

**The Bill Blackwood
Law Enforcement Management Institute of Texas**

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**An Examination of a Local Fingerprint Identification System
For a Large Sized Police Department**

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**An Administrative Research Paper
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ABSTRACT

The origin of fingerprint filing systems can be traced back to the 1800s when forefathers in the fingerprint community invented a number of fingerprint filing systems. Manual filing systems were used until the automated systems in the early 1970s were invented and proven effective. Automated Fingerprint Identification Systems are now widely used all across the globe. This paper examines the needs of an AFIS for a large sized police department. Research was conducted from surveys sent out to area agencies, on line Internet research and on site visits to area agencies. In determining the need to purchase an AFIS, a large sized police agency should consider numerous factors. During the review of literature, it was discovered there were several issues such as costs of systems; reliability and error rates which need to be researched before a purchase could be made. The surveys indicated all larger agencies have their own AFIS. AFIS meet their department goals and saved Identification officer time and workload. Agencies that have their own AFIS clear more offenses and identify more subjects.

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INTRODUCTION

The origin of fingerprint filing systems can be traced back to the 1800s when forefathers in the fingerprint community invented a number of fingerprint filing systems. Manual filing systems such as Vucetich and Battley were created. Sir Francis Henry, a commissioner for the London police, also formed his own fingerprint filing system. The “Henry” system, as it is still known and used today, is a system, which assigns an alphanumeric code to a ten print card. This classification code subsequently allows common fingerprint pattern types, such as loops, arches and whorls (and all combinations thereof) to be filed together. Manual filing systems were used until the automated systems in the early 1970s were invented and proven effective.

The demand for automation of fingerprint systems started roughly in 1976 with the FBI’s experimentation of an automatic fingerprint system, which stored fingerprint cards into a database for later comparison and retrieval. During this time period the process was time consuming, taking hours to enter one ten print card into the computer. As late as 1979, the FBI was still trying to convert its 17 million fingerprint cards into the computer. During the nineteen eighties, fingerprint systems became newer and faster, which generated more interest with law enforcement agencies. As a department’s ten print files grow larger, the importance of computerizing fingerprint data becomes vital. Without today’s modern technology, an Automated Fingerprint Identification System (AFIS) would be impossible. In the past ten years computer chips became smaller and faster. Computer language became more efficient. The law enforcement community recognized the need for AFIS, and responded by purchasing faster systems. Companies like NEC, Cogent Systems, Sagem Morpho, and PrintTrak quickly rose to

prominence in the arena. Access to the FBI's International Automated Fingerprint Identification System (IAFIS) became more readily available and access to state systems became more prevalent. The National Institute of Standards and Technology (NIST) created standardizations. Although interoperability issues between vendors still exist, NIST standards allow for some compatibility. Interoperability between vendors is expected to be resolved in forthcoming years.

Since September 11th, 2001, more emphasis has been placed on Homeland Security. Issues have been raised regarding the protection of our nation's borders and identification of unknown potentially dangerous people entering the United States. With an increase in global terrorism, the need for immediate identification of these unknown individuals is of more importance. No longer can we depend upon only state and federal databases for criminal record information. Deficiencies need to be identified and repaired. Local fingerprint databases, which are comprised of 10 print cards from local arrests, need to be computerized and updated where they are searchable.

The purpose of this research paper is to determine an answer to the following question: What are "up front" considerations large sized police departments (with more than 200 officers) should identify before purchasing a local AFIS?

Methodology utilized for this topic will include research from publications, surveys sent out to area agencies, on-line Intranet research and on site visits to agencies with local AFIS systems. It is hypothesized larger agencies will have purchased their own AFIS systems, recognizing the numerous benefits from the system. It is theorized owning one's own AFIS will create a balance between workload and personnel as well as make more efficient use of the "ten print" workflow. Furthermore, larger departments

will recognize owning its own AFIS will meet departmental goals and strategies, including increasing the number of unsolved cases cleared by the new technology. Lastly, any interoperability issues will be identified and addressed.

Benefits to law enforcement will be numerous. The purchase of a local AFIS will support departmental visions to achieve safer communities. The community will reap the rewards of increased customer service as a result of more victims' cases cleared as well as the identities of unknown individuals will be determined at the time of arrest.

REVIEW OF LITERATURE

The main impetus behind the development of fingerprint identification was using fingerprint patterns to index large databases of criminal records in order to prevent recidivists from evading their past crimes by adopting an alias (Cole, 2004). As criminal records grew larger and larger, the existing manual systems were modified and extended to accommodate the growth. However, as manual filing systems grew larger, they became less useful for forensic identification. Crime scenes, however, often yield single latent prints, and even those are often incomplete to the point that the pattern type may not be determinable (Cole, 2004). That is to say, it became increasingly difficult to search a single latent fingerprint in a database that held hundreds of thousands of fingerprint cards.

As early as the 1970s, one of the first automated fingerprint systems was based upon a key punch card system in which a person's biographical data were key punched on a card and fed into a computer. This was not a "true" fingerprint filing system, but a means by which to narrow the search based on a given set of parameters. This process

was designed to narrow the search down to a manageable number of fingerprint cards a fingerprint examiner had to compare. Throughout the late 1960s, large companies like McDonnell Douglas experimented with “holographic” systems. They were never developed as they were deemed to be extremely expensive and sensitive to “noise”, which would exist in almost any fingerprint or latent print collected from the scene of a crime. In 1972, the U.S. Federal Bureau of Investigation (FBI) installed a prototype AFIS using a fingerprint scanner built by Cornell Aeronautical Laboratory and fingerprint reader built by North American Aviation. The FBI began testing automatic searching in 1979, and automated searches became routine by 1983 (Cole, 2004). Not long thereafter, smaller agencies began to afford their own AFIS and began purchasing systems manufactured by available vendors like Printrak and NEC.

Over the past 20 years, Automated Fingerprint Identification Systems have become much more affordable. The first system purchased by the Dallas Police Department in the 1990s cost millions of dollars. Nearby agencies like the Arlington Police Department could access the Dallas AFIS, by purchasing a satellite system to the Dallas AFIS. In a sense, Dallas had created a regional AFIS. Today, one of the most expensive systems available to a law enforcement agency would cost approximately \$500,000. Conversely, a smaller agency could purchase a smaller Identix System for \$20,000.

AFIS in relation to fingerprint work flow is intriguing. A suspect's fingerprints are rolled onto a standard eight by eight inch fingerprint card. The fingerprint card consists of blocks for each of the eight fingers and two thumbs. There are spaces provided for “slaps” or simultaneous impressions of the left and right set of four fingers at the bottom

of the ten print fingerprint card. Next, the rolled inked impressions on the card are scanned into the computer using a flatbed scanner or camera - like capturing device. In some agencies, the suspect's fingerprints are rolled onto a glass plate and captured in a computer called a "Live Scan" at the time of their arrest. The friction ridge detail contained within a rolled inked impression is captured at 600 to 1000 dpi by scanner or live scan computer. The image is converted to a computerized algorithm and stored in the computer.

AFIS systems utilize specialized software and powerful computer hardware configurations to create unique mathematical 'maps' (algorithms) based upon relationships between the characteristics present within the finger or palm friction ridge skin structures. Modern AFIS systems rapidly extract information from the fingerprint to establish the pattern type, minutiae points and the axis of the image. The use of mathematical algorithms enables a fingerprint to be compared with millions of file prints within a matter of seconds. The latest AFIS systems may also incorporate palm print matching capabilities. In the majority of operating systems palm print images are divided up into a number of small segments so that the software can effectively and efficiently code, store and search the palm data within a reasonable time frame (similar size to a rolled fingerprint impression) (Lennard, 2004, p.1).

In the case of the Live Scan capture, algorithms are transmitted to the Texas Department of Public Safety, the repository for Class B and above criminal records. Felony arrests are forwarded onto the FBI's IAFIS. Herein lays a Homeland Security issue. Since the Texas DPS takes only class B offenses and above, all Class C

offenses are not transmitted to the state. Instead they are stored locally after they are purged from the Live - Scan system. All Class C ten print cards are directed to a local storage device. The drive holds a small number (about two hundred) of ten print cards. When two hundred and one (201) cards are directed to the storage device, the system automatically purges the first card in the system. Purged data are printed on ten print cards and carried to the Identification Unit for filing. In the case of the Arlington Police Department, all purged ten print cards are routed to the crime scene unit where they are filed by the PIN number (Personal Identification Number). This is a very labor intensive process and especially time consuming. The Investigative Aide assigned to the unit first sorts the cards by their PIN. Duplicate cards are never thrown away, but stored together. This increases storage space. Each card is hand filed. Before filing, each card is compared to fingerprint cards already on file in search of duplicate arrest records. Ten Crime Scene Investigators are assigned to the unit help file cards when time permits. Due to a heavy work volume fingerprint cards have backed up for more than a year and have created a workflow problem. By implementation of a local AFIS system, thousands of personnel hours can be reduced to a few minutes work. Additionally, new space for personnel and equipment will become available as there will be no need for numerous fingerprint filing cabinets.

Instead of purging and printing Class C arrest records, the Live – Scan system can dump algorithm data directly into a local AFIS. The AFIS will complete all current manual labor tasks. Incoming ten print cards will be searched against the existing database. In less than thirty minutes, a candidate list will be provided. A Certified Latent Print Examiner (CLPE) reviews the candidate list for potential print matches.

Fingerprints are printed out and a manual comparison is initiated. Once a manual comparison of two fingerprint records has been done, the CLPE can queue the AFIS to merge the two ten print records. There is no longer a need to store tens of thousands of fingerprint cards in metal filing cabinets. More than one hundred square feet of filing cabinet storage space can be reduced to a single PC desktop workstation. In the event a fingerprint card is required, it can be retrieved and printed from the desktop. Even a fingerprint card from a specific arrest may be retrieved. What will be eliminated is the possibility of a terrorist being arrested for a Class C offense (i.e., Public Intoxication), and his identity or arrest going undetected because his fingerprints were not searched through any local AFIS database.

There are many other issues to consider before purchasing one's own local AFIS. For example, one might be the initial cost of the system. How much does it cost to own and operate a local AFIS? The cost will vary from vendor to vendor, but for an AFIS solution for a large agency, they will most likely purchase a system which scored highly on the LST test. According to the FpVTE tests, that system will be NEC, Sagem Morpho or Cogent. All three of those solutions will cost upwards of one hundred thousand dollars. Additionally, a large department may wish to consider the questions: is one AFIS vendor more reliable than another? Are there accuracy rates comparing one vendor to another? There are numerous systems being sold on the market today. How does a department determine reliability of such a costly computer?

The most thorough examination of fingerprint matching systems was conducted by NIST in October of 2003, ending in November of 2003, with the report being published in April of 2004:

The Fingerprint Vendor Technology Evaluation (FpVTE) 2003 was conducted to evaluate the accuracy of fingerprint matching, identification, and verification systems. FpVTE 2003 was conducted by the National Institute of Standards & Technology (NIST) on behalf of the Justice Management Division (JMD) of the U.S. Department of Justice. The report further states FpVTE 2003 serves as part of the NIST statutory mandate under section 403(c) of the USA PATRIOT Act to certify biometric technologies that may be used in the U.S. Visitor and Immigrant Status Indicator Technology (US-VISIT) Program (NIST, 2004, p.2).

During this test, there were eighteen different companies participating in the comparative study. Each company had the option of participating any or all of three different tests: a small scale test (SST), a medium scale test (MST), and a large scale test (LST). All vendors have written computer code to process their algorithms differently from each other. Error rates were recorded for all thirty four machines compared (See Appendix 2).

NEC, SAGEM, and Cogent were identified as the top three systems which performed most accurately, with the smallest margin of error. NEC, Sagem and Cogent were the top performers in the LST test (Appendix 3). NEC, Cogent, and Sagem were the top performing vendors in the MST test (Appendix 4).

There are numerous regional benefits to surrounding agencies. There are smaller agencies which will not, regardless of price, be able to afford their own AFIS. These smaller agencies may take their ten print or latent print evidence to the large department and have their evidence searched through the AFIS database. By doing so, the smaller agency will inadvertently have access to the State database. Lastly, the

department should identify any interoperability issues as the local system should communicate with state and national systems. The Texas Department of Public Safety uses the NEC system; however, if a large department chooses to use another vendor like Sagem Morpho or Cogent, there are computer language protocols vendors can create to eliminate any interoperability issues. (Cogent, 2005) states in their own promotional literature:

For cities, Counties, States or Countries needing an AFIS solution requiring integration with existing information systems and that must be able to interface with external AFIS systems, Cogent provides a turn – key customized solution to meet customer requirements (p.2).

Most vendors have similar options. Lastly, are there costs for the conversion of existing ten print card data? There are going to be associated costs for the AFIS solution. Historically, purchasing an AFIS will require monies for hardware (computer), software and conversion of records. The conversion is most often the most substantial investment. There are three options for data conversion. First, obtain the data from the State for all Class B and above offenses. This data belongs to the local agency and may be obtained at no charge from the State. This option does not provide the local agency with their Class C offense records, as they were never initially sent to the State. The next option is to scan all of one's own local records. Costs for data conversion are usually five dollars per record. Assuming an agency had 100,000 records for conversion, there would be an anticipated cost of \$500,000. Option three is to 'date-purge records' and convert only records from 1990 to present.

METHODOLOGY

The purpose of this research paper is to determine “up front” considerations large sized police departments (with more than 200 officers) should identify before purchasing a local Automated Fingerprint Identification System (AFIS)? Methodology utilized for this topic was primarily reviewing vendor publications and promotional literature. Additionally, a survey was administered to the participants of Law Enforcement Management Module One (September, 2004). The module participants represented a diverse group of different sized agencies throughout Texas. Out of twenty two surveys administered, five were from large departments with two hundred officers or more. Those five surveys were used to accumulate data. The responses from smaller departments were not used. In addition, telephone contact was made with three more large police departments known to have their own AFIS solutions to further identify any up front considerations. Lastly, extensive on-line Intranet research was completed to determine error rates and reliability issues between vendors.

FINDINGS

The surveys indicated all larger agencies had their own AFIS solutions. Those agencies who indicated they had AFIS, all participants indicated the system meet their departmental goals, and saved identification officer time and workload. Additionally, all participants indicated having one’s AFIS increased the possibility of identifying unknown individuals and increases the number of crimes solved. Contact with three additional departments indicated the same conclusion. Fort Worth Police Department, Dallas Police Department and Austin Police Department all have their own local AFIS solutions. Owning one’s own AFIS solution reduces workload, and increases

identification of unknown individuals and the clearance of cases due to latent print evidence. Through research, up front considerations were identified. Issues which were identified were costs; both purchasing the hardware, software as well as data conversion. Simple AFIS systems can be purchased in the neighborhood of \$20,000; however more complex systems for larger agencies will cost substantially more. Surprisingly, data conversion turned out to be as much of the expense as the purchase of the hardware and software combined. Most vendors charge a 'per card' fee for converting the ten print card records to algorithm data for entry into the computer. This fee, generally fifty cents per card, can add up exponentially when there are 100,000 fingerprint records to convert. This is an unanticipated \$50,000 cost to budget. A portion of this cost can be defrayed by obtaining an electronic tape of the record data from the State and importing these records. Class C offenses will still need to be scanned by hand and converted the old fashioned way, as "fine only" offenses are not usually sent to the state record repository. Interoperability issues were also identified and eliminated as an issue as well as workflow issues and how they directly relate to staffing. By purchasing their own local AFIS solution, hundreds of staffing hours can be saved, or redirected to other duties. Manual sorting and filing of fingerprint cards would no longer be necessary. Manual merging of duplicate criminal records would be eliminated, and reduced to AFIS completing the work for the Certified Latent Print Examiner in minutes. Homeland Security issues and reliability and error rates were identified. Terrorists and other arrested suspects would not go unidentified or their arrests unnoticed when they gave a false name at the time of their booking. Their fingerprints would be collected via a live-scan machine and sent to the AFIS computer. Searches of the local database

would result in near immediate identifications. The computer software identifies algorithms which appear similar to the sample submitted. It produces a candidate list of possible matches which must be reviewed by the CLPE. The CLPE identifies the candidate on the list which matches the submitted fingerprint card. The examiner finalizes the fingerprint identification and clicks a button on the computer to merge the two records, and files the fingerprint card electronically. Last, reliability and error rates were identified by reviewing National Institute of Standards and Technology (NIST) tests which were completed in 2004. The NIST Fingerprint Vendor Technology Evaluation (FpVTE) conducted in 2003 identified the top three vendors in the test. All data from this conclusive test are posted to the <http://fpvte.nist.gov/> website.

CONCLUSION

By necessity, Automated Fingerprint Identification Systems (AFIS) were designed to speed the search of a ten print card or a latent fingerprint in a large database. As older manual systems were modified to refine a search, they became to difficult to use for forensic identification work. The advent of automated systems in the 1970s were clumsy and time consuming. As technology advanced, faster, smarter systems began to emerge. Initially, these systems were very expensive, but were soon replaced by newer faster (and cheaper) systems. One of the first systems in place was utilized by the Federal Bureau of Investigation (FBI) in the 1970s. Over the next twenty years, desktop systems, with the newer technology, replaced the first solutions on the market. Now, an AFIS solution is affordable by larger agencies. Smaller agencies have the option of taking their work to their larger next door counter part, or purchasing a smaller version suitable for the needs of their own department.

State agencies have come on line with their own AFIS systems. In Texas, the Texas Department of Public Safety is the repository for all state criminal records, including fingerprint cards. Most police agencies have access to the state database either through their own AFIS or their neighbor's AFIS system. However, with the advent of global terrorism, the necessity for an immediate identification of an unknown individual upon their arrest is of the utmost importance. It is no longer acceptable to fingerprint an individual and simply file their fingerprint card in a drawer. The needs of a safer society now outweigh the cost aspect of the fingerprint system. A subject arrested for a Class C misdemeanor could theoretically not get identified if the agency does not have their own local AFIS. The Class C arrest record data does not get transmitted to the state repository.

Larger agencies who desire to purchase their own local AFIS solution have several considerations to explore. Of course issues of cost; both for the system, its software and the conversion of fingerprint cards is of the utmost importance. This number varies from vendor to vendor. Interoperability appears not to be an issue with the top vendors, as most have language protocols which will interface with the state NEC system. Reliability and error rates have been identified and published at the Fingerprint Vendor Technology Evaluation website. The FpVTE site identified the top three vendors for an AFIS solution as NEC, Cogent and Sagem Morpho. The 'pecking order' of the latter two vendors can be switched depending upon the needs of the department. That is to say, a larger department may require a large system. Sagem Morpho edges out Cogent in the LST. Conversely, Cogent edged out Sagem Morpho in

the MST. The cost of the system and ease of use may make a critical decision in which system is purchased.

Regardless, the findings of the research supported the hypothesis. Once the upfront questions are answered, larger agencies should purchase their own local AFIS. This is relevant to all law enforcement agencies and the communities they serve. A large agency who owns their own AFIS solution will clear more offenses, and identify more subjects. The purchase of an AFIS solution will support any agency's strategic plan. Specifically addressed are those strategic goals are to achieve a balance of personnel and workload; use innovative technology to maximize their performance; and using partnerships to provide for a safer community.

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APPENDIX ONE

#1 Survey

AFIS – (A)utomated (F)ingerprint (I)dentification (S)ystem

Agency Name _____

How many commissioned officers does your agency have? (Please circle one)

Less than 50 50-199 200-499 500 or more

Does your agency have access to the FBI's International Automated Fingerprint Identification System? (IAFIS) Y / N

Does your agency have access to the state AFIS system through the DPS?
Y / N

Does your agency have its own (local) AFIS system in which your Class C cards and palm prints are stored? Y / N

If you know, how was your local AFIS funded? (Please circle one)

Grant Budgeted Item Other Don't know

What is the brand name of the AFIS system your agency purchased, if known?
(Example: NEC, Cogent, Sagem Morpho, PrintTrak, AFIX Tracker)

If your agency has a local AFIS, please check all that apply (in regards to the benefits it supplies to your agency)

- Meets your departmental goals (if applicable)
- Decreases crime scene / identification officer workload
- Reduces need for manual search and comparison of ten print cards
- Increases storage space (by the elimination of fingerprint cabinets)
- Increases identification of unknown arrested suspects
- Increases clearance of unsolved crimes in which latent prints were collected

Thank you for your time.

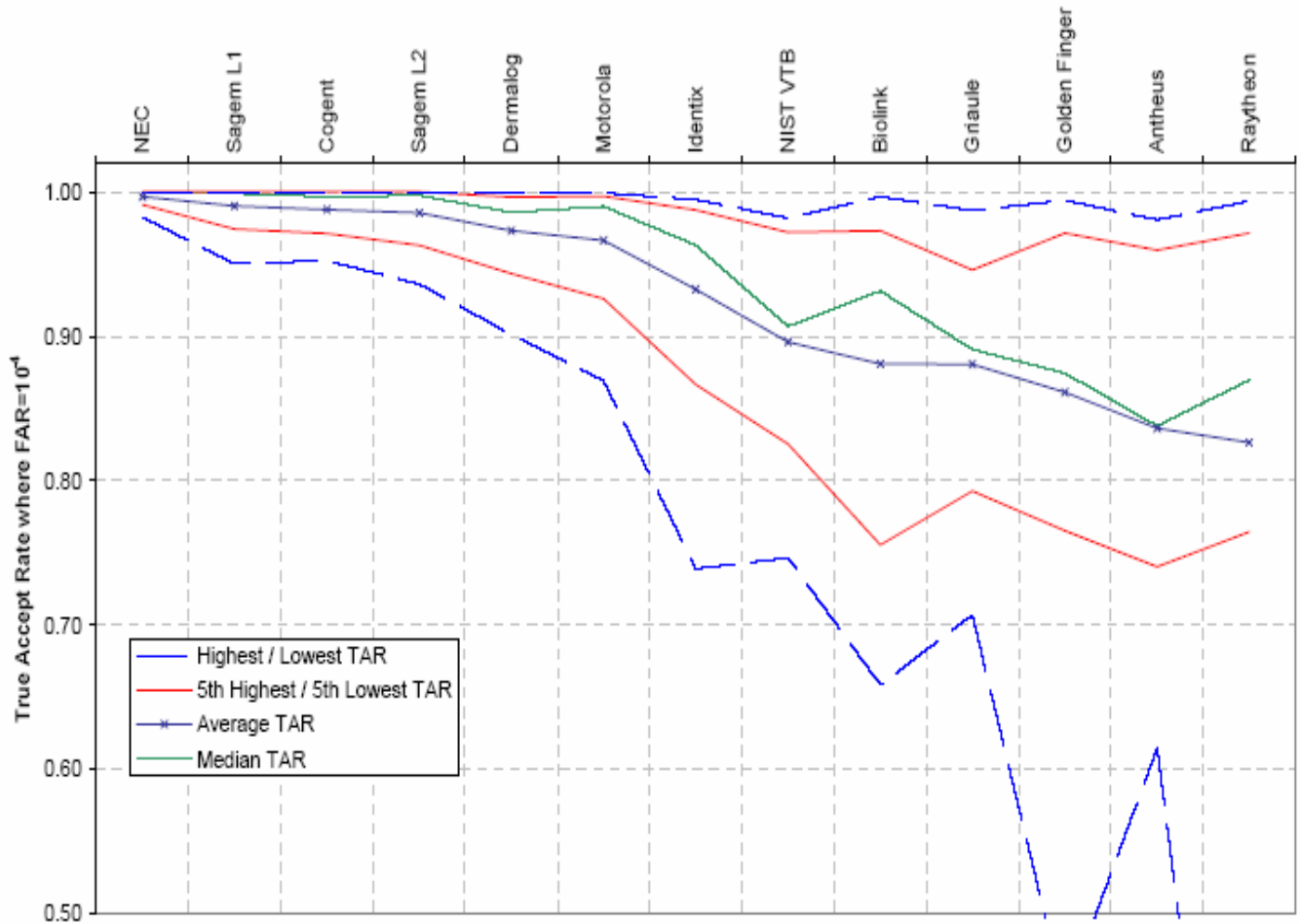
APPENDIX TWO

Test	Compares	# Subtests	# Comparisons	# Systems Successfully Completed	Allowed Time
LST	Sets of 1-10 fingerprint images (Flat, Slap, and Rolled; various combinations of fingers)	31 (uses 10 datasets containing 64,000 fingerprint sets)	1.044 billion set-to-set comparisons	13	21 days
MST	Single images (Flat & Slap Right index)	1 (compares a single 10,000 image dataset against itself)	100 million single image comparisons	18	14 days
SST ²	Single images (Flat Right index) (Subset of MST)	1 (compares a single 1,000 image dataset against itself)	1 million single image comparisons	3 (SST only) 21 (as a subset of MST)	14 days

Summary of FpVTE Tests

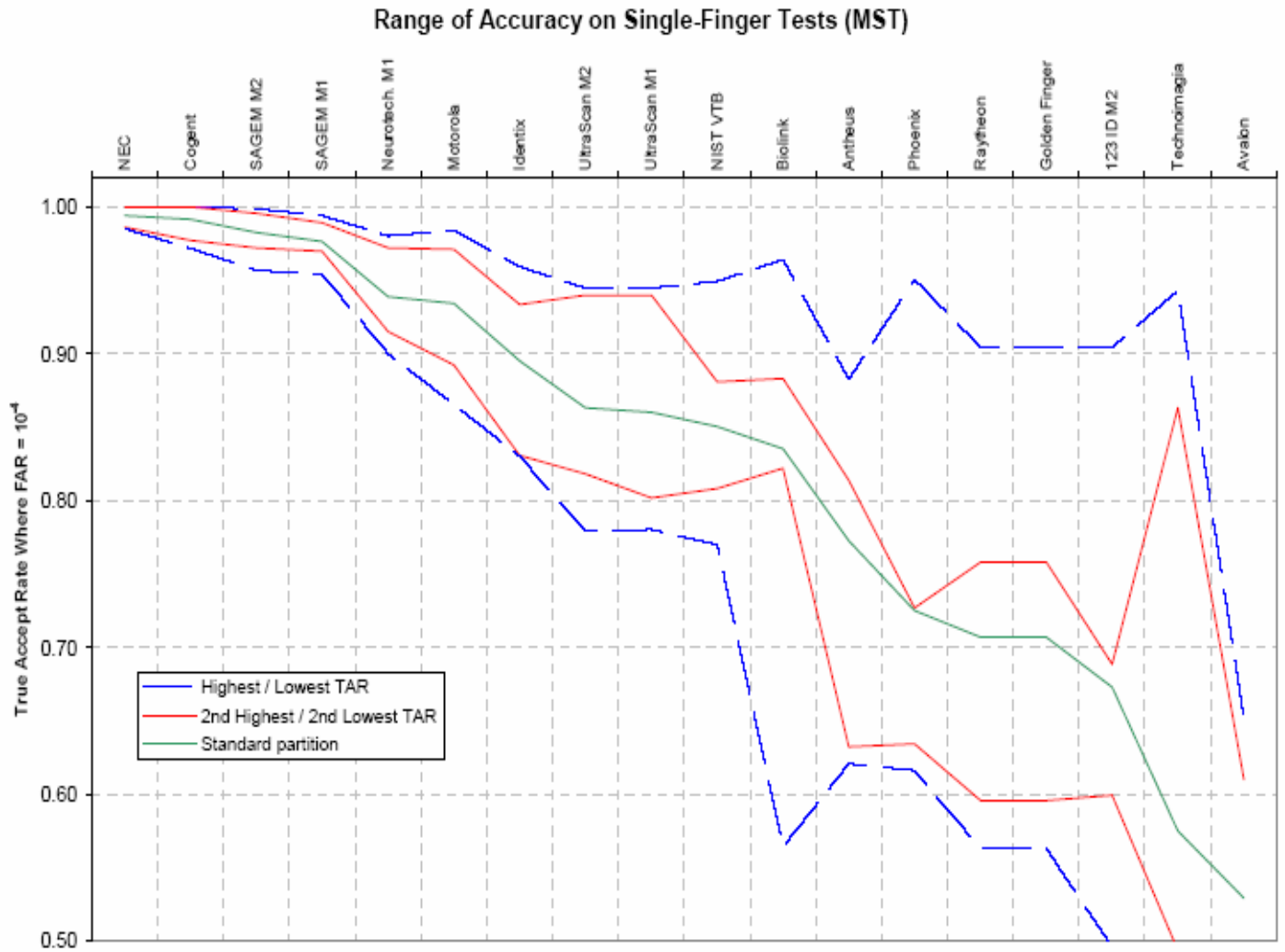
APPENDIX THREE

Range of Accuracy over 27 LST Operational Data Partitions



LST Test Results

APPENDIX FOUR



MST Test Results