



NEUROtechnology



Large-scale
AFIS and
multi-biometric
identification

MegaMatcher SDK



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Document updated on **January 19, 2011**

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MegaMatcher technology is intended for large-scale AFIS and multi-biometric systems developers. The technology ensures high reliability and speed of biometric identification even when using large databases.

MegaMatcher is available as a software development kit that allows development of large-scale single- or multi-biometric fingerprint, iris, face or palm print identification products for Microsoft Windows, Linux and Mac OS X platforms.

- Proven in national-scale projects, including passport issuance and voter deduplication.
- NIST MINEX-compliant fingerprint engine, NIST IREX proven iris engine.
- 200,000,000 irises or 100,000,000 fingerprints per second can be matched using MegaMatcher Accelerator.
- Fingerprint and faces can be matched on smart card using MegaMatcher On Card.
- Includes fingerprint, iris, face and palm print modalities.
- Rolled, flat and latent fingerprint matching.
- BioAPI 2.0 and other ANSI and ISO biometric standards support.
- Multiplatform, scalable cluster architecture for parallel matching.
- Effective price/performance ratio, flexible licensing and free customer support.



Requirements for large-scale biometric systems

Nowadays the need for automated biometric identification systems is increasing in civil and forensic fields of applications. Fast and accurate identification becomes particularly critical for large-scale applications, such as passport and visa documentation, border crossings, election control systems, credit card transaction control and crime scene investigations. Many countries, including the US, European countries and others, incorporate biometric data into passports, ID cards, visas and other documents for use in large national-scale automatic biometric identification systems.

Automated fingerprint identification systems (AFIS) have been widely used in forensics for the past two decades, and recently they have become **relevant for civil applications** as well. Whereas large-scale biometric applications require high identification speed and reliability, multi-biometric systems that incorporate both face and fingerprint recognition offer a number of advantages for improving identification quality and usability.

Large-scale automatic biometric identification systems have a number of special requirements, which are different from those for small- or middle-scale biometric systems:

- The system must perform reliable identification with large databases, as biometric identification systems tend to accumulate False Acceptance Rate with database size increase and using a single fingerprint, face or iris image for identification becomes unreliable for a large-scale application. Several fingerprint images from person's different fingers or iris images from person's two eyes may be taken to increase matching reliability. Also, multi-biometric technologies (i.e. collecting fingerprint, face and/or iris samples from the same person) can be employed for greater reliability. A **fused** algorithm is used create a single identification decision based on the results of those measurements.
- The system must show high productivity and efficiency, which correspond to its scale:
 - System scalability is important, as the system might be extended in the future, so a high productivity level should be kept by adding new units to the existing system.
 - The daily number of identification requests could be very high.
 - Identification requests should be processed in a very short time (ideally in real time), thus high computational power is required.
 - Support for large databases (tens or hundreds of millions of records) is required.
 - General system robustness. The system must be tolerant to hardware failures, as even temporary pauses in its work may cause big problems taking into account the application size.
- The system must support major biometric standards. This should allow using the system-generated templates or databases with systems from other vendors and vice versa.
- The system may need to match flat (plain) fingerprints with rolled fingerprints, as many institutions collect rolled fingerprint databases.
- The system must be able to work in the network, as in most cases client workstations are remote from the server with the central database.
- A forensic system must be able to edit latent fingerprint templates in order to submit latent fingerprints into the AFIS for the identification.

Despite all these requirements, the system price should be as low as possible.

Many existing AFIS are specialized for criminalistics or other particular applications and are quite expensive. Neurotechnology offers MegaMatcher SDK that includes **technology and solutions for large-scale AFIS or multi-biometric fingerprint, iris, face and palm print identification products**. MegaMatcher SDK meets all of the requirements mentioned above, for a competitive price.



MegaMatcher algorithm features and capabilities

MegaMatcher includes fingerprint, facial, iris and palm print recognition engines along with a new fused algorithm for fast and reliable identification in large-scale systems.

Fingerprint, face and iris identification algorithms can be used alone to develop an AFIS or an automated face or iris identification system respectively.

The biometric software engines contain many proprietary algorithmic solutions that are especially useful for large-scale identification problems. These solutions were specially developed for MegaMatcher and some were inherited from the VeriFinger, VeriLook and VeriEye algorithms. Some of these solutions are listed below for fingerprint, face and iris biometric identification engines.

MegaMatcher fingerprint matching engine

- **Full MINEX Certification.** NIST has certified MegaMatcher fingerprint algorithm for use in personal identity verification (PIV) program applications.
- **Rolled and flat fingerprints matching.** The MegaMatcher fingerprint engine matches rolled and flat fingerprints **between themselves**. Usually conventional “flat” fingerprint identification algorithms perform matching between flat and rolled fingerprints less reliably due to the specific deformations of rolled fingerprints. MegaMatcher allows matching of flat-flat, flat-rolled or rolled-rolled fingerprints with high reliability. The algorithm matches up to 160,000 fingerprint records per second.
- MegaMatcher includes fingerprint **image quality determination**, which can be used during enrollment to ensure that only the best quality fingerprint template will be stored into database.
- **Template generalization** is used to generate a better quality template from several fingerprints. Better quality templates result in higher identification quality.
- MegaMatcher is **tolerant to fingerprint translation, rotation and deformation**. It uses a proprietary fingerprint matching algorithm that identifies fingerprints even if they are rotated, translated and have deformations.
- **Faster matching using pre-sorted database entries.** For some identification tasks MegaMatcher’s fingerprint engine effective matching speed can be increased to up to **960,000 fingerprints per second** by pre-sorting database entries using certain global features. Fingerprint matching is performed first with the database entries having global features most similar to those of the test fingerprint. If matching within this group yields no positive result, then the next record with the most similar global features is selected, and so on until the matching is successful or the end of the database is reached. In most cases there is a fairly good chance that the correct match will be found at the beginning of the search. As a result, the number of comparisons required to achieve fingerprint identification decreases drastically, and the **effective matching speed increases** correspondingly.
- **Adaptive image filtration** algorithm eliminates noises, ridge ruptures and stuck ridges, and extract minutiae reliably even from poor quality fingerprints, with processing time of less than 1 second.



MegaMatcher face matching engine

- **Template generalization** is used to generate a better quality template from several face images. Better quality templates result in higher identification quality.
- **Tolerance to face posture** assures face enrollment convenience. MegaMatcher allows 360 degrees head roll. Head pitch and yaw can be up to 15 degrees in each direction. See technical specifications for more details.
- **Reliable face detection** assures convenient face enrollment from cameras, webcams and especially various scanned documents: faces will be found on scanned pages from passports, files etc. **Multiple faces** can be also detected on an image and simultaneously processed.
- **Live face detection.** A conventional face identification system can be easily cheated by placing a photo of another person in front of a camera. MegaMatcher is able to prevent this kind of security breach by determining whether a face in a video stream belongs to a real human or is a photo.
- The biometric template record can contain **several face samples belonging to the same person**. These samples can be enrolled from different sources and in different time, thus allowing improvement in matching quality. For example a person could be enrolled with and without eyeglasses or with different eyeglasses, with and without beard or moustache, etc.

MegaMatcher iris matching engine

- **NIST IREX proven reliability.** MegaMatcher iris matching engine is based on VeriEye, that was recognized by NIST in 2009 as one of the most reliably accurate iris recognition algorithms.
- **Fast matching.** Configurable matching speed varies from 60,000 to **1,440,000 comparisons per second**. See “technical specifications” section for more details.
- **Robust eye iris detection.** Irises are detected even when the images have obstructions, visual noise and different levels of illumination. Lighting reflections, eyelids and eyelashes obstructions are eliminated. Images with narrowed eyelids or eyes that are gazing away are also accepted.
- **Automatic interlacing detection and correction.** The correction results in maximum quality of iris features templates from moving iris images.
- **Correct iris segmentation** is achieved when perfect circles fail, the centers of the iris inner and outer boundaries are different, iris boundaries are definitely not circles and even not ellipses or iris boundaries seem to be perfect circles.



MegaMatcher and MegaMatcher Accelerator in High Productivity Systems

See also *MegaMatcher Accelerator brochure*.

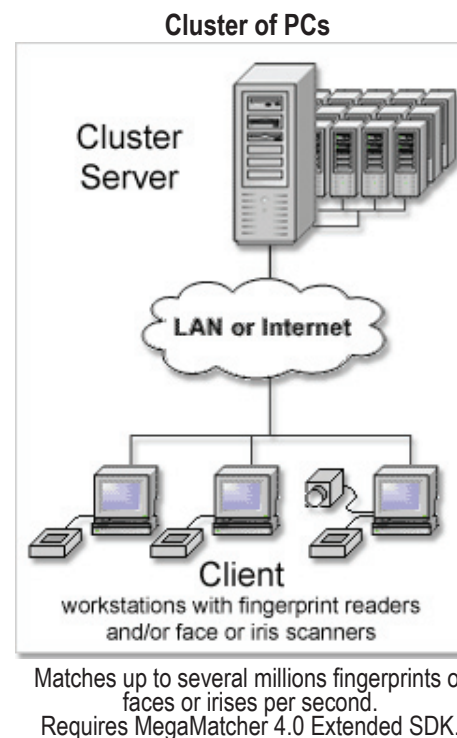
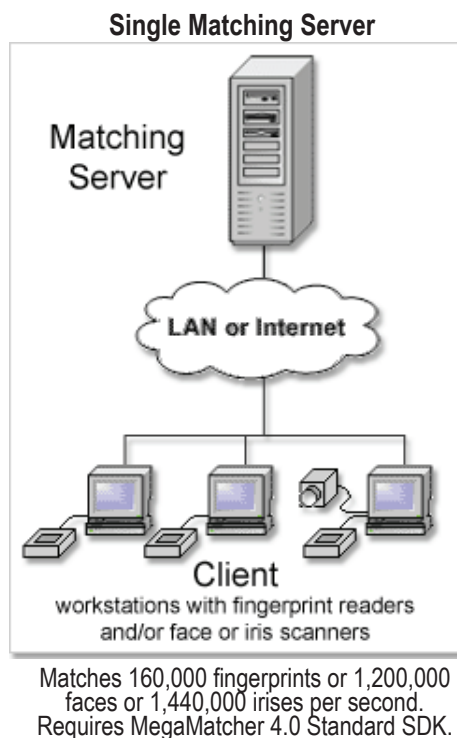
Different AFIS projects may require specific biometric system performance. These matching engines and architectures may be used depending on the required matching speed, database size and system availability:

- Single Matching Server;
- Cluster of PCs running MegaMatcher components;
- Single MegaMatcher Accelerator 3.0 Standard or Extended unit (see “*MegaMatcher Accelerator*” brochure);
- Cluster of MegaMatcher Accelerator 3.0 Standard or Extended units (see “*MegaMatcher Accelerator*” brochure).

It is possible to use more than one architecture within a large-scale biometric system to reach optimal system performance and/or availability. For example, MegaMatcher Accelerator 3.0 unit(s) can be used for candidates selection using irises or several fingerprints, and then the results can be validated on Matching Server or cluster with other biometric modalities. Also, two or more Cluster Servers or MegaMatcher Accelerator 3.0 clusters can be connected together for high availability system.

See Product Advisor at www.neurotechnology.com/product-advisor.html to find out what Neurotechnology products and system architectures will suit your project requirements.

The charts below compare MegaMatcher SDK architectures for high performance AFIS:





Single Matching Server

The architecture with a single Matching Server is intended to be used in moderate size systems like local AFIS or multi-biometric system which do not have strict requirements on performance or availability. The Matching Server software is available in MegaMatcher 4.0 Standard and Extended SDKs, as well as in VeriFinger 6.3 Extended SDK, VeriLook 5.0 Extended SDK and VeriEye 2.3 Extended SDK.

A PC running Matching Server software accepts identification requests from client-side components for fingerprint, face and/or iris biometrics and returns back the identification results. Up to 160,000 fingerprints or 1,200,000 faces or 1,440,000 irises per second can be matched on single Matching Server (on Intel Core2 processor with 4 cores running at 2.66 GHz).

The Matching Server can be also used for multi-biometric systems that use any combination of these biometric modalities: fingerprints, faces and/or irises. See “technical specifications” section for more information on fingerprint, face, iris and fused matching engines performance.

Cluster of PCs running MegaMatcher components

This architecture is designed for high productivity AFIS or multi-biometric system with millions of biometric templates stored in the database. The Cluster Server component is available in MegaMatcher Extended SDK.

Cluster Server distributes identification task over computers connected to the network. A biometric system based on Cluster Server software can be scaled up anytime to meet changing project requirements in increasing user amount or request environment. The cluster software consists of a Cluster Server and software for cluster nodes that run fingerprint, face and/or iris components.

The Cluster Server accepts requests from client side, manages cluster work, distributes tasks over cluster nodes, collects results, reports them back to client side. Also it communicates with the main database which stores the biometric data.

Each cluster node matches up to 160,000 fingerprints or 1,200,000 faces or 1,440,000 irises per second (on Intel Core2 processor with 4 cores running at 2.66 GHz). The Cluster Server can be also used for multi-biometric systems that use any combination of these biometric modalities: fingerprints, faces and/or irises. See technical specifications for more information on fingerprint, face, iris and fused matching engines performance.

A cluster node contains part of the main database, performs identification tasks in it and reports results to the Cluster Server. The node must have enough memory to store that database part, as all data is kept in memory during identification to achieve the best matching speed. A larger number of nodes results in faster matching, because each node operates on a smaller part of the database.

The cluster node uses database to store its database part and in order to perform relational queries, such as filter persons by gender, age, living place.



The amount of required cluster nodes is calculated is this way:

1. The whole database should fit into nodes memory (RAM). For example, if there are 10GB of biometric data and each node has 2GB of free memory available, at least 5 nodes should be used as otherwise the database will not fit into nodes memory and the cluster will not work.
2. The identification speed should satisfy project requirements. The speed requirements may be defined indirectly via identification request response time and/or peak hour request quantity with a given database.
 - **Response time.** For example, a database stores biometric data for 1 million people with 2 fingerprints for each of them, and the response time for an identification request should be 1 second. At least 13 cluster nodes should be used to provide the required response time.
 - **Peak hour request quantity.** For example, the project with the same database as above requires to process 5,000 identification requests at the peak hour. At least 18 cluster nodes should be used to provide the required peak hour availability.

Two methods of node fault tolerance are implemented in the Cluster Server software:

1. **Spare nodes** (enabled by **default**). A spare node “waits” until an operating node fails and is used to replace the failed one by copying the part of database that was used in the failed node. If the failed node restored, it become the spare node.
2. **Re-split** tasks and database over existing nodes. If a node fails, the system finishes all tasks which are not related with the failed node, reinitializes nodes again by re-splitting the database over them and continues tasks passed into cluster. As a result the overall cluster performance decreases but the cluster continues to operate until the failed node is fixed or replaced. Note, that the database re-split is possible only if total amount of memory available in the remaining nodes is larger than the database size.

We recommend to leave at least 10%-20% free memory reserve when calculating the amount of used nodes in a cluster for both fault tolerance methods. The memory reserve would allow to avoid situations when the system can not continue work as it has not enough resources.



Contents of MegaMatcher 4.0 Standard SDK and Extended SDK

MegaMatcher SDK is intended for development of large-scale AFIS or multi-biometric identification products. Fingerprint, face, iris and palm print recognition engines are included in MegaMatcher 4.0 SDK.

MegaMatcher 4.0 SDK includes server-side software and a set of modules for developing client-side applications. .NET components are included for rapid development of client-side software. MegaMatcher 4.0 supports **BioAPI 2.0**. To ensure system compatibility with other software, **WSQ** component is available, as well as modules for conversion between MegaMatcher template and biometric standards.

MegaMatcher 4.0 is suitable not only for developing **civil AFIS**, but also for **forensic AFIS applications**, as it includes an API for **latent fingerprint template editing**. Latent fingerprint template editing is necessary in order to submit a latent fingerprint (for example, one taken from a crime scene) for the identification into AFIS. Also MegaMatcher is able to **match rolled and flat fingerprints between themselves**.

There are these types of MegaMatcher 4.0 SDK:

- **MegaMatcher 4.0 Standard SDK** for developing a client/server based multi-biometric face-fingerprint and optionally iris identification product. This SDK is suitable for **network-based** and **web-based** systems with database size ranging from several thousands records up to million records. The SDK includes ready-to-use server-side software and a set of components for developing client-side applications. Also one or more MegaMatcher Accelerator units or installation licenses can be additionally purchased for building high performance systems that match tens of millions fingerprints and/or irises per second.
- **MegaMatcher 4.0 Extended SDK** for developing a large-scale network-based AFIS or multi-biometric identification product. The fault-tolerant **scalable cluster** software allows to perform fast parallel matching, processes high number of identification requests and handles databases with practically **unlimited size**. The SDK includes all components of MegaMatcher 4.0 Standard SDK and ready-to-use cluster server and node software. This SDK also allows to develop **network-based** and **web-based** systems.

The table below compares MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. Note that the table lists only those components that are included with the SDKs and make difference between the Standard and Extended SDKs; the other components (listed below the table) are not included with an SDK but can be purchased additionally.

	MegaMatcher 4.0 Standard SDK	MegaMatcher 4.0 Extended SDK
Fingerprint component licenses included with a specific SDK:		
• Fingerprint Extractor	1 license	1 license
• Fingerprint Client	3 licenses and 1 concurrent license	3 licenses and 1 concurrent license
• Fingerprint Matcher	1 license	1 license
• Fast Fingerprint Matcher	1 license	2 licenses
Face component licenses included with a specific SDK:		
• Face Extractor	1 license	1 license
• Face Client	3 licenses and 1 concurrent license	3 licenses and 1 concurrent license
• Face Matcher	1 license	1 license
• Fast Face Matcher	1 license	2 licenses
Iris component licenses included with a specific SDK:		
• Iris Extractor	1 license	1 license
• Iris Client	3 licenses and 1 concurrent license	3 licenses and 1 concurrent license
• Iris Matcher	1 license	1 license
• Fast Iris Matcher	1 license	2 licenses
Palm print component licenses included with a specific SDK:		
• Palm Print Client	1 license	1 license
• Palm Print Matcher	1 license	2 licenses
Server and cluster component licenses included with a specific SDK:		
• Matching Server	+	+
• Cluster Server		1 license



Additional licenses for these components are available for MegaMatcher 4.0 SDK customers:

Fingerprint components:

- Fingerprint Extractor
- Fingerprint Segmenter
- Fingerprint BSS
- Fingerprint WSQ
- Fingerprint Client
- Fingerprint Matcher
- Fast Fingerprint Matcher

Face components:

- Face Extractor
- Face Client
- Face Matcher
- Fast Face Matcher

Iris components:

- Iris Extractor
- Iris Client
- Iris Matcher
- Fast Iris Matcher

Palm print components:

- Palm Print Client
- Palm Print Matcher

Server and cluster components:

- Matching Server
- Cluster Server
(available only for MegaMatcher 4.0 Extended SDK customers)

MegaMatcher 4.0 SDK includes programming samples and tutorials that show how to use the components of the SDK to perform fingerprint, face and iris template extraction or matching against other templates. The samples and tutorials are available for these programming languages and platforms:

	Microsoft Windows 32 & 64 bit	Linux 32 & 64 bit	Mac OS X
Programming samples			
• C/C++	+	+	+
• C#	+		
• Sun Java 2	+		
• Visual Basic .NET	+		
• Delphi	+		
Programming tutorials			
• C	+	+	+
• C#	+		
• Visual Basic .NET	+		
• Delphi	+		



Fingerprint Components Description

Fingerprint Extractor

Fingerprint Extractor creates fingerprint templates from fingerprint images. Image quality control can be applied to accept only good quality fingerprint images.

The Fingerprint Extractor can generalize a fingerprint template from several fingerprint images to improve the template's quality.

See "technical specifications" section for the template extraction speed, the size of fingerprint template and the requirements for fingerprint image size and resolution.

One Fingerprint Extractor license is included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 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.

The component can be used from **C/C++** and **C#** applications on all supported platforms. **.NET wrappers** of Windows libraries are provided for .NET developers.

The Fingerprint Segmenter licenses can be purchased anytime by MegaMatcher 4.0 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.

The component can be used from **C/C++** and **C#** applications on all supported platforms. **.NET wrappers** of Windows libraries are provided for .NET developers.

Licenses for the Fingerprint WSQ component can be purchased anytime by MegaMatcher 4.0 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 MegaMatcher SDK.

These biometric standards are supported:

- **BioAPI 2.0 (ISO/IEC 19784-1:2006)** (Framework and Biometric Service Provider for fingerprint identification engine)
- **ISO/IEC 19794-2:2005** (Fingerprint Minutiae Data)
- **ISO/IEC 19794-4:2005** (Finger Image Data)
- **ANSI/INCITS 378-2004** (Finger Minutiae Format for Data Interchange)
- **ANSI/INCITS 381-2004** (Finger Image-Based Data Interchange Format)
- **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, ANSI/INCITS 378-2004 and ANSI/NIST-ITL templates.

Fingerprint pattern classification module that allows to determine a fingerprint pattern class is included with Fingerprint BSS module. 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 BSS component also includes:

- JPEG 2000 image format support module with 1000 dpi 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.

The Fingerprint BSS component can be used from **C/C++** and **C#** applications on all supported platforms. **.NET** wrappers of Windows libraries are provided for .NET developers.

Licenses for the Fingerprint BSS component can be purchased anytime by MegaMatcher 4.0 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.

Three non-concurrent licenses and one concurrent license for the Fingerprint Client component are included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More non-concurrent and concurrent licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.

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 and/or iris records (note that matching faces and irises requires Face Matcher and Iris Matcher components correspondingly);

“Technical specifications” and “reliability and performance tests” sections below contain information about the template matching speeds and recognition quality in different scenarios.

One Fingerprint Matcher license is included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.

Fast Fingerprint Matcher

The Fast Fingerprint Matcher component is intended for the large-scale AFIS and biometric systems. The component includes a **fast matching mode** and also has the same matching mode as the regular Fingerprint Matcher.

Multi-biometric fused template matching can be achieved by combining the Fast Fingerprint Matcher component with Face and/or Iris Matchers (regular or fast versions of them can be used depending on project implementation).

See the “reliability and performance testing results” section for the comparison of matching modes and multi-modal template matching.

One Fast Fingerprint Matcher license is included with MegaMatcher 4.0 Standard SDK. Two Fast Fingerprint Matcher licenses are included with MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.



Face Components Description

Face Extractor

Face Extractor creates face templates from face images. Image quality control can be applied to accept only good quality face images.

The Extractor can generalize a face template from several images that include the same face to improve the template's quality.

Live face detection can be used for determining whether a face in a video stream belongs to a real human or is a photo.

Camera management software allows to perform simultaneous capture from multiple cameras.

See “technical specifications” section for the template extraction speed, the size of face template and the requirements for image size and camera resolution.

One Face Extractor license is included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.

Face Client

The Face Client component is a combination of the Face Extractor and Face BSS components. It is intended for the systems that need to support 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.

Three non-concurrent licenses and one concurrent license for the Face Client component are included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More non-concurrent and concurrent licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers

Face Matcher

The Face Matcher performs facial template matching in 1-to-1 (verification) and 1-to-many (identification) modes. Also the Face Matcher component includes **fused** matching algorithm that allows to increase template matching reliability by matching templates that contain fingerprint, face and/or iris records (note that matching fingerprint and irises requires Fingerprint Matcher and Iris Matcher components correspondingly).

“Technical specifications” and “reliability and performance tests” sections contain information about the template matching speeds and recognition quality in different scenarios.

One Face Matcher license is included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.

Fast Face Matcher

The Fast Face Matcher component is intended for the large-scale biometric systems. The component includes a **fast matching mode** and also has the same matching mode as the regular Face Matcher.

Multi-biometric fused template matching can be achieved by combining the Fast Face Matcher component with Fingerprint and/or Iris Matchers (regular or fast versions of them can be used depending on project implementation).

See the “reliability and performance testing results” section for the comparison of matching modes and multi-modal template matching.

One Fast Face Matcher license is included with MegaMatcher 4.0 Standard SDK. Two Fast Face Matcher licenses are included with MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.



Face BSS (Biometric Standards Support)

The Face BSS (Biometric Standards Support) component allows to integrate support for facial image format standards and additional image formats with new or existing biometric systems based on MegaMatcher SDK.

These biometric standards are supported:

- **BioAPI 2.0 (ISO/IEC 19784-1:2006)** (Framework and Biometric Service Provider for Face Identification Engine)
- **ISO/IEC 19794-5:2005** (Face Image Data)
- **ANSI/INCITS 385-2004** (Face Recognition Format for Data Interchange)

Face BSS component also allows to integrate **JPEG 2000** with Lossy and Lossless Face Profiles support into applications based on MegaMatcher SDK.

Neurotechnology Token Face Image (NTFI) module is included in the component.

The NTFI module is intended to provide token* face images compatible with the Face Image Format as in ISO/IEC 19794 standard. This face image format enables range of applications on variety of devices, including devices that have limited resources required for data storage, and improves recognition accuracy by specifying data format, scene constraints (lighting, pose), photographic properties (positioning, camera focus) and digital image attributes (image resolution, image size).

The NTFI module has the following features:

- Token face image creation from an image containing human face using eye coordinates which may be either hand marked or detected automatically using Neurotechnology face detection algorithm.
- Face is detected and eye coordinates are acquired using state-of-the-art Neurotechnology face detection and recognition algorithm.
- Geometrical normalization of face image according to proportions and photographic properties in ISO/IEC 19794 standard.
- Intelligent image padding algorithm for cut of parts of token face image as in ISO/IEC 19794 standard.
- Test the created token face image for following quality criteria suggested in ISO/IEC 19794 standard:
 - Background uniformity – the background in the token face image should be uniform, not cluttered.
 - Sharpness – the token face image should not be blurred.
 - Too light or too dark images – the token face image should not be too dark or too light.
 - Exposure range of an image – the token face image should have a reasonable exposure range to represent as much details of the subject in the image as possible.
- Evaluate token face image quality based on suggestions of ISO/IEC 19794 standard (Using the quality criteria above).

Licenses for the Face BSS component can be purchased anytime by MegaMatcher 4.0 SDK customers.

**Token in this context is used as “symbolic image, good enough image for machine recognition”. Token Image as in ISO/IEC19794-5: “A Face Image Type that specifies frontal images with a specific geometric size and eye positioning based on the width and height of the image. This image type is suitable for minimizing the storage requirements for computer face recognition tasks such as verification while still offering vendor independence and human verification (versus human examination which requires more detail) capabilities.”*



Iris Components Description

Iris Extractor

Iris Extractor creates iris templates from eye images.

See “technical specifications” section for the template extraction speed, the size of iris template and the requirements for image size, illumination and camera resolution.

One Iris Extractor license is included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.

Iris BSS (Biometric Standards Support)

The Iris BSS (Biometric Standards Support) component allows to integrate support for eye iris image format standards and additional image formats with new or existing biometric systems based on MegaMatcher SDK.

These biometric standards are supported:

- **BioAPI 2.0** (ISO/IEC 19784-1:2006) (Framework and Biometric Service Provider for iris identification engine)
- **ISO/IEC 19794-6:2005** (Iris Image Data)
- **ANSI/INCITS 379-2004** (Iris Image Interchange Format)

Iris BSS component also allows to integrate **JPEG 2000** image format support into applications based on the MegaMatcher SDK.

Licenses for the Iris BSS component can be purchased anytime by MegaMatcher 4.0 SDK customers.

Iris Client

The Iris Client component is a combination of the Iris Extractor and Iris BSS components. It is intended for the systems that need to support 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.

Three non-concurrent licenses and one concurrent license for the Iris Client component are included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More non-concurrent and concurrent licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.



Iris Matcher

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

- matching templates that contain 2 iris records;
- matching templates that contain fingerprint, face and/or iris records (note that matching fingerprints and faces requires Fingerprint Matcher and Face Matcher components correspondingly);

“Technical specifications” and “reliability and performance tests” sections contain information about the template matching speeds and recognition quality in different scenarios.

One Iris Matcher license is included with MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.

Fast Iris Matcher

The Fast Iris Matcher component is intended for the large-scale biometric systems. The component includes a fast matching mode and also has the same matching modes as the regular Iris Matcher.

Multi-biometric fused template matching can be achieved by combining the Fast Iris Matcher component with Fingerprint and/or Face Matchers (regular or fast versions of them can be used depending on project implementation).

See the “reliability and performance testing results” section for the comparison of matching modes and multi-modal template matching.

One Fast Iris Matcher license is included with MegaMatcher 4.0 Standard SDK. Two Fast Iris Matcher licenses are included with MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.



Palm print components description

Palm Print Client

The Palm Print Client component creates palm print templates from palm images. Also, it allows to integrate support for palm print template and image format standards and additional image formats with new or existing biometric systems based on MegaMatcher SDK.

These biometric standards are supported:

- **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 Palm Print Client component allows conversion between Neurotechnology proprietary palm print templates and ANSI/NIST-ITL templates.

The Palm Print Client component also includes:

- **WSQ** (Wavelet Scalar Quantization) image format support module. The WSQ format allows to compress a palm print 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 palm print or fingerprint information therefore the reconstructed image is as close as possible to the original.
- **JPEG 2000** image format support module.

The Palm Print Client component can be used from **C/C++** and **C#** applications on all supported platforms. **.NET** wrappers of Windows libraries are provided for **.NET** developers.

See “technical specifications” section for the template extraction speed and the size of palm print template.

One license for the Palm Print Client component is included in MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.

Palm Print Matcher

The Palm Print Matcher component performs palm print template matching in 1-to-1 (verification) and 1-to-many (identification) modes.

“Technical specifications” and “reliability and performance tests” sections contain information about the template matching speeds and recognition quality.

One license for the Palm Print Matcher component is included in MegaMatcher 4.0 Standard SDK. Two licenses for the Palm Print Matcher component is included in MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 SDK customers.



Server and Cluster Components Description

Cluster Server

Cluster Server component allows to scale-up a biometric identification system to multiple PCs (cluster nodes) that are linked together via LAN or Internet. The Cluster Server splits the biometric templates database and distributes it between cluster nodes. Each cluster node performs the actual template matching within its own part of the database using:

- Fast Fingerprint Matcher or Fingerprint Matcher component for fingerprint template matching;
- Fast Face Matcher or Face Matcher component for face template matching;
- Fast Iris Matcher or Iris Matcher component for iris template matching.

A larger number of nodes results in faster matching, because each node operates on a smaller part of the database. A cluster node can store templates using a database, or using RAM for achieving better performance.

Cluster Server component can be used on Microsoft Windows, Linux and Mac OS X platforms. See system requirements for more information on recommended hardware configuration.

Software for running cluster nodes is also included together with Cluster Server. The cluster node software can be run on unlimited numbers of machines that are connected to the Cluster Server.

Client communication module that allows sending a task to the Cluster Server, querying status of the task, getting the results and removing the task from server, is included with MegaMatcher 4.0 SDK, VeriFinger 6.3 SDK, VeriLook 5.0 SDK and VeriEye 2.3 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 Cluster Server component are listed in the table below. Custom modules for working with other databases can also be developed by integrator and used with Cluster Server components.

Component	Microsoft Windows 32-bit & 64-bit	Linux 32-bit & 64-bit	Mac OS X
• Cluster Server software	+	+	+
• Cluster administrating software	+	+	+
• Software for a cluster node	+	+	+
• Microsoft SQL Server support module	+		
• Oracle database support module	+	+	
• MySQL database support module	+	+	+
• SQLite database support module	+	+	+
• PostgreSQL database support module	+	+	

One Cluster Server component license is included with MegaMatcher 4.0 Extended SDK. More licenses for this component can be purchased any time by MegaMatcher 4.0 Extended SDK customers.



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.

Fused multi-biometric matching can be enabled by running components for fingerprint, face 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 4.0 SDK, VeriFinger 6.3 SDK, VeriLook 5.0 SDK and VeriEye 2.3 SDK. This module hides all low level communications and provides high-level API for the developer.

Source code of **sample web server software** is included with the Matching Server. The web server software accepts biometric templates from a web client application, sends them to Matching Server for matching and returns matching results to the client application. The web server is stand-alone and does not require any third-party web server software (like Apache or Microsoft IIS).

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	+	+	
• Source code of sample web server software	+		
Database support modules			
• Microsoft SQL Server	+		
• PostgreSQL	+	+	
• MySQL	+	+	
• Oracle	+	+	
• SQLite	+	+	+
Programming samples			
• C# client	+		
• Sun Java 2 web client	+		
Programming tutorials			
• C/C++	+	+	
• C#	+		

The Matching Server component requires a special one-time 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 MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK.

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

- VeriFinger 6.3 Extended SDK;
- VeriLook 5.0 Extended SDK;
- VeriEye 2.3 Extended SDK.



Supported fingerprint scanners under Microsoft Windows

List of fingerprint scanners supported by MegaMatcher SDK under Linux and Mac OS X is available on the next page.

	Windows XP		Windows Vista		Windows 7	
	32 bit	64 bit	32 bit	64 bit	32 bit	64 bit
• ARH AFS 510	+		+	+	+	+
• Atmel FingerChip	+					
• Athena ASEDrive Ille Combo Bio F2	+	+	+	+		
• AuthenTec AF-S2 / AES4000 / AES2501B	+					
• BioLink U-Match MatchBook v.3.5	+		+			
• Biometri-CS CS-Pass	+					
• Biometrika Fx2000 / Fx3000	+		+			
• Biometrika HiScan	+					
• Cross Match L SCAN Guardian / Verifier 300 / 310 / 320	+	+	+	+	+	+
• Dakty Naos-1	+					
• Dermalog ZF1	+					
• Digent FD1000	+					
• DigitalPersona U.are.U 2000	+		+			
• DigitalPersona U.are.U 4000 / 4500	+	+	+	+	+	+
• Fujitsu MBF200	+					
• Futronic FS50 / FS80 / FS82 / FS88 / FS90 / eFAM (FS84)	+	+	+	+	+	+
• Futronic FS60	+		+		+	
• Green Bit DactyScan 26	+		+			
• Hongda S500 / S680 / S700	+		+			
• id3 Certis Image	+					
• Identix DFR 2080 and DFR 2090	+					
• Identix DFR 2100	+		+			
• Intech SOP1	+					
• Integrated Biometrics LES650	+	+	+	+	+	+
• Jstac Athena 210	+					
• Lumidigm Mercury / Venus Series sensors	+	+	+	+	+	+
• NITGEN Fingkey Hamster / Fingkey Hamster II / Fingkey Mouse III / eNBioScan-F	+	+	+	+	+	+
• SecuGen Hamster III / Hamster Plus / Hamster IV / iD-USB SC / iD-USB SC/PIV	+	+	+	+	+	+
• Startek FM200	+		+			
• Suprema BioMini	+		+		+	
• Suprema RealScan-10 / RealScan-D / RealScan-S / SFR300-S / SFU300	+					
• Tacoma CMOS	+		+			
• Testech Bio-i	+		+			
• TST Biometrics BiRD 3	+		+			
• UPEK Eikon / Eikon To Go / EikonTouch 300 / 700 / TouchChip TCRU1C / TCRU2C	+		+		+	
• VistaMT Multimodal Biometric Device ⁽¹⁾	+	+	+	+	+	+
• ZKSoftware ZK6000	+		+			
• Zvetco Verifi P4000	+					
• Zvetco Verifi P5000	+				+	

(1) The list of supported OS is given only for fingerprint scanner part of the device; the device is also able to capture faces and irises.



Supported fingerprint scanners under Linux and Mac OS X

List of fingerprint scanners supported by MegaMatcher SDK under Microsoft Windows is available on the previous page.

	Linux		Mac OS X	
	32 bit	64 bit	x86	PowerPC
• AuthenTec AF-S2 / AES4000	+	+	+	+
• BioLink U-Match MatchBook v.3.5	+			
• Biometri-CS CS-Pass	+	+	+	+
• Biometrika Fx2000 / Fx3000 / HiScan	+			
• Fujitsu MBF200	+	+	+	+
• Futronic eFAM (FS84)	+	+	+	+
• Futronic FS50 / FS80 / FS82 / FS88 / FS90	+		+	
• Lumidigm Mercury / Venus series sensors	+			
• NITGEN eNBioScan-F	+			
• SecuGen Hamster III	+			
• Startek FM200	+	+	+	+
• Suprema BioMini	+			
• Tacoma CMOS	+	+	+	+
• Zvetco Verifi P4000	+	+	+	+



Supported face capture cameras

These cameras are supported by MegaMatcher SDK:

- Any **webcam** or camera that is accessible using:
 - **DirectShow** interface for Microsoft Windows platform
 - **Video4Linux** interface for Linux platform.
 - **QuickTime** interface for Mac platform.
- Also these specific models of high-resolution cameras are supported:
 - Axis M1114 camera (Microsoft Windows only)
 - Cisco 4500 IP camera (Microsoft Windows and Linux)
 - IrisGuard IG-AD100 iris & face camera (Microsoft Windows only)
 - Mobotix DualNight M12 IP camera (Microsoft Windows and Linux)
 - PiXORD N606 camera (Microsoft Windows and Linux)
 - Prosilica GigE Vision camera (Microsoft Windows and Linux)
 - VistaFA2 / VistaFA2E face & iris cameras (Microsoft Windows only)
 - VistaMT Multimodal Biometric Device (Microsoft Windows only)

A **video file** can be also used as a data source for face capture on MegaMatcher based application.

Supported iris capture cameras

Iris capture cameras	Microsoft Windows XP		Microsoft Windows Vista		Microsoft Windows 7	
	32 bit	64 bit	32 bit	64 bit	32 bit	64 bit
• Cross Match I Scan 2	+		+			
• IrisGuard IG-AD100 iris & face camera	+		+		+	
• VistaFA2 / VistaFA2E iris & face cameras	+	+	+	+	+	+
• VistaMT Multimodal Biometric Device	+	+	+	+	+	+



System Requirements and Supported Development Environments

System Requirements for applications based on MegaMatcher client-side components

- **PC with x86 (32-bit) or x86-64 (64-bit) compatible processors or Mac with x86 or PowerPC compatible processors.** 2 GHz processor or better is recommended, as template creation time directly depends on CPU speed. On one core of Intel Core 2 running at 2.66 GHz it takes:
 - 0.19 - 0.23 seconds for fingerprint template creation from an image captured with AFIS class single finger scanner;
 - 0.08 - 0.21 seconds for face template creation;
 - 0.13 - 0.17 seconds for iris template creation;
 - about 6.8 seconds for palm print template creation;
 - 0.1-0.2 seconds for WSQ compression/decompression.
- **at least 128 MB of free RAM** should be available for the application.
- **Free space on hard disk drive (HDD):**
 - at least 1 GB required for the development.
 - 100 MB for client-side components deployment.
 - Additional space optionally would be required in these cases:
 - MegaMatcher does not require the original biometric data (such as fingerprint image or photo) to be stored for the matching; it is enough to use the templates. However, we would recommend to store this data on hard drive for the potential future usage.
 - Usually a database engine runs on back-end servers (on separate computer). However, DB engine can be installed together with MegaMatcher client-side components and Matching Server on the same computer for standalone applications. In this case more HDD space for biometrical templates storage must be available. For example, 1 million users templates (each with 2 fingerprint records) stored using a relational database would require about 2 GB of free HDD space.
- **Optionally, depending on biometrical modalities and requirements:**
 - A **fingerprint scanner**. MegaMatcher SDK includes support modules for more than 70 models of fingerprint scanners under Microsoft Windows, Linux and Mac OS X platforms.
 - A **webcam or camera** (recommended frame size: 640 x 480 pixels) for face images capturing. MegaMatcher SDK includes support modules for several cameras. Any other webcam or camera should provide DirectShow interface for Windows platform or Video4Linux interface for Linux platform or QuickTime interface for Mac platform.
 - An **iris camera** (recommended image size: 640 x 480 pixels) for iris image capture. MegaMatcher SDK includes support modules for several iris cameras.
 - An **palm print scanner**.
 - A **flatbed scanner** for fingerprint or palm print data capturing from paper can be used. 500dpi or 1000dpi FBI certified scanners are recommended. Flatbed scanners are supported only under Microsoft Windows platform and should have TWAIN drivers.
- **Network/LAN connection (TCP/IP)** for communication with Matching Server, Cluster Server or MegaMatcher Accelerator unit(s). MegaMatcher client-side components can be used without network if they are used only for data collection. For secure communication we would recommend to use a dedicated network or a secured network (such as VPN; VPN must be configured using operating system or third party tools).



- **Linux specific requirements:**

- Linux 2.6 or newer kernel, 32-bit or 64-bit. If a fingerprint scanner is required, it is recommended to choose 32-bit platform as most scanners have only 32-bit support.
- glibc 2.3.6 or newer
- GTK+ 2.10.x or newer libs and dev packages (to run SDK samples and applications based on them)
- GCC-4.0.x or newer (for application development)
- GNU Make 3.81 or newer (for application development)
- Video4Linux (for face capture using camera/webcam)

- **Microsoft Windows specific requirements:**

- Microsoft Windows 2000/XP/2003/2008/Vista/7, 32-bit or 64-bit. If a fingerprint scanner is required, it is recommended to choose 32-bit platform as most scanners have only 32-bit support.
- Microsoft .NET framework 2.0 (for .NET components usage)
- Microsoft Visual Studio 2005 SP1 or newer (for application development)
- Microsoft DirectX 9.0 or later (for face capture using camera/webcam)

- **Mac OS X specific requirements:**

- Mac OS X (version 10.4 or newer)
- QuickTime (for camera/webcam usage)
- XCode 2.4 or newer (for application development)



System Requirements for Matching Server and Server-side Matching Components

- **PC or server with x86 (32-bit) or x86-64 (64-bit) compatible processor.**
 - 64-bit platform must be used when large databases (more than 2.5 million fingerprints or more than 580,000 users with 2 fingerprints and 1 face enrolled) used and 3 GB RAM is not enough for templates storing in RAM.
 - Intel Core 2 (2.66 GHz) processor or better is recommended.
 - Computer with processors that have **two or more cores** can run more than one instance of MegaMatcher matching components (see also “licensing model” section). In this case the memory and disk requirements for the computer should be multiplied by the number of running matching components.
- **Enough free RAM** to store Matching Server code (about 5 MB), matching engines and templates. For example, 1 million users templates (each with 2 fingerprint records) require about 2 GB of RAM. At least 20% reserve recommended and some additional memory may be taken by an operating system. Therefore **to hold mentioned 1 million users data, 3 GB of free RAM is recommended** for the computer running Matching Server software or a cluster node.
- **Free space on hard disk drive (HDD):**
 - 5 MB required for Matching Server software.
 - If a database engine is installed on the same computer, enough HDD space for DB engine installation and data storage is required. For example, 1 million users templates with 2 fingerprint records stored using a relational database would require about 2.2 GB of free HDD space.
 - A database engine itself requires HDD space for running. Please refer to HDD space requirements from the database engine providers.
 - For example, 1 million users templates with 10 fingerprint records and 1 face record stored using a relational database would require about 15 GB of free HDD space.
 - MegaMatcher does not require the original biometric data (such as fingerprint image or photo) to be stored for the matching; it is enough to use the templates. However, we would recommend to store this data on hard drive for the potential future usage.
- **Database engine** or connection with it. SDK contains support modules for Microsoft SQL Server (only for Microsoft Windows platform), MySQL, PostgreSQL, Oracle, SQLite and memory DB. SQLite is recommended only for development or evaluation purposes.
- **Network/LAN connection (TCP/IP)** for the communication with client side. Communication is not encrypted therefore, if communication must be secured, we would recommend to use 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).
- **Linux specific requirements:**
 - Linux 2.6 or newer kernel, 32-bit or 64-bit.
 - glibc 2.3.6 or newer
- **Microsoft Windows specific requirements:**
 - Microsoft Windows 2000/XP/2003/2008/Vista/7, 32-bit or 64-bit.



System Requirements for Cluster Server

- **PC or server with x86 (32-bit) or x86-64 (64-bit) compatible CPU.** 2 GHz processor or better is recommended. The Cluster Server distributes identification tasks over cluster nodes, performs cluster work monitoring, collects results and reports results to the client side. Computer speed for the Cluster Server speed is not critical but the computer must be **as much stable as possible**.
- **Enough free RAM** for Cluster Server code (about 5 MB), ongoing tasks and results. For example, 1,000 matching tasks each with 2 fingerprint records would require about 3 MB of RAM.
- **Free space on hard disk drive (HDD):**
 - 5 MB required for Cluster Server software.
 - Up to 2 MB required for saving server state.
 - If a database engine is installed on the same computer, enough HDD space for DB engine installation and data storage is required. For example, 1 million users templates (each with 2 fingerprint records) stored using a relational database would require about 2.2 GB of free HDD space.
- **Database engine (optional).** A connection to a database engine running on a different computer can be provided or the engine can be installed on the same computer with the Cluster Server. MegaMatcher SDK contains support modules for Microsoft SQL Server (only for Microsoft Windows platform), PostgreSQL, MySQL, Oracle and SQLite. SQLite is recommended only for development or evaluation purposes.
- **Network/LAN connection (TCP/IP)** for the communication with Cluster Nodes and client side. Communication is not encrypted therefore if communication must be secured, we would recommend to use 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).
- **Linux specific requirements:**
 - Linux 2.6 or newer kernel, 32-bit or 64-bit.
 - glibc 2.3.6 or newer
- **Microsoft Windows specific requirements:**
 - Microsoft Windows 2000/XP/2003/2008/Vista/7, 32-bit or 64-bit.

Supported Development Environments

These development environments are supported by MegaMatcher SDK:

- Microsoft Windows platform, Microsoft Visual Studio 2005 SP1 (or newer) is required.
- Linux, following tools are required:
 - GCC-4.0.x or newer
 - GNU Make 3.81 or newer
 - pkg-config-0.21 or newer (optional; only for database engines support modules compilation)



Technical Specifications

All specifications are given for Intel Core2 processor with 4 cores running at 2.66 GHz.

Fingerprint, Face and Iris Engines Technical Specifications

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

- Fingerprint scanners are recommended to have at least **500 dpi** resolution and at least **1" x 1"** fingerprint sensors
- Face capture cameras are recommended to produce at least **640 x 480 pixels** images
- The recommended **minimal distance between eyes is 75 pixels** for a face on image or video stream to perform face template extraction.
- Face recognition engine has certain tolerance to face posture:
 - head **roll** (tilt) – ± 180 degrees (configurable); **± 15 degrees recommended** as it is the fastest setting which is usually sufficient for most near-frontal face images.
 - head **pitch** (nod) – ± 15 degrees from frontal position.
 - head **yaw** (bobble) – ± 15 degrees from frontal position.
- Iris capture cameras are recommended to produce at least **640 x 480 pixels** images

MegaMatcher biometric template matching algorithm can use more than one processor core on **multi-core processors** allowing to increase template matching speed. The template matching speeds in the table below are given as a range, where the smaller number means matching speed using **1 processor core**, while the larger number means matching speed using all **4 processor cores**.

MegaMatcher 4.0 biometric engines technical specifications			
	Fingerprints	Faces	Irises
Template extraction time (seconds)	0.19 - 0.23	0.08 - 0.21 ⁽¹⁾	0.13 - 0.17
Single biometric record size in a template ⁽²⁾ (bytes)	700 - 6,000 (configurable)	4,026 - 35,994 (configurable)	2,328
Template ⁽³⁾ matching speed ⁽⁴⁾ in maximize matching accuracy scenario (templates per second)	10,000 - 40,000	13,000 - 52,000	60,000 - 240,000
Template ⁽³⁾ matching speed ⁽⁴⁾ in maximize matching speed scenario (templates per second)	40,000 - 160,000	300,000 - 1,200,000	360,000 - 1,440,000

Notes:

(1) Face template extraction time depends on the selected template size.

(2) MegaMatcher 4.0 allows to store multiple biometric records in a template; in this case the template size is the sum of all included biometric records.

(3) Here one template contains one biometric record (fingerprint, face or iris respectively).

(4) The speeds are given for one PC with Intel Core2 processor running at 2.66 GHz. If a cluster is used, the speeds should be multiplied by the number of cluster nodes.



Palm Print Engine Technical Specifications

Palm print template extraction and matching require much more time than fingerprints, as palm images are much larger compared to fingerprint images, but have similar features density.

An image of fingerprint, which was scanned with AFIS-class scanner at 500 dpi resolution, is usually at least 500 x 500 pixels (0.25 Megapixels). Full palm image, scanned at the same resolution, is 160 times bigger (40 Megapixels). After excluding white space, palm image is still about 50 times bigger than fingerprint image. Also, full palm print templates may contain about 2,000 minutiae compared to about 50 for fingerprint templates.

MegaMatcher palm print template matching algorithm can use more than one processor core on **multi-core processors** allowing to increase template matching speed. The template extraction algorithm can be also run on more than one processor core allowing to process several templates in parallel.

MegaMatcher palm print identification algorithm has this performance when processing full palm prints:

- Template extraction time: 6.8 seconds;
- Template matching time:
 - 3 templates per second (using 1 processor core);
 - 12 templates per second (using 4 processor cores).
- Average template size: 69 kilobytes.



Full palm print;
fingerprints marked
in red for reference



Reliability and Performance Tests Results

All tests were performed on Intel Core2 processor with 4 cores running at 2.66 GHz

Fingerprint, Face and Iris Engines Tests

The identification reliability and speed are important for large-scale systems. MegaMatcher SDK includes a fused algorithm for fast and reliable identification using several biometric templates taken from the same person. The tests with MegaMatcher biometric fingerprint, face and iris matching engines and fused template matching algorithm were performed using a multi-biometric database:

- The database had 7,500 sets of biometric records; each set contained 1 face, 2 irises and 10 fingerprints representing a unique person.
- 1,500 unique persons were represented in the database.
- 5 capture sessions were performed for each person.

The tests were performed with these biometric template types:

- **1 fingerprint record.**
- **1 face record.**
- **1 iris record.**
- **2 fingerprint records** taken from same person's different fingers.
- **2 iris records** taken from same person's different eyes.
- **1 fingerprint + 1 face records** taken from the same person.
- **1 face + 1 iris records** taken from the same person.
- **1 fingerprint + 1 iris records** taken from the same person.
- **1 fingerprint + 1 face + 1 iris records** taken from the same person.

Two tests were performed with each template type:

- **Test 1 maximized matching accuracy.** MegaMatcher 4.0 fused algorithm reliability in this test is shown as **blue curves** on the ROC charts.
- **Test 2 maximized matching speed.** MegaMatcher 4.0 fused algorithm reliability in this test is shown as **red curves** on the ROC charts.

Template matching was performed using **all 4 cores** of the processor.

Receiver operation characteristics (**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**).

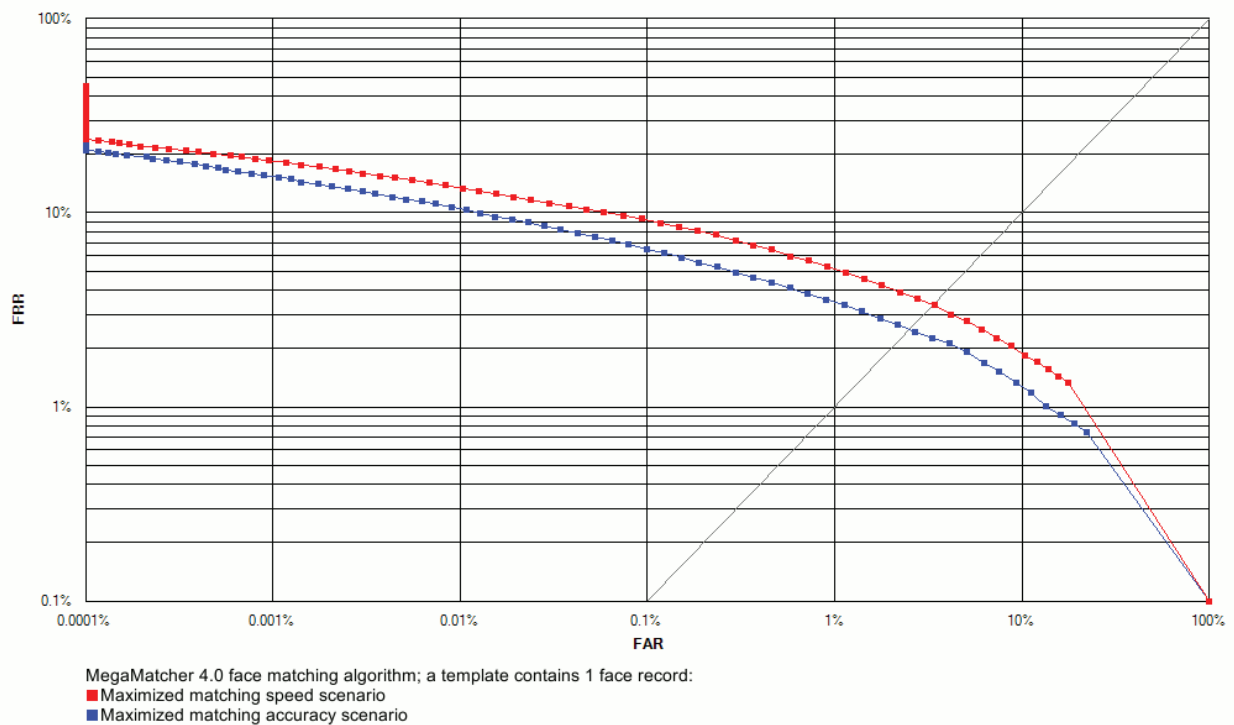
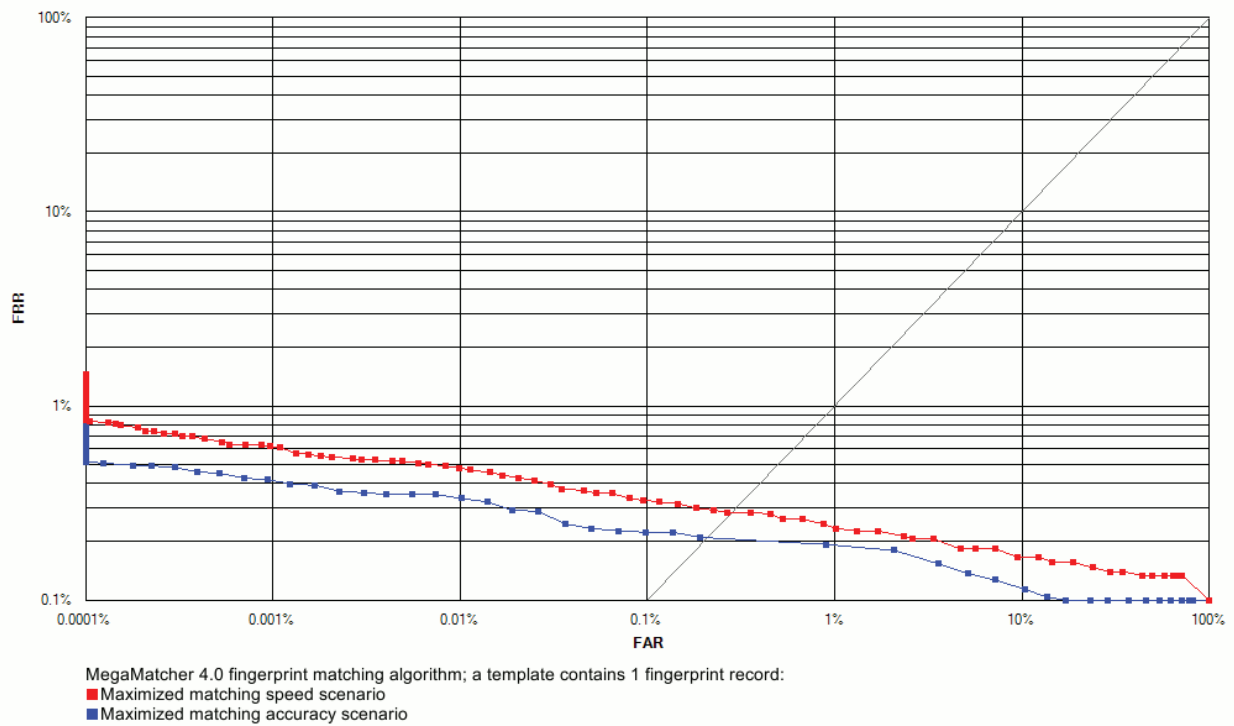
The tests with templates that contained **1 fingerprint + 1 face + 1 iris** records produced **0 % FRR for all FARs**.

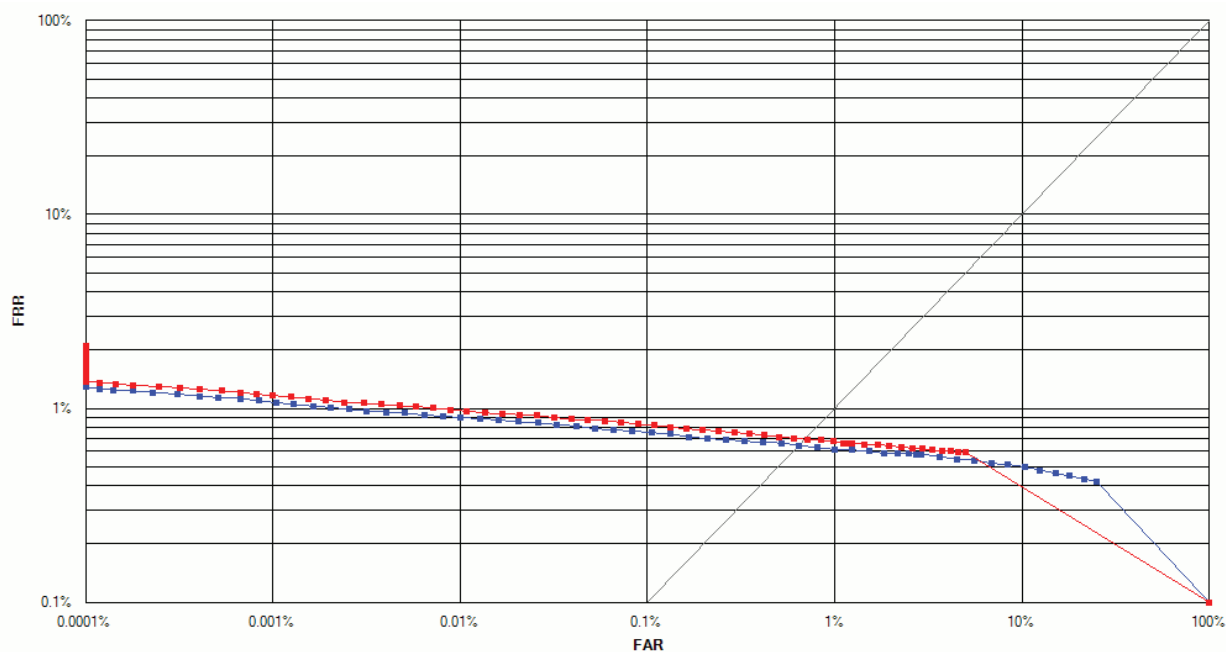


MegaMatcher 4.0 single modality template matching engines tests						
A template contains these biometric records	Matching speed (templates per second)		FRR at 0.001 % FAR		FRR at 0.0001 % FAR	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
1 fingerprint	49544	171768	0.417 %	0.620 %	0.517 %	0.847 %
1 face	57760	1316468	15.590 %	18.540 %	20.990 %	23.910 %
1 iris	288384	1652064	1.093 %	1.180 %	1.287 %	1.370 %

MegaMatcher 4.0 fused template matching algorithm tests						
A template contains these biometric records	Matching speed (templates per second)		FRR at 0.001 % FAR		FRR at 0.0001 % FAR	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
2 fingerprints	24688	85944	0.047 %	0.073 %	0.007 %	0.080 %
2 irises	144048	844443	0.233 %	0.247 %	0.263 %	0.273 %
1 fingerprint + 1 face	26696	149856	0.053 %	0.100 %	0.127 %	0.170 %
1 face + 1 iris	51848	773760	0.257 %	0.347 %	0.440 %	0.500 %
1 fingerprint + 1 iris	41452	149856	0.007 %	0.013 %	0.007 %	0.020 %
1 fingerprint + 1 face + 1 iris	24168	132100	0.000 %	0.000 %	0.000 %	0.000 %

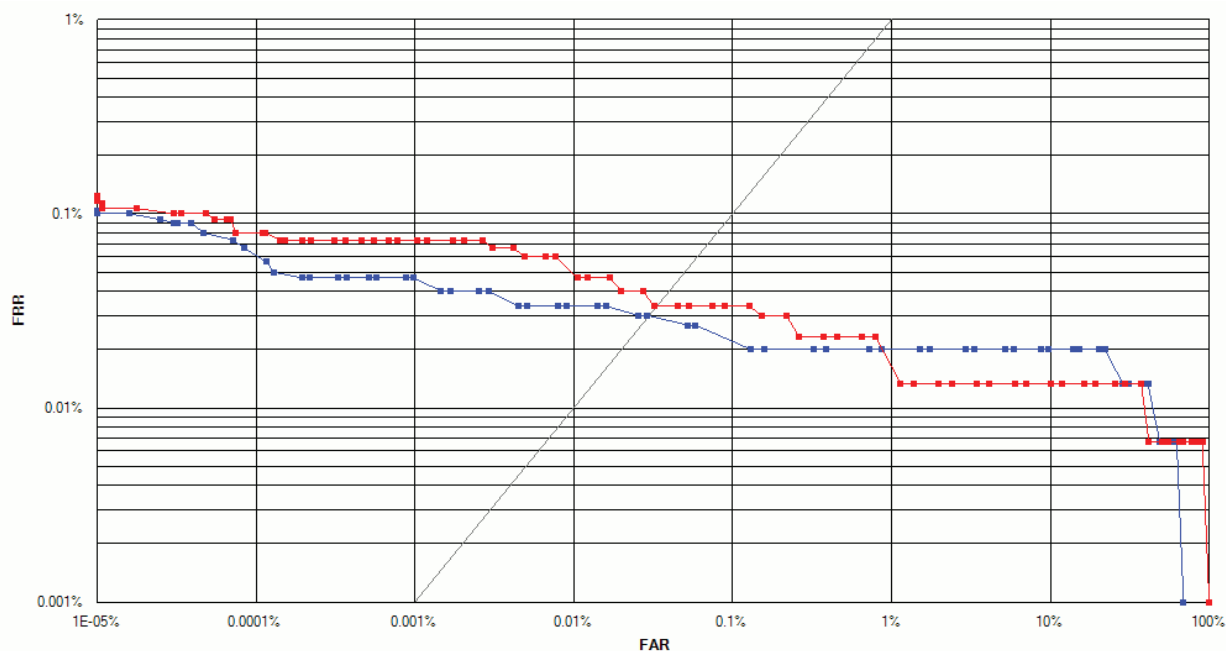
These tests show that a large-scale automated biometric identification system based on MegaMatcher provides high identification reliability when using fingerprints, using fused same-biometric (different fingerprints or irises from the same person) matching significantly reduces FRR, and using multi-biometric identification results in a significant reliability increase, allowing the system to reach almost **0 % FRR**.





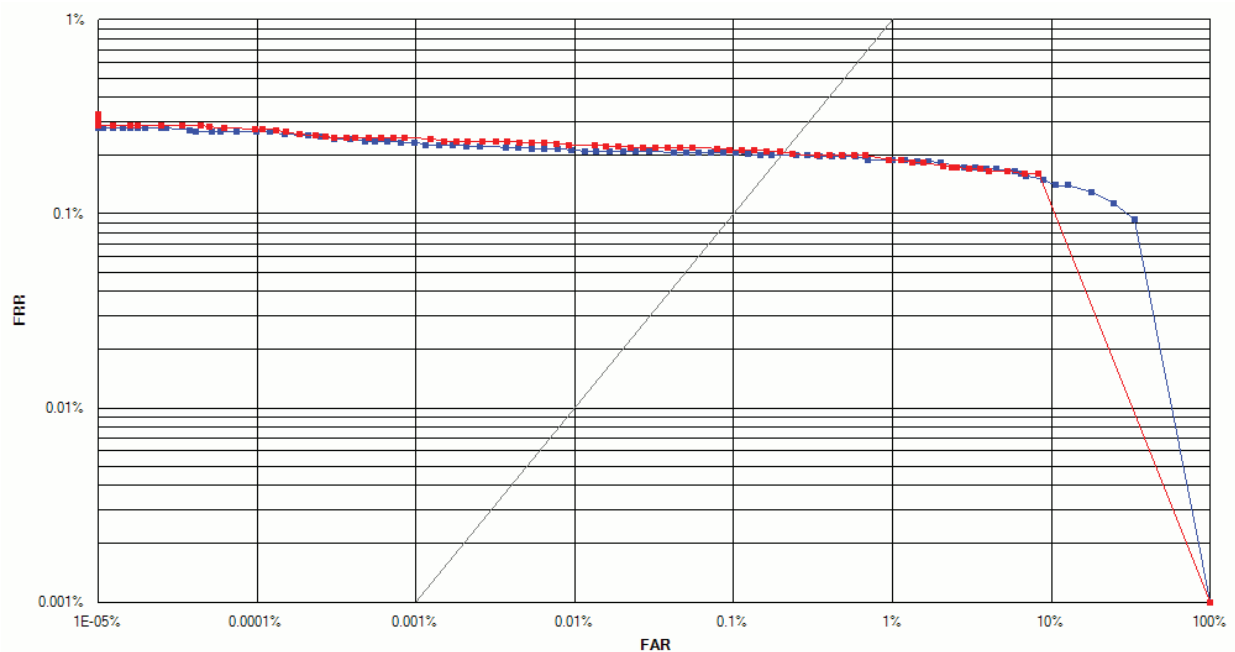
MegaMatcher 4.0 iris matching algorithm; a template contains 1 iris record:

- Maximized matching speed scenario
- Maximized matching accuracy scenario



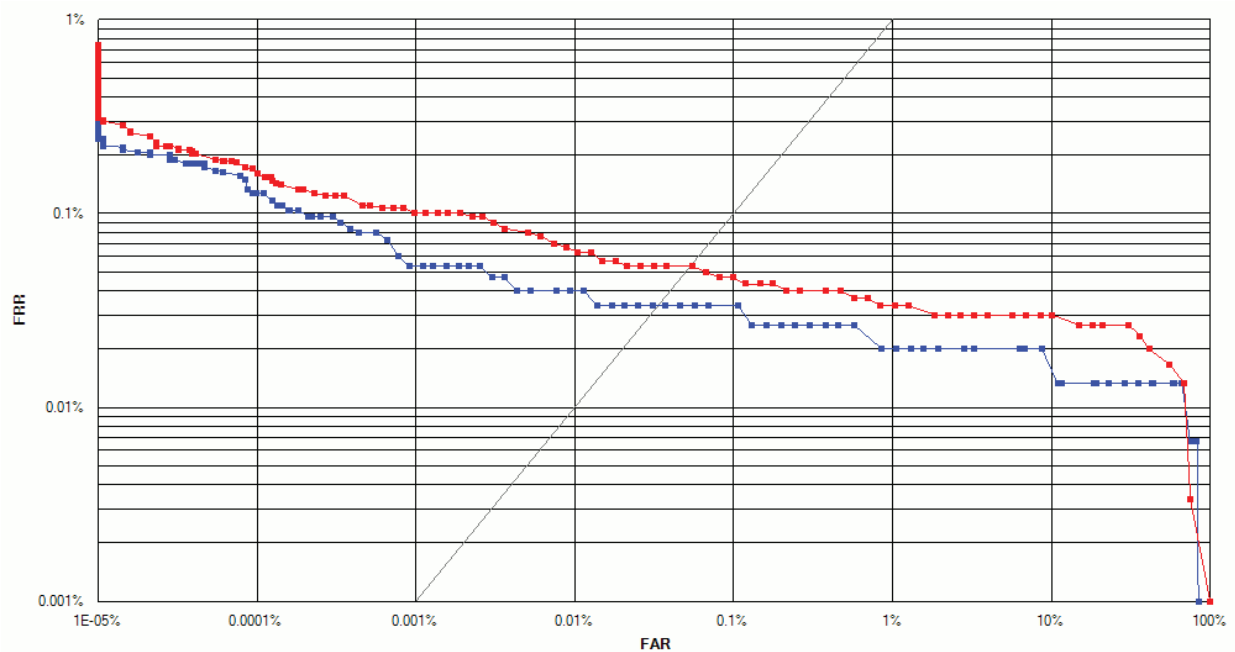
MegaMatcher 4.0 fused template matching algorithm; a template contains 2 different fingerprints from the same person:

- Maximized matching speed scenario
- Maximized matching accuracy scenario



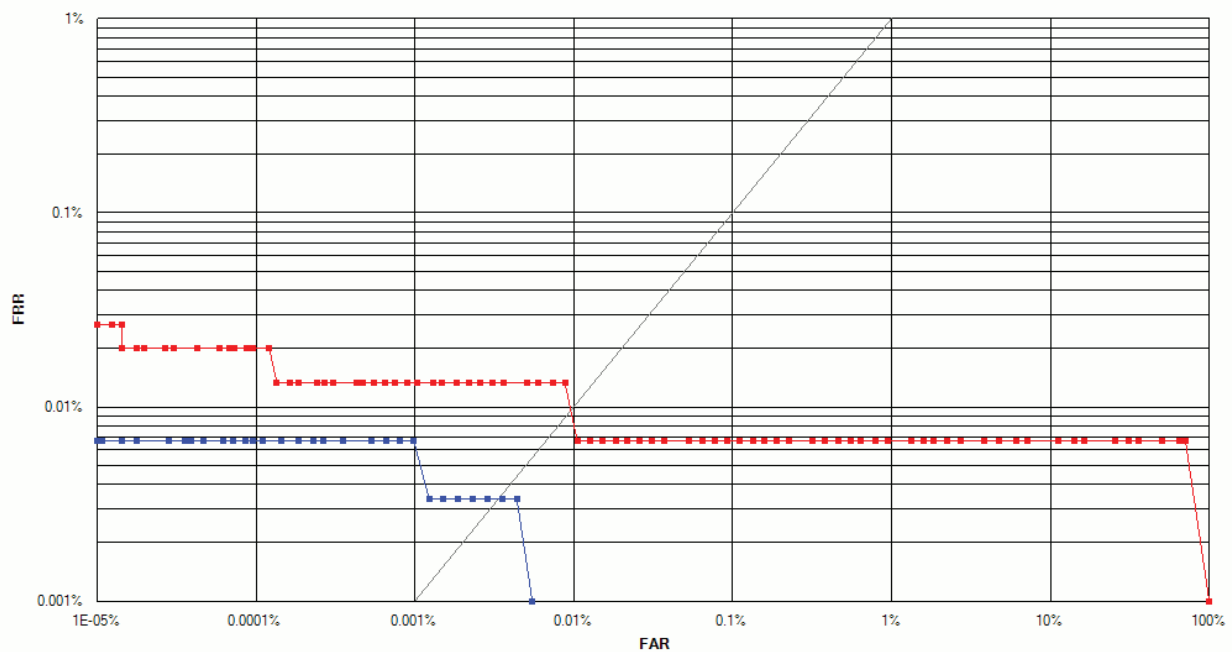
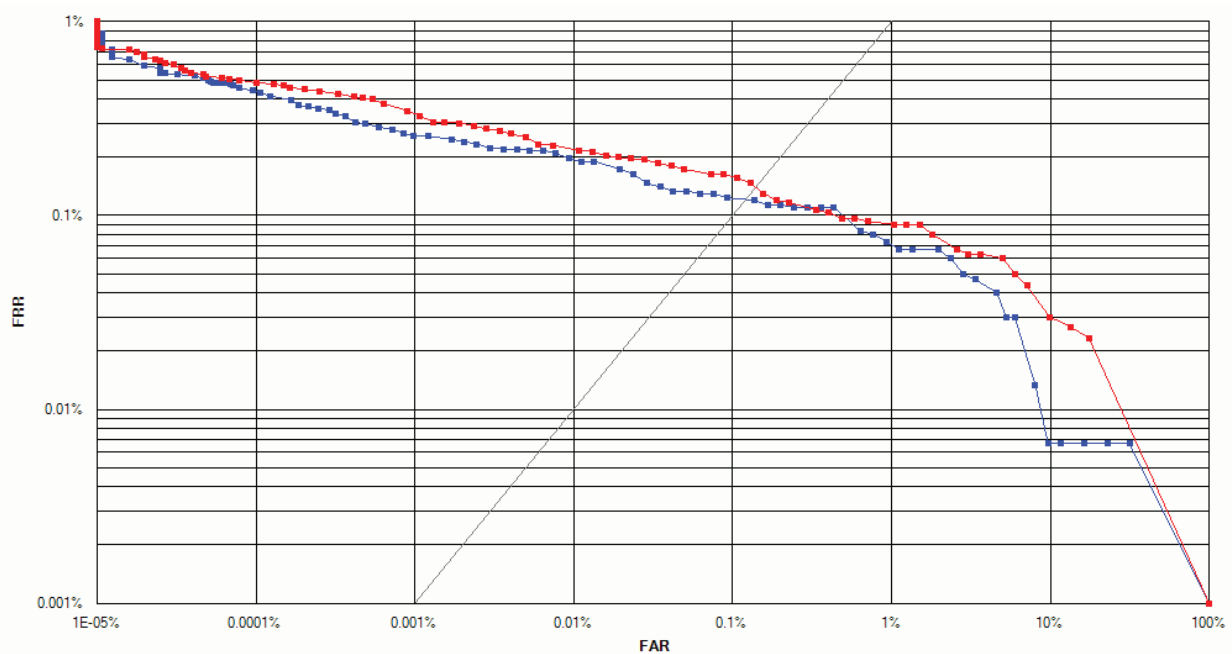
MegaMatcher 4.0 fused template matching algorithm; a template contains 2 different irises from the same person:

- Maximized matching speed scenario
- Maximized matching accuracy scenario



MegaMatcher 4.0 fused template matching algorithm; a template contains 1 fingerprint and 1 face from the same person:

- Maximized matching speed scenario
- Maximized matching accuracy scenario

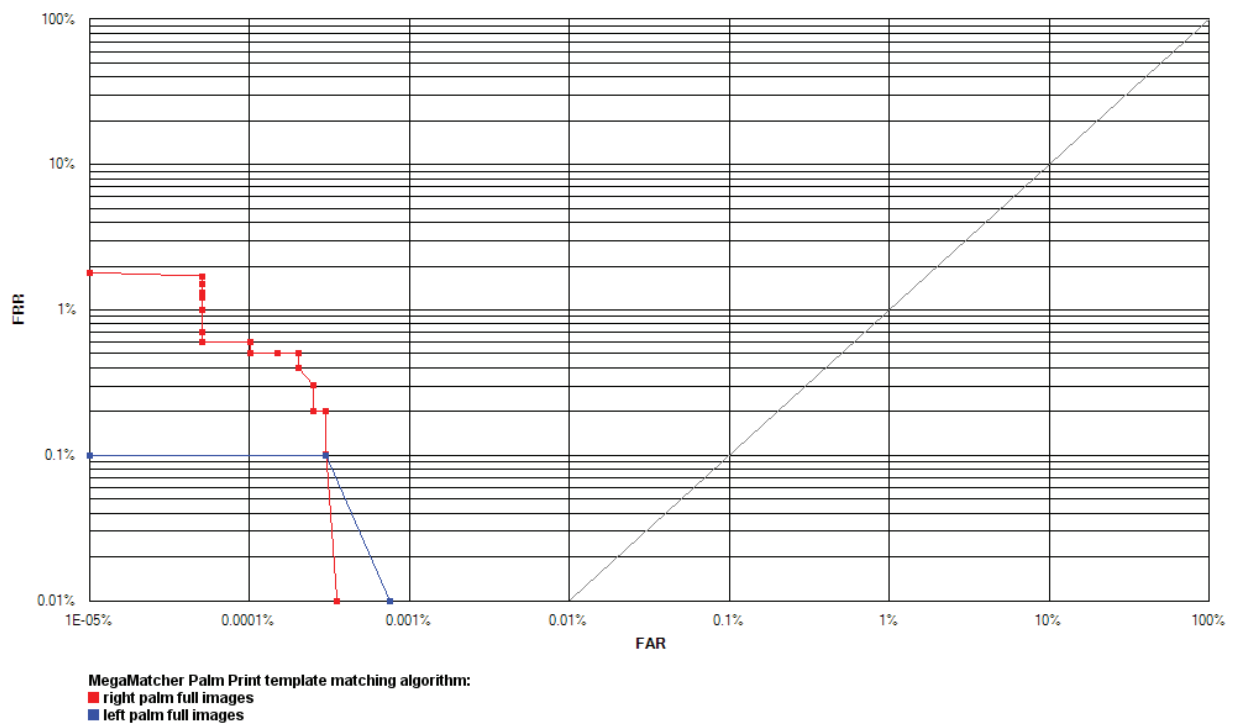




Palm Print Engine Tests

The MegaMatcher Palm Print template matching algorithm reliability tests were performed using internal palm print images database. The database contained 1,993 images of right hand full palms and 1,996 images of left hand full palms. The database represented 1,000 unique persons.

Receiver operation characteristics (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). The chart with ROC curves for the MegaMatcher Palm Print template matching algorithm are available below.





MegaMatcher SDK Trial, Demo Applications and Related Products

MegaMatcher **30-day SDK Trial**, as well as fingerprint, face and iris engines **demo applications** are available for downloading at www.neurotechnology.com/download.html

These products are related to MegaMatcher SDK:

- **MegaMatcher Accelerator 3.0** – a solution for building the server-side part of a large-scale AFIS or multi-biometric system; available in Standard and Extended versions; a single MegaMatcher Accelerator Standard matches **30 million fingerprints per second** or **50 million irises per second**, and Extended matches **100 million fingerprints per second** or **200 million irises per second**. See “MegaMatcher Accelerator” brochure for more information.
- **MegaMatcher On Card SDK** – a product for fingerprint and face matching on smart cards. See “MegaMatcher On Card SDK” brochure for more information.
- **VeriFinger SDK** – intended for development of PC-based or Web-based fingerprint identification systems. See “VeriFinger SDK” brochure for more information.
- **VeriLook SDK** – intended for development of PC-based or Web-based face identification systems. See “VeriLook SDK” brochure for more information.
- **VeriEye SDK** – intended for development of PC-based or Web-based iris identification systems. See “VeriEye SDK” brochure for more information.



Licensing MegaMatcher SDK

To **develop** a product based on MegaMatcher technology, an integrator should obtain MegaMatcher 4.0 Standard SDK (EUR 2,590) or MegaMatcher 4.0 Extended SDK (EUR 4,990).

Integrators can develop only an **end-user** product using MegaMatcher SDK and sell/install the product to their own customers. If the integrator wants to develop and sell a MegaMatcher based development tool (with API, programming possibilities, programming samples, etc.), he/she will need a permission from Neurotechnology and shall sign a special VAR agreement.

To **deploy** the product that was developed with MegaMatcher 4.0 SDK, the integrator should obtain only additional MegaMatcher 4.0 component licenses for product installations. Also the additional MegaMatcher 4.0 component licenses may be required during development of the product. The additional MegaMatcher 4.0 component licenses can be obtained by MegaMatcher 4.0 SDK customers at any time.

Below are listed the components of MegaMamatcher 4.0 SDK. Additional licenses for these components are available for both MegaMatcher 4.0 Standard SDK and MegaMatcher 4.0 Extended SDK customers, except the Cluster Server component:

Fingerprint components:

- Fingerprint Extractor
- Fingerprint Segmenter
- Fingerprint BSS
- Fingerprint WSQ
- Fingerprint Client
- Fingerprint Matcher
- Fast Fingerprint Matcher

Face components:

- Face Extractor
- Face Client
- Face Matcher
- Fast Face Matcher

Iris components:

- Iris Extractor
- Iris Client
- Iris Matcher
- Fast Iris Matcher

Palm print components:

- Palm Print Client
- Palm Print Matcher

Server and cluster components:

- Cluster Server
(available only for MegaMatcher 4.0 Extended SDK customers)

A license for a MegaMatcher component is required for **each PC** or **each server CPU** that runs this component. The following license types are available:

- Single computer license.
- Concurrent network license
- Enterprise license.



The table below shows what component licenses are included with MegaMatcher 4.0 Standard and Extended SDKs.

	MegaMatcher 4.0 Standard SDK	MegaMatcher 4.0 Extended SDK
Fingerprint component licenses included with a specific SDK:		
• Fingerprint Extractor	1 license	1 license
• Fingerprint Client	3 licenses and 1 concurrent license	3 licenses and 1 concurrent license
• Fingerprint Matcher	1 license	1 license
• Fast Fingerprint Matcher	1 license	2 licenses
Face component licenses included with a specific SDK:		
• Face Extractor	1 license	1 license
• Face Client	3 licenses and 1 concurrent license	3 licenses and 1 concurrent license
• Face Matcher	1 license	1 license
• Fast Face Matcher	1 license	2 licenses
Iris component licenses included with a specific SDK:		
• Iris Extractor	1 license	1 license
• Iris Client	3 licenses and 1 concurrent license	3 licenses and 1 concurrent license
• Iris Matcher	1 license	1 license
• Fast Iris Matcher	1 license	2 licenses
Palm print component licenses included with a specific SDK:		
• Palm Print Client	1 license	1 license
• Palm Print Matcher	1 license	2 licenses
Server and cluster component licenses included with a specific SDK:		
• Matching Server	+	+
• Cluster Server		1 license

Please, also refer to *MegaMacher 4.0*, *VeriFinger 6.3*, *VeriLook 5.0*, *VeriEye 2.3 SDK License Agreement* on Neurotechnology web site for all licensing terms and conditions.

Single computer licenses

A single computer license allows to install and run a MegaMatcher component installation on a single Personal Computer or on one Server CPU. The license will not be lost if computer will be reinstalled.

The following license management options are available:

- license activation online by communicating with Neurotechnology's server;
- license activation by email;
- license activation using volume license manager;
- license management using volume license manager on LAN or Internet.

Single computer license activated over Internet or by email is not suitable for virtual environments. Volume license manager used as a dongle or license management over network would be required.



Concurrent network licenses

Fingerprint Client, Face Client or Iris Client concurrent license allows to install Fingerprint Client, Face Client or Iris Client components respectfully on an unlimited number of computers. An application should obtain Fingerprint Client, Face Client or Iris Client license for capturing process and to perform template creation (extraction). In average it takes 10-20 seconds for face or iris capturing/enrolling and 0.1-0.2 sec for fingerprint enrolling. After this time license can be released to be available for another user. Even one Fingerprint Client, Face Client or Iris Client concurrent license can be shared among tens or hundreds of users.

The allowed number of simultaneously running Fingerprint Client, Face Client and Iris Client component instances is limited by the number of obtained concurrent licenses which are stored in the volume license manager dongle. Additional licenses can be obtained at any time and put inside the existing dongle.

This type of licensing is especially **useful for web-based** software.

MegaMatcher enterprise license

MegaMatcher enterprise license allows an **unlimited use** of MegaMatcher components in the end-user products in the certain territory, market segment or project. These limitations would be included in the licensing agreement.

The enterprise license price depends on the application size and the number of potential application's users within the designated territory, market segment or project. MegaMatcher enterprise licenses are provided only for big projects, with price range starting at **EUR 80,000**.

For more information please contact us.

Volume license manager

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

- **Activating the single computer licenses.** An installation license for a MegaMatcher component will be activated for using on a particular computer. The license quantity in the license manager will be decreased by the amount of activated licenses.
- **Managing the single computer or concurrent licenses on LAN or Internet.** The license manager allows to manage installation licenses for MegaMatcher components across the computers on LAN or Internet. The number of managed licenses is limited by the number of licenses in the license manager. No license activation is needed and the license quantity is not decreased. Once issued, the license is assigned to certain computer on the network.
- **Using a license manager as a dongle.** The volume license manager containing at least one license for a MegaMatcher component can be used as a dongle that allows to run the MegaMatcher component on a particular computer.

Additional MegaMatcher component licenses for the license manager can be purchased anytime. Neurotechnology will generate a special update code and send it to you. Then you will just have to enter the code to the license manager to add these purchased licenses.



Prices for MegaMatcher products

- The prices are **effective from January 10, 2011**. 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.
- The prices do not include any local import duties or taxes.
- Product shipping cost depends on delivery country
- Our customers can gain a discount for our products by getting the Solution Partner status.

MegaMatcher 4.0 SDK

MegaMatcher 4.0 Standard SDK	€ 2,590.00
MegaMatcher 4.0 Extended SDK	€ 4,990.00

Fingerprint, Face and Iris Client components concurrent licenses

	Fingerprint Client	Face Client	Iris Client
Price per license	€ 590.00	€ 390.00	€ 1,200.00

Fingerprint components (prices per single computer license)

Quantity	Fingerprint Client	Fingerprint Matcher	Fast Fingerprint Matcher
1-9	€ 35.00	€ 25.00	€ 540.00
10-19	€ 26.00	€ 18.00	€ 390.00
20-49	€ 23.00	€ 16.00	€ 355.00
50-99	€ 20.00	€ 14.00	€ 305.00
100-199	€ 18.00	€ 12.50	€ 275.00
200-499	€ 16.00	€ 11.00	€ 245.00
500-999	€ 14.00	€ 10.00	€ 215.00
1000-1999	€ 12.00	€ 9.00	€ 190.00
2000-3999	€ 11.00	€ 8.00	€ 170.00
4000-7999	€ 10.00	€ 7.00	€ 155.00
8000 and more	Please contact us for more information		

Face components (prices per single computer license)

Quantity	Face Client	Face Matcher	Fast Face Matcher
1-9	€ 25.00	€ 25.00	€ 160.00
10-19	€ 18.00	€ 18.00	€ 120.00
20-49	€ 16.00	€ 16.00	€ 105.00
50-99	€ 14.00	€ 14.00	€ 90.00
100-199	€ 12.50	€ 12.50	€ 80.00
200-499	€ 11.00	€ 11.00	€ 70.00
500-999	€ 10.00	€ 10.00	€ 63.00
1000-1999	€ 9.00	€ 9.00	€ 57.00
2000-3999	€ 8.00	€ 8.00	€ 51.00
4000-7999	€ 7.00	€ 7.00	€ 45.00
8000 and more	Please contact us for more information		



Iris components (prices per single computer license)

Quantity	Iris Client	Iris Matcher	Fast Iris Matcher
1-9	€ 101.00	€ 124.00	€ 800.00
10-19	€ 74.00	€ 90.00	€ 580.00
20-49	€ 65.00	€ 80.00	€ 520.00
50-99	€ 57.00	€ 70.00	€ 450.00
100-199	€ 51.00	€ 63.00	€ 405.00
200-499	€ 46.00	€ 56.00	€ 360.00
500-999	€ 41.00	€ 49.00	€ 315.00
1000-1999	€ 36.00	€ 44.00	€ 280.00
2000-3999	€ 32.00	€ 40.00	€ 255.00
4000-7999	€ 29.00	€ 36.00	€ 230.00
8000 and more	Please contact us for more information		

Cluster server component (prices per single computer license)

Quantity	Price
1-9	€ 1,790.00
10-19	€ 1,290.00
20 and more	Please contact us for more information

Palm print components (prices per single computer license)

Quantity	Palm Print Client	Palm Print Matcher
1-9	€ 123.00	€ 154.00
10-19	€ 90.00	€ 112.00
20-49	€ 80.00	€ 100.00
50-99	€ 70.00	€ 87.00
100 and more	Please contact us for more information	

License management

Volume License Manager dongle	€ 16.00
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MegaMatcher enterprise license

Please contact us for more information about MegaMatcher enterprise license

Ordering

MegaMatcher 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