

BioPass3000

Developer's Guide

Version 1.0

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This equipment is USB based.

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1 Overview

This chapter describes the development of BioPass3000 applications, including the APIs supported by BioPass3000 and the development method for each of these APIs. This chapter covers the following topics:

- BioPass3000 APIs
- Developing BioPass3000 Applications with MS CryptoAPI
- Developing BioPass3000 Applications with PKCS#11

1.1 BioPass3000 Application Programming Interface

The development of BioPass3000 applications mainly comprises two aspects: developing PKI applications and developing smartcard applications. For developing BioPass3000 PKI applications, two main types of APIs are provided. They are PKCS#11 which is compliant with the RSA PKCS#11 API standards and CSP for Microsoft CryptoAPI 2.0 which is compliant with Microsoft CryptoAPI standard. Because these two standards are accepted by most software providers and hardware manufacturers, BioPass3000 can be integrated with applications designed based on these two types of API without the need of additional development. Another kind of API is provided for smartcard PC/SC interfaces.

BioPass3000 PKI API itself is built based on the PC/SC interface. Software developers can choose one or multiple types of API according to their project requirements.

1.2 Developing with MS CryptoAPI

Microsoft CryptoAPI is provided by the Win32 platform for developers designing data encryption and security applications. CryptoAPI comprises a basic ASN.1 encryption / decryption interface, hashing interface, data encryption/decryption interface, digital certificate managing interface and many other important cryptographic features. The data encryption and decryption support symmetrical and public key algorithms. All of the Microsoft applications such as Internet Explorer, Outlook and many other third party applications are developed based on CryptoAPI.

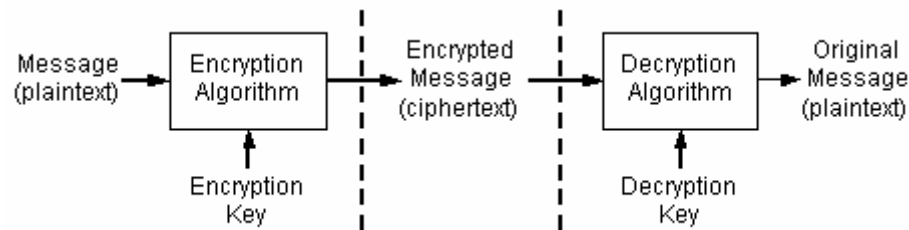
There are three key requirements for secure data transmission over insecure networks: information concealment, identity authentication and integrity check. CryptoAPI does not only satisfy these requirements, but it also provides standard ASN.1 encryption/decryption, data encryption/decryption, digital certificate and certificate storage management, Certificate Trust List (CTL) and Certificate Revocation List (CRL) features.

1.2.1 Information Concealment

The purpose of information concealment is to make sure that content can only be retrieved by authorized people. Normally, information concealment is achieved by applying some cryptographic methods. Data encryption algorithms can ensure secure information concealment and transmission with algorithms converting plain-text data to a set of hash data.

It is almost impossible to deduce plain text from cipher text forcibly without the encryption key for “good” encryption algorithms. The original data could be ASCII text files, database files or any other kind of files which need to be transmitted securely. Herein the word “information” means a set of data. The term “plain text” means the data that has not been encrypted. The term “cipher text” means the encrypted data.

Cipher text could be transferred through insecure media or networks without compromising security. After that, the cipher text could be retrieved back to plain text. This process can be demonstrated as follows:



The concept of data encryption and decryption is fairly simple. To encrypt data, an encryption key is required. The key is like the key used to open a door in function. When performing decryption, a decryption key is required as well. The encryption key and the decryption key could be the same or different.

The encryption key must be stored safely and securely. When provided to other users, the transfer process of the key must be secure and reliable. The access to the decryption key must be under strict control, as it can be used to decrypt the encrypted data with the same encryption key.

1.2.2 Identity Authentication

The precondition of secure communication is that both sides of the communication definitely know each other's identity. The purpose of identity authentication is to verify the true identity of a person or an entity involved in the communication. The document to identify the identity is called a credential. Just like withdrawing money from a bank, people need to prove their identity by using an identity card. Passport is another example. The landing-waiter needs to check the passport to verify the passenger's true identity. The verification is based on the belief that the passport publishing department had verified the person's identity. In the above examples, the identity credential exists in the form of a physical document.

Identity authentication sometimes is used to identify that the received data is from the correct source. For example, when A sends some data to B, B needs to verify the data received is

really sent by A (other than other people in the name of A). To achieve this authentication request, CryptoAPI provides the digital signature and verification functions to perform the authentication.

Because there is no physical link between the data transferred over the network and the user, the credential used to authenticate the data should also be transferable on the network. The credentials must be issued by trusted authorities.

Digital certificates, also referred to as certificate, are such a kind of credential. It is a valid credential used to authenticate on the network.

The digital certificate is a credential issued by a trusted organization or entity called a Certificate Authority (CA). It contains an appropriate public key, the certificate subject and user information. CA issues a certificate only when it has verified the accuracy of user information and a public key's validity.

The information exchanged between the certificate applicant and the CA can use physical media, such as floppy disks, for transmission. Typically, this kind of information exchange is achieved through the network. CA uses trusted service program to handle applicant's requests and certificate issues.

1.2.3 Integrity Check

All the information transferred by unsafe media faces the risk of being tampered. The seal is used as a tool for an integrity check in the real world. For example, the unrecoverable package and intact seal are used to ensure that the goods are unchanged after it left the factory.

For the same reason, the information receiver not only needs to verify that the information is from the correct sender, but also needs to check the information has not changed. To build the integrity check mechanism, both the information and the verification information for it (which is usually called a hash value) must be sent together. The information and its verification information could be sent together with the digital certificate to prove information integrity.

1.2.4 CSP and Encryption Process

CryptoAPI functions use "Cryptographic Service Providers" (CSPs) to perform the data encryption/decryption and encryption key storage management. All of the CSPs are

independent modules. Theoretically, CSPs should be independent of specific applications, say; each of the applications could use any CSP. But sometimes, some applications can only interact with some specific CSPs. The relationship between CSPs and applications is similar to the Windows GDI model. CSPs work like graphic hardware drivers.

The storage security of the encryption key is laid on the CSP's implementation. It is not laid on the operating system. This makes it so that the application can be run under different security environments without modification.

The communication between application program and encryption module must be controlled strictly so the application's security and migration can be guaranteed. Here are three applicable rules:

- Application must not access the contents of the encryption key directly because all the encryption keys are generated within the CSP and applications use a transparent handler to handle it. This avoids any circumstances where the encryption key is leaked by the application or the related dynamic linking library and the encryption key is derived from a bad random factor.
- Application must not specify the detailed implementation of the encryption operation. CSP API allows the application to choose the algorithm for performing encryption operations and signature operations. The actual implementation should be performed within the CSP.
- Application must not process the data in the verification voucher or other identity authentication data. User's identity authentication should be achieved by the CSP. This ensures the application needs to be modified in the future when more identity authentication approaches is applied such as finger print scanning.

The simplest CSP is comprised of a Win32 Dynamic Linking Library (DLL) and a signature file. Only by providing the correct signature file, the CSP can be recognized and used by CryptoAPI. CryptoAPI will check the signatures of CSPs periodically to prevent them being tampered with.

Some CSP modules perform sensitive encryption operations at separate memory spaces by calling local RPC or hardware driver programs. Placing encryption keys and performing sensitive encryption operations in separate memory space or hardware can ensure the keys are not tampered with by the applications.

It is not recommended to have an application rely on only one specific CSP. For example, Microsoft Base Cryptographic Provider provides a 40-bit communication key and 512-bit public key. Applications should avoid only using these sizes as the length of communication and public key, because once an application uses another CSP, the key length might change. Good

applications should interact with different CSPs.

1.2.5 CSP Context

The first CryptoAPI function called by an application must be CryptAcquireContext. This function returns a special handler containing a special key container. The selection of key container can be specified or be the logon user's default container. CryptAcquireContext can be used to create new key containers.

The CSP module itself has a name and a type. For example, Windows operating system's default installed CSP is: Microsoft Base Cryptographic Provider. Its type is PROV_RSA_FULL. Each CSP's name must be different, but their types can be same.

When an application calls the CryptAcquireContext function to get a CSP operation handler, it can specify the name and type of CSP. When the CSP name and type are specified, only the matching CSP will be called. After a successfully call, the function returns the CSP operating handler. Application can use the handler to access the CSP and the key container in the CSP.

1.2.6 CryptoAPI Architecture

CSP architecture is mainly comprised of five kinds of elements:

- **Cryptographic Functions**

Functions are used to link and create CSP handler. These functions allow applications to choose special CSP by specifying its name and type.

Key generation functions are used to create and store an encryption key. Their functions include changing encryption mode, initializing encryption vector etc.

Key exchange functions are used to exchange and transmit keys.

- **Certificate Encoding/Decoding Functions**

These functions are used to encrypt and decrypt data, including calculating the data's hashing value.

- **Certificate Storage Functions**

These functions are used to manage digital certificate sets.

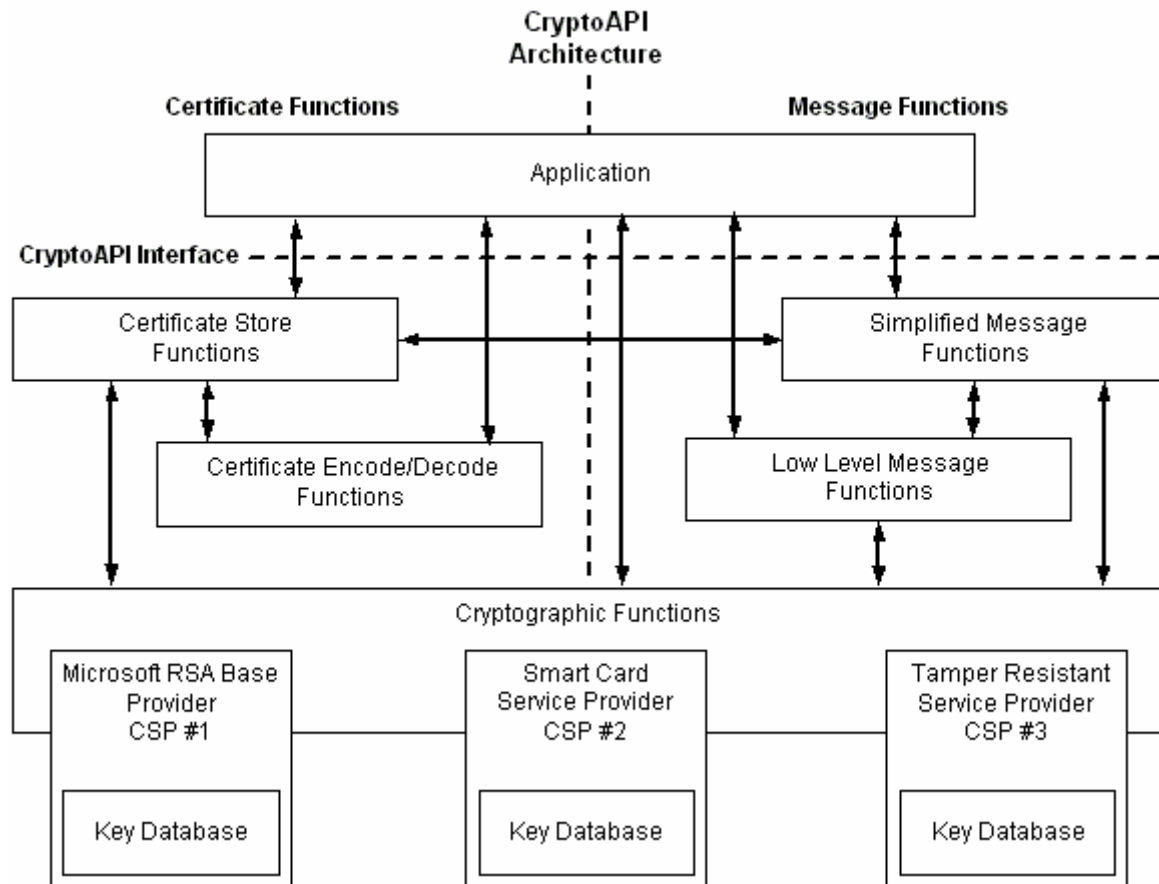
- **Simplified Message Functions**

These functions are used to encrypt and decrypt messages and data, sign the message and

data, and verify the signature validity of messages and data.

- **Low Level Message Functions**

These functions implement the Simplified Message Functions. It provides more detailed control on each message operation.



The prefix of each set of functions has the following format:

Functions	Prefix
Cryptographic Functions	Crypt
Certificate Encoding/Decoding Functions	Crypt
Certificate Storage Functions	Store
Simplified Message Functions	Message
Low Level Message Functions	Msg

1.3 Developing BioPass3000 Applications with PKCS#11

Because of the blooming growth of Internet, security requirement for applications has become

increasingly important. The growth of security products also derives the requirement for interacting with applications. RSA company set up the Public Key Cryptographic Standard (PKCS) to meet these requirements.

PKCS#11 standard is one of the PKCS standard set. PKCS#11 standard (also known as "Cryptoki") is used to resolve the compatibility problems of interaction between different manufacturers and public key applications. It defines a uniform programming interface model – Cryptoki tokens. The PKCS#11 interface of BioPass3000 is compliant with the PKCS#11 standard version 2.11.

Before programming with the BioPass3000 PKCS#11 interfaces, developers should be familiar with the PKCS#11 standard. The standard's related documents can be downloaded from the RSA company's website at

<http://www.rsa.com/rsalabs/node.asp?id=2133>

2 CSP Module

This chapter introduces the CryptoAPI development supported by BioPass3000. In particular, the CSP interface name of BioPass3000, supported functions and algorithm implementation are described. This chapter covers the following topics:

- Description
- Supported Algorithms
- Function Implementation
- Parameters of the Functions
- Function Calling Notes

2.1 Description

BioPass3000 provides standard CSP modules for seamless integration with CryptoAPI applications. BioPass3000 CSP module is compliant with Microsoft Crypto Service Provider programming standard. It can be compatible with current and future CryptoAPI applications.

2.1.1 Profile

- Type: PROV_RSA_FULL

This general type of CSP provides support for digital signature and data encryption and decryption. All public key operations are processed using RSA algorithms.

- Name: EnterSafe BioPass3000 CSP V1.0

Developers may notice that the hardware type of BioPass3000 is denoted in the name.

2.1.2 Features

The CSP of BioPass3000:

- Provides secure RSA key-pair storage container;
- Provides several grouping encryption and hashing algorithms;
- Supports hardware implemented RSA operation (Maximum: 2048 bits);
- Supports hardware implemented random number generation;
- Supports multi-thread access and multi-device management;
- Supports multi-certificate applications;
- Is compliant with PKCS#11 data format;
- Truly supports dual-credential, i.e. there may be two key pairs (AT_KEYEXCHANGE and AT_SIGNATURE) and corresponding certificates in a container;
- Supports Windows 98 SE or higher operating systems (Except for Windows Vista);
- Is seamlessly compliant with existing Windows applications, such as Office encryption and decryption, Windows native logon, Windows network domain logon, VPN client logon, Internet Explorer Webpage and SSL Website logon, and Outlook secured emails;
- Uses fingerprint instead of PIN for authenticating, providing higher security.

2.2 Supported Algorithms

The supported algorithms for the CSP module of BioPass3000 are provided in the following list:

Algorithm	Default Length (bit)	Minimum Length (bit)	Maximum Length (bit)	Purpose
CALG_RC2	40	8	1024	Encryption and decryption
CALG_RC4	40	8	2048	
CALG_DES	56	56	56	
CALG_3DES	192	192	192	
CALG_SHA1	160	160	160	Hashing
CALG_MD2	128	128	128	
CALG_MD5	128	128	128	
CALG_SSL3_SHAMD5	288	288	288	
CALG_RSA_SIGN or AT_SIGNATURE	1024	512	2048	Signature verification
CALG_RSA_KEYX or AT_KEYEXCHANGE	1024	512	2048	Encryption, decryption and signature verification

2.3 Function Implementation

The following table summarizes the support and implementation of CSP interface functions. “Not Implemented” indicates that there is the interface in CSP module, but it is not implemented. “Not Supported” indicates that there is no that interface in CSP module.

It is reasonable that some functions listed in the table are not supported, because the CSP type is PROV_RSA_FULL for BioPass3000. The “Not Implemented” functions return FALSE and the ErrorCode is set to E_NOTIMPL. CryptoAPI applications are not required to call these interface functions directly.

Name	Description	Support
Connection Functions		
CPAcquireContext	Create a context for the application.	Implemented
CPGetProvParam	Return CSP related information.	Implemented
CPReleaseContext	Release the context created by CPAcquireContext.	Implemented
CPSetProvParam	Set CSP parameter operations.	Implemented
Key Generation and Exchange Functions		

CPDeriveKey	Generate a session key from a data hash. The key is unique.	Implemented
CPDestroyKey	Release a key handle. The handle will be invalid then, and the key cannot be accessed.	Implemented
CPDuplicateKey	Create a copy of a key.	Not Supported
CPExportKey	Export a key from a CSP container.	Implemented
CPGenKey	Generate a key or key pair.	Implemented
CPGenRandom	Write a random number to a buffer.	Implemented
CPGetKeyParam	Get the attributes of an encryption key.	Implemented
CPGetUserKey	Get the persisted key pairs from a CSP container.	Implemented
CPImportKey	Import a key from a blob to a CSP container.	Implemented
CPSetKeyParam	Set key attributes.	Implemented
Data Encryption Functions		
CPDecrypt	Decrypt the encrypted data.	Implemented
CPEncrypt	Encrypt the plain text.	Implemented
Hashing and Digitally Signing Functions		
CPCreateHash	Initialize and hash input data.	Implemented
CPDestroyHash	Delete the handle of a hashed object.	Implemented
CPDuplicateHash	Create a copy of a hashed object.	Not Supported
CPGetHashParam	Get the calculation result of a hashed object.	Implemented
CPHashData	Hash input data.	Implemented
CPHashSessionKey	Hash a session key and do not expose its value to the application.	Not Implemented
CPSetHashParam	Customize the attributes of a hashed object.	Implemented
CPSignHash	Sign a hashed object.	Implemented
CPVerifySignature	Verify a digital signature.	Implemented

In addition, the function, OffloadModExpo, is defined in the CSP standard. It is not supported by the CSP module of BioPass3000 currently.

2.4 Parameters of the Functions

2.4.1 CPAcquireContext

——*dwFlags*

It supports the following values: CRYPT_VERIFYCONTEXT, CRYPT_NEWKEYSET, CRYPT_DELETEKEYSET and CRYPT_SILENT; No CRYPT_MACHINE_KEYSET scenario.

——*pszContainer*

It could be NULL or "", or a string with a reader name (the length of the string should not exceed MAX_PATH) depending on the value of dwFlags.

2.4.2 CPGetProvParam

——*dwParam*

It supports the following values: PP_CONTAINER, PP_ENUMALGS, PP_ENUMALGS_EX, PP_ENUMCONTAINERS, PP_IMPTYPE, PP_NAME, PP_VERSION, PP_UNIQUE_CONTAINER, PP_PROVTYPE, PP_SIG_KEYSIZE_INC, PP_KEYX_KEYSIZE_INC, PP_KEYSPEC; and does not support the following values: PP_KEYSET_SEC_DESCR, PP_USE_HARDWARE_RNG etc.

——*dwFlags*

According to the analysis on CSP, when the value of dwParam is PP_ENUMALGS or PP_ENUMALGS_EX, enumerating begins in case dwFlags is CRYPT_FIRST; or (the value is 0 or CRYPT_NEXT) enumerate the next. When the value of dwParam is PP_ENUMCONTAINERS, enumerating begins in case dwFlags is CRYPT_FIRST (1) or CRYPT_FIRST|CRYPT_NEXT (3); or enumerate the next when the value is 0 or CRYPT_NEXT. dwFlags does not support CRYPT_MACHINE_KEYSET. When dwParam is other value, do not check the value of dwFlags.

2.4.3 CPReleaseContext

——*dwFlags*

Its value must be zero.

2.4.4 CPSetProvParam

——*dwParam*

It supports the following values: PP_KEYEXCHANGE_PIN and PP_SIGNATURE_PIN. Logout if pbData is NULL. If developers have not registered a fingerprint in BioPass3000, pbData is an initial password (a string that ends with '\0'). Otherwise, if developers have registered a fingerprint and pbData is not NULL, an error will be returned.

It does not support other values.

——*dwFlags*

Not checked.

2.4.5 CPDeriveKey

——*AlgId*

It supports the following algorithms only: CALG_RC2, CALG_RC4, CALG_DES, and CALG_3DES.

——*dwFlags*

It returns an error for the following cases: (CRYPT_CREATE_SALT | CRYPT_NO_SALT), CRYPT_PREGEN and CRYPT_USER_PROTECTED. Not supported for other cases.

2.4.6 CPDestroyKey

2.4.7 CPDuplicateKey

Not supported.

2.4.8 CPExportKey

——*dwBlobType*

It supports only PUBLICKEYBLOB and SIMPLEBLOB, and does not support PRIVATEKEYBLOB, OPAQUEKEYBLOB, and PLAINTEXTKEYBLOB etc.

——*dwFlags*

If dwBlobType is PUBLICKEYBLOB or SIMPLEBLOB, dwFlags must be zero. The value of this parameter is ignored for other cases.

2.4.9 CPGenKey

——AlgId

It supports the following values: CALG_RSA_KEYX, CALG_RSA_SIGN, AT_KEYEXCHANGE, AT_SIGNATURE, CALG_DES, CALG_RC2, CALG_RC4 and CALG_3DES. CALG_3DES_112 is supported for the next version.

——dwFlags

Not supported CSP returns an error message: CRYPT_CREATE_SALT, CRYPT_NO_SALT, or CRYPT_PREGEN. The length of the key to be generated is the first two bytes of this parameter (the key with default length will be generated for 0). The last two bytes are ignored.

2.4.10 CPGenRandom

2.4.11 CPGetKeyParam

This function supports only CALG_RSA_KEYX, CALG_RSA_SIGN, AT_KEYEXCHANGE, AT_SIGNATURE, CALG_DES, CALG_RC2, CALG_RC4 and CALG_3DES key types.

——dwParam

For the key types like CALG_RSA_KEYX, CALG_RSA_SIGN, AT_KEYEXCHANGE and AT_SIGNATURE, its value could be KP_PERMISSIONS, KP_CERTIFICATE, KP_BLOCKLEN, KP_KEYLEN or KP_ALGID; for the key type like CALG_RC2, its value could be KP_BLOCKLEN, KP_EFFECTIVE_KEYLEN, KP_KEYLEN, KP_ALGID or KP_SALT; for the key type like CALG_RC4, its value could be KP_BLOCKLEN (return value 0), KP_KEYLEN, KP_ALGID or KP_SALT; for the key types like CALG_3DES and CALG_DES, its value could be KP_BLOCKLEN, KP_KEYLEN or KP_ALGID.

——dwFlags

It must be zero.

2.4.12 CPGetUserKey

——dwParam

It supports the following values: AT_KEYEXCHANGE, AT_SIGNATURE, and (AT_KEYEXCHANGE | AT_SIGNATURE).

2.4.13 CPImportKey

——*pbData*

This keyBlob supports SIMPLEBLOB, PUBLICKEYBLOB and PRIVATEKEYBLOB.

——*dwFlags*

Ignored.

2.4.14 CPSetKeyParam

——*dwParam*

For the key types like CALG_RC2, CALG_DES and CALG_3DES, its value is KP_IV; for the key type like CALG_RC2, its value is KP_EFFECTIVE_KEYLEN; for the key types like CALG_RC2 and CALG_RC4, its value is KP_SALT or KP_SALT_EX; for the key types like CALG_RSA_KEYX, CALG_RSA_SIGN, AT_KEYEXCHANGE and AT_SIGNATURE, its value is KP_CERTIFICATE.

——*dwFlags*

It must be zero.

2.4.15 CPDecrypt

It supports the following key types: CALG_RSA_KEYX, AT_KEYEXCHANGE, CALG_RC2, CALG_DES, CALG_3DES and CALG_RC4.

——*dwFlags*

It must be zero.

2.4.16 CPEncrypt

It supports the following key types: CALG_RSA_KEYX, AT_KEYEXCHANGE, CALG_RC2, CALG_DES, CALG_3DES and CALG_RC4.

——*dwFlags*

It must be zero.

2.4.17 CPCreateHash

——*AlgId*

It supports the following algorithms: CALG_MD2, CALG_MD5, CALG_SHA1 and

CALG_SSL3_SHAMD5.

——*dwFlags*

It must be zero.

2.4.18 CPDestroyHash

2.4.19 CPDuplicateHash

Not supported.

2.4.20 CPGetHashParam

——*dwParam*

It supports the following values: HP_ALGID, HP_HASHSIZE and HP_HASHVAL.

——*dwFlags*

It must be zero.

2.4.21 CPHashData

——*dwFlags*

It must be zero. It does not support the value of CRYPT_USERDATA.

2.4.22 CPHashSessionKey

Not implemented. It returns FALSE and sets ErrorCode to E_NOTIMPL.

2.4.23 CPSetHashParam

——*dwParam*

It supports only the value of HP_HASHVAL.

——*dwFlags*

It must be zero.

2.4.24 CPSignHash

——*sDescription*

Ignored.

——*dwFlags*

It supports only the value of CRYPT_NOHASHOID. Other values are ignored.

2.4.25 CPVerifySignature

——*sDescription*

Ignored.

——*dwFlags*

It does not support any value.

2.5 Function Calling Notes

2.5.1 Introduction

The function firstly called is CPAcquireContext among all CSP functions. Upper applications call this function to determine which key container they operate on. Each key container can only store one RSA key pair of the same type and many session keys at one time. The RSA key pair is an object that could be persisted, while the session keys exist only at runtime. If an application requests the access to the private key in the container, the CSP module of BioPass3000 would require authentication to the user. The user would be authenticated as follows: the user inputs his fingerprint he registered before when the CSP module pops up "Verify Fingerprint" dialog box. If correct, the CSP module goes on to perform the following operations. But if developers expect to avoid this dialog box, developers should set the flag CRYPT_SILENT. However, doing so will cause that all operations with access to the private key and protected data fail, because BioPass3000 does not support the use of CPSetProvParam for setting user identification.

2.5.2 Development Samples

Developers could find some sample programs developed with the CryptoAPI interface of BioPass3000 and compile and debug them in SDK package under Samples\CryptAPI. Some samples may require Platform SDK from Microsoft.

3 PKCS#11 Module

This chapter introduces the PKCS#11 development supported by BioPass3000. In particular, the PKCS#11 interface name of BioPass3000, supported functions and algorithm implementation are described. This chapter covers the following topics:

- Description
- Supported PKCS#11 Objects
- Supported Algorithms
- Supported PKCS#11 Interface Functions
- Customizing Fingerprint Verification Prompt Dialog Box

3.1 Description

BioPass3000 PKCS#11 interface is provided as a Win32 dynamic linking library (DLL). Developers can statically (using .lib file) or dynamically perform the access. The PKCS#11 standard related documents are listed below:

File	SDK Path
Cryptoki.h	\Include\pkcs11 (Provided by RSA)
Pkcs11.h	\Include\pkcs11 (Provided by RSA)
Pkcs11f.h	\Include\pkcs11 (Provided by RSA)
Pkcs11t.h	\Include\pkcs11 (Provided by RSA)
cryptoki_ft.h	\Include\pkcs11 (BioPass3000 extension algorithms and return values included)
cryptoki_win32.h	\Include\pkcs11 (Required type definition for the first header files under Windows included)
cryptoki_linux.h	\Include\pkcs11 (Required type definition for the first header files under Linux included)
auxiliary.h	\Include\pkcs11 (The definition of BioPass3000 related extension functions included)
es1b3k.lib	\Lib

es1b3k.dll is the core file for BioPass3000. It is placed in system directory. It implements all interface functions defined in RSA PKCS#11 standard. If developers need to use these interfaces and all interfaces and definition developers wish to access are PKCS#11 specific, the file cryptoki.h must be included in developersr project. If developers use BioPass3000-specific extension functions and algorithms, developers need only to include cryptoki_ft.h. This header file includes all other header files inside. If developers use static connection to gain the access to the BioPass3000 PKCS#11 libraries, developers need also to include the project needs to include es1b3k.lib in developersr project.

3.2 Supported PKCS#11 Objects

BioPass3000 PKCS#11 module supports creating and using the following objects:

Class Object	Description
CKO_DATA	Object defined by application. Object's structure is decided by the application. The data rendering is

	also handled by the application.
CKO_SECRET_KEY	Key of symmetry encryption algorithm.
CKO_CERTIFICATE	X.509 digital certificate object.
CKO_PUBLIC_KEY	RSA public key object.
CKO_PRIVATE_KEY	RSA private key object.

All the objects can be divided into groups according to the length of their lifetime. One group is a permanently stored object. This group of objects will be stored in BioPass3000's security storage zone until being deleted by the application. The other group is session objects. This group of objects is only used in the temporary communication session. Once the session is finished, the object will be deleted as well. The object's attribute which decides the object lifetime is CKA_TOKEN and is a Boolean value. All the objects have this attribute. Developers need to decide different object's lifetimes according to the BioPass3000 memory space's size limit. Only the important objects should be stored within the BioPass3000 internal memory space.

Besides lifetime difference, the PKCS#11 objects also have a difference in accessing privileges. All the objects can be divided into two types according to their different accessing privilege. One type is public object with this type of object being accessed by any user. The other type is private object which can only be accessed by users who have passed identity verification. The object's attribute which decides the accessing type is CKA_PRIVATE. It is a Boolean value and all the objects have this attribute. Application can decide one object is public or private by its actual usage. One thing needing to be taken into account is that the sizes of private storage zone and public storage zone are limited. These two storage zones are independent. Application must assign the size well. Once the sizes are decided in the BioPass3000 initialization, they can not be changed anymore.

3.3 Supported Algorithms

The following table lists all the encryption algorithms supported by BioPass3000 PKCS#11 module:

Cryptographic Algorithm	Encryption /Decryption	Signature Check	Hashing	Key-pair Generation	Package
CKM_RSA_PKCS_KEY_PAIR_GEN				√	
CKM_RSA_PKCS	√	√			√
CKM_MD2_RSA_PKCS	√	√			√
CKM_MD5_RSA_PKCS	√	√			√

CKM_SHA1_RSA_PKCS	√	√			√
CKM_RC2_KEY_GEN				√	
CKM_RC2_ECB	√				
CKM_RC2_CBC	√				
CKM_RC4_KEY_GEN				√	
CKM_RC4	√				
CKM_DES_KEY_GEN				√	
CKM_DES_ECB	√				√
CKM_DES_CBC	√				√
CKM_DES3_KEY_GEN				√	
CKM_DES3_ECB	√				√
CKM_DES3_CBC	√				√
CKM_MD2			√		
CKM_MD5			√		
CKM_SHA_1			√		

The following table lists the key length supported by BioPass3000 PKCS#11 module:

Cryptographic Algorithm	Key Length
CKM_RSA_KEY_PAIR_GEN	512, 1024 or 2048 bits
CKM_RC2_KEY_GEN	1 to 128 bytes
CKM_RC4_KEY_GEN	1 to 256 bytes
CKM_DES_KEY_GEN	8 bytes
CKM_DES3_KEY_GEN	24 bytes

3.4 Supported PKCS#11 Interface Functions

PKCS#11 is the universal standard for Cryptoki hardware. Different hardware manufacturers may implement it with minor variance.

BioPass3000 PKCS#11 interface module also has a little difference:

- C_WaitForSlotEvents function is not fully implemented. It does not support block-calling mode. If applications need this calling mode, it needs to implement the mode by itself.
- Some of the interfaces defined in PKCS#11 standard are not implemented. Once an application calls this kind of interface, the value CKR_FUNCTION_NOT_SUPPORT will be returned.

Note: BioPass3000 is just the “token” mentioned in PKCS#11 standard.

PKCS#11 standard calls smartcard reader “slot”. As the BioPass3000's usage does not require a smartcard reader, the slot is only a virtual device. But for applications, there will be no difference.

The following table lists all the interfaces defined in PKCS#11 2.10 standard:

Name	Description
Basic Functions	
C_Initialize	This function initializes the library. It must be called before calling other functions with the only exception being the C_GetFunctionList function.
C_Finalize	This function should be called when finished accessing.
C_GetInfo	Get the information of cryptoki library.
C_GetFunctionList	Get the function pointer list of the library.
Slot and Token Management Functions	
C_GetSlotList	Get slot list.
C_GetSlotInfo	Get slot information.
C_GetTokenInfo	Get token information in the slot.
C_WaitForSlotEvent	Wait for slot event, such as token is inserted or removed.
C_GetMechanismList	Get the library's supported algorithm list.
C_GetMechanismInfo	Get the detail information of the algorithm.
C_InitToken	Initialize token.
C_InitPIN	Initialize USER PIN.
C_SetPIN	Set current user PIN.
Session Management Functions	
C_OpenSession	Open a session between application and token.
C_CloseSession	Close session.
C_CloseAllSessions	Close all the opened session.
C_GetSessionInfo	Get session information.
C_GetOperationState	Get current operation state.
C_SetOperationState	Use state returned by C_GetOperationState to resume the library's operating state.
C_Login	Log on the token.
C_Logout	Log out the token.
Object Management Functions	
C_CreateObject	Create new Cryptoki object.
C_CopyObject	Create the copy of object.
C_DestroyObject	Destroy the object.

C_GetObjectSize	Get the size of object.
C_GetAttributeValue	Get the attributes of the object.
C_SetAttributeValue	Set the attributes of the object.
C_FindObjectsInit	Initialize an object finding operation.
C_FindObjects	Perform an object finding operation.
C_FindObjectsFinal	Finish an object finding operation.
Encryption Functions	
C_EncryptInit	Initialize an encryption operation.
C_Encrypt	Encrypt the data.
C_EncryptUpdate	Continue encrypting data.
C_EncryptFinal	End a data encryption operation.
Decryption Functions	
C_DecryptInit	Initialize a decryption operation.
C_Decrypt	Decrypt the data.
C_DecryptUpdate	Continue decrypting data.
C_DecryptFinal	End a data decryption operation.
Digest Functions	
C_DigestInit	Initialize a digest operation.
C_Digest	Input data for digesting.
C_DigestUpdate	Continue digesting data.
C_DigestKey	Continue digesting key.
C_DigestFinal	End a data digest operation.
Signature Functions	
C_SignInit	Initialize a signature operation.
C_Sign	Signature operation.
C_SignUpdate	Update signature operation.
C_SignFinal	Finalize signature operation.
C_SignRecoverInit	Initialize a data recoverable signature operation.
C_SignRecover	Recover signature operation.
Signature Verification Functions	
C_VerifyInit	Initialize a signature verification operation.
C_Verify	Verification operation.
C_VerifyUpdate	Update verification operation.
C_VerifyFinal	Finalize verification operation.
C_VerifyRecoverInit	Initialize a data recoverable verification operation.
C_VerifyRecover	Recover verification operation.
Digest Encryption Functions	

C_DigestEncryptUpdate	Continue a digest and encryption operation.
C_DecryptDigestUpdate	Continue a digest and decryption operation.
C_SignEncryptUpdate	Continue a signature and encryption operation.
C_DecryptVerifyUpdate	Continue a signature and decryption operation.
Key Management Functions	
C_GenerateKey	Generate the key and create the new key object.
C_GenerateKeyPair	Generate the key pair and create the new public key object.
C_DeriveKey	Derive a private key or encryption key.
C_WrapKey	Wrap a private key or encryption key.
C_UnwrapKey	Unwrap a private key or encryption key.
Random Number Generation Functions	
C_SeedRandom	Input seed for random generator.
C_GenerateRandom	Generate random number.
Parallel Management Functions	
C_GetFunctionStatus	It has been deprecated.
C_CancelFunction	It has been deprecated.

3.5 Customizing Fingerprint Verification Prompt Dialog Box

BioPass3000 performs the authentication by verifying the fingerprint. To facilitate the developers, the PKCS#11 module of BioPass3000 provides support for the customization of fingerprint verification interface.

For the PKCS#11 module, there are two mechanisms of fingerprint verification. The PKCS#11 module could pop up a prompt dialog box itself. Developers should use C_OpenSession(SlotID, flags, NULL, NULL, phSession) when calling the function C_OpenSession, and use C_Login(hSession, CKU_USER, NULL, 0) when calling C_Login. Alternatively, developers could customize the interface and prompt the user to verify the fingerprint, and call C_Login to wait for fingerprint scan through an application. In this way, developers could place any elements on the interface, such as the logo, animation, and/or picture etc.

Developers could call the PKCS#11 module of BioPass3000 by customizing the interface as follows:

To customize the interface, developers must pass appropriate arguments to the sessions used by C_Login following the calling of C_OpenSession. The prototype of C_OpenSession is:

```
CK_RV C_OpenSession(CK_SLOT_ID slotID,
```

```

    CK_FLAGS flags,
    CK_VOID_PTR pApplication,
    CK_NOTIFY Notify,
    CK_SESSION_HANDLE_PTR phSession)

```

At this point, developers must pass the pointer of implemented recall function to the argument Notify. For the prototype and declaration of this recall function, refer to the header file, pkcs11. And developers must pass the pointer of the following extended construct to the argument pApplication:

```

typedef struct CK_NOTIFY_PARAM
{
    CK_FLAGS    ucCallbackFlags; // must be CKF_BIOPASS_CALL_BACK
    CK_VOID_PTR pCallerDefined;  // user defined data
    CK_ULONG    ulTimeoutOnce;   // wait to scrape finger once
    CK_ULONG    ulNotifyEvent;   // returned status this time
} CK_NOTIFY_PARAM, *CK_NOTIFY_PARAM_PTR;

```

Developers must set ucCallbackFlags to CKF_BIOPASS_CALL_BACK, indicating the customized interface. pCallerDefined is user defined data, not used and accessed by middleware. ulTimeoutOnce is the timeout for a scan of the fingerprint in seconds. If no scan is processed within this timeout, the scan fails.

Developers could call C_Login(hSession, CKU_USER, NULL, 0) to acquire the fingerprint before or after the interface shows up. If the acquisition and verification are both successful, CKR_OK will be returned. Otherwise, C_Login would call the function Notify passed to C_OpenSession to determine whether to continue or to quit. If CKR_OK is returned by Notify, C_Login returns nothing and continues to wait for a scan. If CKR_CANCEL is returned by Notify, C_Login fails, and quits and returns CKR_CANCEL. When calling the function Notify, C_Login passes the pointer of pApplication passed upon C_OpenSession to it. In fact, the pointer is the construct pointer CK_NOTIFY_PARAM. Meanwhile, C_Login sets the reason why failed in ulNotifyEvent (see auxiliary.h for the values) for textual display or the like on the customized interface. There are many cases Notify returns CKR_CANCEL. One of the cases is that the user clicks "Cancel" to cancel the verification. It is possible that C_Login is waiting for a scan at this point and cannot return. Therefore, developers must prompt the user to wait for ulTimeoutOnce seconds or touch the sensor to have C_Login return on the interface. Otherwise, the client program will suspend for ulTimeoutOnce seconds because C_Login has not returned yet.

For the specific call method, refer to the samples in SDK under Samples\PKCS#11\VC\AuthFingerPrint.