Windows 10 Fingerprint Introduction and Implementation

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Agenda

- About Biometrics
- WBF Overview
- WBF Fingerprint Device
- Fingerprint Device Driver
- Fingerprint Engine Adapter
- Fingerprint Driver Test
- References
About Biometrics

What’s Biometrics

• Biometric Identification is an increasingly popular technology that provides convenient access to systems, services, and resources.
• Biometric Device is a sensor device to measure an unchanging physical characteristic of a person to uniquely identify that person.
• Biometrics Usage – Identification
• Biometrics Technologies – Pattern Recognition
  • Face
  • Fingerprint
  • Iris
  • DNA
  • Smell, Sound, Gait ...
About Biometrics

Biometrics Advantages

- Portable
- Convenience
- Gather-able/Measurability
- Stability
- Security
- Uniqueness
- Generality
About Biometrics

Biometrics Usage

- All Authentication scenarios
- Instead of Password
- Fingerprint on Windows
  - Power-On, Boot, Logon ...
  - App Launch
  - Web Login
  - Payment

<table>
<thead>
<tr>
<th>OEM</th>
<th>Product</th>
<th>Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG</td>
<td>LP-380/G3</td>
<td>FingerPrint Cards - FPCs</td>
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<tr>
<td>Apple</td>
<td>iPhone5s/6/6 Plus</td>
<td>AuthenTec</td>
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<tr>
<td>HTC</td>
<td>One Max</td>
<td>Synaptics (Validity)</td>
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<tr>
<td>Samsung</td>
<td>Galaxy S4/S5</td>
<td>Synaptics (Validity)</td>
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<td>Huawei</td>
<td>Mate 7</td>
<td>FingerPrint Cards - FPCs</td>
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<tr>
<td>MX</td>
<td>MX4 Pro</td>
<td>Goodix</td>
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![Fingerprint setup for Windows Hello](image)

Software and hardware used for biometric authentication.
About Biometrics

Biometric Identification

Enrollment
- Gathering and Quantizing
- Feature Extracting
- Template Storing

Identification
- Gathering and Quantizing
- Feature Extracting
- Comparing and Matching
About Biometrics

Biometrics Key-points

• Precise Sensor Device

• Efficient Algorithm

• High Privacy and Security
  • FAR(False Accept Rate) - Uniqueness
  • FRR(False Reject Rate) - Reliability
WBF Overview

Windows Biometric Framework Architecture

- FMA (Fingerprint Management Application)
- WBS (Windows Biometric Service)
- WBSP (Windows Biometric Service Provider)
- BU (Biometric Unit)
- Adapters
- WBDI (Windows Biometric Driver Interface)
- Sensor Driver
WBF Overview

Windows Biometric Framework Core Platform
WBF Overview

Biometric Device based on USB

- Kernel WinUsb.sys driver
- UMDF sensor device driver
WBF Fingerprint Device

Support WBF Fingerprint Devices what needs to be done

- Select a Driver Model
- Develop a WBDI Fingerprint Device Driver
- Develop Biometric Adapters to co-work with the WBDI Driver and BSP
- Develop a credential provider for logon (provided by OS from Win8)
- Develop a FMA to enhance the management (provided by OS from Win8)

- Notice:
  Win7 FMA using different working flow as Win8 or later, once developing the FMA/Driver/Adapters on Win7, they must be based-on Win7 WDK and instructions
WBF Fingerprint Device

Windows In-box Components

- `%SystemRoot%\System32\WbiosSrvc.dll` - Windows Biometric Services
- `%SystemRoot%\System32\WinBioPlugIns\winbiosensoradapter.dll` - Sensor Adapter
- `%SystemRoot%\System32\WinBioPlugIns\winbiostorageadapter.dll` - Storage Adapter
- `%SystemRoot%\System32\WinBioPlugIns\winbio.dll` – In-box Fingerprint App Client

**Notice:**
- For fingerprint biometric devices that do not have on-chip storage or matching capabilities, Microsoft provides inbox sensor and storage adapters components. An IHV or ISV must supply the engine adapter component for these devices.
- For fingerprint biometric devices that do support on-chip matching and storage, the IHV or ISV must supply all BU adapter components.
WBF Fingerprint Device

WDK Supports

- \Windows Kits\10\Include\%WDKVersion%\um\WinBio.h
- \Windows Kits\10\Include\%WDKVersion%\um\winbio_adapter.h
- \Windows Kits\10\Include\%WDKVersion%\shared\winbio_err.h
- \Windows Kits\10\Include\%WDKVersion%\shared\winbio_ioctl.h
- \Windows Kits\10\Include\%WDKVersion%\shared\winbio_types.h
WBF Fingerprint Device

Two Types

- Touch: Gathering the fingerprint by finger pressing
- Swipe: Gathering the fingerprint by finger sliding
#define WINBIO_ANSI_381_POS_UNKNOWN (WINBIO_BIOMETRIC_SUBTYPE)0
#define WINBIO_ANSI_381_POS_RH_THUMB (WINBIO_BIOMETRIC_SUBTYPE)1
#define WINBIO_ANSI_381_POS_RH_INDEX_FINGER (WINBIO_BIOMETRIC_SUBTYPE)2
#define WINBIO_ANSI_381_POS_RH_MIDDLE_FINGER (WINBIO_BIOMETRIC_SUBTYPE)3
#define WINBIO_ANSI_381_POS_RH_RING_FINGER (WINBIO_BIOMETRIC_SUBTYPE)4
#define WINBIO_ANSI_381_POS_RH_LITTLE_FINGER (WINBIO_BIOMETRIC_SUBTYPE)5
#define WINBIO_ANSI_381_POS_LH_THUMB (WINBIO_BIOMETRIC_SUBTYPE)6
#define WINBIO_ANSI_381_POS_LH_INDEX_FINGER (WINBIO_BIOMETRIC_SUBTYPE)7
#define WINBIO_ANSI_381_POS_LH_MIDDLE_FINGER (WINBIO_BIOMETRIC_SUBTYPE)8
#define WINBIO_ANSI_381_POS_LH_RING_FINGER (WINBIO_BIOMETRIC_SUBTYPE)9
#define WINBIO_ANSI_381_POS_LH_LITTLE_FINGER (WINBIO_BIOMETRIC_SUBTYPE)10

#define WINBIO_ANSI_381_POS_RH_FOUR_FINGERS (WINBIO_BIOMETRIC_SUBTYPE)13
#define WINBIO_ANSI_381_POS_LH_FOUR_FINGERS (WINBIO_BIOMETRIC_SUBTYPE)14
#define WINBIO_ANSI_381_POS_TWO_THUMBS (WINBIO_BIOMETRIC_SUBTYPE)15
WBF Fingerprint Device

Two Standards - NISTIR 6529-A & ANSI-INCITS-381-2004

- NISTIR 6529-A: CBEFF – Common Biometric Exchange Formats Framework
- ANSI-381: Finger Image-Based Data Interchange Format

- NIST (National Institute of Standards and Technology - U.S. Department of Commerce)
- NISTIR (NIST Interagency Report)
- ANSI (American National Standards Institute)
WBF Fingerprint Device

One Sample

- Windows Biometric Driver Samples – based on USB
Fingerprint Device Driver

WBDI Driver INF

- Declare the Driver Class

```
[Version]
Signature="Windows NT$
Class=Biometric
ClassGuid={53D25EF7-377C-4D14-8648-ED3A85769359}
Provider="ProviderName" 
DriverVer=12/19/2013, 0.0.1.0
```

- Add Adapter Registry Info in HW installation section

```
[DriverPlugInAddReg]
HKEY\WinBio\Configurations,DefaultConffiguration,0
HKEY\WinBio\Configurations,0,SensorMode,0x10001,1
HKEY\WinBio\Configurations,0,SystemSensor,0x10001,1
HKEY\WinBio\Configurations,0,SensorAdapter\Binary,"\WinBioSensorAdapter.DLL"
HKEY\WinBio\Configurations,0,EngineAdapter\Binary,"\EngineAdapter.DLL"
HKEY\WinBio\Configurations,0,StorageAdapter\Binary,"\WinBioStorageAdapter.DLL"
HKEY\WinBio\Configurations,0,DatabaseID,"ED6486E7-FDB9-435d-9088-344C008C00F5"
```

```
[DatabaseAddReg]
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},BiometricType,0x00010001,0x00000000
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},Attributes,0x00010001,0x00000001
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},Format,"\CDAC92F1-5B3E-4ae1-9448-56ACA204B309"
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},Initialize,0x00010001,0x00000000
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},AutoCreate,0x00010001,0x00000000
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},AutoName,0x00010001,0x00000000
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},Path,"
HKEY,\System\CurrentControlSet\Services\\BioSvc\\Databases\{ED6486E7-FDB9-435d-9088-344C008C00F5},ConnectionString,""
```
Fingerprint Device Driver

WBDI Driver

- Expose the GUID_DEVINTERFACE_BIOMETRIC_READER device interface which defined in winbio_ioctl.h

```
DEFINE_GUID( GUID_DEVINTERFACE_BIOMETRIC_READER,
              0xe2b5183a, 0x99ea, 0x4cc3, 0xad, 0x6b, 0x80, 0xca, 0x8d, 0x71, 0x5b, 0x80);
```

- Support the mandatory IOCTL codes

```
#define FILE_DEVICE_BIOMETRIC 0x00000044
#define BIO_CTL_CODE(code) CTL_CODE(FILE_DEVICE_BIOMETRIC, (code), METHOD_BUFFERED, FILE_ANY_ACCESS)
#define IOCTL_BIOMETRIC_GET_ATTRIBUTES BIO_CTL_CODE(1)
#define IOCTL_BIOMETRIC_RESET BIO_CTL_CODE(2)
#define IOCTL_BIOMETRIC_CALIBRATE BIO_CTL_CODE(3)
#define IOCTL_BIOMETRIC_GET_SENSOR_STATUS BIO_CTL_CODE(4)
#define IOCTL_BIOMETRIC_CAPTURE_DATA BIO_CTL_CODE(5)
```
Fingerprint Device Driver

IOCTL Codes

• IOCTL_BIOMETRIC_GET_ATTRIBUTES
  • Return a WINBIO_SENSOR_ATTRIBUTES structure to describe the sensor attributes

• IOCTL_BIOMETRIC_GET_SENSOR_STATUS
  • Return a WINBIO_DIAGNOSTICS structure to indicate current sensor status

• IOCTL_BIOMETRIC_CAPTURE_DATA
  • Return the fingerprint data read from sensor device

• IOCTL_BIOMETRIC_CALIBRATE
  • Direct the driver to calibrate the sensor device

• IOCTL_BIOMETRIC_RESET
  • Reset the device to a known or idle state
Fingerprint Device Driver

WBIO_CAPTURE_DATA & WINBIO_DATA

```c
typedef struct _WINBIO_DATA{
    DWORD Size;
    BYTE Data[1];
} WINBIO_DATA, *PWINBIO_DATA;

typedef struct _WINBIO_CAPTURE_DATA { 
    DWORD PayloadSize;
    HRESULT WinBioHresult;
    WINBIO_SENSOR_STATUS SensorStatus;
    WINBIO_REJECT_DETAIL RejectDetail;
    WINBIO_DATA CaptureData;
} WINBIO_CAPTURE_DATA, *PWINBIO_CAPTURE_DATA;
```
typedef struct _WINBIO_BIR_DATA {
    ULONG Size;
    ULONG Offset;
} WINBIO_BIR_DATA;

typedef WINBIO_BIR_DATA *PWINBIO_BIR_DATA;

typedef struct _WINBIO_BIR {
    WINBIO_BIR_DATA HeaderBlock;
    WINBIO_BIR_DATA StandardDataBlock;
    WINBIO_BIR_DATA VendorDataBlock;
    WINBIO_BIR_DATA SignatureBlock;
} WINBIO_BIR;

typedef WINBIO_BIR *PWINBIO_BIR;
Fingerprint Device Driver

WINBIO_BIR_HEADER & WINBIO_REGISTERED_FORMAT

typedef struct _WINBIO_REGISTERED_FORMAT {
    USHORT Owner;
    USHORT Type;
} WINBIO_REGISTERED_FORMAT, *PWINBIO_REGISTERED_FORMAT;

#define WINBIO_NO_FORMAT_OWNER_AVAILABLE ((USHORT)0)
#define WINBIO_NO_FORMAT_TYPE_AVAILABLE ((USHORT)0)

typedef struct _WINBIO_BIR_HEADER {
    ...
    WINBIO_REGISTERED_FORMAT BiometricDataFormat;
    WINBIO_REGISTERED_FORMAT ProductId;
    ...
} WINBIO_BIR_HEADER;

typedef WINBIO_BIR_HEADER *PWINBIO_BIR_HEADER;
Fingerprint Device Driver

WINBIO_BDB_ANSI_381_HEADER

#define WINBIO_ANSI_381_FORMAT_OWNER ((USHORT)0x001B)
#define WINBIO_ANSI_381_FORMAT_TYPE ((USHORT)0x0401)

typedef struct _WINBIO_BDB_ANSI_381_HEADER {
    ULONG64 RecordLength;
    ULONG FormatIdentifier;
    ULONG VersionNumber;
    WINBIO_REGISTERED_FORMAT ProductId;
    USHORT CaptureDeviceId;
    USHORT ImageAcquisitionLevel;
    USHORT HorizontalScanResolution;
    USHORT VerticalScanResolution;
    USHORT HorizontalImageResolution;
    USHORT VerticalImageResolution;
    UCHAR ElementCount;
    UCHAR ScaleUnits;
    UCHAR PixelDepth;
    UCHAR ImageCompressionAlg;
    USHORT Reserved;
    // 38 bytes (because of unused 2 bytes in ULONG64) vs. 36 bytes defined in ANSI INCITS spec
} WINBIO_BDB_ANSI_381_HEADER;

typedef WINBIO_BDB_ANSI_381_HEADER *PWINBIO_BDB_ANSI_381_HEADER;
typedef struct _WINBIO_BDB_ANSI_381_RECORD {
    ULONG BlockLength;
    USHORT HorizontalLineLength;
    USHORT VerticalLineLength;
    WINBIO_BIOMETRIC_SUBTYPE Position;
    UCHAR CountOfViews;
    UCHAR ViewNumber;
    UCHAR ImageQuality;
    UCHAR ImpressionType;
    UCHAR Reserved;
} WINBIO_BDB_ANSI_381_RECORD;

typedef WINBIO_BDB_ANSI_381_RECORD *PWINBIO_BDB_ANSI_381_RECORD;
Fingerprint Engine Adapter

Role of Engine Adapter

- Manage the Algorithm Module
- Access sample image from Sensor Adapter
- Co-work with Algorithm Module to validate the sample images, and generate the Hash Value/Feature Set/Template from sample images
- Call Storage Adapter to store the Enrolled Templates
- Match Identification/Verification sample image with Stored Templates
Fingerprint Engine Adapter

Expose the WbioQueryEngineInterface external function

```c
; EngineAdapter.def

LIBRARY Inadapter

EXPORTS
    WbioQueryEngineInterface

HRESULT
WINAPI
WbioQueryEngineInterface(
    _Out_ PWINBIO_ENGINE_INTERFACE *ppEngineInterface
)
```
Fingerprint Engine Adapter

WINBIO_ENGINE_INTERFACE

```c
static WINBIO_ENGINE_INTERFACE g_EngineInterface = {
#if (NTDDI_VERSION > NTDDI_WIN7)
    WINBIO_ENGINE_INTERFACE_VERSION_2,
#else
    WINBIO_ENGINE_INTERFACE_VERSION_1,
#endif
    WINBIO_ADAPTER_TYPE_ENGINE,
    sizeof(WINBIO_ENGINE_INTERFACE),
    { 0xA6650C3E, 0x9A11, 0x4f25, { 0x8A, 0x02, 0x5D, 0x54, 0x10, 0x19, 0xD5, 0x87 }:
        EngineAdapterAttach,
        EngineAdapterDetach,
        EngineAdapterClearContext,
        EngineAdapterQueryPreferredFormat,
        EngineAdapterQueryIndexVectorSize,
        EngineAdapterQueryHashAlgorithms,
        EngineAdapterSetHashAlgorithm,
        EngineAdapterQuerySampleHint,
        EngineAdapterAcceptSampleData,
        EngineAdapterExportEngineData,
        EngineAdapterVerifyFeatureSet,
        EngineAdapterIdentifyFeatureSet,
        EngineAdapterCreateEnrollment,
        EngineAdapterUpdateEnrollment,
        EngineAdapterGetEnrollmentStatus,
        EngineAdapterGetEnrollmentHash,
        EngineAdapterCheckForDuplicate,
        EngineAdapterCommitEnrollment,
        EngineAdapterDiscardEnrollment,
        EngineAdapterControlUnit,
        EngineAdapterControlUnitPrivileged,
#if (NTDDI_VERSION > NTDDI_WIN7)
    EngineAdapterNotifyPowerChange,
#else
    NULL
#endif
};
```
Fingerprint Engine Adapter

Identification Example
Fingerprint Engine Adapter

Enable Integrity Check

- Add `/integritycheck` flag into “Project->Properties->Linker->Command Line”
Fingerprint Engine Adapter

Test Sign

- Make a test sign certificate with MakeCert.exe
- Install the test sign certificate into compiler PC with CertMgr.exe
- Install the test sign certificate into test PC with CertMgr.exe
- Enable the test sign in EngineAdapter project with test sign certificate with /ph parameter
  - Add the following command into “Project->Properties->Build Events->Post-Build Event->Command Line”
Fingerprint Engine Adapter

Enable Auto-Sign

[Image of the EngineAdapter Property Pages window showing configuration settings for Post-Build Event and Command Line with a sign tool command and 'Yes' for Use In Build]
Fingerprint Test

HCK Tools/Win10 HLK

- WBDIDriverTest.exe – for WBDI Fingerprint Device Driver – from WHCK
- BioTest.exe – for Fingerprint Sensor/Engine/Storage Adapters – from WHCK
- Fingerprint.Reader Test set in Win10 HLK
References

- WBF Overview
- WBDI Driver
- FMA
- Credential Provider
  http://download.microsoft.com/download/F/3/5/F3536898-FF3C-4548-8418-08D79555A0DB/Credential%20Provider%20Framework%20Changes%20in%20Windows%208.docx
- WBF APIs
- Code Sign
- Fingerprint Test