

MUSCLE PC/SC Lite API

Toolkit API Reference Documentation

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Abstract

This toolkit and documentation is provided on an *as is* basis. The authors shall not be held responsible for any mishaps caused by the use of this software.

For more information please visit <http://www.musclecard.com/>.

Document history:

| | | |
|-------|---------------|--|
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1 Introduction/Overview

This document contains the reference API calls for communicating to the MUSCLE PC/SC Smart Card Resource Manager. PC/SC is a standard proposed by the PC/SC workgroup [2] which is a conglomerate of representative from major smart card manufacturers and other companies. This specification tries to abstract the smart card layer into a high level API so that smart cards and their readers can be accessed in a homogeneous fashion.

This toolkit was written in ANSI C that can be used with most compilers and does NOT use complex and large data structures such as vectors, *etc.* The C API emulates the winscard API that is used on the Windows platform. It is contained in the library `libpcsc-lite.so` that is linked to your application.

I would really like to hear from you. If you have any feedback either on this documentation or on the MUSCLE project please feel free to email me at: corcoran@musclecard.com.

2 Definitions

2.1 Defined types

The following is a list of commonly used type definitions in the following API. These definitions and more can be found in the `include/pcsc-lite.h` file.

| PC/SC type | C type |
|----------------|-----------------------|
| BOOL | short |
| BYTE | unsigned char |
| DWORD | unsigned long |
| LONG | long |
| LPBYTE | unsigned char * |
| LPCBYTE | const unsigned char * |
| LPCTSTR | const char * |
| LPCVOID | const void * |
| LPCWSTR | char * |
| LPDWORD | unsigned long * |
| LPSCARDCONTEXT | unsigned long * |
| LPSCARDHANDLE | unsigned long * |
| LPTSTR | char * |
| LPVOID | void * |
| PSCARDCONTEXT | unsigned long * |
| PSCARDHANDLE | unsigned long * |
| RESPONSECODE | long |
| SCARDCONTEXT | unsigned long |
| SCARDHANDLE | unsigned long |
| ULONG | unsigned long |

| | |
|--------|----------------|
| USHORT | unsigned short |
| WORD | unsigned long |

2.2 Error codes

The following is a list of commonly used errors. Since different cards produce different errors they must map over to these error messages.

| |
|-----------------------------|
| SCARD_S_SUCCESS |
| SCARD_E_CANCELLED |
| SCARD_E_CANT_DISPOSE |
| SCARD_E_CARD_UNSUPPORTED |
| SCARD_E_DUPLICATE_READER |
| SCARD_E_INSUFFICIENT_BUFFER |
| SCARD_E_INVALID_ATR |
| SCARD_E_INVALID_HANDLE |
| SCARD_E_INVALID_PARAMETER |
| SCARD_E_INVALID_TARGET |
| SCARD_E_INVALID_VALUE |
| SCARD_E_NO_MEMORY |
| SCARD_E_NO_SERVICE |
| SCARD_E_NO_SMARTCARD |
| SCARD_E_NOT_READY |
| SCARD_E_NOT_TRANSACTED |
| SCARD_E_PCI_TOO_SMALL |
| SCARD_E_PROTO_MISMATCH |
| SCARD_E_READER_UNAVAILABLE |
| SCARD_E_READER_UNSUPPORTED |
| SCARD_E_SERVICE_STOPPED |
| SCARD_E_SHARING_VIOLATION |
| SCARD_E_SYSTEM_CANCELLED |
| SCARD_E_TIMEOUT |
| SCARD_E_UNKNOWN_CARD |
| SCARD_E_UNKNOWN_READER |
| SCARD_F_COMM_ERROR |
| SCARD_F_INTERNAL_ERROR |
| SCARD_F_UNKNOWN_ERROR |
| SCARD_F_WAITED_TOO_LONG |
| SCARD_W_UNSUPPORTED_CARD |
| SCARD_W_UNRESPONSIVE_CARD |
| SCARD_W_UNPOWERED_CARD |
| SCARD_W_RESET_CARD |
| SCARD_W_REMOVED_CARD |

3 API Routines

These routines specified here are winscard routines like those in the winscard API provided under Windows®. These are compatible with the Microsoft® API calls. This list of calls is mainly an abstraction of readers. It gives a common API for communication to most readers in a homogeneous fashion.

Since all functions can produce a wide array of errors, please refer to § 2.2 on the preceding page for a list of error returns.

For a human readable representation of an error the function `pcsc_stringify_error()` is declared in `pcsc-lite.h`. This function is not available on Microsoft® winscard API and is pcsc-lite specific.

3.1 SCardEstablishContext

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardEstablishContext(DWORD dwScope,  
    LPCVOID pvReserved1,  
    LPCVOID pvReserved2,  
    LPSCARDCONTEXT phContext);
```

Parameters:

| | | |
|--------------------------|-----|---|
| <code>dwScope</code> | IN | Scope of the establishment This can either be a local or remote connection |
| <code>pvReserved1</code> | IN | Reserved for future use. Can be used for remote connection |
| <code>pvReserved2</code> | IN | Reserved for future use |
| <code>phContext</code> | OUT | Returned reference to this connection |

Description:

This function creates a communication context to the PC/SC Resource Manager. This must be the first function called in a PC/SC application.

| Value of <code>dwScope</code> | Meaning |
|-----------------------------------|-------------------------------|
| <code>SCARD_SCOPE_USER</code> | Not used |
| <code>SCARD_SCOPE_TERMINAL</code> | Not used |
| <code>SCARD_SCOPE_GLOBAL</code> | Not used |
| <code>SCARD_SCOPE_SYSTEM</code> | Services on the local machine |

Example:

```
SCARDCONTEXT hContext;  
LONG rv;  
  
rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
```

Returns:

| | |
|-----------------------|---------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_VALUE | Invalid scope type passed |

3.2 SCardReleaseContext

Synopsis:

```
#include <winscard.h>  
  
LONG SCardReleaseContext(SCARDCONTEXT hContext);
```

Parameters:

hContext IN Connection context to be closed

Description:

This function destroys a communication context to the PC/SC Resource Manager. This must be the last function called in a PC/SC application.

Example:

```
SCARDCONTEXT hContext;  
LONG rv;  
  
rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);  
rv = SCardReleaseContext(hContext);
```

Returns:

| | |
|------------------------|-------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hContext handle |

3.3 SCardListReaders

Synopsis:

```
#include <winscard.h>

LONG SCardListReaders(SCARDCONTEXT hContext,
    LPCTSTR mszGroups,
    LPTSTR mszReaders,
    LPDWORD pcchReaders);
```

Parameters:

| | | |
|--------------------|-------|--|
| hContext | IN | Connection context to the PC/SC Resource Manager |
| mszGroups | IN | List of groups to list readers (not used) |
| mszReaders | OUT | Multi-string with list of readers |
| pcchReaders | INOUT | Size of multi-string buffer including NULL's |

Description:

This function returns a list of currently available readers on the system. **mszReaders** is a pointer to a character string that is allocated by the application. If the application sends **mszGroups** and **mszReaders** as NULL then this function will return the size of the buffer needed to allocate in **pcchReaders**.

The reader names is a multi-string and separated by a nul character (`'\0'`) and ended by a double nul character. "Reader A\0Reader B\0\0".

Example:

```
SCARDCONTEXT hContext;
LPTSTR mszReaders;
DWORD dwReaders;
LONG rv;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardListReaders(hContext, NULL, NULL, &dwReaders);
mszReaders = (LPTSTR)malloc(sizeof(char)*dwReaders);
rv = SCardListReaders(hContext, NULL, mszReaders, &dwReaders);
```


Returns:

| | |
|-----------------------------|--------------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid Scope Handle |
| SCARD_E_INSUFFICIENT_BUFFER | Reader buffer not large enough |

3.4 SCardListReaderGroups

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardListReaderGroups(SCARDCONTEXT hContext,  
    LPTSTR mszGroups,  
    LPDWORD pcchGroups);
```

Parameters:

| | | |
|------------|-------|--|
| hContext | IN | Connection context to the PC/SC Resource Manager |
| mszGroups | OUT | List of groups to list readers |
| pcchGroups | INOUT | Size of multi-string buffer including NULL's |

Description:

This function returns a list of currently available reader groups on the system. **mszGroups** is a pointer to a character string that is allocated by the application. If the application sends **mszGroups** as NULL then this function will return the size of the buffer needed to allocate in **pcchGroups**.

The group names is a multi-string and separated by a nul character ('\\0') and ended by a double nul character. "SCard\$DefaultReaders\\0Group 2\\0\\0".

Example:

```
SCARDCONTEXT hContext;  
LPTSTR mszGroups;  
DWORD dwGroups;  
LONG rv;  
  
rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);  
rv = SCardListReaderGroups(hContext, NULL, &dwGroups);  
mszGroups = (LPTSTR)malloc(sizeof(char)*dwGroups);  
rv = SCardListReaderGroups(hContext, mszGroups, &dwGroups);
```

Returns:

| | |
|-----------------------------|--------------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid Scope Handle |
| SCARD_E_INSUFFICIENT_BUFFER | Reader buffer not large enough |

3.5 SCardConnect

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardConnect(SCARDCONTEXT hContext,  
    LPCTSTR szReader,  
    DWORD dwShareMode,  
    DWORD dwPreferredProtocols,  
    LPSCARDHANDLE phCard,  
    LPDWORD pdwActiveProtocol);
```

Parameters:

| | | |
|----------------------|-----|--|
| hContext | IN | Connection context to the PC/SC Resource Manager |
| szReader | IN | Reader name to connect to |
| dwShareMode | IN | Mode of connection type: exclusive or shared |
| dwPreferredProtocols | IN | Desired protocol use |
| phCard | OUT | Handle to this connection |
| pdwActiveProtocol | OUT | Established protocol to this connection. |

Description:

This function establishes a connection to the friendly name of the reader specified in `szReader`. The first connection will power up and perform a reset on the card.

| Value of dwScope | Meaning |
|-----------------------|--|
| SCARD_SHARE_SHARED | This application will allow others to share the reader |
| SCARD_SHARE_EXCLUSIVE | This application will NOT allow others to share the reader |
| SCARD_SHARE_DIRECT | Direct control of the reader, even without a card |

SCARD_SHARE_DIRECT can be used before using `SCardControl()` to send control commands to the reader even if a card is not present in the reader.

| Value of dwPreferredProtocols | Meaning |
|-------------------------------|----------------------------|
| SCARD_PROTOCOL_T0 | Use the T=0 protocol |
| SCARD_PROTOCOL_T1 | Use the T=1 protocol |
| SCARD_PROTOCOL_RAW | Use with memory type cards |

`dwPreferredProtocols` is a bit mask of acceptable protocols for the connection. You can use `(SCARD_PROTOCOL_T0 | SCARD_PROTOCOL_T1)` if you do not have a preferred protocol.

Example:

```
SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol;
LONG rv;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
    SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
```

Returns:

| | |
|--|--|
| <code>SCARD_S_SUCCESS</code> | Successful |
| <code>SCARD_E_INVALID_HANDLE</code> | Invalid <code>hContext</code> handle |
| <code>SCARD_E_INVALID_VALUE</code> | Invalid sharing mode, requested protocol, or reader name |
| <code>SCARD_E_NOT_READY</code> | Could not allocate the desired port |
| <code>SCARD_E_READER_UNAVAILABLE</code> | Could not power up the reader or card |
| <code>SCARD_E_SHARING_VIOLATION</code> | Someone else has exclusive rights |
| <code>SCARD_E_UNSUPPORTED_FEATURE</code> | Protocol not supported |

3.6 SCardReconnect

Synopsis:

```
#include <winscard.h>

LONG SCardReconnect(SCARDHANDLE hCard,
    DWORD dwShareMode,
    DWORD dwPreferredProtocols,
    DWORD dwInitialization,
    LPDWORD pdwActiveProtocol);
```

Parameters:

| | | |
|----------------------|-----|---|
| hCard | IN | Handle to a previous call to connect |
| dwShareMode | IN | Mode of connection type: exclusive/shared |
| dwPreferredProtocols | IN | Desired protocol use |
| dwInitialization | IN | Desired action taken on the card/reader |
| pdwActiveProtocol | OUT | Established protocol to this connection |

Description:

This function reestablishes a connection to a reader that was previously connected to using `SCardConnect()`. In a multi application environment it is possible for an application to reset the card in shared mode. When this occurs any other application trying to access certain commands will be returned the value `SCARD_W_RESET_CARD`. When this occurs `SCardReconnect()` must be called in order to acknowledge that the card was reset and allow it to change it's state accordingly.

| Value of dwShareMode | Meaning |
|-----------------------|--|
| SCARD_SHARE_SHARED | This application will allow others to share the reader |
| SCARD_SHARE_EXCLUSIVE | This application will NOT allow others to share the reader |

| Value of dwPreferredProtocols | Meaning |
|-------------------------------|----------------------------|
| SCARD_PROTOCOL_T0 | Use the T=0 protocol |
| SCARD_PROTOCOL_T1 | Use the T=1 protocol |
| SCARD_PROTOCOL_RAW | Use with memory type cards |

`dwPreferredProtocols` is a bit mask of acceptable protocols for the connection. You can use `(SCARD_PROTOCOL_T0 | SCARD_PROTOCOL_T1)` if you do not have a preferred protocol.

| Value of dwInitialization | Meaning |
|---------------------------|-------------------------------|
| SCARD_LEAVE_CARD | Do nothing |
| SCARD_RESET_CARD | Reset the card (warm reset) |
| SCARD_UNPOWER_CARD | Unpower the card (cold reset) |
| SCARD_EJECT_CARD | Eject the card |

Example:

```
SCARDCONTEXT hContext;  
SCARDHANDLE hCard;  
DWORD dwActiveProtocol, dwSendLength, dwRecvLength;  
LONG rv;  
BYTE pbRecvBuffer[10];  
BYTE pbSendBuffer[] = {0xC0, 0xA4, 0x00, 0x00, 0x02, 0x3F, 0x00};  
  
rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
```

```

rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
    SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
dwSendLength = sizeof(pbSendBuffer);
dwRecvLength = sizeof(pbRecvBuffer);
rv = SCardTransmit(hCard, SCARD_PCI_T0, pbSendBuffer, dwSendLength,
    &pioRecvPci, pbRecvBuffer, &dwRecvLength);

/* Card has been reset by another application */
if (rv == SCARD_W_RESET_CARD)
{
    rv = SCardReconnect(hCard, SCARD_SHARE_SHARED, SCARD_PROTOCOL_T0,
        SCARD_RESET_CARD, &dwActiveProtocol);
}

```

Returns:

| | |
|-----------------------------|--|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hCard handle |
| SCARD_E_NOT_READY | Could not allocate the desired port |
| SCARD_E_INVALID_VALUE | Invalid sharing mode, requested protocol, or reader name |
| SCARD_E_READER_UNAVAILABLE | The reader has been removed |
| SCARD_E_UNSUPPORTED_FEATURE | Protocol not supported |
| SCARD_E_SHARING_VIOLATION | Someone else has exclusive rights |

3.7 SCardDisconnect

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardDisconnect(SCARDHANDLE hCard, DWORD dwDisposition);
```

Parameters:

| | | |
|---------------|----|-----------------------------------|
| hCard | IN | Connection made from SCardConnect |
| dwDisposition | IN | Reader function to execute |

Description:

This function terminates a connection to the connection made through SCardConnect. dwDisposition can have the following values:

| Value of dwDisposition | Meaning |
|------------------------|-------------------------------|
| SCARD_LEAVE_CARD | Do nothing |
| SCARD_RESET_CARD | Reset the card (warm reset) |
| SCARD_UNPOWER_CARD | Unpower the card (cold reset) |
| SCARD_EJECT_CARD | Eject the card |

Example:

```

SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol;
LONG rv;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
                  SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
rv = SCardDisconnect(hCard, SCARD_UNPOWER_CARD);

```

Returns:

| | |
|------------------------|-----------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hCard handle |
| SCARD_E_INVALID_VALUE | Invalid dwDisposition |

3.8 SCardBeginTransaction

Synopsis:

```

#include <winscard.h>

LONG SCardBeginTransaction(SCARDHANDLE hCard);

```

Parameters:

hCard IN Connection made from SCardConnect

Description:

This function establishes a temporary exclusive access mode for doing a series of commands or transaction. You might want to use this when you are selecting a few files and then writing a large file so you can make sure that another application will not change

the current file. If another application has a lock on this reader or this application is in SCARD_SHARE_EXCLUSIVE there will be no action taken.

Example:

```
SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol;
LONG rv;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
    SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
rv = SCardBeginTransaction(hCard);

/* Do some transmit commands */
```

Returns:

| | |
|----------------------------|-----------------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hCard handle |
| SCARD_E_SHARING_VIOLATION | Someone else has exclusive rights |
| SCARD_E_READER_UNAVAILABLE | The reader has been removed |

3.9 SCardEndTransaction

Synopsis:

```
#include <winscard.h>

LONG SCardEndTransaction(SCARDHANDLE hCard,
    DWORD dwDisposition);
```

Parameters:

| | | |
|---------------|----|-----------------------------------|
| hCard | IN | Connection made from SCardConnect |
| dwDisposition | IN | Action to be taken on the reader |

Description:

This function ends a previously begun transaction. The calling application must be the owner of the previously begun transaction or an error will occur. **dwDisposition** can have the following values: The disposition action is not currently used in this release.

| Value of dwDisposition | Meaning |
|------------------------|------------------|
| SCARD_LEAVE_CARD | Do nothing |
| SCARD_RESET_CARD | Reset the card |
| SCARD_UNPOWER_CARD | Unpower the card |
| SCARD_EJECT_CARD | Eject the card |

Example:

```

SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol;
LONG rv;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
    SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
rv = SCardBeginTransaction(hCard);

/* Do some transmit commands */

rv = SCardEndTransaction(hCard, SCARD_LEAVE_CARD);

```

Returns:

| | |
|----------------------------|-----------------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hCard handle |
| SCARD_E_SHARING_VIOLATION | Someone else has exclusive rights |
| SCARD_E_READER_UNAVAILABLE | The reader has been removed |

3.10 SCardTransmit

Synopsis:

```

#include <winscard.h>

LONG SCardTransmit(SCARDHANDLE hCard,
    LPCSCARD_IO_REQUEST pioSendPci,
    LPBYTE pbSendBuffer,
    DWORD cbSendLength,
    LPCSCARD_IO_REQUEST pioRecvPci,
    LPBYTE pbRecvBuffer,
    LPDWORD pcbRecvLength);

```


Parameters:

| | | |
|---------------|-------|-----------------------------------|
| hCard | IN | Connection made from SCardConnect |
| pioSendPci | INOUT | Structure of protocol information |
| pbSendBuffer | IN | APDU to send to the card |
| cbSendLength | IN | Length of the APDU |
| pioRecvPci | INOUT | Structure of protocol information |
| pbRecvBuffer | OUT | Response from the card |
| pcbRecvLength | INOUT | Length of the response |

Description:

This function sends an APDU to the smart card contained in the reader connected to by SCardConnect(). The card responds from the APDU and stores this response in pbRecvBuffer and it's length in SpcbRecvLength. SSendPci and SRecvPci are structures containing the following:

```
typedef struct {
    DWORD dwProtocol;    /* SCARD_PROTOCOL_T0 or SCARD_PROTOCOL_T1 */
    DWORD cbPciLength;    /* Length of this structure - not used */
} SCARD_IO_REQUEST;
```

| Value of pioSendPci | Meaning |
|---------------------|-------------------------------|
| SCARD_PCI_T0 | Pre-defined T=0 PCI structure |
| SCARD_PCI_T1 | Pre-defined T=1 PCI structure |

Example:

```
LONG rv;
SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol, dwSendLength, dwRecvLength;
SCARD_IO_REQUEST pioRecvPci;
BYTE pbRecvBuffer[10];
BYTE pbSendBuffer[] = { 0xC0, 0xA4, 0x00, 0x00, 0x02, 0x3F, 0x00 };

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
    SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
dwSendLength = sizeof(pbSendBuffer);
dwRecvLength = sizeof(pbRecvBuffer);
rv = SCardTransmit(hCard, SCARD_PCI_T0, pbSendBuffer, dwSendLength,
    &pioRecvPci, pbRecvBuffer, &dwRecvLength);
```

Returns:

| | |
|----------------------------|--|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hCard handle |
| SCARD_E_NOT_TRANSACTED | APDU exchange not successful |
| SCARD_E_PROTO_MISMATCH | Connect protocol is different than desired |
| SCARD_E_INVALID_VALUE | Invalid Protocol, reader name, etc |
| SCARD_E_READER_UNAVAILABLE | The reader has been removed |
| SCARD_W_RESET_CARD | The card has been reset by another application |
| SCARD_W_REMOVED_CARD | The card has been removed from the reader |

3.11 SCardControl

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardControl(SCARDHANDLE hCard,  
    DWORD dwControlCode,  
    LPCVOID pbSendBuffer,  
    DWORD cbSendLength,  
    LPVOID pbRecvBuffer,  
    DWORD pcbRecvLength,  
    LPDWORD lpBytesReturned);
```

Parameters:

| | | |
|-----------------|-----|-----------------------------------|
| hCard | IN | Connection made from SCardConnect |
| dwControlCode | IN | Control code for the operation |
| pbSendBuffer | IN | Command to send to the reader |
| cbSendLength | IN | Length of the command |
| pbRecvBuffer | OUT | Response from the reader |
| pcbRecvLength | IN | Length of the response buffer |
| lpBytesReturned | OUT | Length of the response |

Description:

This function sends a command directly to the IFD Handler to be processed by the reader. This is useful for creating client side reader drivers for functions like PIN pads, biometrics, or other extensions to the normal smart card reader that are not normally handled by PC/SC.

Note: the API of this function changed. In pcsc-lite 1.2.0 and before the API was not Windows® PC/SC compatible. This has been corrected.

see § 5 for a list of supported commands by some drivers.

Example:

```
LONG rv;
SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol, dwSendLength, dwRecvLength;
BYTE pbRecvBuffer[10];
BYTE pbSendBuffer[] = { 0x06, 0x00, 0x0A, 0x01, 0x01, 0x10 0x00 };

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
    SCARD_PROTOCOL_RAW &hCard, &dwActiveProtocol);
dwSendLength = sizeof(pbSendBuffer);
dwRecvLength = sizeof(pbRecvBuffer);
rv = SCardControl(hCard, 0x42000001, pbSendBuffer, dwSendLength,
    pbRecvBuffer, sizeof(pbRecvBuffer), &dwRecvLength);
```

Returns:

| | |
|----------------------------|--|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_NOT_TRANSACTED | Data exchange not successful |
| SCARD_E_INVALID_HANDLE | Invalid hCard handle |
| SCARD_E_INVALID_VALUE | Invalid value was presented |
| SCARD_E_READER_UNAVAILABLE | The reader has been removed |
| SCARD_W_RESET_CARD | The card has been reset by another application |
| SCARD_W_REMOVED_CARD | The card has been removed from the reader |

3.12 SCardStatus

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardStatus(SCARDHANDLE hCard,
    LPTSTR szReaderName,
    LPDWORD pcchReaderLen,
    LPDWORD pdwState,
    LPDWORD pdwProtocol,
    LPBYTE pbAtr,
    LPDWORD pcbAtrLen);
```

Parameters:

| | | |
|---------------|-------|---|
| hCard | IN | Connection made from <code>SCardConnect</code> |
| szReaderName | INOUT | Friendly name of this reader |
| pcchReaderLen | INOUT | Size of the <code>szReaderName</code> multistring |
| pdwState | OUT | Current state of this reader |
| pdwProtocol | OUT | Current protocol of this reader |
| pbAtr | OUT | Current ATR of a card in this reader |
| pcbAtrLen | OUT | Length of ATR |

Description:

This function returns the current status of the reader connected to by `hCard`. It's friendly name will be stored in `szReaderName`. `pcchReaderLen` will be the size of the allocated buffer for `szReaderName`. If this is too small the function will return with the necessary size in `pcchReaderLen`. The current state, and protocol will be stored in `pdwState` and `pdwProtocol` respectively. `pdwState` is a `DWORD` possibly OR'd with the following values:

| Value of <code>pdwState</code> | Meaning |
|--------------------------------|---|
| <code>SCARD_ABSENT</code> | There is no card in the reader |
| <code>SCARD_PRESENT</code> | There is a card in the reader, but it has not been moved into position for use |
| <code>SCARD_SWALLOWED</code> | There is a card in the reader in position for use. The card is not powered |
| <code>SCARD_POWERED</code> | Power is being provided to the card, but the reader driver is unaware of the mode of the card |
| <code>SCARD_NEGOTIABLE</code> | The card has been reset and is awaiting PTS negotiation |
| <code>SCARD_SPECIFIC</code> | The card has been reset and specific communication protocols have been established |

| Value of <code>dwPreferredProtocols</code> | Meaning |
|--|----------------------|
| <code>SCARD_PROTOCOL_T0</code> | Use the T=0 protocol |
| <code>SCARD_PROTOCOL_T1</code> | Use the T=1 protocol |

Example:

```
SCARDCONTEXT hContext;  
SCARDHANDLE hCard;  
DWORD dwActiveProtocol;  
DWORD dwState, dwProtocol, dwAtrLen, dwReaderLen;  
BYTE pbAtr[MAX_ATR_SIZE];  
  
rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);  
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,  
    SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
```

```
dwAtrLen = sizeof(pbAtr);
rv=SCardStatus(hCard, NULL, &dwReaderLen, &dwState, &dwProtocol,
pbAtr, &dwAtrLen);
```

Returns:

| | |
|-----------------------------|---|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hCard handle |
| SCARD_E_INSUFFICIENT_BUFFER | Not enough allocated memory for szReaderName or for pbAtr |
| SCARD_E_READER_UNAVAILABLE | The reader has been removed |

3.13 SCardGetStatusChange

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardGetStatusChange(SCARDCONTEXT hContext,
    DWORD dwTimeout,
    LPSCARD_READERSTATE rgReaderStates,
    DWORD cReaders);
```

Parameters:

| | | |
|----------------|-------|---|
| hContext | IN | Connection context to the PC/SC Resource Manager |
| dwTimeout | IN | Maximum block waiting time for status change, zero for infinite |
| rgReaderStates | INOUT | Structures of readers with current states |
| cReaders | IN | Number of structures |

Description:

This function receives a structure or list of structures containing reader names. It then blocks for a change in state to occur on any of the OR'd values contained in **dwCurrentState** for a maximum blocking time of **dwTimeout** or forever if **INFINITE** is used. The new event state will be contained in **dwEventState**. A status change might be a card insertion or removal event, a change in ATR, *etc.*

This function will block for reader availability if **cReaders** is equal to zero and **rgReaderStates** is **NULL**.

```
typedef struct {
    LPCTSTR szReader;    /* Reader name */
    /* ... */
};
```

```

    LPVOID pvUserData;    /* User defined data */
    DWORD dwCurrentState; /* Current state of reader */
    DWORD dwEventState;   /* Reader state after a state change */
    DWORD cbAtr;          /* ATR Length, usually MAX_ATR_SIZE */
    BYTE rgbAtr[MAX_ATR_SIZE]; /* ATR Value */
} SCARD_READERSTATE;

typedef SCARD_READERSTATE *PSCARD_READERSTATE, **LPSCARD_READERSTATE;

```

| Value of dwCurrentState and dwEventState | Meaning |
|--|---|
| SCARD_STATE_UNAWARE | The application is unaware of the current state, and would like to know. The use of this value results in an immediate return from state transition monitoring services. This is represented by all bits set to zero |
| SCARD_STATE_IGNORE | This reader should be ignored |
| SCARD_STATE_CHANGED | There is a difference between the state believed by the application, and the state known by the resource manager. When this bit is set, the application may assume a significant state change has occurred on this reader |
| SCARD_STATE_UNKNOWN | The given reader name is not recognized by the resource manager. If this bit is set, then SCARD_STATE_CHANGED and SCARD_STATE_IGNORE will also be set |

| Value of dwCurrentState and ddwEventState | Meaning |
|---|--|
| SCARD_STATE_UNAVAILABLE | The actual state of this reader is not available. If this bit is set, then all the following bits are clear |
| SCARD_STATE_EMPTY | There is no card in the reader. If this bit is set, all the following bits will be clear |
| SCARD_STATE_PRESENT | There is a card in the reader |
| SCARD_STATE_ATRMATCH | There is a card in the reader with an ATR matching one of the target cards. If this bit is set, SCARD_STATE_PRESENT will also be set. This bit is only returned on the SCardLocateCards function |
| SCARD_STATE_EXCLUSIVE | The card in the reader is allocated for exclusive use by another application. If this bit is set, SCARD_STATE_PRESENT will also be set |
| SCARD_STATE_INUSE | The card in the reader is in use by one or more other applications, but may be connected to in shared mode. If this bit is set, SCARD_STATE_PRESENT will also be set |
| SCARD_STATE_MUTE | There is an unresponsive card in the reader |

Example:

```
SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol, cReaders;
SCARD_READERSTATE_A rgReaderStates[1];
LONG rv;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);

rgReaderStates[0].szReader = strdup("Reader X");
rgReaderStates[0].dwCurrentState = SCARD_STATE_EMPTY;

cReaders = 1;
rv = SCardGetStatusChange(hContext, INFINITE, rgReaderStates, cReaders);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
                  SCARD_PROTOCOL_T0, &hCard, &dwActiveProtocol);
```

Returns:

| | |
|----------------------------|--------------------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_VALUE | Invalid States, reader name, etc |
| SCARD_E_INVALID_HANDLE | Invalid <code>hContext</code> handle |
| SCARD_E_READER_UNAVAILABLE | The reader is unavailable |

3.14 SCardCancel

Synopsis:

```
#include <winscard.h>

LONG SCardCancel(SCARDCONTEXT hContext);
```

Parameters:

`hContext` IN Connection context to the PC/SC Resource Manager

Description:

This function cancels all pending blocking requests on the `GetStatusChange()` function.

Example:

```
SCARDCONTEXT hContext;  
DWORD cReaders;  
SCARD_READERSTATE rgReaderStates;  
LONG rv;  
  
rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);  
  
rgReaderStates.szReader = strdup("Reader X");  
rgReaderStates.dwCurrentState = SCARD_STATE_EMPTY;  
  
/* Spawn off thread for following function */  
rv = SCardGetStatusChange(hContext, 0, rgReaderStates, cReaders);  
  
rv = SCardCancel(hContext);
```

Returns:

| | |
|------------------------|-------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_INVALID_HANDLE | Invalid hContext handle |

3.15 SCardSetTimeout

Synopsis:

```
#include <winscard.h>  
  
LONG SCardSetTimeout(SCARDCONTEXT hContext,  
    DWORD dwTimeout);
```

Parameters:

| | | |
|-----------|----|--|
| hContext | IN | Connection context to the PC/SC Resource Manager |
| dwTimeout | IN | New timeout value |

Description:

This function is not in Microsoft® WinSCard API and is deprecated in pcsc-lite API. The function does not do anything except returning **SCARD_S_SUCCESS**.

Returns:

SCARD_S_SUCCESS Successful

3.16 SCardGetAttrib

Synopsis:

```
#include <winscard.h>
```

```
LONG SCardGetAttrib(SCARDHANDLE hCard,  
    DWORD dwAttrId,  
    LPBYTE pbAttr,  
    LPDWORD pcbAttrLen);
```

Parameters:

| | | |
|------------|--------|---|
| hCard | IN | Connection made from SCardConnect |
| dwAttrId | IN | Identifier for the attribute to get |
| pbAttr | OUT | Pointer to a buffer that receives the attribute |
| pcbAttrLen | IN/OUT | Length of the pbAttr buffer in bytes |

Description:

This function get an attribute from the IFD Handler. The list of possible attributes is available in the file `pcsclite.h`.

- SCARD_ATTR_ASYNC_PROTOCOL_TYPES
- SCARD_ATTR_ATR_STRING
- SCARD_ATTR_CHANNEL_ID
- SCARD_ATTR_CHARACTERISTICS
- SCARD_ATTR_CURRENT_BWT
- SCARD_ATTR_CURRENT_CLK
- SCARD_ATTR_CURRENT_CWT
- SCARD_ATTR_CURRENT_D
- SCARD_ATTR_CURRENT_EBC_ENCODING
- SCARD_ATTR_CURRENT_F

- SCARD_ATTR_CURRENT_IFSC
- SCARD_ATTR_CURRENT_IFSD
- SCARD_ATTR_CURRENT_IO_STATE
- SCARD_ATTR_CURRENT_N
- SCARD_ATTR_CURRENT_PROTOCOL_TYPE
- SCARD_ATTR_CURRENT_W
- SCARD_ATTR_DEFAULT_CLK
- SCARD_ATTR_DEFAULT_DATA_RATE
- SCARD_ATTR_DEVICE_FRIENDLY_NAME_A
- SCARD_ATTR_DEVICE_FRIENDLY_NAME_W
- SCARD_ATTR_DEVICE_IN_USE
- SCARD_ATTR_DEVICE_SYSTEM_NAME_A
- SCARD_ATTR_DEVICE_SYSTEM_NAME_W
- SCARD_ATTR_DEVICE_UNIT
- SCARD_ATTR_ESC_AUTHREQUEST
- SCARD_ATTR_ESC_CANCEL
- SCARD_ATTR_ESC_RESET
- SCARD_ATTR_EXTENDED_BWT
- SCARD_ATTR_ICC_INTERFACE_STATUS
- SCARD_ATTR_ICC_PRESENCE
- SCARD_ATTR_ICC_TYPE_PER_ATR
- SCARD_ATTR_MAX_CLK
- SCARD_ATTR_MAX_DATA_RATE
- SCARD_ATTR_MAX_IFSD
- SCARD_ATTR_MAXINPUT
- SCARD_ATTR_POWER_MGMT_SUPPORT
- SCARD_ATTR_SUPPRESS_T1_IFS_REQUEST
- SCARD_ATTR_SYNC_PROTOCOL_TYPES

- SCARD_ATTR_USER_AUTH_INPUT_DEVICE
- SCARD_ATTR_USER_TO_CARD_AUTH_DEVICE
- SCARD_ATTR_VENDOR_IFD_SERIAL_NO
- SCARD_ATTR_VENDOR_IFD_TYPE
- SCARD_ATTR_VENDOR_IFD_VERSION
- SCARD_ATTR_VENDOR_NAME

Not all the `dwAttrId` values listed above may be implemented in the IFD Handler you are using. And some `dwAttrId` values not listed here may be implemented.

Example:

```
LONG rv;
SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol;
unsigned char pbAtr[MAX_ATR_SIZE];
DWORD dwAtrLen;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
    SCARD_PROTOCOL_RAW &hCard, &dwActiveProtocol);
rv = SCardGetAttrib(hCard, SCARD_ATTR_ATR_STRING, pbAtr, &dwAtrLen);
```

Returns:

| | |
|-----------------------------|--------------------------------|
| SCARD_S_SUCCESS | Successful |
| SCARD_E_NOT_TRANSACTED | Data exchange not successful |
| SCARD_E_INSUFFICIENT_BUFFER | Reader buffer not large enough |

3.17 SCardSetAttrib

Synopsis:

```
#include <winscard.h>

LONG SCardSetAttrib(SCARDHANDLE hCard,
    DWORD dwAttrId,
    LPCBYTE pbAttr,
    DWORD cbAttrLen);
```

Parameters:

| | | |
|-------------------------|----|---|
| <code>hCard</code> | IN | Connection made from <code>SCardConnect</code> |
| <code>dwAttrId</code> | IN | Identifier for the attribute to get |
| <code>pbAttr</code> | IN | Pointer to a buffer that receives the attribute |
| <code>pcbAttrLen</code> | IN | Length of the <code>pbAttr</code> buffer in bytes |

Description:

This function set an attribute of the IFD Handler. The list of attributes you can set is dependent on the IFD Handler you are using.

Example:

```
LONG rv;
SCARDCONTEXT hContext;
SCARDHANDLE hCard;
DWORD dwActiveProtocol;
unsigned char pbAttr[MAX_ATR_SIZE];
DWORD dwAttrLen;

rv = SCardEstablishContext(SCARD_SCOPE_SYSTEM, NULL, NULL, &hContext);
rv = SCardConnect(hContext, "Reader X", SCARD_SHARE_SHARED,
                  SCARD_PROTOCOL_RAW &hCard, &dwActiveProtocol);
rv = SCardSetAttrib(hCard, 0x42000001, "\x12\x34\x56", 3);
```

Returns:

| | |
|-------------------------------------|------------------------------|
| <code>SCARD_S_SUCCESS</code> | Successful |
| <code>SCARD_E_NOT_TRANSACTED</code> | Data exchange not successful |

3.18 pcsc_stringify_error

Synopsis:

```
#include <pcsc-lite.h>

char *pcsc_stringify_error(long error);
```

Description:

This function return a human readable text for the given PC/SC error code.

Example:

```
SCARDCONTEXT hContext;
LONG rv;

rv = SCardEstablishContext(SCARD\_SCOPE\_SYSTEM, NULL, NULL, &hContext);
if (rv != SCARD_S_SUCCESS)
    printf("SCardReleaseContext: %s (0x%lX)\n",
        pcsc_stringify_error(rv), rv);
```

4 Multithreading and contexts

From version 1.2.0 pcsc-lite is much more multithreading friendly.

You have to follow some rules:

- For security reasons, a context can only be released (using `SCardReleaseContext()`) by the thread that created it.
- To access different readers (*i.e.* cards) in different threads, each thread must use a different context (not necessarily created by this thread itself).

Each thread should create his own context with `SCardEstablishContext()` and should release it with `SCardReleaseContext()` when the context is not necessary any more.

If different threads share a same context, the calls to different functions of the pcsc-lite API are stored in a queue and the executions serialised for this context because there is a mutex shared for all the (critical) operations of this context.

Note: The SCF (Smart Card Framework) used by Solaris has not been updated. So if you compile pcsc-lite using `./configure -enable-scf` you will still have a global lock mechanism.

5 Some SCardControl commands

The commands described here may not be implemented by all the drivers. They are implemented by the CCID driver available at <http://pcsclite.alioth.debian.org/ccid.html> and maybe some other.

The tag names used by these functions are `IOCTL_SMARTCARD_VENDOR_*`. They are vendor (driver) specific.

5.1 IFD_EXCHANGE

This command is used to send a proprietary command to a reader.

The CCID specification [1] describes a `PC_to_RDR_Escape` command to send proprietary commands to the reader.

Example:

```
#include <wintypes.h>
#include <winscard.h>

#define SCARD_CTL_CODE(code) (0x42000000 + (code))
#define IOCTL_SMARTCARD_VENDOR_IFD_EXCHANGE SCARD_CTL_CODE(1)

SCARDHANDLE hCard;
unsigned char bSendBuffer[MAX_BUFFER_SIZE];
unsigned char bRecvBuffer[MAX_BUFFER_SIZE];
DWORD length;

/* get firmware */
bSendBuffer[0] = 0x02;
rv = SCardControl(hCard, IOCTL_SMARTCARD_VENDOR_IFD_EXCHANGE,
    bSendBuffer, 1, bRecvBuffer, sizeof(bRecvBuffer), &length);

printf(" Firmware: ");
for (i=0; i<length; i++)
    printf("%02X ", bRecvBuffer[i]);
printf("\n");
```

5.2 VERIFY_PIN

This command is used to perform a secure PIN verification using a smart card reader equipped with a keyboard or keypad.

The CCID specification [1] describes a `PC_to_RDR_Secure` command to perform such a PIN verification.

The `bSendBuffer` to pass to `SCardControl()` contains:

- the VERIFY APDU

That is the APDU sent to the card with the PIN code values replaced by the actually entered PIN code. See the CCID specification [1] for a more precise description.

- the CCID `abPINDataStructure`

This is the CCID structure used to parameter the PIN verification command.

You can omit to send the 3 bytes of the `bTeoPrologue` field. This field is only significant with a T=1 card.

Example:

```
#include <wintypes.h>
#include <winscard.h>

#define SCARD_CTL_CODE(code) (0x42000000 + (code))
#define IOCTL_SMARTCARD_VENDOR_VERIFY_PIN SCARD_CTL_CODE(2)

LONG rv;
SCARDHANDLE hCard;
char attribute[1];
DWORD attribute_length;

/* does the reader support PIN verification? */
attribute_length = sizeof(attribute);
rv = SCardGetAttrib(hCard, IOCTL_SMARTCARD_VENDOR_VERIFY_PIN, attribute,
    &attribute_length);
if (TRUE == attribute[0])
{
    int i, offset;
    unsigned char bSendBuffer[MAX_BUFFER_SIZE];
    unsigned char bRecvBuffer[MAX_BUFFER_SIZE];
    DWORD length;

    /* verify PIN */
    offset = 0;
    /* APDU: 00 20 00 00 08 30 30 30 30 00 00 00 00 */
    bSendBuffer[offset++] = 0x00; /* CLA */
    bSendBuffer[offset++] = 0x20; /* INS: VERIFY */
    bSendBuffer[offset++] = 0x00; /* P1 */
    bSendBuffer[offset++] = 0x00; /* P2 */
    bSendBuffer[offset++] = 0x08; /* Lc: 8 data bytes */
    bSendBuffer[offset++] = 0x30; /* '0' */
    bSendBuffer[offset++] = 0x30; /* '0' */
    bSendBuffer[offset++] = 0x30; /* '0' */
    bSendBuffer[offset++] = 0x30; /* '0' */
    bSendBuffer[offset++] = 0x00; /* '\0' */
    bSendBuffer[offset++] = 0x00; /* '\0' */
    bSendBuffer[offset++] = 0x00; /* '\0' */
    bSendBuffer[offset++] = 0x00; /* '\0' */
}
```

```

/* CCID PIN verification data structure */
bSendBuffer[offset++] = 0x00; /* bTimeOut */
bSendBuffer[offset++] = 0x82; /* bmFormatString */
bSendBuffer[offset++] = 0x04; /* bmPINBlockString (PIN length) */
bSendBuffer[offset++] = 0x00; /* bmPINLengthFormat */
bSendBuffer[offset++] = 0x04; /* wPINMaxExtraDigit: min */
bSendBuffer[offset++] = 0x04; /* wPINMaxExtraDigit: max */
bSendBuffer[offset++] = 0x02; /* bEntryValidationCondition */
bSendBuffer[offset++] = 0x00; /* bNumberMessage */
bSendBuffer[offset++] = 0x04; /* wLangId: english */
bSendBuffer[offset++] = 0x09; /* " */
bSendBuffer[offset++] = 0x00; /* bMsgIndex */
bSendBuffer[offset++] = 0x00; /* bTeoPrologue */
bSendBuffer[offset++] = 0x00; /* " */
bSendBuffer[offset++] = 0x00; /* " */

rv = SCardControl(hCard, IOCTL_SMARTCARD_VENDOR_VERIFY_PIN,
    bSendBuffer, offset, bRecvBuffer, sizeof(bRecvBuffer), &length);

printf(" card response:");
for (i=0; i<length; i++)
    printf(" %02X", bRecvBuffer[i]);
printf("\n");
}

```

References

- [1] Universal Serial Bus, Device Class Specification for USB Chip/Smart Card Interface Devices, 20 March 2001. Revision 1.00, http://www.usb.org/developers/devclass_docs/ccid_classspec_1_00a.pdf.
- [2] PC/SC workgroup. <http://www.pcscworkgroup.com/>.