uint iID, u8 *pModemStatus, u8 *pLineStatus);
int	**su_FTDISetEventChar**(uint iID, u8 cData);
int	**su_FTDISetErrorChar**(uint iID, u8 cData);
int	**su_FTDISetLatencyTimer**(uint iID, uint iMS);
int	**su_FTDIGetLatencyTimer**(uint iID);

int **su_FTDIOpen** (uint iID)

Summary Open the FTDI serial converter port.

Details This function must be called **after** the FTDI serial converter has been connected to the USB and configured by the device driver and **before** any FTDIRead/FTDIWrite functions. It sets the line coding information such as baud rate and number of data bits. It also sets the RTS and DTR signals of the serial port. The default flow control setting is to hardware signal CTS_RTS. The default baud rate is 115200. The default line coding is 8 data bits, none parity and 1 stop bit.

Parameters iID Index of the serial device. Should be less than SU_FTDI232.

Returns
- == 0 The device has been opened and the line coding and line state have also been set up.
- < 0 An error occurred.

int **su_FTDIClose** (uint iID)

Summary Close the FTDI serial converter port.

Details This function must be called **after** finishing any FTDIRead/FTDIWrite function calls. It clears the DSR and DTR signals of the serial converter port.

Parameters

iID	Index of the serial device. Should be less than SU_FTDI.

Returns

== 0	The device has been closed.
< 0	An error occurred.

BOOLEAN **su_FTDIInserted** (uint iID)

Summary Returns status indicating if a FTDI serial converter device has been connected.

Details This function can be called at any time to determine if a supported serial converter device has been connected to the USB.

Parameters

iID	Index of the serial converter device. Should be less than SU_FTDI232.

Returns

TRUE	A supported FTDI serial converter device has been connected to the USB and initialized by the device driver.
FALSE	No FTDI serial converter device has been connected.

int **su_FTDIReadData** (uint iID, u8 * pData, int len)

Summary Reads data from the serial converter device.

Details This function tries to read some data from the serial port. If there is no data within the latency time (default time is 40 ms), this function returns 0.

Parameters

iID	Index of the serial converter device. Should be less than SU_FTDI232.
pData	Pointer to the data buffer.
len	Length of the data buffer.

Returns

> 0	Length of the data read from the serial converter device.
= 0	An error occurred or there is no data.

int **su_FTDIWriteData** (uint iID, u8 * pData, int len)

Summary	Sends data to the serial converter device.	
Details	This function can be called once a serial converter device has been connected to the USB and configured by the device driver. It tries to write some data to the serial converter device.	
Parameters	iID	Index of the serial converter device. Should be less than SU_FTDI232
	pData	Pointer to the data buffer.
	len	Length of the data buffer.
Returns	> 0	Length of the data written to the serial converter device.
	= 0	An error occurred.

int **su_FTDISetModemCtrl** (uint iID, uint Data)

Summary	Set the DTR and RTS signal.	
Details	This function can be called once a serial converter device has been connected to the USB and configured by the device driver and after calling su_FTDIOpen(). su_FTDIOpen() sets DTR and RTS high, by default. Call this function to override the defaults.	
Parameters	iID	Index of the serial converter device. Should be less than SU_FTDI232
	Data	DTR and RTS settings. SU_FTDI232_DTR will set DTR to high and SU_FTDI232_RTS will set RTS to high. You can also OR those two macros together to setting both DTR and RTS to high.
Returns	== 0	DTR and RTS has been set.
	-1	An error occurred.

int **su_FTDISetFlowCtrl** (uint iID, uint Data)

Summary Set the Flow Control of the FTDI serial converter.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver and after calling su_FTDIOpen(). su_FTDIOpen() sets the default Flow Control to SU_FTDI232_FLOWCTRL_RTSCTS. Call this function to override the Flow Control default.

Parameters	iID	Index of the serial converter device. Should be less than SU_FTDI232
	Data	Flow Control settings. Valid settings include: SU_FTDI232_FLOWCTRL_NONE SU_FTDI232_FLOWCTRL_RTSCTS SU_FTDI232_FLOWCTRL_DTRDSR SU_FTDI232_FLOWCTRL_XONXOFF
Returns	== 0	Flow Control has been set.
	-1	An error occurred.

int **su_ FTDISetLineCoding** (uint iID, u32 dwDTERate, u16 wParityType,
u16 wDataBits, u16 wStopBits)

Summary Set the Baudrate, Parity type, Data bits and Stop bits of the FTDI serial converter.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver and after calling su_FTDIOpen(). su_FTDIOpen() sets default line values. Call this function to override the line coding defaults.

Parameters	iID	Index of the serial converter device. Should be less than SU_FTDI232
	dwDTERate	Baud rate. Valid settings include: 115200, 57600, 38400, 19200, 9600, 4800, 2400, 1200 and 300
	wParityType	Parity type of the serial converter, valid settings include: SU_FTDI232_PARITY_NONE SU_FTDI232_PARITY_ODD SU_FTDI232_PARITY_EVEN SU_FTDI232_PARITY_MARK SU_FTDI232_PARITY_SPACE
	wDataBits	7 or 8 bits
	wStopBits	Stop bits, valid settings include: SU_FTDI232_STOP_BITS_1 SU_FTDI232_STOP_BITS_15 SU_FTDI232_STOP_BITS_2
Returns	== 0	Line coding has been set.
	-1	An error occurred.

int **su_FTDIGetModemStatus** (uint iID)

Summary Get the current Modem status register.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver. Returns the current modem status register value.

Parameters iID Index of the serial converter device. Should be less than SU_FTDI232

Returns
> 0 Mode status register which may include the following bitmap.
SU_FTDI232_CTS
SU_FTDI232_DSR
SU_FTDI232_RI
SU_FTDI232_RLSD
-1 An error occurred or the serial converter was removed.

int **su_FTDIGetStatus** (uint iID, u8 *pModemStatus, u8 *pLineStatus)

Summary Get the current Modem and Line status register.

Details FTDI serial converter returns the modem and line status register after a call to su_FTDIReadData(). This function returns the last value of modem and line status register returned by su_FTDIReadData().

Parameters
iID Index of the serial converter device. Should be less than SU_FTDI232
pModemStatus Pointer to the current Modem Status Register. It contains the following bitmap.
SU_FTDI232_CTS
SU_FTDI232_DSR
SU_FTDI232_RI
SU_FTDI232_RLSD
pLineStatus Pointer to the current Line Status Register. It contains the following bitmap.
SU_FTDI232_DR
SU_FTDI232_OE
SU_FTDI232_PE
SU_FTDI232_FE
SU_FTDI232_BI
SU_FTDI232_THRE
SU_FTDI232_TEMT
SU_FTDI232_FIFOE

Returns
== 0 Got the status.
-1 An error occurred or the serial converter was removed.

int **su_ FTDISetEventChar** (uint iID, u8 cData)

Summary Set the event character.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver, to change the default setting for event character.

Parameters

	iID	Index of the serial converter device. Should be less than SU_FTDI232
	cData	The new event character.

Returns

	== 0	The new event character has been set.
	-1	An error occurred or the serial converter was removed.

int **su_FTDISetErrorChar** (uint iID, u8 cData)

Summary Set the error character.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver, to change the default setting for error character.

Parameters

	iID	Index of the serial converter device. Should be less than SU_FTDI232
	cData	The new error character.

Returns

	== 0	The new error character has been set.
	-1	An error occurred or the serial converter was removed.

int **su_ FTDISetLatencyTimer** (uint iID, uint iMS)

Summary Set the new latency timer.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver, to change the default setting for latency timer. The latency timer is the timer used to time out read requests. The default time is 40 ms. If there is no data within the latency period, the read request will return zero length data.

Parameters

	iID	Index of the serial converter device. Should be less than SU_FTDI232
	iMS	New latency timer in milliseconds.

Returns

	== 0	The new latency timer has been set.
	-1	An error occurred or the serial converter was removed.

int **su_ FTDIGetLatencyTimer** (uint iID)

Summary Get the current latency timer.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver, to retrieve the current latency timer value.

Parameters iID Index of the serial converter device. Should be less than SU_FTDI232

Returns
> 0 The current latency timer.
-1 An error occurred or the serial converter was removed.

4.4.4 Serial Converter Prolific 2303HXD

4.4.4.1 API

The application level interface is defined in **upl2303.h**. This interface includes:

int	**su_PL2303Open**(uint iID)
int	**su_PL2303Close** (uint iID)
BOOLEAN	**su_PL2303Inserted** (uint iID)
int	**su_PL2303ReadData** (uint iID, u8 * pData, int len)
int	**su_PL2303WriteData** (uint iID, u8 * pData, int len)
int	**su_PL2303SetModemCtrl**(uint iID, uint Data)
int	**su_PL2303SetFlowCtrl**(uint iID, uint Data)
int	**su_PL2303SetLineCoding**(uint iID, u32 dwDTERate, u16 wbParityType, u16 wDataBits, u16 wStopBits);
int	**su_PL2303LineStateChangeNotify**(PHOSTPL2303FUNC handler)

int **su_PL2303Open** (uint iID)

Summary Open the Prolific 2303 serial converter port.

Details This function must be called **after** the Prolific serial converter has been connected to the USB and configured by the device driver and **before** any PL2303Read/ PL2303Write functions. It sets the line coding information such as baud rate and number of data bits. It also sets the RTS and DTR signals of the serial port. The default flow control setting is to none. The default baud rate is 115200. The default line coding is 8 data bits, none parity and 1 stop bit.

Parameters iID Index of the serial device. Should be less than SU_PL2303.

Returns
== 0 The device has been opened and the line coding and line state have also been set up.
< 0 An error occurred

int **su_PL2303Close** (uint iID)

Summary Close the Prolific 2303 serial converter port.

Details This function must be called **after** finishing any PL2303Read/PL2303Write function calls. It clears the DSR and DTR signals of the serial converter port.

Parameters

iID	Index of the serial device. Should be less than SU_PL2303.

Returns

== 0	The device has been closed.
< 0	An error occurred.

BOOLEAN **su_PL2303Inserted** (uint iID)

Summary Returns status indicating if a Prolific 2303 serial converter device has been connected.

Details This function can be called at any time to determine if a supported serial converter device has been connected to the USB.

Parameters

iID	Index of the serial converter device. Should be less than SU_PL2303.

Returns

TRUE	A supported Prolific serial converter device has been connected to the USB and initialized by the device driver.
FALSE	No Prolific serial converter device has been connected.

int **su_PL2303ReadData** (uint iID, u8 * pData, uint len, uint timeout)

Summary Reads data from the serial converter device.

Details This function tries to read some data from the serial port. If there is no data within timeout, this function returns 0.

Parameters

iID	Index of the serial converter device. Should be less than SU_PL2303.
pData	Pointer to the data buffer.
len	Length of the data buffer.
timeout	Timeout period (in milliseconds) of the read operation.

Returns

> 0	Length of the data read from the serial converter device.
= 0	An error occurred or there is no data.

int **su_PL2303WriteData** (uint iID, u8 * pData, uint len)

Summary	Sends data to the serial converter device.	
Details	This function can be called once a serial converter device has been connected to the USB and configured by the device driver. It tries to write some data to the serial converter device.	
Parameters	iID	Index of the serial converter device. Should be less than SU_PL2303
	pData	Pointer to the data buffer.
	len	Length of the data buffer.
Returns	> 0	Length of the data written to the serial converter device.
	= 0	An error occurred.

int **su_PL2303SetModemCtrl** (uint iID, uint Data)

Summary	Set the DTR and RTS signal.	
Details	This function can be called once a serial converter device has been connected to the USB and configured by the device driver and after calling su_PL2303Open(). su_PL2303Open() sets DTR and RTS high, by default. Call this function to override the defaults.	
Parameters	iID	Index of the serial converter device. Should be less than SU_PL2303
	Data	DTR and RTS settings. SU_PL2303_LINE_OUT_DTR will set only DTR to high and SU_PL2303_LINE_OUT_RTS will set only RTS to high. You can also OR those two macros together to setting both DTR and RTS to high.
Returns	== 0	DTR and RTS has been set.
	-1	An error occurred.

int **su_PL2303SetFlowCtrl** (uint iID, uint Data)

Summary Set the Flow Control of the Prolific serial converter.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver and after calling su_PL2303Open(). su_ProlificOpen() sets the default Flow Control to none. Call this function to override the default.

Parameters

iID	Index of the serial converter device. Should be less than SU_PL2303
Data	Flow Control settings. Valid settings include: SU_PL2303_FLOWCTRL_NONE SU_PL2303_FLOWCTRL_RTSCTS

Returns

== 0	Flow Control has been set.
-1	An error occurred.

int **su_ PL2303SetLineCoding** (uint iID, u32 dwDTERate, u16 wParityType, u16 wDataBits, u16 wStopBits)

Summary Set the Baudrate, Parity type, Data bits and Stop bits of the Prolific serial converter.

Details This function can be called once a serial converter device has been connected to the USB and configured by the device driver and after calling su_PL2303Open(). su_PL2303Open() sets default line coding values. Call this function to override the defaults.

Parameters

iID	Index of the serial converter device. Should be less than SU_PL2303
dwDTERate	Baud rate. Valid settings include: 115200, 57600, 38400, 19200, 9600, 4800, 2400 and 1200
wParityType	Parity type of the serial converter, valid settings include: SU_PL2303_PARITY_NONE SU_PL23032_PARITY_ODD SU_PL2303_PARITY_EVEN SU_PL2303_PARITY_MARK SU_PL2303_PARITY_SPACE
wDataBits	7 or 8 bits
wStopBits	Stop bits, valid settings include: SU_PL2303_STOP_BITS_1 SU_PL2303_STOP_BITS_1_5 SU_PL2303_STOP_BITS_2

Returns

== 0	Line coding has been set.
-1	An error occurred.

void **su_PL2303LineStateChangeNotify** (PHOSTPL2303FUNC handler)

Summary Set the line state change notification callback function.

Details This function sets up the callback function when the line status is changed. The callback function is defined as:

typedef void (* PHOSTPL2303FUNC)(uint iID, u16 wNewLineState);

This callback function will be called when any of the following line states is changed:

SU_PL2303_LINE_IN_DCD
SU_PL2303_LINE_IN_DSR
SU_PL2303_LINE_IN_BRK
SU_PL2303_LINE_IN_RI
SU_PL2303_LINE_IN_FRAMING
SU_PL2303_LINE_IN_PARITY
SU_PL2303_LINE_IN_OVERRUN
SU_PL2303_LINE_IN_CTS

For example, if the remote side opened the serial port, a new line state is detected with the value 0x81 which means DCD and CTS are high. After the remote side closes the serial port connection, a new line state 0x0 is detected.

Parameters handler Callback function pointer.

Returns None.

4.4.5 USB to Ethernet Adapter

This driver is not the CDC/ECM class driver. You may need to add a special USB to Ethernet chipset driver if that chipset is not supported by smxUSBH yet.

4.4.5.1 API

The application level interface is defined in **unet.h**. This interface includes:

```
BOOLEAN   su_NetInserted(uint iID);
int       su_NetOpen(uint iID);
int       su_NetClose(uint iID);

int       su_NetWriteData(uint iID, u8 *pData, int len);
int       su_NetGetNodeID(int port, u8 *pData);
void      su_NetRegisterPortNotify(int port, PNETFUNC handler);
```

BOOLEAN **su_NetInserted** (uint iID)

Summary Returns status indicating if a USB to Ethernet device has been connected.

Details This function can be called at any time to determine if a supported USB to Ethernet device has been connected to the USB.

Parameters iID Index of the serial device. Should be less than SU_NET.

Returns

TRUE	A supported USB to Ethernet device has been connected to the USB and initialized by the device driver.
FALSE	No USB to Ethernet device has been connected.

int **su_NetOpen** (uint iID)

Summary Open a USB to Ethernet device for further use.

Details This function must be called **after** the USB to Ethernet adapter has been connected to the USB and configured by the device driver and **before** any NetWrite functions. It will initialize the adapter and create a separate task to receive the incoming data packets sent to this adapter.

Parameters iID Index of the serial device. Should be less than SU_NET.

Returns

0	This USB to Ethernet device has been opened successfully.
< 0	An error occurred when trying to open this device.

int **su_NetClose** (uint iID)

Summary	Close the opened USB to Ethernet device.	
Details	This function must be called **after** the USB to Ethernet adapter has been removed from the USB host do not call any NetWrite functions after this function call.	
Parameters	iID	Index of the serial device. Should be less than SU_NET.
Returns	0	This USB to Ethernet device has been closed successfully.
	< 0	An error occurred when try to close this device.

int **su_NetWriteData** (uint iID, u8 *pData, int len)

Summary	Send Ethernet packet data to the USB to Ethernet device.	
Details	This function must be called **after su_NetOpen**().	
Parameters	iID	Index of the serial device. Should be less than SU_NET.
	pData	Ethernet packet data buffer pointer for sending.
	len	Length of the Ethernet data buffer.
Returns	0	The data has been successfully sent.
	< 0	An error occurred when sending data.

int **su_NetGetNodeID** (uint iID, u8 *pMACAddr)

Summary	Get the Node ID (MAC address) of this USB over Ethernet adapter.	
Details	Call this function to get the MAC address of this adapter.	
Parameters	iID	Index of the serial device. Should be less than SU_NET.
	pMACAddr	The byte array of the Ethernet address. The size of this buffer should be at least 6 bytes.
Returns	0	Got the address successfully.
	< 0	An error occurred when getting the address.

void **su_NetRegisterPortNotify** (uint iID, PNETFUNC handler)

Summary	Register the callback function for receiving Ethernet packet data.	
Details	The callback function is called when the driver receives an Ethernet data packet. The received data should be passed onward to the TCP/IP stack.	
Parameters	iID	Index of the serial device. Should be less than SU_NET.
	handler	The callback function pointer.
Returns	None.	

4.4.5.2 Supporting Other USB to Ethernet Chips

Different USB to Ethernet chip vendors may use different vendor-specific requests to set up their chip. They may use different USB headers to wrap Ethernet data packets, so the smxUSBH USB to Ethernet driver provides an easy way to support other chips if needed. It is only necessary to implement a Net Chip Operation interface and add it to the USB to Ethernet framework. That interface is defined in unetchip.h.

```
typedef struct
{
   int (*Init) (void);
   int (*Release) (void);
   int (*AddPacketHeader) (SU_DRV_DEVICEINFO_T *pDevice,
                                        SU_DRV_INQUIRY_INFO_T *pInquiryInfo, u8 *pData, uint len);
   int (*GetOnePacket) (SU_DRV_DEVICEINFO_T *pDevice,
                                        SU_DRV_INQUIRY_INFO_T *pInquiryInfo, u8 *pData, uint len);
   int (*GetEthernetID) (u8 *pMACAddr);
   SU_DRV_CHECKDEVICEINFO_T * (*GetCheckDeviceID) (uint *piSize);
} SU_NET_CHIP_OPER_T;
```

Init() is called when opening this device for data transfer. Some vendor-specific requests for the device may be needed to set internal registers of the adapter or start the adapter.

Release() is called when data transfer is finished.

AddPacketHeader() is called when sending an Ethernet packet to the USB adapter. Some additional header may be needed to generate a USB packet.

GetOnePacket() is called when the stack gets some data from this adapter. Analysis of the header of the USB packet may be required and additional send requests may be needed to receive the remaining data.

GetEthernetID() is called by the stack to retrieve the Ethernet address of this adapter. This may require a vendor specific request.

GetCheckDeviceID() is called by the stack to get the Check Device information. This information is used by the stack to match the device through the Vendor ID and Product ID. Adapters from different vendors may use the same chip, so more entries can be added to this array to support them.

4.4.6 WCESerial (Windows Mobile 5 Device, non-CDC/ACM)

4.4.6.1 API

The application level interface is defined in **uwceser.h**. This interface includes:

```
int        su_WCESerialOpen (uint iID)
int        su_WCESerialClose (uint iID)
BOOLEAN    su_WCESerialInserted (uint iID)
int        su_WCESerialRead (uint iID, u8 * pData, int len)
int        su_WCESerialWrite (uint iID, u8 * pData, int len)
```

int **su_WCESerialOpen** (uint iID)

Summary Open the serial port.

Details This function must be called **after** the USB serial device has been connected to the USB and configured by the device driver and **before** any SerialRead/SerialWrite functions. It sets the line coding information such as baud rate and number of data bits. It also sets the DCD and DTR signals of the serial port.

Parameters iID Index of the serial device. Should be less than SU_WCESERIAL.

Returns

- == 0 The device has been opened and the line coding and line state have also been set up.
- < 0 An error occurred.

int **su_WCESerialClose** (uint iID)

Summary Close the serial port.

Details This function must be called **after** finishing SerialRead/SerialWrite function calls. It clears the DCD and DTR signals of the serial port.

Parameters iID Index of the serial device. Should be less than SU_WCESERIAL.

Returns

- == 0 The device has been closed.
- < 0 An error occurred.

BOOLEAN **su_WCESerialInserted** (uint iID)

Summary	Returns status indicating if this serial device has been connected.	
Details	This function can be called at any time to determine if a supported serial device has been connected to the USB.	
Parameters	iID	Index of the serial device. Should be less than SU_WCESERIAL.
Returns	TRUE	A supported USB serial device has been connected to the USB and initialized by the device driver.
	FALSE	No USB serial device has been connected.

int **su_WCESerialRead** (uint iID, u8 * pData, int len)

Summary	Reads data from the serial device.	
Details	This function tries to read some data from the serial port. If there is no data within 1 second, this function returns 0.	
Parameters	iID	Index of the serial device. Should be less than SU_WCESERIAL.
	pData	Pointer to the data buffer.
	len	Length of the data buffer.
Returns	> 0	Length of the data read from the serial device.
	= 0	An error occurred or there is no data.

int **su_WCESerialWrite** (uint iID, u8 * pData, int len)

Summary	Sends data to the serial device.	
Details	This function can be called once a serial device has been connected to the USB and configured by the device driver. It tries to write some data to the serial device.	
Parameters	iID	Index of the serial device. Should be less than SU_WCESERIAL
	pData	Pointer to the data buffer.
	len	Length of the data buffer.
Returns	> 0	Length of the data written to the serial device.
	= 0	An error occurred.

4.4.7 Sierra Wireless Dongle

4.4.7.1 API

The application level interface is defined in **usierra.h**. This interface includes:

int	**su_SierraOpen** (uint iID)
int	**su_SierraClose** (uint iID)
BOOLEAN	**su_SierraInserted** (uint iID)
int	**su_SierraRead** (uint iID, uint iPort, u8 * pData, int len, int timeout)
int	**su_SierraWrite** (uint iID, uint iPort, u8 * pData, int len, int timeout)
void	**su_SierraLineStateChangeNotify** (SU_PSIERRAFUNC handler);

int **su_SierraOpen** (uint iID)

Summary Open the Sierra Wireless port.

Details This function must be called **after** the USB Sierra Wireless device has been connected to the USB and configured by the device driver and **before** any SerialRead/SerialWrite functions. It sets the DCD and DTR signals of the device.

Parameters iID Index of the device. Should be less than SU_SIERRA.

Returns

== 0	The device has been opened and DCD and DT have also been set up.
< 0	An error occurred.

int **su_SierraClose** (uint iID)

Summary Close the Sierra Wireless port.

Details This function must be called **after** finishing SierraRead/SierraWrite function calls. It clears the DCD and DTR signals of the Sierra Wireless port.

Parameters iID Index of the device. Should be less than SU_SIERRA.

Returns

== 0	The device has been closed.
< 0	An error occurred.

BOOLEAN **su_SierraInserted** (uint iID)

Summary Returns status indicating if the Sierra Wireless device has been connected.

Details This function can be called at any time to determine if a supported Sierra Wireless device has been connected to the USB.

Parameters

iID	Index of the device. Should be less than SU_SIERRA.

Returns

TRUE	A supported USB Sierra Wireless device has been connected to the USB and initialized by the device driver.
FALSE	No USB Sierra Wireless device has been connected.

int **su_SierraRead** (uint iID, uint iPort, u8 * pData, int len, int timeout)

Summary Reads data from the Sierra device port.

Details This function tries to read some data from the Sierra Wireless port. If there is no data within timeout milliseconds, this function returns 0. A Sierra Wireless dongle may have one or multiple ports. Port 0 may be used for data transfer and other ports may be used as control channels.

Parameters

iID	Index of the device. Should be less than SU_SIERRA.
iPort	Index of the port.
pData	Pointer to the data buffer.
len	Length of the data buffer.
timeout	Timeout for the operation, in milliseconds.

Returns

> 0	Length of the data read from the port.
= 0	An error occurred or there is no data.

int **su_SierraWrite** (uint iID, uint iPort, u8 * pData, int len, int timeout)

Summary Sends data to the Sierra device port.

Details This function can be called once a Sierra Wireless device has been connected to the USB and configured by the device driver. It tries to write some data to the device. A Sierra Wireless dongle may have one or multiple ports. Port 0 may be used for data transfer and other ports may be used as control channels.

Parameters

iID	Index of the device. Should be less than SU_SIERRA.
iPort	Index of the port.

	pData	Pointer to the data buffer.
	len	Length of the data buffer.
	timeout	Timeout for the operation, in milliseconds.

Returns > 0 Length of the data written to the serial device.
= 0 An error occurred.

void **su_SierraLineStateChangeNotify** (SU_PSIERRAFUNC handler)

Summary Register a callback notification function for device line state changes.

Details This function can be called any time the smxUSBH has started.
The callback function is defined as:
typedef void (*SU_PSIERRAFUNC)(uint iID, u16 wNewLineState);
Valid values for wNewLineState includes:
SU_SIERRA_LINE_IN_DCD
SU_SIERRA_LINE_IN_DSR
SU_SIERRA_LINE_IN_BRK
SU_SIERRA_LINE_IN_RI
SU_SIERRA_LINE_IN_FRAMING
SU_SIERRA_LINE_IN_PARITY
SU_SIERRA_LINE_IN_OVERRUN

Parameters iID Index of the device. Should be less than SU_SIERRA.
wNewLineState Value for the new line state.

Returns None

4.4.8 Huawei K4510 3G Wireless Dongle

4.4.8.1 API

The application level interface is defined in **uk4510.h**. This interface includes:

int	**su_K4510Open** (uint iID)
int	**su_K4510Close** (uint iID)
BOOLEAN	**su_K4510Inserted** (uint iID)
BOOLEAN	**su_K4510Connected** (uint iID)
int	**su_K4510CheckNetworkState** (uint iID)
BOOLEAN	**su_K4510GetNetworkName** (uint iID, char *pName)
int	**su_K4510Read** (uint iID, u8 * pData, int len, int timeout)
int	**su_K4510Write** (uint iID, u8 * pData, int len, int timeout)

int **su_K4510Open** (uint iID)

Summary	Open the Huawei K4510 3G Wireless port.	
Details	This function must be called **after** the USB Huawei 3G Wireless device has been connected to the USB and configured by the device driver.	
Parameters	iID	Index of the device. Should be less than SU_K4510.
Returns	== 0	The device has been opened.
	< 0	An error occurred.

int **su_K4510Close** (uint iID)

Summary	Close the Huawei K4510 3G Wireless port.	
Details	This function must be called **after** finishing Huawei K4510 3G wireless communication function.	
Parameters	iID	Index of the device. Should be less than SU_K4510.
Returns	== 0	The device has been closed.
	< 0	An error occurred.

BOOLEAN **su_K4510Inserted** (uint iID)

Summary	Returns status indicating if the Huawei 3G Wireless device has been inserted to the USB port.	
Details	This function can be called at any time to determine if a supported Huawei K4510 3G Wireless device is present on the USB port.	
Parameters	iID	Index of the device. Should be less than SU_K4510.
Returns	TRUE	A supported Huawei K4510 3G Wireless device has been inserted to the USB and initialized by the device driver.
	FALSE	No USB Huawei K4510 3G Wireless device has been inserted.

int **su_K4510CheckNetworkState** (uint iID)

Summary Check the Huawei 3G Wireless dongle network register state.

Details Keep calling this function to check the network register state of the Huawei K4510 3G wireless dongle. This dongle internally automatic search the available 3G network and try to register to it. It may take more than one minute for the dongle to register to a network. A roaming network may need more time.

Parameters iID Index of the device. Should be less than SU_K4510.

Returns One of the following states:

SU_K4510_NS_REG_NOT
The dongle has not registered to a network yet

SU_K4510_NS_REG_LOCAL
The dongle has registered to a local newwork.

SU_K4510_NS_SEARCHING
The dongle is searching the network.

SU_K4510_NS_REG_REJECTED
The dongle's attampt to register to a network has been rejected.

SU_K4510_NS_REG_UNKNOWN
The network state is unknown

SU_K4510_NS_REG_ROAMING
The dongle has registered to a roaming network.

BOOLEAN **su_K4510Connected** (uint iID)

Summary Returns status indicating if the Huawei 3G Wireless device has connected to a carrier's network.

Details This function can be called at any time to determine if a supported Huawei K4510 3G Wireless device has connected to a carrier's network.

Parameters iID Index of the device. Should be less than SU_K4510.

Returns

TRUE The Huawei K4510 3G Wireless device has connected to a carrier's network. su_K4510CheckNetworkState() should return SU_K4510_NS_REG_LOCAL or SU_K4510_NS_REG_ROAMING.

FALSE The USB Huawei K4510 3G Wireless device has not been inserted or it is still trying to find and connect to a carrier's network.

BOOLEAN **su_K4510GetNetworkName** (uint iD, char *pName)

Summary Return to the carrier's network name.

Details After **su_K4510Connected()** returns TRUE, you can call this function return the name of the carrier's network, such as "AT&T".

Parameters

iID	Index of the device. Should be less than SU_K4510.
pName	Pointer to the buffer for the network name.

Returns

TRUE	Got the network name.
FALSE	An error occurred.

int **su_K4510Read** (uint iID, u8 * pData, int len, int timeout)

Summary Reads data from the Huawei K4510 3G wireless device port.

Details This function tries to read some data from the Huawei K4510 3G Wireless dongle. Only call this function after su_K4510CheckNetworkState() returns SU_K4510_NS_REG_LOCAL or SU_K4510_NS_REG_ROAMING. If there is no data within timeout milliseconds, this function returns 0.

Parameters

iID	Index of the device. Should be less than SU_K4510.
pData	Pointer to the data buffer.
len	Length of the data buffer.
timeout	Timeout for the operation, in milliseconds.

Returns

> 0	Length of the data read from the port.
= 0	An error occurred or there is no data.

int **su_K4510Write** (uint iID, u8 * pData, int len, int timeout)

Summary Sends data to the Huawei K4510 3G wireless device port.

Details Only call this function after su_K4510CheckNetworkState() returns SU_K4510_NS_REG_LOCAL or SU_K4510_NS_REG_ROAMING. It tries to send some data to the device.

Parameters

iID	Index of the device. Should be less than SU_K4510.
pData	Pointer to the data buffer.
len	Length of the data buffer.
timeout	Timeout for the operation, in milliseconds.

Returns	> 0	Length of the data written to the wireless device.
	= 0	An error occurred.

4.5 Human Interface (HID)

smxUSBH not only supports the general HID class, but also includes simplified keyboard and mouse drivers.

4.5.1 Keyboard

4.5.1.1 API

The application level interface is defined in **ukbd.h**. This interface includes:

```
BOOLEAN   su_KbdInserted(void)
void      su_KbdSetCallback(PKBDFUNC handler)


typedef void (* PKBDFUNC)(unsigned long key);
```

This is a callback function that is called by the keyboard device driver. This function is called when any key event occurs, such as when a key is pressed or released. The application should implement this function to process the key scan code information that is passed as appropriate for the application.

BOOLEAN **su_KbdInserted** (void)

Summary Returns status indicating if a USB keyboard has been connected.

Details You can call this function at any time to find out if a supported keyboard has been connected to the USB.

Parameters none

Returns	TRUE	A supported USB keyboard has been connected to the USB and initialized by the device driver.
	FALSE	No USB keyboard is connected.

void **su_KbdSetCallback** (PKBDFUNC handler)

Summary Registers a keyboard event callback handler with the device driver.

Details This function can be called at any time. This function is called for any key event, once a keyboard is connected to the USB and the device is configured by the device driver.

Parameters handler Callback function pointer.

Returns none

4.5.2 Mouse

4.5.2.1 API

The application level interface is defined in **umouse.h**. This interface includes:

```
BOOLEAN   su_MouseInserted(void)
void      su_MouseSetCallback(PMOUSEFUNC handler)


typedef void (* PMOUSEFUNC)(SU_MOUSE_MSG * mouseMsg);
```

This is a callback function. It is called when any mouse event occurs, such as when the right mouse button is pressed. The application should implement this callback function and pass the mouse event to the part of the application requiring mouse events. A mouse event is defined as one of the following:

```
typedef struct
{
   u8 button;
   s8 x;
   s8 y;
   s8 wheel;
} SU_MOUSE_MSG;
```

1. *button* is a bitmap encoding the button state. When a bit is set to '1', it indicates that the corresponding button is pressed. The following button definitions are supported:

   - SU_MOUSE_BTN_LEFT
   - SU_MOUSE_BTN_RIGHT
   - SU_MOUSE_BTN_MIDDLE
   - SU_MOUSE_BTN_SIDE
   - SU_MOUSE_BTN_EXTRA

2. *x* indicates movement along the x-axis, using a right-handed coordinate system. If the user is facing the USB mouse, then the reported values should increase as the mouse is moved from left to right

3. y indicates movement along the y-axis, using a right-handed coordinate system. If the user is facing the USB mouse, then the reported values should increase as the mouse is dragged nearer to the user.
4. *wheel* indicates the direction of mouse wheel rotation. 1 indicates that the wheel is rolling up, and –1 indicates that the wheel is rolling down.

BOOLEAN **su_MouseInserted** (void)

Summary	Returns status indicating if a USB mouse has been connected.	
Details	Call this function at any time to find out if a supported mouse has been connected to the USB.	
Parameters	none	
Returns	TRUE	A supported USB mouse has been connected to the USB and initialized by the device driver.
	FALSE	No USB mouse is connected.

void **su_MouseSetCallback** (PMOUSEFUNC handler)

Summary	Registers a mouse event callback handler with the device driver.	
Details	This function can be called at any time. Once the USB mouse is connected and the device is configured by the device driver, this function will be called whenever a mouse event occurs.	
Parameters	handler	Callback function pointer.
Returns	none	

4.5.3 Generic HID

4.5.3.1 API

The application level interface is defined in **uhid.h**. This interface includes:

BOOLEAN	**su_HIDInserted**(void)
void	**su_HIDSetCallback**(PHIDFUNC handler)

```
typedef void (* PHIDFUNC)(SU_HID_FIELD_INFO *pFieldInfo, SU_HID_USAGE_INFO *pUsageInfo,
                                                                              s32 data);
```

Callback function type, which is called when any HID event occurs, for example a right mouse button press. The application should implement this callback function and pass the HID event to the part of the application requiring HID events. An HID Usage Information structure is defined as:

```
typedef struct
{
   uint  hid;
   u16   code;
   u8    type;
}SU_HID_USAGE_INFO;
```

hid is the internal HID ID for this event

code indicates which HID usage issued this event, for example, mouse left key or joystick trigger button. For the complete usage codes, check the macros defined in uhid.h

type is the type of this HID event. Valid types include:

SU_HID_TYPE_RST
SU_HID_TYPE_KEY
SU_HID_TYPE_REL
SU_HID_TYPE_ABS
SU_HID_TYPE_MSC
SU_HID_TYPE_LED
SU_HID_TYPE_SOUND
SU_HID_TYPE_MAX

An HID Field Information structure is defined as:

```
typedef struct
{
   uint  physical;
   uint  logical;
   uint  application;
   uint  flags;
   s32   logicalMin;
   s32   logicalMax;
   s32   physicalMin;
   s32   physicalMax;
   uint  unitExponent;
   uint  unit;
}SU_HID_FIELD_INFO;
```

This structure is used to provide additional information of the event data, such as minimum and maximum values of the data.

BOOLEAN **su_HIDInserted** (void)

Summary Returns status indicating if a USB HID has been connected.

Details You can call this function at any time to find out if an HID has been connected to the USB.

Parameters none

Returns

TRUE	A supported USB HID has been connected to the USB and initialized by the device driver.
FALSE	No USB HID is connected.

void **su_HIDSetCallback** (PHIDFUNC handler)

Summary Registers an HID event callback handler with the device driver.

Details This function can be called at any time. Once the USB HID is connected and the device is configured by the device driver, this function is called whenever an HID event occurs.

Parameters handler Callback function pointer.

Returns none

4.6 Mass Storage

4.6.1 API

The application level interface is defined in **umsintf.h**. This interface includes:

int	**su_MStorIO**(uint iID, uint iLUN, u8* pRAMAddr, u32 nStartSector, u16 nSectors, BOOLEAN Reading)
BOOLEAN	**su_MStorMediaInserted**(uint iID, uint iLUN)
BOOLEAN	**su_MStorMediaRemoved**(uint iID, uint iLUN)
u32	**su_MStorSectorNum**(uint iID, uint iLUN)
u32	**su_MStorSectorSize**(uint iID, uint iLUN)
BOOLEAN	**su_MStorMediaChanged**(uint iID, uint iLUN, int nClearStatus);
BOOLEAN	**su_MStorMediaProtected**(uint iID, uint iLUN);
BOOLEAN	**su_MStorTestReady**(uint iID, uint iLUN);
int	**su_MStorMaxLUN(uint iID);**

int **su_MStorIO** (uint iID, uint iLUN, u8* pRAMAddr, u32 nStartSector, u16 nSectors, BOOLEAN Reading)

Summary Write or read data to/from the USB Mass Storage Device.

Details Call this function any time after su_Initialize() has been called. If a USB Mass Storage Class device is not connected, this function will return an error. This function will not return until the data transfer has completed.

Parameters

iID	Index of the mass storage device, from 0 to SU_MSTOR-1.
iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.
pRAMAddr	Pointer to the transfer data buffer in RAM.
nStartSector	The initial sector that will be transferred.
nSectors	Number of Sectors to transfer to or from the Mass Storage Device.
Reading	TRUE for a read operation, FALSE for write.

Returns

SU_STORAGE_E_OK	The data transfer completed OK.
SU_MS_E_PROTECTED	Attempted write to a write protected USB drive.

Otherwise an error occurred during the transfer.

See Also su_MStorSectorSize()

BOOLEAN **su_MStorMediaInserted** (uint iID, uint iLUN)

Summary Determine if a USB drive is inserted and correctly configured by the Mass Storage Device driver.

Details This function can be called any time after su_Initialize() has been called. It checks if a recognized USB Mass Storage Device has been connected and all the necessary parameters have been retrieved.

Parameters

iID	Index of the mass storage device. Should be less than SU_MSTOR-1.
iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.

Returns

TRUE	A USB Mass Storage Device has been recognized.
FALSE	No Mass Storage device is connected or the device driver does not support this device.

See Also su_MStorMediaRemoved()

BOOLEAN **su_MStorMediaRemoved** (uint iID, uint iLUN)

Summary	Determine if a connected USB drive has been removed.	
Details	This function can be called any time after su_Initialize() has been called.	
Parameters	iID	Index of the mass storage device. Should be less than SU_MSTOR-1.
	iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.
Returns	TRUE	A USB Mass Storage Device has been removed.
	FALSE	A recognized Mass Storage device is connected.
See Also	su_MStorMediaInserted()	

u32 **su_MStorSectorNum** (uint iID, uint iLUN)

Summary	Gets the total size (in sectors) for the USB Mass Storage device.	
Details	This function can be called at any time after su_Initialize() has been called. This function will return the total size of the Mass Storage device, in sectors. If no Mass Storage device is connected, this function returns 0.	
Parameters	iID	Index of the mass storage device. Should be less than SU_MSTOR-1.
	iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.
Returns	0	No Mass Storage device is connected.
	Otherwise returns the total size in blocks.	

u32 **su_MStorSectorSize** (uint iID, uint iLUN)

Summary	Gets the sector size (in bytes) for the USB Mass Storage device.	
Details	This function can be called at any time after su_Initialize() has been called. This function will return the sector size for the Mass Storage device. If no Mass Storage device is connected, this function returns 0.	
Parameters	iID	Index of the mass storage device. Should be less than SU_MSTOR-1.
	iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.

Returns	0	No Mass Storage device is connected.
	Otherwise returns the sector size in bytes, for example 512.	

BOOLEAN **su_MStorMediaChanged** (uint iID, uint iLUN, int nClearStatus)

Summary Determine if the USB drive has been changed.

Details This function can be called at any time after su_Initialize() has been called. Normally file system will call this function to determine if it need to remount (unmount and then mount) the disk volume, This function does not detect if the reinserted device is the same one as the just removed one.

Parameters	iID	Index of the mass storage device. Should be less than SU_MSTOR-1.
	iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.
	nClearStatus	If smxUSBH should clear the internal status after this function returns.

Returns TRUE if Mass Storage device has been changed.
FALSE the Mass Storage device did not change.

BOOLEAN **su_MStorMediaProtected**(uint iID, uint iLUN)

Summary Determine if the connected USB drive is write protected.

Details Call this function any time after su_MStorMediaInserted() has returned 1.

Parameters	iID	Index of the mass storage device. Should be less than SU_MSTOR-1.
	iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.

Returns	TRUE	The Mass Storage device is write protected.
	FALSE	The Mass Storage device is NOT write protected.

BOOLEAN **su_MStorTestReady**(uint iID, uint iLUN)

Summary Check if the media in this device is ready to be used.

Details This function sends the SCSI Test Unit Ready command to the device. You can use it to check if the media of this device is ready to be used. Some flash disks also use

this command to flush internal buffers. Windows uses this command to poll the status of removable disks, such as an SD card reader.

Parameters	iID	Index of the mass storage device. Should be less than SU_MSTOR-1.
	iLUN	The logical unit number of this mass storage device. Use 0 for this parameter if it does not support multiple LUNs.
Returns	TRUE	The Mass Storage device is ready to be used, or this command is not supported.
	FALSE	The Mass Storage device has no media in it.

int **su_MStorMaxLUN**(uint iID)

Summary Get the maximum LUN of the USB device.

Details Call this function to get the maximum logical unit number supported by this USB device. Most USB flash disks only support one LUN, but some card readers support many LUNs requiring a non-zero iLUN parameter to be used by other API calls.

Parameters iID Index of the mass storage device. Should be less than SU_MSTOR-1.

Returns > 0 The total LUN number this device supports.
= 0 if the device is not connected to the USB.

4.6.2 Support for USB CD-ROM and Floppy

For USB CD-ROM or floppy support, set SU_MSTOR_FULL_SUPPORT to 1. This configuration parameter defaults to 0, in which case only Bulk Only Transport protocol and Reduced Block Command (RBC) set are supported. Almost all flash disk devices (thumb drives) use that protocol. One known exception is the Prolific pl2518 chipset. It uses the SFI8070i protocol.

4.7 Printer

4.7.1 API

The application level interface is defined in **uprinter.h**. This interface includes:

int	**su_PrnID** (uint iID, u8 * pData, int len)
BOOLEAN	**su_PrnInserted** (uint iID)
int	**su_PrnRead** (uint iID, u8 * pData, int len)
int	**su_PrnReset** (uint iID)
u8	**su_PrnStatus** (uint iID)
int	**su_PrnWrite** (uint iID, u8 * pData, int len)

int **su_PrnID** (uint iID, u8 * pData, int len)

Summary Returns the DeviceID string.

Details This function can be called once a printer has been connected to the USB and configured by the device driver. It returns the DeviceID string compatible with the IEEE 1284.4 bi-directional interface. For syntax and formatting information, see the IEEE 1284.4 specification.

Parameters

iID	Index of the printer device. Should be less than SU_PRINTER-1.
pData	Pointer to the data buffer.
len	Length of the data buffer.

Returns

> 0	Length of the data read from the printer.
< 0	An error occurred.

BOOLEAN **su_PrnInserted** (uint iID)

Summary Returns status indicating if a USB printer has been connected

Details This function can be called at any time to determine if a supported printer has been connected to the USB.

Parameters

iID	Index of the printer device. Should be less than SU_PRINTER-1.

Returns

TRUE	A supported USB printer has been connected to the USB and initialized by the device driver.
FALSE	No USB printer has been connected.

int **su_PrnRead** (uint iID, u8 * pData, int len)

Summary	Reads data from the printer.	
Details	This function can be called if the printer supports bi-directional mode.	
Parameters	iID	Index of the printer device. Should be less than SU_PRINTER-1.
	pData	Pointer to the data buffer.
	len	Length of the data buffer.
Returns	> 0	Length of the data read from the printer
	= 0	An error occurred.

int **su_PrnReset** (uint iID)

Summary	Resets the printer.	
Details	This function can be called once a printer has been connected to the USB and configured by the device driver.	
Parameters	iID	Index of the printer device. Should be less than SU_PRINTER-1.
Returns	0	The command has been sent to the printer successfully.
	< 0	An error occurred.

u8 **su_PrnStatus** (uint iID)

Summary	Returns the status of the USB printer.	
Details	This function returns the printer status. The following three bit flags are supported. SU_PRN_STATUS_PAPEREMPTY SU_PRN_STATUS_SELECTED SU_PRN_STATUS_NOERROR	
Parameters	iID	Index of the printer device. Should be less than SU_PRINTER-1.
Returns	Printer status	

int **su_PrnWrite** (uint iID, u8 * pData, int len)

Summary	Sends data to the printer.	
Details	This function can be called once a printer has been connected to the USB and configured by the device driver.	
Parameters	iID	Index of the printer device. Should be less than SU_PRINTER-1.
	pData	Pointer to the data buffer.
	len	Length of the data buffer.
Returns	> 0	The amount of data sent to the printer.
	= 0	An error occurred.

4.8 Video

The video class driver currently only supports video cameras. Output and transport operations are not supported. Limitations:

1. Video camera still image capture function methods 2 and 3 are currently not supported.
2. MPEG streaming video format is not currently supported.

4.8.1 API

The application level interface is defined in **uvideo.h**. This interface includes:

```
int  su_VideoCameraGetStillImageFormatNum(uint iID);
int  su_VideoCameraGetStillImageFormat(uint iID, uint iIndex,
                                       SU_VIDEO_STILL_IMAGE_FORMAT *pFormat);
int  su_VideoCameraGetCaptureFormatNum(uint iID);
int  su_VideoCameraGetCaptureFormat(uint iID, uint iIndex,
                                       SU_VIDEO_CAPTURE_FORMAT *pFormat);
int  su_VideoCameraGetCurrent(uint iID, SU_VIDEO_SETTINGS *pCurrent);
int  su_VideoCameraGetDefault(uint iID, SU_VIDEO_SETTINGS *pDefault);
int  su_VideoCameraGetMin(uint iID, SU_VIDEO_MIN_MAX *pMin);
int  su_VideoCameraGetMax(uint iID, SU_VIDEO_MIN_MAX *pMax);
int  su_VideoCameraGetInfo(uint iID, SU_VIDEO_INFO *pInfo);
int  su_VideoCameraSetCaptureFrame(uint iID, uint iFormat, u16 wWidth, u16 wHeight,
                                       u32 dwFrameInterval);
int  su_VideoCameraSetStillImageFormat(uint iID, uint iFormat, u16 wWidth, u16 wHeight);
int  su_VideoCameraSetCurrent(uint iID, SU_VIDEO_SETTINGS *pNewCurrent);
int  su_VideoCameraGetCaptureSize(uint iID, u32 *pMaxVideoFrameSize, u32 *pMaxPayloadBufferSize);

int  su_VideoCameraOpen(uint iID);
int  su_VideoCameraClose(uint iID);
int  su_VideoCameraCapture(uint iID, u8 *pData, uint iLen, BOOLEAN *pbIncludeNewFrame,
                                       uint *piNewFrameOffset);
BOOLEAN  su_VideoInserted(uint iID);
```

int **su_VideoCameraGetStillImageFormatNum** (uint iID)

Summary Returns video camera still image number of formats.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the total number of still image formats.

Parameters iID Index of the video device. Should be less than SU_VIDEO.

Returns

>= 0	Number of still image formats.
< 0	An error occurred.

int **su_VideoCameraGetStillImageFormat** (uint iID, uint iIndex, SU_VIDEO_STILL_IMAGE_FORMAT *pFormat)

Summary Returns video camera still image format detailed information.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the detailed video camera still image format information such as width, height and color primaries.

Parameters

iID Index of the format, should be less than the format number returned by su_VideoCameraGetStillImageFormatNum().

pFormat Pointer to the detailed format information.

SU_VIDEO_STILL_IMAGE_FORMAT is defined as:

```
typedef struct
{
   u16  wWidth[SU_VIDEO_MAX_STILL_IMAGE_PATTERN];
   u16  wHeight[SU_VIDEO_MAX_STILL_IMAGE_PATTERN];
   u8   bColorPrimaries;
   u8   bTransferCharacteristics;
   u8   bMatrixCoefficients;
   uint iPatternNum;
   uint iFormat;
}SU_VIDEO_STILL_IMAGE_FORMAT;
```

wWidth[] is the array of the width of the still image. Real array number is iPatternNum.

wHeight[] is the array of the height of the still image. Real array number is iPatternNum.

bColorPrimaries is the color primaries. For details see the USB Video Class Device spec.

bTransferCharacteristics is the transfer characteristics. For details see the USB Video Class Device spec.

bMatrixCoefficients is the matrix coefficients, for details check USB Video Class Device spec.
iPatternNum is the total pattern number (the array size of the wWidth[] and wHeight[]).
iFormat is the format of the still image. Is is one of the following:
SU_VIDEO_FORMAT_UNCOMPRESSED
SU_VIDEO_FORMAT_MJPEG

Returns	0	Gott the format information.
	< 0	An error occurred.

int **su_VideoCameraGetCaptureFormatNum** (uint iID)

Summary Returns video camera number of capture formats.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the total number of capture formats.

Parameters iID Index of the video device. Should be less than SU_VIDEO.

Returns	>= 0	Capture format number.
	< 0	An error occurred.

int **su_VideoCameraGetCaptureFormat** (uint iID, uint iIndex, SU_VIDEO_CAPTURE_FORMAT *pFormat)

Summary Returns video camera capture format detailed information.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the detailed video camera capture format information such as frame and bits per pixel.

Parameters iID Index of the format, should be less than the format number returned by su_VideoCameraGetCaptureFormatNum().

pFormat Pointer to the detailed format information.

SU_VIDEO_CAPTURE_FORMAT is defined as

```
typedef struct
{
   uint iFormat;
   uint iYUVFormat;
   u8   bBitsPerPixel;
   u8   bDefaultFrameIndex;
   SU_VIDEO_CAPTURE_FRAME Frame[SU_VIDEO_MAX_FRAME];
   uint  bNumFrame;
}SU_VIDEO_CAPTURE_FORMAT;
```

iFormat is the format of the still image. One of the following:
SU_VIDEO_FORMAT_UNCOMPRESSED
SU_VIDEO_FORMAT_MJPEG
SU_VIDEO_FORMAT_MPEG2TS

iYUVFormat is one of the following YUV format if iFormat is SU_VIDEO_FORMAT_UNCOMPRESSED:
SU_VIDEO_FORMAT_UNCOMPRESSED_UNKNOWN
SU_VIDEO_FORMAT_UNCOMPRESSED_YUV422
SU_VIDEO_FORMAT_UNCOMPRESSED_YUV420

bBitsPerPixel is the bit number of each pixel.

bDefaultFrameIndex is the default frame index if you don't call su_VideoCameraSetCaptureFrame() to change it.

Frame[] is the array of the support frame information for this format. The size of the array is bNumFrame. The frame information is defined as:

```
typedef struct
{
   u16  wWidth;
   u16  wHeight;
   u32  dwFrameInterval[SU_VIDEO_MAX_FRAME_INTERVAL];
   uint iNumFrameInterval;
}SU_VIDEO_CAPTURE_FRAME;
```

wWidth is the width of the video capture frame.

wHeight is the height of the video capture frame.

dwFrameInterval[] is the array of the frame internal. Units are 1/10 microsecond. For example, 333333 is 33.3333 millisecond which means 30 fps

iNumFrameInterval is the size of frame interval array.

bNumFrame is the size of frame array Frame[]

Returns 0 Got the format information.

< 0 An error occurred.

int **su_VideoCameraGetCurrent** (uint iID, SU_VIDEO_SETTINGS *pCurrent)

Summary Returns video camera current setting information.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the current setting information, which includes the camera controls, such as AutoExposureMode and Focus. It also includes processing unit controls, such as Brightness and Contrast.

Parameters

iID Index of the video device. Should be less than SU_VIDEO.

pCurrent Pointer to the current settings.
Video Camera settings are defined as:

```
typedef struct
{
   u8  bDevicePowerMode;
   /* Camera Control */
   u8  bScanningMode;
   u8  bAutoExposureMode;
   u8  bAutoExposurePriority;
   u32 dwExposureTimeAbsolute;
   u8  bExposureTimeRelative;
   u16 wFocusAbsolute;
   u8  bFocusRelative;
   u8  bFocusRelativeSpeed;
   u8  bFocusAuto;
   u16 wIrisAbsolute;
   u8  bIrisRelative;
   u16 wObjectiveFocalLength;
   s8  bZoom;
   u8  bDigitalZoom;
   u8  bZoomSpeed;
   s32 dwPanAbsolute;
   s32 dwTiltAbsolute;
   s8  bPanRelative;
   u8  bPanSpeed;
   s8  bTiltRelative;
   u8  bTiltSpeed;
   u16 wRollAbsolute;
   u8  bRollRelative;
   u8  bRollRelativeSpeed;
   u8  bPrivacy;
   /* Select Unit Control */
   u8 bSelector;
   /* Processing Unit Control */
   u16 wBacklightCompensation;
   s16 wBrightness;
```

```
    u16 wContrast;
    u16 wGain;
    u8  bPowerLineFrequency;
    s16 wHue;
    u8  bHueAuto;
    u16 wSaturation;
    u16 wSharpness;
    u16 wGamma;
    u16 wWhiteBalanceTemperature;
    u8  bWhiteBalanceTemperatureAuto;
    u16 wWhiteBalanceBlue;
    u16 wWhiteBalanceRed;
    u8  bWhiteBalanceComponentAuto;
    u16 wMultiplierStep;
    u16 wMultiplierLimit;
    u8  bVideoStandard;
    u8  bAnalogVideoLockStatus;
    u16 wSyncDelay;
}SU_VIDEO_SETTINGS;
```

Returns 0 Get the current settings.
< 0 An error occurred.

int **su_VideoCameraGetDefault** (uint iID, SU_VIDEO_SETTINGS *pCurrent)

Summary Returns video camera default setting information.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the default setting information, which includes the camera controls, such as AutoExposureMode and Focus. It also includes processing unit controls, such as Brightness and Contrast.

Parameters iID Index of the video device. Should be less than SU_VIDEO.
pDefault Pointer to the default settings.

Returns 0 Got default settings.
< 0 An error occurred.

int **su_VideoCameraGetMin** (uint iID, SU_VIDEO_MIN_MAX *pMin)

Summary Returns video camera minimium values of the setting information.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the minimum values of the setting

information, which includes the camera control, such as ExposureTimeAbsolute and FocusAbsolute. It also includes processing unit controls, such as Brightness and Contrast.

Parameters iID Index of the video device. Should be less than SU_VIDEO.

pMin Pointer to the minimium values.

minimium value structure is defined as

```
typedef struct
{
   /* Camera Control */
   u32 dwExposureTimeAbsolute;
   u16 wFocusAbsolute;
   u8  bFocusRelative;
   u8  bFocusRelativeSpeed;
   u16 wIrisAbsolute;
   u16 wObjectiveFocalLength;
   s8  bZoom;
   u8  bDigitalZoom;
   u8  bZoomSpeed;
   s32 dwPanAbsolute;
   s32 dwTiltAbsolute;
   s8  bPanRelative;
   u8  bPanSpeed;
   s8  bTiltRelative;
   u8  bTiltSpeed;
   u16 wRollAbsolute;
   u8  bRollRelative;
   u8  bRollRelativeSpeed;
   /* Processing Unit Control */
   u16 wBacklightCompensation;
   s16 wBrightness;
   u16 wContrast;
   u16 wGain;
   s16 wHue;
   u16 wSaturation;
   u16 wSharpness;
   u16 wGamma;
   u16 wWhiteBalanceTemperature;
   u16 wWhiteBalanceBlue;
   u16 wWhiteBalanceRed;
   u16 wMultiplierStep;
   u16 wMultiplierLimit;
   u16 wSyncDelay;
}SU_VIDEO_MIN_MAX;
```

Returns	0	Got the minimium values of settings.
	< 0	An error occurred.

int **su_VideoCameraGetMax**(uint iID, SU_VIDEO_MIN_MAX *pMax)

Summary Returns video camera maxmium values of the setting information.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the maxmium values of the setting information, which includes the camera controls, such as ExposureTimeAbsolute and FocusAbsolute. It also includes processing unit controls, such as Brightness and Contrast.

Parameters	iID	Index of the video device. Should be less than SU_VIDEO.
	pMax	Pointer to the maxmium values.

Returns	0	Got the maxmium values of settings.
	< 0	An error occurred.

int **su_VideoCameraGetInfo**(uint iID, SU_VIDEO_INFO *pInfo)

Summary Returns video camera capabilities and status of the specified control.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. It returns the capabilities and status of the specified control, which includes the camera controls, such as ExposureTimeMode and FocusAuto. It also includes processing unit controls, such as Brightness and Contrast.

Parameters
iID Index of the video device. Should be less than SU_VIDEO.
pInfo Pointer to the information. The information is defined as:

```
typedef struct
{
   u8  bDevicePowerMode;
   u8  bRequestErrorCode;
   /* Camera Control */
   u8  bScanningMode;
   u8  bAutoExposureMode;
   u8  bAutoExposurePriority;
   u8  dwExposureTimeAbsolute;
   u8  bExposureTimeRelative;
   u8  wFocusAbsolute;
```

```
    u8  bFocusRelative;
    u8  bFocusRelativeSpeed;
    u8  bFocusAuto;
    u8  wIrisAbsolute;
    u8  bIrisRelative;
    u8  wObjectiveFocalLength;
    u8  bZoom;
    u8  bDigitalZoom;
    u8  bZoomSpeed;
    u8  dwPanAbsolute;
    u8  dwTiltAbsolute;
    u8  bPanRelative;
    u8  bPanSpeed;
    u8  bTiltRelative;
    u8  bTiltSpeed;
    u8  wRollAbsolute;
    u8  bRollRelative;
    u8  bRollRelativeSpeed;
    u8  bPrivacy;
    /* Select Unit Control */
    u8  bSelector;
    /* Processing Unit Control */
    u8  wBacklightCompensation;
    u8  wBrightness;
    u8  wContrast;
    u8  wGain;
    u8  bPowerLineFrequency;
    u8  wHue;
    u8  bHueAuto;
    u8  wSaturation;
    u8  wSharpness;
    u8  wGamma;
    u8  wWhiteBalanceTemperature;
    u8  bWhiteBalanceTemperatureAuto;
    u8  wWhiteBalanceBlue;
    u8  wWhiteBalanceRed;
    u8  bWhiteBalanceComponentAuto;
    u8  wMultiplierStep;
    u8  wMultiplierLimit;
    u8  bVideoStandard;
    u8  bAnalogVideoLockStatus;
    u8  wSyncDelay;
    u8  ProbeCommit;
}SU_VIDEO_INFO;
```

For each field of this structure, 0 means this setting is not supported.

Returns 0 Get the information settings.
< 0 An error occurred.

int **su_VideoCameraSetCaptureFrame**(uint iID, uint iFormat, u16 wWidth, u16 wHeight, u32 dwFrameInterval)

Summary Set the desired video camera capture format and frame settings.

Details This function can be called once the video camera has been connected to the USB and configured by the device driver. Most video camera support multiple format, such as uncompressed (YUV 422 or YUV 420) or MJPEG. For each format, it may also support multiple frame size (such as 640x480, 320x240, etc) and frame interval (such as 333333 for 20 frame per second or 1000000 for 10 fps). Video camera also has default format and frame that you can use without calling this function but if you don't want to use the default settings. You can use this function to change the capture format and frame settings.
You mean need to call su_VideoCameraGetCaptureFormatNum() and su_VideoCameraGetCaptureFormat() to quiry the format and frame information this video camera supported and only pass the supported format, width, height and frame interval to this function.

Parameters
iID Index of the video device. Should be less than SU_VIDEO.
iFormat One of the following format.
SU_VIDEO_FORMAT_UNCOMPRESSED
SU_VIDEO_FORMAT_MJPEG
wWidth The width of the desired frame
wHeight The height of the desired frame
dwFrameInterval The interval of each frame. The unit is 1/10 microsecond so 333333 mean 33 frame per second.

Returns 0 Format and frame is set.
< 0 video camera is not connected or the settings is invalid.

int **su_VideoCameraSetCurrent**(uint iID, SU_VIDEO_SETTINGS *pNewCurrent)

Summary	Change the current settings of the video camera control.
Details	If you need to change any of the video camera control, such as the camera's controls or the processing unit controls, you need to call this function. You need to call su_VideoCameraGetCurrent() first to get the current one and modify the desired value and call this function to let it take effect. Video class driver will only set request to the changed control.
Parameters	iID — Index of the video device. Should be less than SU_VIDEO. pNewCurrent — Pointer to the new camera control settings.
Returns	0 — Video camera control settings are updated. < 0 — Video camera is not connected.

int **su_VideoCameraGetCaptureSize**(uint iID, u32 *pMaxVideoFrameSize, u32 *pMaxPayloadBufferSize)

Summary	Get the size of the video capture-related buffers.
Details	The application needs to allocate enough memory buffers to perform the video capture smoothly. This function will provide the maximum buffer size that is needed according to the settings for format and frame size. You may need to call su_VideoCameraSetCaptureFrame() first if you don't want to use the default settings. Because it is unlikely the video camera output data format (either uncompressed YUV or compressed MJPEG) can be used directly by the LCD display frame buffer (most are RGB format), the application may require at least two captured frame buffers. One should be used to store the captured whole frame data so application can convert them to the desired LCD display format. Another buffer can be used to capture the incoming video streaming data.

Parameters iID Index of the video device. Should be less than SU_VIDEO.

pMaxVideoFrameSize Pointer to the maximum video frame buffer size. For uncompressed format, this value is the same for each frame and it is (bBitsPerPixel/8)* wWidth* wHeight. For compressed formats, the value may be much larger than the actual data size because some video cameras may use the uncompressed video frame size for the compressed format. The actual data length for each frame may vary. See the information for function su_VideoCameraCapture() about how to determine the data length.

pMaxPayloadBufferSize The pointer to the maxmium payload buffer size for each packet. Normally you need to pass this size when you call su_VideoCameraCapture() to make sure the video class driver will not drop any data because of the buffer size.

Returns 0 Got the video capture buffer size.

< 0 Video camera is not connected.

int **su_VideoCameraOpen** (uint iID)

Summary Start to capture video streaming data.

Details Call this API to start video streaming.

Parameters iID Index of the video device. Should be less than SU_VIDEO.

Returns 0 Video streaming started.

< 0 Video camera is not connected.

int **su_VideoCameraCapture**(uint iID u8 *pData, uint iLen, BOOLEAN *pbIncludeNewFrame, uint *piNewFrameOffset)

Summary Retrieve some video streaming data.

Details After the application calls su_VideoCameraOpen(), it will still need to keep calling su_VideoCameraCapture() to retrieve the received video streaming data. Normally the application needs to call it in a high priority task to keep up with the streaming data. Check the the example code in usbhdemo.c for details about how to capture video streaming data

Parameters iID Index of the video device. Should be less than SU_VIDEO.
pData Pointer to the captured video streaming data
iLen Size of the capture buffer. Should be MaxPayloadBufferSize or multiple of MaxPayloadBufferSize
pbIncludeNewFrame Boolean value if the return data buffer contains the start of a new frame. If the returned value is TRUE and iNewFrameOffset is less than the return value of this function, then the returned data buffer contains the data for two frames. The data from pData to iNewFrameOffset is the last part of the previous frame and the data from iNewFrameOffset to iLen is the start of the next frame.
piNewFrameOffset Pointer to the offset of the new frame within the returned data buffer if bIncludeNewFrame is TRUE. Do not use the value if bIncludeNewFrame is FALSE.

Returns >= 0 Data length in the buffer.
< 0 Video camera is not connected or an error occurred during the capture.

int **su_VideoCameraClose** (uint iID)

Summary Stop capturing video streaming data.

Details Call this API to stop the video streaming.

Parameters iID Index of the video device. Should be less than SU_VIDEO.

Returns 0 Video streaming stopped.
< 0 Video camera is not connected.

int **su_VideoInserted** (uint iID)

Summary Check if there is any video device connected.

Details Call this API to check is any video class device is available to use.

Parameters iID Index of the video device. Should be less than SU_VIDEO.

Returns TRUE Video class device is connected.
< 0 No video class device.

4.9 Writing a New Class Driver

Note: Writing a new USB class driver is difficult and may require assistance from Micro Digital. The following information may not cover every detail about implementing a new class driver. Please discuss this with Micro Digital before you decide to do it.

Micro Digital provides a class driver template in the CTempl subdirectory. This class driver template is a full-featured, working driver that shows how to send/receive control, bulk, and interrupt requests. smxUSBD has a function driver template which can work with this class driver for demonstration.

The class driver requires the interface class, subclass, and protocol to be 0xFF, and there are four endpoints not including the default control endpoint. These four endpoints are for BULK IN, BULK OUT, INT IN, and INT OUT.

4.9.1 Send Vendor-Specific Control Request

Two vendor-specific requests are defined as:

SU_REQ_SET_DATA
SU_REQ_GET_DATA

su_CTemplSendCtrl() sends a vendor-specific request to send 8 bytes of data to the device.
su_CTemplSendCtrl() sends a vendor-specific request to get 8 bytes of data from the device.

The data sent and received can be compared to verify that the transfer is correct. Refer to the code for the details.

4.9.2 Send and Receive BULK Requests

su_CTemplSendBulk() sends bulk data to the device.
su_CTemplRecvBulk() receives bulk data from the device.

Refer to the code for the details of how to send and receive bulk requests.

4.9.3 Send INT Request

su_CTemplSendINT() sends INT data to the device.
su_CTemplRecvINT() receives INT data from the device.

Normally for the INT IN request, the host controller will resubmit so the device can interrupt the host at any time. Therefore the class driver does not need to call the su_CTemplRecvINT() function to poll it. The different INT callback functions will be called when the host gets the data from the device. However if there is a requirement to support polling, handle the INT IN request in the class driver instead of the host driver. Also within the INT IN call back function, set pInquiryInfo->status to SU_DRV_INQUIRY_CMD_STATUS_KILLED so the host controller driver will not automatically resubmit the request.

4.10 Device Plugin/Remove Event Callback

In smxUSBH version 2.31, a new callback function was added to allow the application to be notified when a USB device is plugged in or removed. Each class driver has its own notification function.

Use the following function to register a PlugIn / Remove callback function

void   su_xxxRegDevEvtCallback(SU_PDEVEVTCBFUNC func);

Check the class driver header file to find out the exactly function name for each class driver.

Following is a sample callback function

```
static void smx_msc_device_event(uint iID, BOOLEAN bInserted)
{
   if(bInserted)
   {
      printf("mass storage device plugged in\r\n");
   }
   else
   {
      printf("mass storage device remove\r\n");
   }
}
```

4.11 Stack Event Callback

In smxUSBH version 2.51, a new callback function was added to allow the application to be notified when smxUSBH needs to report some events. In version 2.54, the data parameter was added to this callback function

Use the following function to register the callback function:

void su_RegStackCallback(SU_PSTACKEVTCBFUNC pCallback);.

typedef void (* SU_PSTACKEVTCBFUNC)(uint iFlag, u32 data);

iFlag will be one of the following values:

SU_CB_DEVICE_INSERTED
When the hub (root or external) detects there is a device on the hub port, the callback function will be called with this flag. At that time, the device is not enumerated yet, so the stack does not know if it can support it or not. Data is (HubAddr<<16|HubPort).

SU_CB_DEVICE_REMOVED
When the hub (root or external) detects that a device on the hub port is removed, the callback function will be called with this flag. Data is (HubAddr<<16|HubPort).

SU_CB_HUB_INSERTED
When the hub (root or external) detects there is an external hub device on the hub port, the callback function will be called with this flag. At that time, the device is already enumerated. Data is (HubAddr<<16|HubPort).

SU_CB_HUB_REMOVED
When the hub (root or external) detects that an external hub device on the hub port is removed, the callback function will be called with this flag. Data is (HubAddr<<16|HubPort).

SU_CB_OVERCURRENT
When the host controller's root hub or external hub reports an overcurrent event, the callback function will be called with this flag. Data is (HubAddr<<16|HubPort).

SU_CB_UNKNOWN_DEV_REMOVED
When a previous unsupported/unrecognized device has been removed, the callback function will be called with this flag. Data is (HubAddr<<16|HubPort).

SU_CB_HUB_UNSUPPORTED
When a hub device is detected but SU_HUB is not set, the callback function will be called with this flag. Data is (HubAddr<<16|HubPort).

SU_CB_DEVICE_UNRECOGNIZED
When the hub task cannot enumerate the attached device, the callback function will be called with this flag. Data is (HubAddr<<16|HubPort).

SU_CB_DEVICE_UNSUPPORTED
When the hub task cannot find a driver for an enumerated device, or when the driver's deviceConn() interface returns an error so the class driver cannot be loaded, the callback function will be called with this flag. Data is (HubAddr<<16|HubPort).

SU_CB_HC_FATAL_ERROR
When the host controller gets an unrecoverable error, the callback function will be called with this flag. For most cases you may need to shutdown smxUSBH and re-init it to recover from this problem. Data is the Host controller index.

SU_CB_STACK_FATAL_ERROR
When smxUSBH detects any internal error, such as data is corrupted or insufficient memory, the callback function will be called with this flag. For most cases you may need to shutdown smxUSBH and re-init it to recover from this problem. Data is the error number SU_STACK_FATAL_ERROR_xxx.

5. Host Controller Drivers

5.1 Host Controller Driver Interface

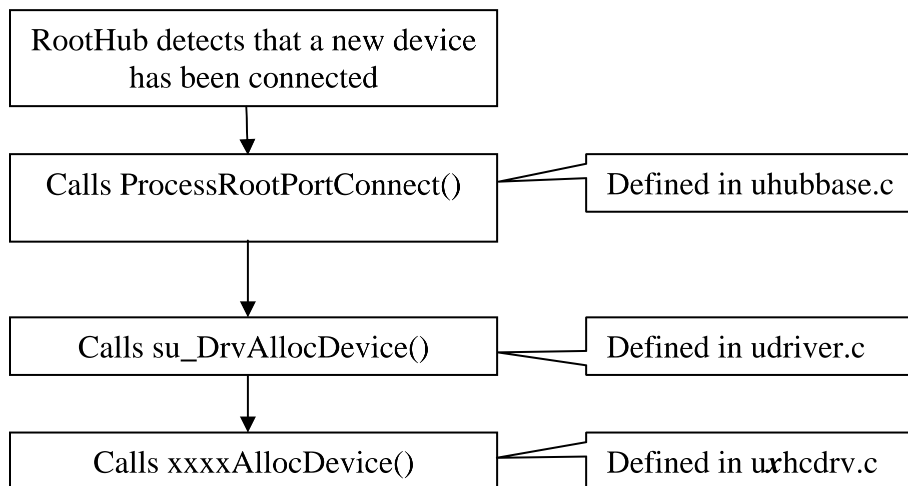
The USB Driver defines a structure that contains five function pointers. All Host Controller Drivers should implement these functions and call su_DrvAllocHost() and su_DrvApplyUSBHost() to register the Host Controller with the USB Driver. The functions are described below. They are:

int **AllocDevice**(struct SU_DRV_DeviceInfo_T * pDeviceInfo)
int **FreeDevice**(struct SU_DRV_DeviceInfo_T * pDeviceInfo)
int **TransferCmd**(struct SU_DRV_Inquiry_Info_T * pInquiryInfo)
int **RemoveCmd**(struct SU_DRV_Inquiry_Info_T * pInquiryInfo)
int **RoothubCmd**(uint iHCIndex, uint portNum, uint request, u32 *pData)

5.1.1 AllocDevice()

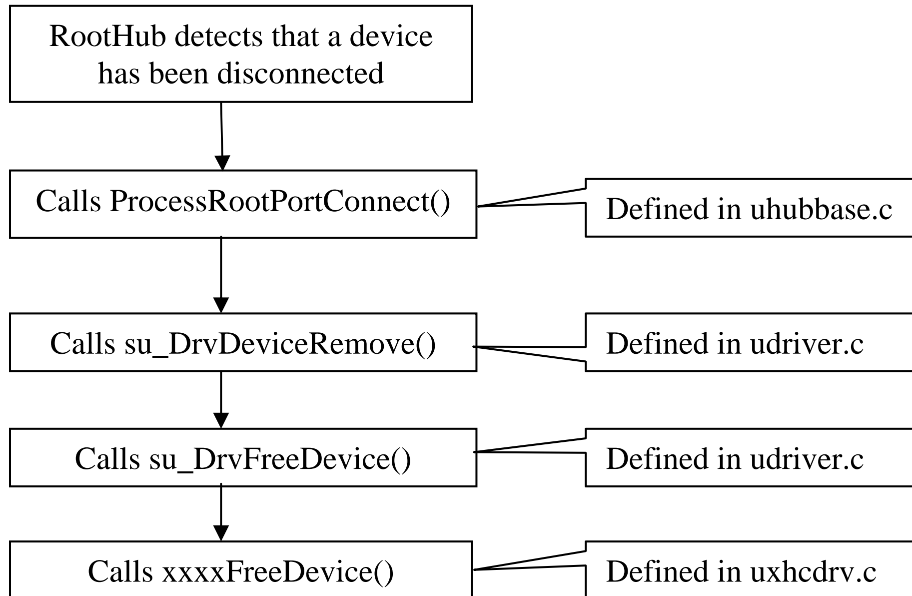
This function is called when the hub task detects that a new device has been connected to the hub port. The Host Controller may allocate the newly added device information structure. The information may only be used internally by the host controller driver. You can save the pointer to that structure in pDeviceInfo->pPrivateData so it can be used later.

The calling procedure is:



5.1.2 FreeDevice()

This function is called when the hub detects that a device has been removed from the hub port. The Host Controller will free the device's information structure. pDeviceInfo->pPrivateData points to it. The following series of calls is made:



5.1.3 TransferCmd()

The USB Driver calls this function to send a request to the device. All device drivers' data transfer requests will ultimately call this function. The basic idea is to create a list from each type of transfer request: control, bulk, interrupt, and isochronous. Whenever HCXXXXTransferCmd() is called, the request is added to the list. Then general information carried by that request is converted to the specific host controller related data structure, such as some kind of Transfer Descriptor. Then that TD is submitted to the host controller. The request can be sent immediately or sent later by the ISR, usually the SOF interrupt. Within the ISR, if any request is done, it is removed from the list, and the caller task is notified through the callback function of that request. Then it checks if there are any other pending requests and schedules those requests.

5.1.4 RemoveCmd()

The USB Driver calls this function to cancel a pending request sent to the device. Normally the pending interrupt request will be removed through this function. If any request times out or the device is removed, the USBH stack and/or class driver calls this function to remove the pending request from the host controller. If the host controller has any data structure associated with that request, such as a list of Endpoint/Transfer Descriptors, the function should also remove that from the host controller.

5.1.5 RoothubCmd()

The Roothub Driver calls this function to get the host controller's roothub information, such as total port number and port status. It will also call this function to set/clear the roothub's features, such as: enable and power on the port, reset the port, and clear connect status changed flag.

5.2 Interrupt Handler (ISR)

smxUSBH only processes the host controller interrupt in the ISR in a non-multitasking system (!SB_MULTITASKING). In a multitasking environment, the interrupt processing is done by a separate high priority task. This approach ensures other higher priority jobs can preempt the USB task. Usually, USB communication is not critical.

For the EHCI/OHCI/UHCI controller, if you need to support SMP or multiple controllers and shared interrupts, you need to set SU_USE_PIPE to 1 in ucfg.h. The controller driver first reads the interrupt status register to ensure the interrupt is trigered by this controller. If so, it writes to the interrupt status register to clear the interrupt and then passes the value of the interrupt status register to the interrupt handler task through a pipe. Then the ISR returns. The interrupt handler task processes the interrupt according to the received interrupt status register value. The interrupt is never disabled for this case.

For other cases, to improve the performance of the controller driver, smxUSBH will not pass the interrupt status register by pipe. Instead, the controller driver disables the USB interrupt in the ISR first, then wakes up the interrupt handler task, and then the ISR returns. The interrupt handler task reads the interrupt status register and processes it. During this whole time the USB host controller interrupt will remain disabled. After the interrupt processing is done, the USB interrupt is re-enabled by the interrupt handler task.

Interrupt handling is done internally in the porting layer of smxBase not within the host controller driver. For detailed information, please see smxBase User' Guide. Each controller driver has an InterruptHandler() function that must be called from the ISR. The prototype for these is shown in uinit.h. These are defined in uinit.h rather than in another header file for those who purchase the USB disk driver in binary form, since a minimal set of files is supplied.

If multiple controllers are being used in your system the ISR dispatcher will pass the host controller index to the ISR through the parameter iHCIndex, You can then decide which host controller triggered that interrupt.

5.3 Root Hub

The root hub provides the connection between the Host Controller and one or more USB ports. The root hub provides simplified functionality vs. an external hub (see the USB 2.0 specification, "Chapter 11 Hub Specification"). smxUSBH's Host Controller constructs a virtual Root Hub device as the parent device for all attached USB devices. The host controller may start a timer to poll the status of the root hub port if there is no interrupt for it.

Root hub support is included in smxUSBH. External hub support is an add-on option. Some USB devices have a built-in hub, others don't. If external hub driver support is needed, the add-on must be purchased.

5.4 EHCI

EHCI only supports high speed devices, so in order to connect to a full speed or low speed device, use a high speed hub (Such as NXP ISP176X) or enable the companion OHCI/UHCI controller driver (such as most PCI cards and Atmel AT91SAM9M10G45). Some processors, such as Freescale's MCF5329/5251/54455/52277 have built-in EHCI compatible controllers, and the on-chip or external transceiver may allow connection to full or low speed devices directly through the USB root hub port.

5.5 OHCI

OHCI supports full speed and low speed. Many ARM and other embedded processors have a built-in OHCI-compatible USB host controller.

5.5.1 OHCI for x86 Real Mode

OHCI uses memory-mapped I/O for access to the OHCI registers. Unfortunately, the PCI BIOS assigns a high address near the top of the 4GB memory space, so this is inaccessible in real mode, since memory addressing is limited to about 1MB. smxUSBH offers two solutions to this problem. Try them in this order.

1. Change the PCI base address to an address in the Upper Memory Area. Run our OHCIBASE utility from a DOS prompt to find all possible addresses between the address specified and 0xF0000. For example:

   A:>ohcibase c8000

   This utility will display a list of possible addresses or it will indicate if none are found. Set SU_OHCI_BASE to one of the addresses it returns and try running smxUSBH. Also ensure SB_CFG_REAL_BIG_MODE is 0. Do not select an address that is used by some other device. For example DiskOnChip uses a memory window in this area, which is typically configured by jumpers. Also, see www.smxrtos.com/rtos/dos/undwinpb.htm for a memory map from 0 to 1MB for more explanation.

   This is the easiest technique and adds negligible code (a couple C statements). However, it cannot be used on some systems. In that case, try option 2.

2. Real Big Mode (also called Unreal Mode): This relies on a quirk of the x86 architecture. A search for these terms on the web will yield various articles and code snippets about this. The basic idea is to temporarily enter protected mode to set up a segment register for access to the 4GB memory space and then switch back to real mode, and the register still has 4GB access. It only works on 386 or higher processors. Also, it requires assignment of the FS or GS

register for only the purpose of accessing high addresses. Typically a real mode program uses only ds and es. However, a third-party library or even your own code may use FS or GS.

Do not reload this register in real mode or it loses its "bigness". In particular, it is not permissible to push and pop FS and GS, because the hidden part of the register is changed. The whole point of switching to protected mode was to set that hidden part, which is done when loading a segment selector into the segment register. If you cannot allocate either FS or GS to this purpose, it should be possible to solve the problem by modifying smxUSBH to call rbm_init() everywhere prior to accessing the OHCI registers.

Note that the code sets up FS for this purpose but can be easily changed to use GS by searching and replacing in rbm.asm.

This technique should work on any system but has the above disadvantages and adds some code. It also does not work under emm386.exe. If this technique is not acceptable, consider upgrading your application to protected mode.

5.6 UHCI

UHCI USB controllers are usually used only with x86 processors.

5.6.1 UHCI for x86 Real Mode

Since UHCI uses x86 I/O space to access the UHCI registers, there is no problem when running in real mode vs. protected mode. However, it is necessary to have a 386 or higher processor because UHCI requires 32-bit I/O instructions and 32-bit registers.

5.7 ISP116x

As with other NXP USB controllers, NXP ISP116X has one hardware configuration register to set up properties related to the microprocessor, such as the interrupt trigger mode and level, whether to use internal pull-down resistor, etc. Refer to the ISP116x data sheet for the details. Micro Digital provides the function su_GetISP116XIntSetting() in the hardware porting layer so modifications are needed to return the correct settings for your hardware.

5.8 ISP1362

As with other NXP USB controllers, the NXP ISP1362 has one hardware configuration register to set up properties related to the microprocessor, such as the interrupt trigger mode and level, whether to use internal pull-down resistor, etc. Refer to the ISP1362 data sheet for the details. Micro Digital provides the function su_GetISP1362IntSetting() in the hardware porting layer so modifications are needed to return the correct settings for your hardware.

5.9 ISP176x

As with other NXP USB controllers, NXP ISP176x has one hardware configuration register to set up properties related to the microprocessor, such as the interrupt trigger mode and level. Refer to the ISP176x data sheet for details. Micro Digital provides the function

su_GetISP176XIntSetting() in the hardware porting layer so modifications are needed to return the correct settings for your hardware.

If you are using the ISP1763A, remember to set SU_ISP1763 to 1 in ucfg.h. ISP1763A is basically the same as ISP1760/1 controller, with the following minor differences:

1. Data bus width is 8 or 16 bit for ISP1763
2. Address lines are only 8 bits for ISP1763
3. Number of TDs is only 16 for ISP1763
4. Payload memory is only 20K for ISP1763
5. Register offsets changed and some registers changed to 16 bit.

Remember to check the low level register access functions we implemented in uport.c for the ISP1763A case for how to handle the 32-bit/16-bit register changes.

Set **SU_ISP1763_PORT1** to 1 for port 1 of ISP1763A chip to be a dedicated host port.
Set **SU_ISP1761_PORT1** to 1 for port 1 of ISP1761 chip to be a dedicated host port.
Set **SU_ISP1760_PORT1** to 1 for port 1 of ISP1760 chip to be a dedicated host port.

5.10 Blackfin

Analog Devices BF52x/BF54x USB host controller driver currently does not support ISOC transfer mode. This controller IP does not support external hubs and multiple devices. This controller is an IP implementation from Mentor.

5.11 CF522xx

Freescale CF522xx USB host controller provides limited USB host functionality. Micro Digital currently does not support external hubs and multiple devices for this host controller. ISOC transfer mode is not tested. This controller cannot schedule multiple USB requests so full-duplex data transfer is not supported.

5.12 LM3Sxxxx

The host controller on many LM3S processors (prior to Tempest class, e.g. LM3S9B9x) has a very limited number of endpoints, so for them, connecting a hub only allows supporting two mass storage devices simultaneously. This is not a problem on TI AM17xx/18xx, AM33x, and AM35x processors.

5.13 MAX3421

Maxim MAX3421 interfaces with the microprocessor through an SPI bus so it is necessary to implement SPI communications. In addition, the interrupt trigger mode and level must be set up. This should be done in the su_HdwInit(). Refer to Micro Digital’s demo code for the MAX3421 evaluation board and Keil MCB2130 board. ISOC transfer mode is not tested. This controller cannot schedule multiple USB requests, so full-duplex data transfer is not supported.

5.14 Renesas

Renesas USB host controller driver currently does not support ISOC transfer mode. This controller does not support high speed interrupt transfer so external hub and multiple device support are not fully tested.

5.15 Synopsys

Synopsys DWC host controller driver currently does not support ISOC transfer mode. Only internal DMA/Slave Only mode and external ULPI/FS UTMI is supported and tested. For Dedicated FIFO mode, the size of each FIFO needs to be configured at the top of the controller driver for each processor which is using this USB IP.

5.16 uPD720150

NEC uPD720150 USB host controller driver has been tested on the LPC1788 Embedded Artists board and uPD720150 Application Board (part #ET-D720150-HP) using a custom interface board. DMA data transfer is not support yet. Port2 as host port has not been tested, but the feature is in the controller driver.

Because the device controller and host controller share some registers, separate low-level register access routines are needed in the case the application needs both host and device features. Register access and pipe allocation need to be protected by a mutex. These routines are within upd720150.c/h, which is part of the BSP code (so both host and device controller driver can use it). uport.c/h does not include any uPD720150 low-level access code. If you are only using the host controller, you can build upd720150.c into the XUSBH library.

Set **SU_PD720150_USE_PORT2** to 1 set port 2 as USB host port.

5.17 Writing a New Host Controller Driver

Note: Writing a new USB host controller driver is difficult and may require a lot of assistance from Micro Digital. We do not recommend you do it yourself. Please discuss this with Micro Digital before you decide to do it. The following information only shows the steps to write a new host controller driver. A lot of detailed information is not provided here.

Micro Digital provides a host controller driver template in the HCD directory to use as a starting point. Check all comments marked “TODO” and implement those sections according to the instructions below.

1. Create an HC initialization and release function (su_HCXXXXXInit() and su_HCXXXXXRelease())and call them in uinit.c. See 5.17.1 HC Init and Release.
2. Implement the HCD interface functions and register them with USBD. See 5.17.2 HCD Interface.
3. Create an ISR to handle the host controller’s interrupt and hook the interrupt vector in su_HCXXXXXInit(). See 5.17.3 HC Interrupt.
4. Create a virtual root hub and add it to the USBD. See 5.17.4 HC Virtual Root Hub.

5. Use a timer or HC interrupt get the root hub status change event and then report it to the USBD. Then the hub thread can run to check the attached or detached device. See 5.17.4 HC Virtual Root Hub.

5.17.1 HC Init and Release

In the su_HCXXXXXInit() function, do the following typical steps:

1. Check the HC's ID or Revision number to make sure it is the HC you want to support.
2. Allocate a handle (structure) to record all the important information of this HC.
3. Reset the HC so it resets to the default settings.
4. Allocate any Transfer Descriptor related resources that are needed.
5. Register the HCD with the USBD.
6. Initialize the HC itself.
7. Unmask (enable) the HC's interrupt. Then the HC can begin to work

Our template code provides a framework for the above steps as a starting point for your development.

In the su_HCXXXXXRelease() function, you normally need to release all the resources allocated in su_HCXXXXXInit() and also disable the HC interrupt.

5.17.2 HCD Interface

How you implement HCXXXXXAllocDevice(), HCXXXXXFreeDevice(), HCXXXXXTransferCmd(), HCXXXXXRemoveCmd(), and HCXXXXXRoothubCmd() depends on your host controller and your implementation. The xHCI code is fairly complex; the ISPxxx code is simpler. Refer to the template code and contact Micro Digital for support, if necessary. (see 5.1 Host Controller Driver Interface)

5.17.3 HC Interrupt

The interrupt handler depends on your HC and environment. The template cannot do more than provide a stub function.

5.17.4 HC Virtual Root Hub

Our template provides most of the code for the root hub implementation. You only need to implement the functions related to your HC, most likely read/write registers.

If you don't want or can't use an interrupt to inform you the roothub change event, you can implement the request SU_HUB_ROOT_GET_CHG_STATUS in the RoothubCmd() function so the Hub task will keep polling for status changes.

5.17.5 Debug the Code

It is recommended to debug the host controller driver following this sequence:

1. Device insert/remove event detection
2. Virtual Root Hub Port Reset procedure when new device is plugged in
3. Control Transfer for device enumeration

4. Bulk/full/high speed transfer for mass storage device
5. Interrupt/low speed transfer for mouse/keyboard device
6. Control/Bulk/Interrupt transfer for external Hub device+one mass storage or mouse device
7. Remove and then plug in device again. Host controller driver error handling and content cleanup
8. Multiple device support through hub. For example two mass storage devices or one mass storage and one mouse.
9. Split transfer if your host controller is a high speed one.
10. Test ISOC/full/high speed transfer.

6. Hardware Porting Notes

General interrupt-related hardware porting layer functions are defined in smxBase. Please see the smxBase User's Guide for detailed information. The smxUSBH-specific hardware porting layer consists of uport.h and uport.c. These files contain definitions, macros, and functions to port smxUSBH to particular target hardware.

6.1 uport.h

For clarity and simplicity it is recommended to delete the conditionals used around porting definitions. Just keep one of each setting configured as appropriate for your target. There is also no need for the #error when just one configuration is supported. Micro Digital code must build for different processors and compilers. Your needs are simpler — you only need to set things for one configuration or a limited number.

A. Driver BASE and IRQ settings: Set these to the proper addresses for your host controller.

B. Non-cacheable memory address: If you are using OHCI/UHCI/EHCI compatible host and enable the data cache on your system.

6.2 uport.c

Some of the functions in uport.c may need to be adapted for your target.

su_HdwInit()

This function is called first when initializing the smxUSBH stack. It does the following:

Initializes the hardware platform's USB subsystem. For example, it enables the USB host controller, sets up the clock, and finds the PCI BIOS.

Determines the Host Controller's I/O base, memory base and IRQ number. For systems configured to use an OHCI controller, this function initializes the variables *OHCIbase[]* and *OHCIirq[]* with the controller's memory address and IRQ assignment. For systems using a UHCI controller, this function initializes *UHCIbase[]* and *UHCIirq[]*. For systems using a EHCI controller, this function initializes *EHCIbase[]* and *EHCIirq[]*.

Initializes other hardware required by the smxUSBH. For example, it opens a serial port and sets up the parameters for the su_DebugL() function to output debug information.

su_HdwRelease()

Disables the USB subsystem of the hardware.

su_FlushData(), su_PhysicalToVirtualAddr(), su_VirtualToPhysicalAddr()

These are for MMU support. su_FlushData() flushes data in the cacheable memory. The others are address conversion functions. **If you are not using an MMU, use the default implementation.**

su_UHCIRead16(), su_UHCIWrite16(), su_UHCIWrite32()

These functions are used when the smxUSBH UHCI driver accesses I/O registers. Normally these should be mapped onto your compiler's functions (i.e. inpw(), outpw(), outpd()). The default implementation maps these onto functions defined in smx since some versions of the Borland and Microsoft 32-bit compilers have buggy definitions of these.

su_OHCIRead32()/su_EHCIRead32(), su_OHCIWrite32()/su_EHCIWrite32()

These functions are used when the smxUSBH OHCI/EHCI driver accesses memory mapped registers.

You may need to check if the default implementations of the above I/O functions meet the hardware timing requirements of your system.

su_GetEHCIBase(), su_GetEHCIInterrupt()
su_GetOHCIBase(), su_GetOHCIInterrupt()
su_GetUHCIBase(), su_GetUHCIInterrupt()
su_GetISP116XBase(), su_GetISP116XInterrupt()
su_GetISP1362Base(), su_GetISP1362Interrupt()
su_GetISP176XBase(), su_GetISP176XInterrupt()
su_GetSynopsysBase(), su_GetSynopsysInterrupt()

These functions return the EHCI, OHCI, UHCI, NXP ISP116x/ISP1362/ISP176x or Synopsys DWC host controller I/O base address and IRQ found in su_HdwInit(). **Typically there is no need to change the default implementation but you need to set the correct base address and IRQ number in the uport.h.**

su_GetISP116XIntSetting(), su_GetISP1362IntSetting(), su_GetISP176XIntSetting()

This function returns the system's hardware setting such as whether the interrupt is level or edge trigged and its output polarity. **Change the value according to your hardware's implementation.**

su_ISP116XRead32(), su_ISP116XRead16(), su_ISP116XWrite32(), su_ISP116XWrite16()
su_ISP1362Read32(), su_ISP1362Read16(), su_ISP1362Write32(), su_ISP1362Write16()
su_ISP176XRead32(), su_ISP176XRead16(), su_ISP176XWrite32(), su_ISP176XWrite16()

These functions are used when the smxUSBH NXP ISP116x/ISP1362/ISP176x host driver accesses I/O registers. **It may be necessary to tune the implementation of these functions to meet the timing requirement of ISP116x/ISP1362/ISP176x according to your hardware implementation.**

su_ISP116XReadBuf(), su_ISP116XWriteBuf()
su_ISP1362ReadBuf(), su_ISP1362WriteBuf()
su_ISP176XReadBuf(), su_ISP176XWriteBuf()

These functions are used when the smxUSBH NXP ISP116x/ISP1362/ISP176x host driver accesses ATL and or ITL buffer. **It may be necessary to tune the implementation of these functions to meet the timing requirement of ISP116x/ISP1362/ISP176x according to your hardware implementation.**

su_MAX3421Read(), su_MAX3421Write()
su_MAX3421ReadBuf(), su_ MAX3421WriteBuf(), su_ MAX3421VBusOn()

These functions are used when the smxUSBH Maxim MAX3421 host driver accesses registers. MAX3421 is based on the SPI bus so these functions should use the microprocessor's SPI controller to implement the communications. MAX3421VBusOn() is used to turn on/off the VBus of USB.

su_SynopsysRead(), su_SynopsysWrite()

These functions are used when the smxUSBH Synopsys DWC host driver accesses registers.

su_PCIReadConfigWord(), su_PCIWriteConfigWord()

These functions are only used to support UHCI's Legacy Device support feature, which is not a required part of the UHCI specification. If there is no need to support it or if there is no PCI bus in your system, make them empty functions.

su_PCIReadConfigByte(), su_PCIReadConfigDWord(), su_PCIWriteConfigDWord()

These functions are only used to support EHCI's capability function. If there is no EHCI PCI card on an x86 PC, ignore them.

6.3 DMA Transfer

All smxUSBH external Host Controller Drivers do not use DMA transfer. For ISP116X, ISP1362, and ISP176X external USB host controllers, DMA transfer of data from the microprocessor to those chips' internal FIFO is an option. DMA is highly dependent on the microprocessor so it is hard to write general, efficient, and portable DMA code. Contact Micro Digital for more information if DMA is necessary.

Appendix A. Porting smxUSBH to Another OS

smxUSBH's porting layer maps onto smxBase services. Please see the smxBase User's Guide for the detailed information about how to port it to another OS. The following is the information that is smxUSBH-specific.

A.1 uheap.h and uheap.c

These files handle smxUSBH memory requests. As shipped, they are ported for the SMX® RTOS. Refer to SU_NEED_NC_MEMORY and SU_USE_C_HEAP options described in Miscellaneous Settings.

su_HeapInit(), su_HeapRelease()

> Allocate and initialize non-cacheable memory required to support USB functions. This memory may be pre-allocated from the OS's heap. This memory then works as a non-cacheable memory pool for smxUSBH.

su_AllocNC (uint iSizeInBytes, uint iAlign)

> Allocates *iSizeInBytes* bytes of memory from the pool previously initialized by su_HeapInit(). Because some memory used by the smxUSBH stack requires a specific byte alignment (for example the HCCA pointer in the OHCI should be 256-byte aligned), the su_AllocNC() API includes an alignment parameter, *iAlign*. Returns a void pointer.

su_FreeNC (void * pPreviouslyAllocatedNCMemoryBlock)

> Frees a previously allocated memory block that was allocated using su_AllocNC().

su_Alloc(uint iSizeInBytes)

> Allocates *iSizeInBytes* bytes of normal memory. Mapped to the C function *malloc()*.

su_Free(void * pPreviouslyAllocatedMemoryBlock)

> Frees a previously allocated normal memory block. Mapped to the C function *free()*.

A.2 Non-Multitasking Support

smxUSBH can work in a non-multitasking environment, such as DOS. smxBase already provides a DOS/NORTOS implementation, so use it. Besides that you also need:

1. In your main function or loop, before calling any smxUSBH API, call su_Initialize() first to initialize smxUSBH.

2. In your main function or loop, periodically call su_CheckRoothubStatus() to detect the USB device insert/remove event.

Please check the code in \SMX\APP\NORTOS\usbhdemo.c for the full demo of the USB host stack.

A.3 Task Priority

When using a multitasking environment, normally there are three tasks involved for the USB.

smxUSBH has two built-in tasks. One task is the ISR task, which handles processing the host controller's interrupt. The ISR does nothing except wake up that task. Refer to xxx_HostTaskInit(). Another task is the Hub task, which enumerates the plugged-in device or cleans up the driver when a device is removed. Refer to the *su_HubStart()* subroutine.

Normally the application task calls the class driver API. The application task is the third task and should have a lower priority than the ISR task and Hub task.

The ISR task should be one of the highest priority tasks in your system.

The Hub task's priority should be higher than any application task that will call the class driver API.

Appendix B. Memory Usage and Performance Summary

B.1 Size

B.1.1 Code Size

Code size will vary widely depending upon CPU, compiler, and optimization level. The figures below are intended as examples.

Component	**ARM Thumb-2 IAR v6.10**	**ARM IAR v5.20**	**ColdFire CodeWarrior v7.1**	**X86 Microsoft VC++ v6.0**	**Blackfin VisualDSP**
Core (USBD, Porting Layer, and RootHub driver)	8 KB	10 KB	11 KB	10 KB	13 KB
Audio Device driver	7.5 KB	11 KB	12 KB	8 KB	N/A
CDC ACM (Modem) Device driver	2 KB	3 KB	4 KB	4 KB	2 KB
HID Mouse and Keyboard Device driver	2.5 KB	3.5 KB	4 KB	5 KB	2 KB
HID Generic Device driver	4.5 KB	6.5 KB	7 KB	6 KB	3 KB
Hub (External) driver	2 KB	3.0 KB	3.0 KB	3 KB	2 KB
Mass Storage Device driver	4 KB	6.5 KB	7.5 KB	6 KB	6.3 KB
Printer Device driver	1.5 KB	2 KB	3 KB	3 KB	2 KB
Serial Converter Driver (FTDI)	1.5 KB	2.5 KB	4 KB	3.5 KB	1.5 KB
Serial Converter Driver (Prolific)	2.5 KB	4 KB	4.5 KB	3 KB	1 KB
Serial Device driver	1.5 KB	2.5 KB	3 KB	4 KB	1 KB
Video driver	N/A	13.5 KB	N/A	N/A	N/A
V20K13 driver	N/A	N/A	N/A	5 KB	N/A
Host Controller Drivers					
EHCI	N/A	N/A	14 KB	14 KB	N/A
OHCI	6.5 KB	9 KB	11 KB	12 KB	N/A
UHCI	N/A	N/A	16 KB	14 KB	N/A
Analog Devices Blackfin BF52x	N/A	4 KB	N/A	N/A	5 KB
Freescale MCF522xx	N/A	N/A	5 KB	N/A	N/A
Maxim MAX3421	N/A	4 KB	N/A	N/A	N/A

NEC uPD720150	3 KB	N/A	N/A	N/A	N/A
NXP ISP116x	5.5 KB	6.5 KB	8 KB	7 KB	N/A
NXP ISP1362	6 KB	N/A	8.5 KB	7.5 KB	N/A
NXP ISP176x	9.5 KB	N/A	15 KB	13 KB	N/A
Synopsys	6 KB	N/A	N/A	N/A	N/A
TI LM3Sxxxx	4.5KB	N/A	N/A	N/A	N/A

AM1x, AT91, EP93xx, LPC24xx, LPC3180, LH7A404: See OHCI entry.

AM35x, i.MX31, LPC3131/41/51, MCF525x, MCF532x/7x, MCF5445x: See EHCI entry.

AT91SAM9M10/G45: See OHCI and EHCI entries.

Freescale Kxx: See MCF522xx entry.

STM32F105/7, STM32F205/7: See Synopsys entry.

For example, the total code size on AT91SAM9260 with mouse/keyboard/mass storage support, using IAR EWARM v5.20, is only 29KB (Core + OHCI + Mse/kbd + mass; 10 + 9 + 3.5 + 6.5).

On x86 with the same configuration it is only 33KB (10 + 12 + 5 + 6).

B.1.2 Data Size (RAM Requirement)

The following is a table of RAM usage

Component	**Size**
Core (USBD, Porting Layer, and Roothub driver)	2 KB
Audio Device driver	10 KB
CDC ACM (Modem) Device driver	1 KB
HID Mouse and Keyboard Device driver	0.5 KB
HID Generic Device driver	4 KB
Hub (External) driver	2 KB
Mass Storage Device driver	3 KB
Printer Device driver	2 KB
Serial Converter Driver (FTDI)	2 KB
Serial Converter Driver (Prolific)	2 KB
Serial Device driver	1 KB
Sierra Wireless Device driver	2 KB
Video camera driver	64 KB

V20K13 camera driver	12 KB
Host Controller Drivers	
EHCI	6 KB
OHCI	3 KB
UHCI	70 KB
Analog Devices Blackfin BF52x	1 KB
Freescale MCF522xx	1 KB
Maxim MAX3421	1 KB
NEC uPD720150	1 KB
NXP ISP116x	4 KB
NXP ISP1362	2 KB
NXP ISP176x	2 KB
Synopsys	2 KB
TI LM3Sxxxx	1 KB

Other controllers: See notes below Code Size table.

So the total RAM requirement for OHCI controller + mouse/keyboard/mass storage is only 9KB (Core + OHCI + mouse/keyboard + mass storage = 2 + 3 + .5 + 3).

B.2 Performance

For theoretical performance limits, refer to the tables in Chapter 5 of the Universal Serial Bus Specification, Revision 2.0. Keep in mind that they do not account for software overhead, and the class driver also introduces some overhead. Reaching even 60% of the limit in real world use is a very good result, especially for high speed.

B.2.1 Mass Storage Performance

The following is a table of **raw data** read/write performance. The device driver reads/writes 4KB of data at a time from/to the USB flash disk, for an overall transfer of 30MB.

Host Controller	Raw Reading	Raw Writing
EHCI (NEC)	12684 KB/s	8320 KB/s
OHCI (NEC)	891 KB/s	832 KB/s
UHCI (VIA)	639 KB/s	611 KB/s
ISP116x (NXP)	352 KB/s	334 KB/s
ISP1362 (NXP)	621 KB/s	493 KB/s
ISP176x (NXP)	7425 KB/s	3214 KB/s
Blackfin (ADI)	10000 KB/s	8000 KB/s

The following is a table of measured **smxFile** read/write performance. The file operations read/write 4KB data at a time from/to a USB flash disk, for an overall file size of 20MB.

Host Controller	File Reading	File Writing
OHCI (NEC)	645 KB/s	425 KB/s
UHCI (VIA)	425 KB/s	339 KB/s
ISP116x (NXP)	330 KB/s	298 KB/s
ISP1362 (NXP)	402 KB/s	386 KB/s

The following is a table of measured **smxFS** read/write performance. The file operations read/write 4KB data at a time from/to a USB flash disk, for an overall file size of 20MB.

Host Controller	File Reading	File Writing
EHCI (NEC)	10556 KB/s	7787 KB/s
OHCI (NEC)	885 KB/s	817 KB/s
UHCI (VIA)	611 KB/s	590 KB/s
ISP116x (NXP)	336 KB/s	328 KB/s
ISP1362 (NXP)	591 KB/s	478 KB/s
ISP176x (NXP)	7023 KB/s	3072 KB/s

Blackfin (ADI)	9500 KB/s	7500 KB/s

*The hardware environment for this testing is:
Celeron 300MHz CPU; 32MB 100M SDRAM; PC motherboard; Host Controller connects to System by 33MHz PCI bus.
**Flash Disk is Lexar JumpDrive USB 2.0 512MB
***CPU speed, SDRAM speed and size, External Memory Bus speed will affect the performance.

The following is a table of measured **smxFS** read/write performance for some ARM chips. The file operations read/write 4KB data at a time from/to a USB flash disk, for an overall file size of 20MB.

Host Controller	**File Reading**	**File Writing**
Atmel SAM9260 OHCI Host Controller (AHB is 105 MHz)	555 KB/s	505 KB/s
Atmel SAM9261 OHCI Host Controller (AHB is 60 MHz)	458 KB/s	414 KB/s
Cirrus Logic EP9315 OHCI Host Controller	575 KB/s	498 KB/s

The following is a table for performance testing of EHCI controller and USB hard disk.

Host Controller	**Raw Reading**	**Raw Writing**
VIA EHCI Host Controller	24966 KB/s	19784 KB/s

*The hardware environment for this testing is:
Celeron 300MHz CPU; 32MB 100M SDRAM; PC motherboard; Host Controller connects to System by 33MHz PCI bus.
** Disk is LACIE USB 2.0 40GB

B.2.2 Serial Port Performance

The following is a table of serial port read/write performance. The device driver reads/writes 256 bytes of data at a time from/to the USB serial device (not connected to a real RS232 device).

Host Controller	**Data Reading**	**Data Writing**
OHCI (NEC)	124 KB/s	124 KB/s

Appendix C. Tested Host Controllers and Devices

C.1 Host Controllers

C.1.1 EHCI Controllers

- Atmel AT91SAM9M10G45 built-in EHCI controller
- Coldfire 5329 Built-in EHCI Controller
- Freescale i.MX31 built-in EHCI controller
- NEC D720101GJ PCI EHCI Controller
- NXP LPC313x/4x/5x built-in EHCI controller
- TI AM3517 built-in EHCI controller
- VIA VT6212L PCI EHCI Controller

C.1.2 OHCI Controllers

- ALi M5273 PCI OHCI Controller
- Atmel AT91RM9200 built-in OHCI controller
- Atmel AT91SAM9260/1/3 built-in OHCI controller
- Atmel AT91SAM9M10G45 built-in OHCI controller
- Cirrus Logic EDB9315 built-in OHCI controller
- Cyrix CS5530A (chipset for Geode GX1)
- NEC D720101GJ PCI OHCI Controller
- NXP ISP1561
- NXP LPC2xxx/3xxx built-in OHCI controller
- Samsung S3C2443 built-in OHCI controller
- Sharp LH7A404 built-in OHCI controller
- TI AM17x/18x/35x built-in OHCI controller

C.1.3 UHCI Controllers

- Intel 82371AB built-in UHCI Controller
- Intel 82801DB built-in UHCI Controller
- VIA VT6212L PCI UHCI Controller
- VIA VT8233 built-in UHCI Controller
- VIA VT82c686B built-in UHCI Controller

C.2 Audio Devices

- Cyber Acoustics AC-850 USB Stereo Headset with Microphone
- Cyber Acoustics CA-2908 USB Speaker
- FD552 USB 3D Sound Adaptor
- HP PM107A#ABA 2-Piece Virtual Surround Sound USB Speakers
- Logitech Premium USB Headset 350

- Logitech USB Desktop Microphone
- MIDIPLUS AKM322 MIDI Keyboard

C.3 CDC ACM (Modem) Devices

- MultiTech MT5634ZBA-USB
- Sony Ericsson K800i Mobile Phone
- Sony Ericsson W950i Mobile Phone

C.4 HID Devices

- Apple Pro Keyboard
- Apple Pro Mouse
- Dell USB Keyboard
- Dell USB Mouse
- Logitech Extreme 3D Pro Joystick
- Logitech USB Keyboard
- Logitech M-BD69 USB Mouse
- Microsoft Digital Media Keyboard
- Microsoft Intellimouse Optical USB Mouse

C.5 Mass Storage Devices

Tested by Micro Digital:

- ADISK USB 1.1 32MB flash disk
- Aigo USB 1.1 64M flash disk
- Crucial 1G flash disk
- FPT-D US5B2H01 18-in-1 USB card reader/writer
- HP 1G flash disk
- IBM Portable Diskette Drive (floppy drive)
- IBM USB 2.0 CD-RW / DVD-ROM Combo II Drive (CD-ROM)
- Integral USB 2.0 2GB flash disk
- Kingston DataTraveler 1GB flash disk
- Kingston DataTraveler 100 2GB flash disk
- Kingston DataTraveler 16GB flash disk
- LACIE USB 2.0 40GB mobile hard drive
- Lexar Media JumpDrive Secure USB 2.0 512MB flash disk
- Memorex 2GB flash disk
- NCP XDrivePlus MMC/SD reader
- Newman USB 1.1 64MB flash disk
- PNY Attache USB 1.1 64MB flash disk
- PNY Attache (U3) 1GB
- PNY Attache 2GB
- PNY Attache 8GB

- PQI MMC/SD reader
- RedLeaf USB 2.0 256MB flash disk
- SanDisk Cruzer USB 2.0 256MB flash disk
- SanDisk Cruzer Micro 2GB flash disk
- SanDisk Cruzer Micro (U3) 2GB flash disk
- SanDisk Cruzer Micro (U3) 4GB flash disk
- SONY MICROVAULT USM256U2 USB 2.0 256MB flash disk
- Transcend JF V30 4GB flash disk

Tested by others:

- Edge DiskGO™ 1GB USB Flash Drive Enhanced for ReadyBoost™
- Edge DiskGO™ 2GB USB Flash Drive Enhanced for ReadyBoost™
- Imation 1GB Swivel USB Flash Drive
- Imation 2GB Swivel USB Flash Drive
- Integral 1GB USB Memory Stick
- MARKEM 1GB USB Memory Stick
- Memorex 1GB TravelDrive™ USB Flash Drive
- Memorex 2GB TravelDrive™ USB Flash Drive
- PNY 1GB Attache USB Flash Drive
- SanDisk 2GB Cruzer® Crossfire USB Flash Drive
- SanDisk 512MB Cruzer® Micro USB Flash Drive
- SanDisk 2GB Cruzer® Micro USB Flash Drive
- SanDisk 4GB Cruzer® Micro USB Flash Drive (U3 function not initialized)
- Sony 512MB Micro Vault Tiny USB Flash Drive
- Sony 2GB Micro Vault Tiny USB Flash Drive
- Sony 1GB Micro Vault Classic USB Flash Drive
- Sony 4GB Micro Vault Classic USB Flash Drive
- X Digital Media 1GB Itty Bit USB Flash Drive
- X Digital Media 1GB Poker Chip USB Flash Drive
- X Digital Media 2GB Itty Bit USB Flash Drive

C.6 Printer Devices

- HP Deskjet 2400 series
- HP Deskjet 3500 series
- HP LaserJet 3015
- Panasonic UF 8000 USB facsimile

C.7 FTDI Serial Devices

- QVS USB to RS-232 Cable (FTDI FT232B)
- USB-COM232-PLUS1 (FTDI FT232R)
- VS COM USB to RS-232 Cable (FTDI FT232B)

C.8 Windows Mobile 5 Serial Devices

- Motorola Q Smartphone
- Palm Treo PDA phone

C.9 USB to Ethernet Devices

- D-Link DUB-E100 Adapter (based on ASIX 88772)

C.10 Ralink RT250x WiFi Dongles

- Belkin F5D7050 v3002
- D-Link EWUGRL2700
- Linksys WUSB54GC

C.11 Ralink RT2870 WiFi Dongles

- AmbiCom M600N-USB
- BELKIN N Wireless F5D8053 v3001
- Buffalo WLI-UC-G300N
- D-Link DWA-140

C.12 Ralink RT3070 WiFi Dongles

- AmbiCom WL150N-nUSB
- AmbiCom WL150N-USBx
- Asus USB-N13
- Ralink 3070 WS-WNU682N
- Linksys WUSB54GC ver.3

C.13 Ralink RT3572 WiFi Dongles

- Linksys WUSB600N ver.2
- Linksys AE1000

C.14 Ralink RT5370 WiFi Dongles

- Ralink RT5370 OEM dongle

C.15 MediaTek MT7601 WiFi Dongles

- MediaTek MT7601 OEM dongle

C.16 Sierra Wireless Dongles

- USB 598

C.17 Video Cameras

- Creative Socialize 1080p
- Logitech C200
- Logitech HD Pro Webcam C920

Appendix D. Testing

Unlike USB devices, which plug into USB Hosts, there is no protocol compliance testing available for USB Hosts. Instead testing of the host stack and class drivers is done by testing multiple devices of each class as listed in: Appendix C. Tested Host Controllers and Devices.

Appendix E. Specification Reference

smxUSBH is based on the following specifications. USB specifications are available at www.usb.org or at www.usb.org/developers/docs.

E.1 USB Specifications

Universal Serial Bus Specification, Revision 1.1
Universal Serial Bus Specification, Revision 2.0

E.2 Host Controller Specifications

Open Host Controller Interface Specification for USB, Release: 1.0a
Universal Host Controller Interface (UHCI) Design Guide, Revision 1.1
Enhanced Host Controller Interface Specification for Universal Serial Bus, Revision 1.0
ISP1161 Full-speed Universal Serial Bus single-chip host and device controller, Rev. 02
ISP1161 Embedded Programming Guide, Rev 1.0
ISP1362 Single-chip Universal Serial Bus On-The-Go controller, Rev. 04
ISP1760 Hi-Speed Universal Serial Bus host controller for embedded applications, Rev. 02
ISP1761 Hi-Speed Universal Serial Bus On-The-Go controller, Rev. 02
ISP1763A Hi-Speed USB OTG controller, Rev. 01

E.3 PCI Specification

PCI Local Bus Specification, Revision 2.1

E.4 Audio Devices Specifications

Universal Serial Bus Device Class Definition for Audio Devices, Revision 1.0
Universal Serial Bus Device Class Definition for Terminal Types, Revision 1.0
Universal Serial Bus Device Class Definition for Audio Data Formats, Revision 1.0
Universal Serial Bus Device Class Definition for MIDI Devices, Revision 1.0

E.5 Communication Devices Specifications

Universal Serial Bus Device Class Definition for Communication Devices, Revision 1.1

E.6 HID Specifications

Universal Serial Bus Device Class Definition for Human Interface Devices, Revision 1.11
Universal Serial Bus HID Usage Tables, Version 1.12

E.7 Mass Storage Specifications

Universal Serial Bus Mass Storage Class Specification Overview, Revision 1.2

Universal Serial Bus Mass Storage Class Bulk-Only Transport, Revision 1.0
Universal Serial Bus Mass Storage Class Bulk/Control/Interrupt Transport, Revision 1.1
Universal Serial Bus Mass Storage Class UFI Command Specification, Revision 1.0
SCSI Primary Commands - 2 (SPC-2), Revision 20
SCSI Block Commands - 2 (SBC-2), Revision 14
SFF-8070i Specification for ATAPI Removable Re-writable Media Devices, Rev 1.2
SFF-8020i ATA Packet Interface for CD-ROMs, Revision 2.6
QIC 157, Revision D

E.8 Printer Specifications

Universal Serial Bus Device Class Definition for Printing Devices, Revision 1.1

E.9 Video Class Specifications

Universal Serial Bus Device Class Definition for Video Devices, Revision 1.1

E.10 Referenced Documents

SMX Quick Start - www.smxrtos.com/doc
smxWiFi User's Guide - www.smxrtos.com/doc

Appendix F. Glossary

API	Application Interface
BSP	Board Support Package
CDC	Communications Device Class
EHCI	Enhanced Host Controller Interface
EOI	End Of Interrupt
HCD	Host Controller Driver
HID	Human Interface Device
.inf	Setup Information file, in plain text format
ISOC	Isochronous
ISR	Interrupt Service Routine
LSR	Link Service Routine
MMU	Memory Management Unit
OHCI	Open Host Controller Interface
OS	Operating System
RTOS	Real Time Operating System
UHCI	Universal Host Controller Interface
USB	Universal Serial Bus
USBD	USB Driver
USBDI	USB Driver Interface