



NEUROtechnology



Fingerprint
identification for
stand-alone or
Web solutions

VeriFinger SDK



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VeriFinger is a fingerprint identification technology designed for biometric systems developers and integrators. The technology assures system performance with fast, reliable fingerprint matching in 1-to-1 and 1-to-many modes.

VeriFinger is available as a software development kit that allows development of stand-alone and Web-based solutions on Microsoft Windows, Linux, Mac OS X, iOS and Android platforms.

- 1500+ end-user product brands in 100+ countries used the VeriFinger algorithm over the past 18 years.
- Full NIST MINEX compliance, FpVTE and FVC awards since 2000.
- Rolled and flat fingerprint matching that is tolerant to fingerprint translation, rotation and deformation.
- Compact fingerprint template and unlimited database size.
- Available as multiplatform SDK that supports multiple scanners and multiple programming languages.
- Reasonable prices, flexible licensing and free customer support.



Features and capabilities

Performance numbers are provided for a PC with Intel Core 2 Q9400 processor (2.67 GHz).

In 1998 Neurotechnology developed **VeriFinger**, a **fingerprint identification algorithm** designed for biometric system integrators. Since that time, Neurotechnology has released more than 10 versions of the VeriFinger algorithm, providing the most powerful fingerprint recognition algorithms to date.

The latest VeriFinger 9.0 version is **NIST MINEX compliant**, as it is based on the MegaMatcher fingerprint identification engine that has been acknowledged by NIST as suitable for use in personal identity verification (PIV) program applications.

The VeriFinger algorithm follows the commonly accepted fingerprint identification scheme, which uses a set of specific fingerprint points (minutiae) along with a number of proprietary algorithmic solutions that enhance system performance and reliability. Some are listed below:

- **Rolled and flat fingerprints matching.** The VeriFinger algorithm matches flat-to-rolled, flat-to-flat or rolled-to-rolled fingerprints with a high degree of reliability and accuracy, as it is tolerant to fingerprint deformations. Rolled fingerprints have much bigger deformation due to the specific scanning technique (rolling from nail to nail) than those scanned using the “flat” technique. Conventional “flat” fingerprint identification algorithms usually perform matching between flat and rolled fingerprints less reliably due to the mentioned deformations of rolled fingerprints.
- **Tolerance to fingerprint translation, rotation and deformation.** VeriFinger’s proprietary fingerprint template matching algorithm is able to identify fingerprints even if they are rotated, translated, deformed and have only 5 - 7 similar minutiae (usually fingerprints of the same finger have 20 - 40 similar minutiae) and matches up to 40,000 flat fingerprints per second (see the “technical specifications” chapter for more details).
- **Identification capability.** VeriFinger functions can be used in 1-to-1 matching (verification), as well as **1-to-many** mode (identification).
- **Image quality determination.** VeriFinger is able to ensure that only the best quality fingerprint template will be stored into database by using fingerprint image quality determination during enrollment.
- **Adaptive image filtration.** This algorithm eliminates noises, ridge ruptures and stuck ridges for reliable minutiae extraction – even from poor quality fingerprints – with a processing time of 0.6 seconds (for flat fingerprints).
- **Features generalization mode.** This fingerprint enrollment mode generates the collection of generalized fingerprint features from a set of fingerprints of the same finger. Each fingerprint image is processed and features are extracted. Then the features collection set is analyzed and combined into a single generalized features collection, which is written to the database. This way, the enrolled features are more reliable and the fingerprint recognition quality considerably increases.
- **Scanner-specific algorithm optimizations.** VeriFinger 9.0 includes algorithm modes that help to achieve better results for the supported fingerprint scanners.



Contents of VeriFinger 9.0 Standard SDK and Extended SDK

VeriFinger SDK is based on VeriFinger fingerprint recognition technology and is intended for biometric systems developers and integrators. The SDK allows rapid development of biometric applications using functionality from the VeriFinger algorithm for Microsoft Windows, Linux, Mac OS X and Android. VeriFinger can be easily integrated into the customer's security system. The integrator has complete control over SDK data input and output.

VeriFinger SDK includes the Device Manager library for working with the supported fingerprint readers. Integrators can also write **plug-ins to support their fingerprint readers** or other devices using the plug-in framework provided with the Device Manager.

The following VeriFinger 9.0 SDKs are available:

- **VeriFinger 9.0 Standard SDK** is designed for PC-based, embedded and mobile biometric application development. It includes Fingerprint Matcher and Extractor component licenses, programming samples and tutorials, fingerprint scanner support modules and software documentation. The SDK allows the development of biometric applications for Microsoft Windows, Linux, Mac OS X and Android operating systems.
- **VeriFinger 9.0 Extended SDK** is designed for biometric **Web-based** and network application development. It contains all features and components of the Standard SDK. Additionally, the SDK includes Fingerprint Client component licenses for PCs and mobile devices, sample client applications, tutorials and a **ready-to-use matching server** component.

The table below compares VeriFinger 9.0 Standard SDK and VeriFinger 9.0 Extended SDK. See the licensing model for more information on specific license types.

Component licenses that are included with a specific SDK		
	VeriFinger 9.0 Standard SDK	VeriFinger 9.0 Extended SDK
• Fingerprint Matcher	1 single computer license	1 single computer license
• Embedded Fingerprint Matcher for Android	1 single computer license	1 single computer license
• Embedded Fingerprint Matcher for iOS	1 single computer license	1 single computer license
• Embedded Fingerprint Matcher for ARM Linux	1 single computer license	1 single computer license
• Fingerprint Client ⁽¹⁾		3 single computer licenses
• Embedded Fingerprint Client for Android		3 single computer licenses
• Embedded Fingerprint Client for iOS		3 single computer licenses
• Embedded Fingerprint Client for ARM Linux		3 single computer licenses
• Fingerprint Extractor	1 single computer license	1 single computer license
• Embedded Fingerprint Extractor for Android	1 single computer license	1 single computer license
• Embedded Fingerprint Extractor for iOS	1 single computer license	1 single computer license
• Embedded Fingerprint Extractor for ARM Linux	1 single computer license	1 single computer license
• Matching Server		+

(1) Fingerprint Client component includes Fingerprint Extractor, Fingerprint Segmenter, Fingerprint BSS and Fingerprint WSQ components, which can be also obtained separately.

VeriFinger 9.0 SDK includes programming samples and tutorials that show how to use the components of the SDK to perform fingerprint template extraction or matching against other templates. The samples and tutorials are available for these programming languages and platforms:

	Windows	Linux	Mac OS X	iOS	Android
• C/C++	+	+	+		
• Objective-C ⁽¹⁾				+	
• C#	+				
• Sun Java 2	+	+	+		+
• Visual Basic .NET	+				

(1) There are no tutorials for the Objective-C language.



Biometric Components Description

Fingerprint Matcher

The Fingerprint Matcher performs fingerprint template matching in 1-to-1 (verification) and 1-to-many (identification) modes. Also the Fingerprint Matcher component includes fused matching algorithm that allows to increase template matching reliability by:

- matching templates that contain 2 or more fingerprint records (note that Fingerprint Segmenter or Fingerprint Client components are required to perform template extraction from images that contain more than one fingerprint);
- matching templates that contain fingerprint, face, voiceprint and/or iris records (note that matching faces and irises requires to purchase Face Matcher, Voice Matcher and Iris Matcher components correspondingly - these components are available in *VeriLook 9.0 SDK*, *Verispeak 9.0 SDK* and *VeriEye 9.0 SDK* respectively; see these products brochures for more information).

The Fingerprint Matcher component matches **40,000 fingerprints per second** and is designed to be used in **desktop** or mobile biometric systems, which run on PCs or laptops with at least Intel **Core 2 Q9400** (2.67 GHz) processor.

One Fingerprint Matcher license is included with VeriFinger 9.0 Standard SDK and VeriFinger 9.0 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 9.0 SDK customers.

Embedded Fingerprint Matcher

The Embedded Fingerprint Matcher has the same functionality, as the Fingerprint Matcher. It matches **3,000 fingerprints per second** and is designed to be used in **embedded** or **mobile** biometric systems, which run on ARM Linux, **Android** or **iOS** devices. The Android devices should be based on at least **Snapdragon S4** system-on-chip (**Krait 300** processor with 4 cores running at 1.51 GHz).

One Embedded Fingerprint Matcher license for each of Android, iOS and ARM Linux platforms is included with VeriFinger 9.0 Standard SDK and VeriFinger 9.0 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 9.0 SDK customers.

Fingerprint Client

The Fingerprint Client component is a combination of the **Fingerprint Extractor**, **Fingerprint BSS**, **Fingerprint Segmenter** and **Fingerprint WSQ** components. It is intended for the systems that need to support most or all functionality of the mentioned components on the same PC. Using these licenses allows to optimize component license costs as well as reduce license management.

The Fingerprint Client extracts a single fingerprint template in **0.6 seconds**. The specified performance requires a **PC** or **laptop** with at least Intel **Core 2 Q9400** (2.67 GHz) processor.

Three licenses for the Fingerprint Client component are included with VeriFinger 9.0 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 9.0 Extended SDK customers.

Embedded Fingerprint Client

The Embedded Fingerprint Client component has the same functionality as the Fingerprint Client and is designed to run on **Android** or **iOS** or ARM Linux devices. The Android devices should be based on at least **Snapdragon S4** system-on-chip (**Krait 300** processor with 4 cores running at 1.51 GHz). The component extracts a single fingerprint template in **1.34 seconds**.

Three licenses for the Embedded Fingerprint Client component for each of Android, iOS and ARM Linux platforms are included with VeriFinger 9.0 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 9.0 Extended SDK customers.



Fingerprint Extractor

Fingerprint Extractor creates fingerprint templates from fingerprint images. Fingerprint templates can be stored in the following formats by the Fingerprint Extractor component:

- **Neurotechnology proprietary** fingerprint template format;
- **ISO/IEC 19794-2:2005 with Cor. 1:2009** (General and On-Card Fingerprint Minutiae Data Formats);
- **ISO/IEC 19794-2:2011 with Cor. 1:2012** (General and On-Card Fingerprint Minutiae Data Formats);
- **ANSI/INCITS 378-2004** (Finger Minutiae Format for Data Interchange);
- **ANSI/INCITS 378-2009 with Amd. 1:2010** (Finger Minutiae Format for Data Interchange).

Proprietary image quality control may be applied to accept only good quality fingerprint images.

Fingerprint Extractor can generalize a fingerprint template from several fingerprint images to improve template quality.

The component extracts a single fingerprint template in **1.34 seconds**. The specified performance requires a **PC** or **laptop** with at least Intel **Core 2 Q9400** (2.67 GHz) processor.

One Fingerprint Extractor license is included with VeriFinger 9.0 Standard SDK and VeriFinger 9.0 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 9.0 SDK customers.

Embedded Fingerprint Extractor

The Embedded Fingerprint Extractor has the same functionality as the Fingerprint Extractor and is designed to be run on **Android** or **iOS** or ARM Linux devices. The component extracts a single fingerprint template in **1.34 seconds**.

One Embedded Fingerprint Extractor license for each of Android, iOS and ARM Linux platforms is included with VeriFinger 9.0 Standard SDK and VeriFinger 9.0 Extended SDK,. More licenses for this component can be purchased any time by VeriFinger 9.0 SDK customers.

Fingerprint Segmenter

The Fingerprint Segmenter components separates fingerprints if an image contains more than one fingerprint. This component enables Fingerprint Extractor component to process fingerprints from scanned **tenprint** card or image captured using scanners that allow to scan two or more fingers at once.

Fingerprint pattern classification module that allows to determine a fingerprint pattern class is included with Fingerprint Segmenter component. The classification is usually used in forensics, but also it can be used to increase fingerprint matching speed. The defined classes are:

- Left Slant Loop;
- Right Slant Loop;
- Tented Arch;
- Whorl;
- Scar;
- "Unknown" – for the nondetermined classes.

The Fingerprint Segmenter is designed for desktop or mobile applications that run on **PC** or **laptop** with at least Intel **Core 2 Q9400** (2.67 GHz) processor.

The Fingerprint Segmenter licenses can be purchased anytime by VeriFinger 9.0 Extended SDK customers.



Fingerprint BSS (Biometric Standards Support)

The Fingerprint BSS component allows to integrate support for fingerprint template and image format standards and additional image formats with new or existing biometric systems based on VeriFinger SDK.

These biometric standards are supported:

- **BioAPI 2.0 (ISO/IEC 19784-1:2006)** (Framework and Biometric Service Provider for fingerprint identification engine)
- **CBEFF V1.2 (ANSI INCITS 398-2008)** (Common Biometric Exchange Formats Framework)
- **CBEFF V2.0 (ISO/IEC 19785-1:2006, 19785-3:2007)** (Common Biometric Exchange Formats Framework)
- **ISO/IEC 19794-4:2005 with Cor. 1:2011** (Finger Image Data)
- **ISO/IEC 19794-4:2011 with Cor. 1:2012** (Finger Image Data)
- **ANSI/INCITS 378-2004** (Finger Minutiae Format for Data Interchange)
- **ANSI/INCITS 378-2009 with Amd. 1:2010** (Finger Minutiae Format for Data Interchange)
- **ANSI/NIST-CSL 1-1993** (Data Format for the Interchange of Fingerprint, Facial, & SMT Information)
- **ANSI/NIST-ITL 1a-1997** (Data Format for the Interchange of Fingerprint, Facial, & SMT Information)
- **ANSI/NIST-ITL 1-2000** (Data Format for the Interchange of Fingerprint, Facial, & SMT Information)
- **ANSI/NIST-ITL 1-2007** (Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information)
- **ANSI/NIST-ITL 1a-2009** (Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information)

The Fingerprint BSS component allows **conversion** between Neurotechnology proprietary fingerprint templates, ISO/IEC 19794-2:2005, ISO/IEC 19794-2:2011, ANSI/INCITS 378-2004, ANSI/INCITS 378-2009 and ANSI/NIST-ITL templates.

The Fingerprint BSS component also includes:

- **JPEG 2000** image format support module with 1000 ppi Fingerprint Profile;
- **NIST IHead** image format support module;
- module with NIST Fingerprint Image Quality (**NFIQ**) algorithm, a standard method to determine fingerprint image quality.

Latent Fingerprint Editor is available with Fingerprint BSS component. In most cases automated image processing is unable to extract all minutiae or extracts a lot of false minutiae from latent fingerprint image (for example, taken from the crime scene). Therefore, an expert should manually edit a fingerprint template in order to submit it to an AFIS for the identification. **Sample latent fingerprint template editor (.NET)** shows how to change minutia's coordinates, direction, type and other parameters.

Licenses for the Fingerprint BSS component can be purchased anytime by VeriFinger 9.0 Extended SDK customers.

Fingerprint WSQ

The Fingerprint WSQ component allows to integrate support for WSQ (Wavelet Scalar Quantization) image format. The WSQ format allows to compress a fingerprint image up to 10-15 times. WSQ compression process is "lossy", meaning that the reconstructed image is not equal to the original (some information is lost). However, the WSQ algorithm was specially designed to minimize the loss of fingerprint information therefore the reconstructed image is as close as possible to the original.

Neurotechnology's implementation of WSQ 3.1 fingerprint image compression was **certified by the FBI** as compliant with the accuracy requirements in the Wavelet Scalar Quantization (WSQ) Gray-Scale Fingerprint Image Compression Specification, Version 3.1.

Licenses for the Fingerprint WSQ component can be purchased anytime by VeriFinger 9.0 Extended SDK.



Matching Server

The Matching Server is ready-to-use software intended for building moderate size web-based and other network-based systems like local AFIS or multi-biometric identification system. The Server software runs on a server PC and allows to perform the biometric template matching on server side using Fingerprint Matcher component.

Multi-biometric matching can be enabled by running components for fingerprint, face, voiceprint and iris matching on the same machine.

Client communication module that allows sending a task to the Matching Server, querying status of the task, getting the results and removing the task from server, is included with MegaMatcher 9.0 SDK, VeriFinger 9.0 SDK, VeriLook 9.0 SDK, VeriEye 9.0 SDK and VeriSpeak 9.0 SDK. This module hides all low level communications and provides high-level API for the developer.

The components and database support modules with source codes included for Matching Server component are listed in the table below. Custom modules for working with other databases can also be developed by integrator and used with the Matching Server software.

The table below shows what components are available with Matching Server software.

Components	Microsoft Windows 32 & 64 bit	Linux 32 & 64 bit	Mac OS X
• Matching server software	+	+	+
• Server administration tool API	+	+	
Database support modules			
• Microsoft SQL Server	+		
• PostgreSQL	+	+	
• MySQL	+	+	
• Oracle	+	+	
• SQLite	+	+	+
Programming samples			
• C# client	+		
• Visual Basic .NET client	+		
• Sun Java 2 web client	+	+	+
Programming tutorials			
• C/C++	+	+	
• C#	+		
• Visual Basic .NET	+		

The Matching Server component requires a **special license** that allows to run the component on all machines that run the fingerprint, face, iris or palm print matching components obtained by an integrator. The Matching Server software is included with VeriFinger 9.0 Extended SDK.

Also the Matching Server component is included with these Neurotechnology SDKs (see their brochures for more info):

- MegaMatcher 9.0 Standard or MegaMatcher 9.0 Extended SDK;
- VeriLook 9.0 Extended SDK;
- VeriEye 9.0 Extended SDK.
- VeriSpeak 9.0 Extended SDK.



Supported fingerprint scanners under Microsoft Windows

Fingerprint readers supported by VeriFinger SDK under Linux, Mac OS X, iOS and Android are available on the next pages.

	Windows XP		Windows Vista / 7		Windows 8	
	32 bit	64 bit	32 bit	64 bit	32 bit	64 bit
• 3M Cogent CSD 330			+			
• Abilma UNITY			+	+	+	+
• ACS AET62 / AET65	+		+	+	+	+
• ARH AFS 510	+		+	+		
• Athena ASEDive Ille Combo Bio F2	+	+	+	+	+	+
• Atmel FingerChip	+					
• BioLink U-Match MatchBook v.3.5	+		+	+	+	+
• Biometrika Fx2000 / Fx2100 / Fx3000 / HiScan / HiScan-PRO	+		+			
• Cross Match L Scan 500P / Guardian USB / Patrol / Patrol ID / Verifier 300 / 320	+	+(1)	+	+(1)		
• DERMALOG LF10 / F1 / ZF1	+		+		+	+
• DigitalPersona U.are.U 4000 / 4500 / 5100 / 5160 / 5200 / EikonTouch 710	+	+	+	+	+	+
• Futronic FS10 / FS26 / FS50 / FS64 / FS80 / FS80H / FS82 / FS88 / FS88H / eFAM	+	+	+	+	+	+
• Futronic FS60	+		+		+	+
• Green Bit DactyScan26 / DactyScan40i / DactyScan84c / DactyScan84n / MultiScan527	+	+	+	+	+	+
• Hongda S500 / S680 / S700	+					
• HFSecurity HF-4000 / HF-7000	+		+	+	+	+
• id3 Certis Image	+					
• Integrated Biometrics Columbo / Curve / Kojak / Sherlock / Watson / Watson Mini	+	+	+	+	+	+
• Koehlke KIAU-5110B3 / KIA-UM01	+		+		+	
• L-1 DFR 2080 / DFR 2090 / DFR 2100 / DFR 2300	+		+	+(1)		
• Lumidigm Mercury / Venus series sensors	+	+	+	+	+	+
• Miaxis FPR620 / SM-201 / SM-2BU	+		+		+	
• NeuBio MARS 02			+	+	+	+
• NEXT Biometrics NB-3010-U	+	+	+	+	+	+
• NITGEN Fingkey Hamster / Fingkey Hamster II / Fingkey Mouse III	+	+	+	+	+	+
• NITGEN eNBioScan-F / eNBioScan-C1 / eNBioScan-D Plus	+	+	+	+	+	+
• SecuGen Hamster III	+		+		+	
• SecuGen Hamster Plus / Hamster IV / Hamster Pro 20 / Pro Duo CL/SC/PIV / iD-USB SC	+	+	+	+	+	+
• Shanghai Fingertech BIOCA-111	+		+			
• Startek FC320U / FM220U / FPC360U	+		+		+	
• Suprema BioMini / BioMini Plus2 / BioMini Slim / SFU-S20 / SFR300-S / SFU300	+		+	+	+	+
• Suprema RealScan-G10 / RealScan-G1 / RealScan-10 / RealScan-D / RealScan-S	+	+	+	+	+	+
• Tacoma CMOS	+		+			
• TENBIO TOUCH ONE	+		+		+	
• Testech Bio-i	+		+		+	
• TopLink Pacific BLUEFiN	+		+	+	+	+
• UPEK Eikon / Eikon Solo / Eikon To Go / EikonTouch 300 / 500 / 700 / TouchChip	+		+	+	+	+
• ViRDI FOH02SC	+		+			
• ZKSoftware ZK4000 / ZK4500 / ZK6000 / ZK7000 / ZK8000	+		+			
• ZKS-1000	+					
• Zvetco Verifi P5100	+	+	+	+	+	+

(1) Can be used on 64-bit OS, but only in 32-bit applications.



Supported fingerprint scanners under Linux (x86 and ARM) and Android

	Linux (x86)		Linux (ARM)		Android (ARM)
	32-bit	64-bit	32-bit	64-bit	
• Abilma UNITY	+	+	+	+	+
• ACS AET62 / AET65	+	+			
• ARH AFS 510	+	+			
• BioLink U-Match MatchBook v.3.5	+				
• Credence ID Credence One / Trident					+ (2)
• DERMALOG LF10 / F1 / ZF1	+				
• DigitalPersona U.are.U 4000 / 4500 / 5100 / 5160 / 5200	+	+			
• Fujitsu MBF200	+	+			
• Futronic FS28					+
• Futronic FS10 / FS26 / FS50 / FS80 / FS80H / FS82 / FS88 / FS88H	+	+			+
• Futronic eFAM	+	+	+	+	+
• Green Bit DactyScan26 / DactyScan40i / DactyScan84c / DactyScan84n	+				
• Integrated Biometrics Curve / LES650	+				
• Integrated Biometrics Columbo/ Sherlock / Watson / Watson Mini	+	+			+
• Integrated Biometrics Kojak					+
• Lumidigm Mercury / Venus series sensors	+				
• Maxis SM-201					+
• NEXT Biometrics NB-3010-U	+	+	+	+	+
• NITGEN eNBioScan-F	+				
• SecuGen Hamster III	+				
• SecuGen Hamster IV / Hamster Plus / Hamster Pro / Pro Duo CL/SC/PIV					+
• SMUFS Biometric SMUFS BT					
• Suprema BioMini / BioMini Plus2 / BioMini Slim / SFU-S20	+				+
• Suprema RealScan-G10	+				
• Tacoma CMOS	+	+			
• TazTag TazPad					+
• TopLink Pacific BLUEFiN	+	+			+
• UPEK Eikon / Eikon Solo / Eikon To Go	+	+			+ (1)
• UPEK EikonTouch 300 / 500 / 700 / TouchChip TCRU1C / TCRU2C					+ (1)
• Zvetco Verifi P5100	+	+			

(1) requires root access to the device.

(2) the device has pre-installed Android OS



Supported fingerprint scanners under Mac OS X and iOS

	Mac OS X (x86)		iOS (ARM)
	32-bit	64-bit	
• Abilma UNITY	+	+	
• ACS AET62 / AET65	+	+	
• Fujitsu MBF200	+	+	
• Fulcrum Biometrics mobileOne QuickDock			+
• NEXT Biometrics NB-3010-U	+	+	
• SMUFS Biometric SMUFS BT			+
• Tacoma CMOS	+	+	
• UPEK Eikon / Eikon Solo / Eikon To Go	+	+	



System requirements

There are specific requirements for each platform which will run VeriFinger-based applications.

Microsoft Windows platform requirements

- Microsoft Windows **XP / Vista / 7 / 8 / 10**, 32-bit or 64-bit. If a fingerprint scanner is required, note that some scanners are supported only on 32-bit OS or only from 32-bit applications.
- PC or laptop with **x86 (32-bit)** or **x86-64 (64-bit)** compatible processors.
 - 2 GHz or better processor is recommended.
 - **SSE2 support is required.** Processors that do not support SSE2 cannot run the VeriFinger algorithm. Please check if a particular processor model supports SSE2 instruction set.
- At least **128 MB of free RAM** should be available for the application. Additional RAM is required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching. For example, **25,000 templates** (each with 2 fingerprint records) require about **from 50 MB to 300 MB of additional RAM** depending on configured template size.
- **Free space on hard disk drive (HDD):**
 - at least 1 GB required for the development.
 - 100 MB required for VeriFinger components deployment.
 - Additional space would be required in these cases:
 - VeriFinger does not require the original fingerprint image to be stored for the matching; only the templates need to be stored. However, storing fingerprint images on hard drive for the potential future usage is recommended.
 - Usually a database engine runs on a separate computer (back-end server). However, DB engine can be installed on the same computer for standalone applications. In this case HDD space for templates storage must be available. For example, 25,000 templates (each with 2 fingerprints inside) stored using a relational database would require from 50 to 300 MB of free HDD space depending on configured template size. Also, the database engine itself requires HDD space for running. Please refer to HDD space requirements from the database engine providers.
- **Fingerprint reader.** VeriFinger SDK includes support modules for more than 100 fingerprint scanners under Microsoft Windows platform. Integrators can also write plug-ins to support their fingerprint readers using the plug-in framework provided with the Device Manager from the VeriFinger SDK.
- **Database engine** or connection with it. VeriFinger templates can be saved into any DB (including files) supporting binary data saving. VeriFinger Extended SDK contains the following support modules for Matching Server on Microsoft Windows platform: **Microsoft SQL Server, MySQL, Oracle, PostgreSQL** and **SQLite**.
- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). Communication with Matching server is not encrypted, therefore, if communication must be secured, a dedicated network (not accessible outside the system) or a secured network (such as VPN; VPN must be configured using operating system or third party tools) is recommended.
- Microsoft **.NET framework 3.5** or newer (for .NET components usage).
- One of following **development environments** for application development:
 - Microsoft Visual Studio 2008 SP1 or newer (for application development under C/C++, C#, Visual Basic .Net)
 - Sun Java 1.6 SDK or later.



Android platform requirements

- A smartphone or tablet that is running **Android 4.0 (API level 14)** OS or newer.
 - API level 19 is the recommended **target** for code compilation.
 - If you have a custom Android-based device or development board, contact us to find out if it is supported.
- ARM-based **1.5 GHz processor recommended** for fingerprint processing in the specified time. Slower processors may be also used, but the fingerprint processing will take longer time.
- At least **20 MB of free RAM** should be available for the application. Additional RAM is required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching. For example, **1,000 templates** (each with 2 fingerprint records) require about **2 MB of additional RAM**.
- **Free storage** space (built-in flash or external memory card):
 - 30 MB required for embedded fingerprint components deployment for each separate application.
 - Additional space would be required if an application needs to store original fingerprint images. VeriFinger does not require the original image to be stored for the matching; only the templates need to be stored.
- **Fingerprint reader.** VeriFinger SDK includes support modules for a number of fingerprint scanners under Android platform. Integrators can also write plug-ins to support their fingerprint readers using the plug-in framework provided with the Device Manager from the VeriFinger SDK.
- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). Communication with Matching server is not encrypted, therefore, if communication must be secured, a dedicated network (not accessible outside the system) or a secured network (such as VPN; VPN must be configured using operating system or third party tools) is recommended.
- **PC-side development** environment requirements:
 - Java SE JDK 6 (or higher)
 - Eclipse Indigo (3.7) IDE
 - Android development environment (at least API level 14 required)
 - One of the following build automation systems:
 - Apache Maven 3.1.x or newer
 - Gradle 2.10 or newer
 - Internet connection for activating VeriFinger component licenses



iOS platform requirements

- One of the following devices, running **iOS 8.0** or newer:
 - **iPhone 5** or newer iPhone.
 - **iPad 2** or newer iPad, including iPad Mini and iPad Air models.
 - **iPod Touch 6th Generation** or newer iPod.
- At least **20 MB of free RAM** should be available for the application. Additional RAM is required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching. For example, **1,000 templates** (each with 2 fingerprint records) require about **2 MB of additional RAM**.
- **Free storage space** (built-in flash or external memory card):
 - 30 MB required for embedded fingerprint components deployment for each separate application.
 - Additional space would be required if an application needs to store original fingerprint images. VeriFinger does not require the original fingerprint image to be stored for the matching; only the templates need to be stored.
- **Fingerprint reader.** VeriFinger SDK includes support modules for several fingerprint scanners under iOS platform. Also, fingerprint images in **BMP**, **JPG** or **PNG** formats can be processed thus almost any third-party fingerprint capturing hardware can be used with the VeriFinger technology if it generates images in the mentioned formats.
- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). Communication with Matching server is not encrypted, therefore, if communication must be secured, a dedicated network (not accessible outside the system) or a secured network (such as VPN; VPN must be configured using operating system or third party tools) is recommended.
- **Development environment** requirements:
 - a Mac running Mac OS X 10.10.x or newer.
 - Xcode 6.4 or newer.



Mac OS X platform requirements

- A Mac running **Mac OS X 10.7.x** or newer. 2 GHz or better processor is recommended.
- At least **128 MB of free RAM** should be available for the application. Additional RAM is required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching. For example, **25,000 templates** (each with 2 fingerprint records) require about **from 50 MB to 300 MB of additional RAM** depending on configured template size.
- **Free space on hard disk drive (HDD):**
 - at least 1 GB required for the development.
 - 100 MB required for VeriFinger components deployment.
 - Additional space would be required in these cases:
 - VeriFinger does not require the original fingerprint image to be stored for the matching; only the templates need to be stored. However, storing fingerprint images on hard drive for the potential future usage is recommended.
 - Usually a database engine runs on a separate computer (back-end server). However, DB engine can be installed on the same computer for standalone applications. In this case HDD space for templates storage must be available. For example, 25,000 templates (each with 2 fingerprints inside) stored using a relational database would require from 50 MB to 300 MB of free HDD space depending on configured template size. Also, the database engine itself requires HDD space for running. Please refer to HDD space requirements from the database engine providers.
- **Fingerprint reader.** VeriFinger SDK includes support modules for a number of fingerprint scanners under Mac OS X platform. Integrators can also write plug-ins to support their fingerprint readers using the plug-in framework provided with the Device Manager from the VeriFinger SDK.
- **Database engine** or connection with it. VeriFinger templates can be saved into any DB (including files) supporting binary data saving. VeriFinger Extended SDK contains **SQLite** support modules for Matching Server on Mac OS X platform.
- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). Communication with Matching server is not encrypted, therefore, if communication must be secured, a dedicated network (not accessible outside the system) or a secured network (such as VPN; VPN must be configured using operating system or third party tools) is recommended.
- Specific requirements for **application development:**
 - XCode 4.3 or newer
 - wxWidgets 3.0.0 or newer libs and dev packages (to build and run SDK samples and applications based on them)
 - Qt 4.8 or newer libs, dev and qmake packages (to build and run SDK samples and applications based on them)
 - GNU Make 3.81 or newer (to build samples and tutorials development)
 - Sun Java 1.6 SDK or later.



Linux x86 / x86-64 platform requirements

- Linux 2.6 or newer kernel (32-bit or 64-bit) is required. **Linux 3.0 kernel** or newer is recommended.
- PC or laptop with **x86 (32-bit)** or **x86-64 (64-bit)** compatible processors.
 - 2 GHz or better processor is recommended.
 - **SSE2 support is required.** Processors that do not support SSE2 cannot run the VeriFinger algorithm. Please check if a particular processor model supports SSE2 instruction set.
- At least **128 MB of free RAM** should be available for the application. Additional RAM is required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching. For example, **25,000 templates** (each with 2 fingerprint records) require about **from 50 MB to 300 MB of additional RAM** depending on configured template size.
- **Free space on hard disk drive (HDD):**
 - at least 1 GB required for the development.
 - 100 MB required for VeriFinger components deployment.
 - Additional space would be required in these cases:
 - VeriFinger does not require the original fingerprint image to be stored for the matching; only the templates need to be stored. However, storing fingerprint images on hard drive for the potential future usage is recommended.
 - Usually a database engine runs on a separate computer (back-end server). However, DB engine can be installed on the same computer for standalone applications. In this case HDD space for templates storage must be available. For example, 25,000 templates (each with 2 fingerprints inside) stored using a relational database would require from 50 MB to 300 MB of free HDD space depending on configured template size. Also, the database engine itself requires HDD space for running. Please refer to HDD space requirements from the database engine providers.
- **Fingerprint reader.** VeriFinger SDK includes support modules for a number of fingerprint scanners under Linux platform. Integrators can also write plug-ins to support their fingerprint readers using the plug-in framework provided with the Device Manager from the VeriFinger SDK.
- glibc 2.11.3 library or newer
- **Database engine** or connection with it. VeriFinger templates can be saved into any DB (including files) supporting binary data saving. VeriFinger Extended SDK contains **MySQL, Oracle, PostgreSQL** and **SQLite** support modules for Matching Server on Linux x86 / x86-64 platforms.
- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). Communication with Matching server is not encrypted, therefore, if communication must be secured, a dedicated network (not accessible outside the system) or a secured network (such as VPN; VPN must be configured using operating system or third party tools) is recommended.
- Specific requirements for **application development:**
 - wxWidgets 3.0.0 or newer libs and dev packages (to build and run SDK samples and applications based on them)
 - Qt 4.8 or newer libs, dev and qmake packages (to build and run SDK samples and applications based on them)
 - GCC-4.4.x or newer
 - GNU Make 3.81 or newer (to build samples and tutorials development)
 - Sun Java 1.6 SDK or later.
 - pkg-config-0.21 or newer (optional; only for Matching Server database support modules compilation)



ARM Linux platform requirements

We recommend to contact us and report the specifications of a target device to find out if it will be suitable for running VeriFinger-based applications. There is a list of common requirements for ARM Linux platform:

- A device with ARM-based processor, running **Linux 3.2 kernel** or newer.
- ARM-based **1.5 GHz processor recommended** for fingerprint processing in the specified time. .
 - **ARMHF architecture (EABI 32-bit hard-float ARMv7)** is required.
 - Lower clock-rate processors may be also used, but the fingerprint processing will take longer time
- At least **20 MB of free RAM** should be available for the application. Additional RAM is required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching. For example, **1,000 templates** (each with 2 fingerprint records) require about **2 MB of additional RAM**.
- **Free storage** space (built-in flash or external memory card):
 - 100 MB required for VeriFinger components deployment.
 - Additional space would be required if an application needs to store original fingerprint images. VeriFinger does not require the original fingerprint image to be stored for the matching; only the templates need to be stored.
- **Fingerprint reader.** VeriFinger SDK includes support modules for several fingerprint scanners under ARM Linux platform. Also, fingerprint images in **BMP, JPG or PNG** formats can be processed thus almost any third-party fingerprint capturing hardware can be used with the VeriFinger technology if it generates images in the mentioned formats.
- glibc 2.13 library or newer
- libstdc++-v3 4.7.2 or newer.
- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). Communication with Matching server is not encrypted, therefore, if communication must be secured, a dedicated network (not accessible outside the system) or a secured network (such as VPN; VPN must be configured using operating system or third party tools) is recommended.
- **Development environment** requirements:
 - GCC-4.4.x or newer
 - GNU Make 3.81 or newer
 - JDK 1.6 or later



Technical Specifications

500 ppi is the recommended fingerprint image resolution for VeriFinger. The minimal fingerprint image resolution is 250 ppi.

All fingerprint templates should be loaded into RAM before identification, thus the maximum fingerprint templates database size is limited by the amount of available RAM.

VeriFinger biometric template extraction and matching algorithm is designed to run on **multi-core processors** allowing to reach maximum possible performance on the used hardware.

VeriFinger 9.0 fingerprint engine specifications				
	Embedded / mobile platform ⁽¹⁾		PC-based platform ⁽²⁾	
Template extraction components	Embedded Fingerprint Extractor	Embedded Fingerprint Client	Fingerprint Extractor	Fingerprint Client
Template extraction time (seconds)	1.34	1.20	1.34	0.60
Template matching components	Embedded Fingerprint Matcher		Fingerprint Matcher	
Template matching speed ⁽³⁾ (fingerprints per second)	3,000		40,000	
Single fingerprint record size in a template (bytes)	700 - 6,000 (configurable)			

Notes:

(1) Requires to be run on iOS or Android devices based on at least Snapdragon S4 system-on-chip with Krait 300 processor (4 cores, 1.51 GHz).

(2) Requires to be run on PC or laptop with at least Intel Core 2 Q9400 quad-core processor (2.67 GHz) to reach the specified performance.

(3) Speeds are provided for the maximized matching speed scenario. The templates should be extracted from images, which are not larger than 500 x 500 pixels. Setting the matching algorithm to higher accuracy or using templates from larger fingerprint images may require more powerful hardware to reach the specified speed



Reliability Tests Results

We present the testing results to show VeriFinger 9.0 template matching algorithm reliability on the data from different fingerprint readers.

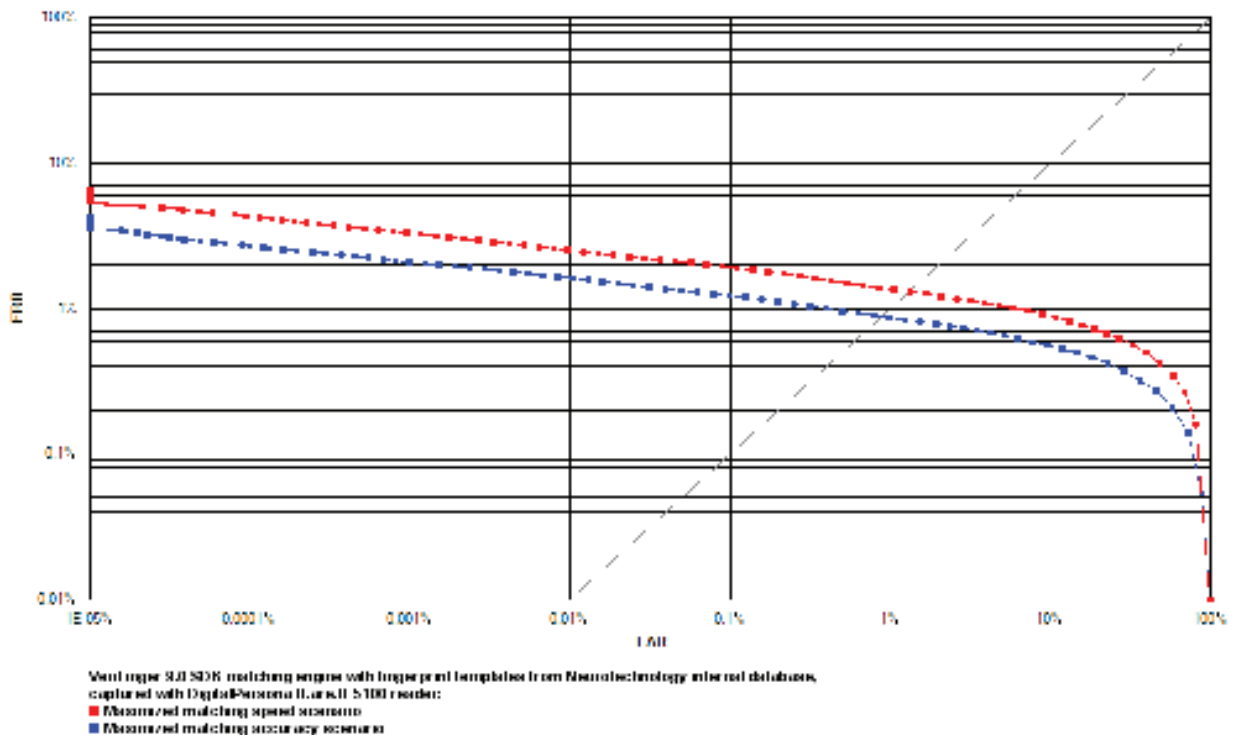
Flat fingerprint image datasets used for VeriFinger 9.0 algorithm testing			
	Experiment 1	Experiment 2	Experiment 3
Fingerprint reader model	DigitalPersona U.are.U 5100	Futronic FS80	Cross Match Verifier 300 LC 2.0
Image count	11900	8600	10400
Subject count	73	43	67
Unique finger count	730	430	670
Session count	10 - 20	20	10 - 20
Image size (pixels)	252 x 324	320 x 480	640 x 480

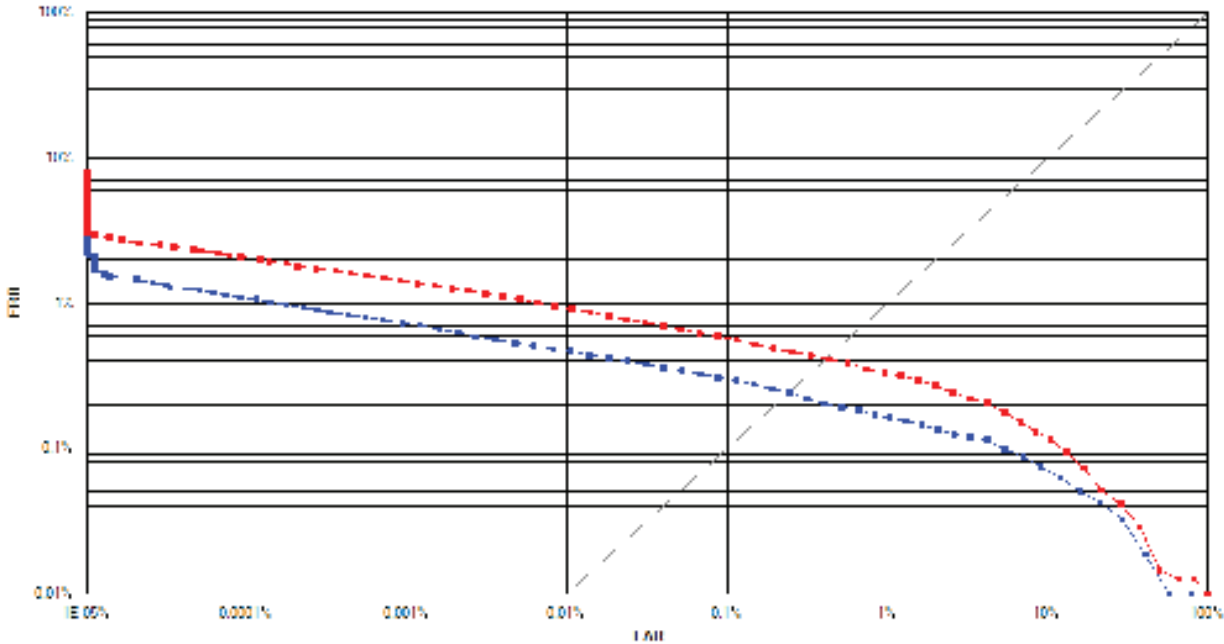
Two tests were performed with each database:

- **Test 1** maximized **matching accuracy**. The algorithm reliability in this test is shown as **blue curves** on the ROC charts.
- **Test 2** maximized **matching speed**. The algorithm reliability in this test is shown as **red curves** on the ROC charts.

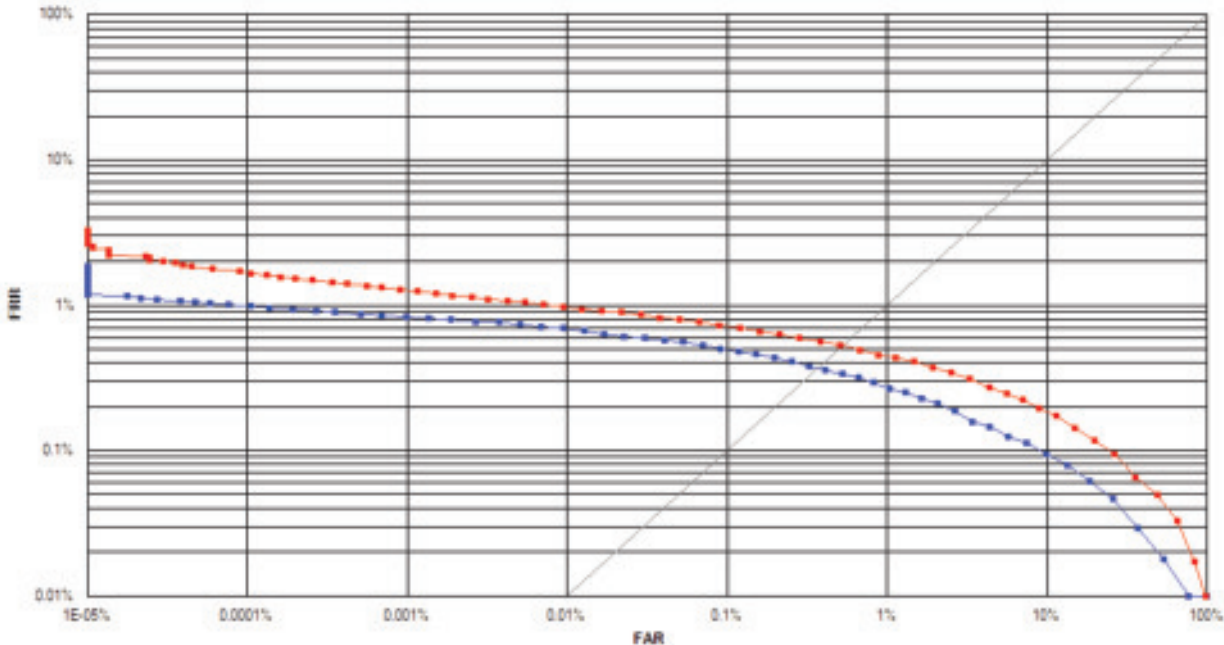
VeriFinger 9.0 algorithm reliability tests						
	Experiment 1		Experiment 2		Experiment 3	
	Test 1	Test2	Test 1	Test2	Test 1	Test2
Average template size (bytes)	3230	586	5584	974	5245	910
FRR at 0.01 % FAR	1.6570 %	2.5120 %	0.6940 %	0.9755 %	0.4839 %	0.9493 %
FRR at 0.001 % FAR	2.0760 %	3.3280 %	0.8280 %	1.2780 %	0.7273 %	1.4270 %

Receiver operation characteristic (**ROC**) curves are usually used to demonstrate the recognition quality of an algorithm. ROC curves show the dependence of false rejection rate (**FRR**) on the false acceptance rate (**FAR**).





VeriFinger 3.0 SDK matching engine with fingerprint templates from Neurotechnology internal database, captured with Laisves LC 500 reader:
 ■ Maximized matching speed scenario
 ■ Maximized matching accuracy scenario



VeriFinger 3.0 SDK matching engine with fingerprint templates from Neurotechnology internal database, captured with Cross Match Verifier 300 LC 2.0 reader:
 ■ Maximized matching speed scenario
 ■ Maximized matching accuracy scenario





VeriFinger Demo, Trial SDK and Related Products

VeriFinger **algorithm demo** application and VeriFinger **30-day SDK Trial** are available for downloading at www.neurotechnology.com/download.html.

These products are related to VeriFinger SDK:

- **MegaMatcher SDK** – for development of AFIS or multi-biometric fingerprint, face, iris, voice and palm print identification products. See “MegaMatcher SDK” brochure for more information.
- **MegaMatcher On Card SDK** – a product for fingerprint, iris and face matching on smart cards. See “MegaMatcher On Card SDK” brochure for more information.
- **FingerCell SDK** – for integrating fingerprint recognition into embedded platforms, like low-power, low-memory microcontrollers. See our web site for more information.
- **Free Fingerprint Verification SDK** – a **freeware** SDK intended for adding fingerprint verification functionality into various applications. See our web site for more information.
- **NCheck Bio Attendance** – an end-user employee attendance management application designed as **ready-to-use time and attendance system** with biometric fingerprint and face identification; the application uses VeriFinger fingerprint recognition algorithm to check person identity.



Licensing VeriFinger SDK

The following licensing model is intended for **end-user** product developers. Integrators who want to develop and sell a VeriFinger-based development tool (with API, programming possibilities, programming samples, etc.), must obtain permission from Neurotechnology and sign a special VAR agreement.

Product Development

An integrator should obtain either a VeriFinger 9.0 Standard SDK (EUR 339) or VeriFinger 9.0 Extended SDK (EUR 859) to develop a product based on VeriFinger technology. The SDK needs to be purchased just once and may be used by all the developers withing the integrator's company.

VeriFinger SDKs include a number of components; each particular component has specific functionality. A **license** for an individual VeriFinger component is required for **each computer or device** that **runs** the component.

See the "Contents of VeriFinger 9.0 Standard SDK and Extended SDK" chapter (the table on the page 4) for the list of component licenses included with VeriFinger 9.0 Standard and VeriFinger 9.0 Extended SDK.

Components are copy-protected – a license is required for a component to run. License activation options are listed below on this page.

Additional component licenses may be obtained by VeriFinger 9.0 SDK customers as required by their development process.

Product Deployment

To deploy a product developed with VeriFinger 6.3 / 6.4 / 6.5 / 6.6 / 6.7 / 7.x / 8.x / 9.0 SDK, an integrator need to obtain only the additional licenses required for the particular VeriFinger 9.0 components that will run on **each computer or device** belonging to their customers. The available VeriFinger components and license types for product deployment are the same as for product development.

Each VeriFinger component running on a computer belonging to the integrator's customer requires a license. License activation options are listed below on this page.

Prices for VeriFinger 9.0 SDK and additional VeriFinger component licenses can be found in the next section.

Licensing Agreement

The Licensing Agreement (http://neurotechnology.com/mm_90_sla.html) contains all licensing terms and conditions.

Note that you unambiguously accept this agreement by placing an order using Neurotechnology online ordering service or by email or other means of communications. Please read the agreement before making an order.



Single computer licenses

A single computer license allows the installation and running of a VeriFinger component installation on one computer or device. Neurotechnology provides a way to renew the license if the computer undergoes changes due to technical maintenance.

Each single computer license requires **activation** for a VeriFinger component to run. The available activation options are listed below on this page.

Additional single computer licenses for VeriFinger components may be obtained at any time by VeriFinger SDK customers.

License activation options

Single computer licenses are supplied in three ways:

- **Serial numbers** are used to activate licenses for particular VeriFinger components. The activation is done via the Internet or by email. After activation the network connection is not required for single computer license usage.
Notes:
 1. Activation by serial number is **not suitable for iOS and ARM-Linux** platforms.
 2. Activation by serial number is **not suitable for virtual environments**.
- **Internet activation.** A special **license file** is stored on a computer or an Android device; the license file allows to run particular VeriFinger components on that computer or device after **checking** the license over the Internet. **Internet connection** should be available periodically for a short amount of time. A single computer license can be **transferred** to another computer or device by moving the license file there and waiting until the previous activation expires.
- Licenses may be stored in a volume license manager **dongle**. License activation using volume license manager may be performed without connection to the Internet and is suitable for virtual environments.



Volume license manager

Volume license manager is used on site by integrators or end users to manage licenses for VeriFinger components. It consists of license management software and a dongle, used to store the purchased licenses. An integrator or an end-user may use the volume license manager in the following ways:

- **Activating single computer licenses** – An installation license for a VeriFinger component will be activated for use on a particular computer. The number of available licenses in the license manager will be decreased by the number of activated licenses.
- **Managing single computer or concurrent licenses via a LAN or the Internet** – The license manager allows the management of installation licenses for VeriFinger components across multiple computers in a LAN or over the Internet. The number of managed licenses is limited by the number of licenses in the license manager. No license activation is required and the license quantity is not decreased. Once issued, the license is assigned to a specific computer or device on the network.
- **Using license manager as a dongle** – A volume license manager containing at least one license for a VeriFinger component may be used as a dongle, allowing the VeriFinger component to run on the particular computer where the dongle is attached.

Additional VeriFinger component licenses for the license manager may be purchased at any time. Neurotechnology will generate an update code and send it to you. Simply enter the code into the license manager to add the purchased licenses.

VeriFinger 9.0 enterprise license

The VeriFinger enterprise license allows an **unlimited use** of VeriFinger components in end-user products for a specific territory, market segment or project. Specific restrictions would be included in the licensing agreement.

The enterprise license price depends on the application size and the number of potential users of the application within the designated territory, market segment or project.

For more information please contact us.



Prices for VeriFinger products

- These prices are **effective June 1, 2016**. The prices may change in the future, so please **download and review the latest version** of the brochure before making an order.
- Quantity discounts do not accumulate over time.
- Prices do not include local import duties or taxes.
- Product shipping costs depend on delivery country
- Our Customers with Solution Partner status are eligible for product discounts.

VeriFinger SDK	
VeriFinger 9.0 Standard SDK	€ 339.00
VeriFinger 9.0 Extended SDK	€ 859.00

Fingerprint components for PCs (prices per single computer license)			
Quantity	Fingerprint Extractor	Fingerprint Client ⁽¹⁾	Fingerprint Matcher
1-9	€ 20.00	€ 70.00	€ 25.00
10-19	€ 15.00	€ 51.00	€ 18.00
20-49	€ 13.00	€ 45.00	€ 16.00
50-99	€ 11.00	€ 40.00	€ 14.00
100-199	€ 10.00	€ 36.00	€ 12.50
200-499	€ 9.00	€ 32.00	€ 11.00
500-999	€ 8.00	€ 28.00	€ 10.00
1000-1999	€ 7.00	€ 25.00	€ 9.00
2000-3999	€ 6.40	€ 22.00	€ 8.00
4000-7999	€ 5.80	€ 20.00	€ 7.00
8000 and more	Please contact us for more information		

Embedded fingerprint components (prices per single computer license)			
Quantity	Embedded Fingerprint Extractor	Embedded Fingerprint Client ⁽¹⁾	Embedded Fingerprint Matcher
1-9	€ 13.00	€ 45.00	€ 17.00
10-19	€ 10.00	€ 33.00	€ 12.00
20-49	€ 8.70	€ 29.00	€ 10.80
50-99	€ 7.50	€ 25.50	€ 9.60
100-199	€ 6.70	€ 22.80	€ 8.40
200-499	€ 6.00	€ 20.50	€ 7.60
500-999	€ 5.30	€ 17.80	€ 6.80
1000-1999	€ 4.70	€ 15.90	€ 6.00
2000-3999	€ 4.20	€ 14.30	€ 5.40
4000-7999	€ 3.80	€ 12.80	€ 4.80
8000 and more	Please contact us for more information		

Continued on the next page



Fingerprint Client advanced sub-components (prices per single computer license)			
Quantity	Fingerprint Segmenter ⁽¹⁾	Fingerprint BSS ⁽¹⁾	Fingerprint WSQ ⁽¹⁾
1 - 9	€ 40.00	€ 10.00	€ 10.00
10 - 19	€ 30.00	€ 7.50	€ 7.50
20 - 49	€ 26.00	€ 6.50	€ 6.50
50 - 99	€ 23.00	€ 5.50	€ 5.50
100 - 199	€ 20.00	€ 5.00	€ 5.00
200 - 499	€ 18.00	€ 4.50	€ 4.50
500 - 999	€ 16.00	€ 4.00	€ 4.00
1000 - 1999	€ 14.00	€ 3.50	€ 3.50
2000 - 3999	€ 12.00	€ 3.10	€ 3.10
4000 - 7999	€ 11.00	€ 2.80	€ 2.80
8000 and more	Please contact us for more information		

License management

Volume license manager	€ 16.00
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⁽¹⁾ These components are not available for VeriFinger Standard SDK customers.

VeriFinger products can be ordered:

- online, at www.neurotechnology.com/cgi-bin/order.cgi
- via a local Neurotechnology distributor; the list of distributors is available at www.neurotechnology.com/distributors.html