Achieving Interoperability for Latent Fingerprint Identification in the United States

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Committee on Science

Subcommittee on Forensic Science

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The purpose of the Subcommittee on Forensic Science (SoFS) was to advise and assist the National Science and Technology Council, Committee on Science, and other coordination bodies of the Executive Office of the President on policies, procedures, and plans related to forensic science at the Federal, state, and local levels. The SoFS coordinated a robust effort across Federal, state, and local agencies to identify and address important policy, program, and budget matters, as well as potential activities to enhance and/or amalgamate forensic science initiatives that support research and development; training, education, and ethics; accreditation and certification; and standards of practice. The Subcommittee's findings and work products will inform efforts to enhance future forensic science policy, research, and practice.

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Executive Summary

Automated Fingerprint Identification System (AFIS) interoperability will support public safety throughout the United States by ensuring local law enforcement agencies are better able to coordinate their investigative fingerprinting efforts. The Federal Government is facilitating AFIS interoperability by implementing standards, developing an overarching national connectivity strategy and infrastructure, and supporting state and local agencies in building connections across jurisdictions. This report describes the current state of latent AFIS interoperability and identifies actions that can be taken by Federal agencies to support the following:

- Acquisition of standards-compliant systems at the Federal, state, and local-levels;
- Furthering connectivity efforts among law enforcement agencies;
- Improved governance structures to reflect the new interoperable environment;
- Developing mechanisms to test system performance and standards compliance; and
- Expanded examiner training.

For over a century, fingerprints have been used among other applications to identify criminal and terrorist suspects, perform background checks, and monitor immigration status. In the context of a criminal investigation, prints found at the scene of a crime, known as “latent prints,” are compared with fingerprint records of known individuals who have been convicted or arrested for a crime. A latent print is an impression of the friction ridges of any part of a human finger. Latent prints include fingerprints that are not readily visible and are recovered from evidence or a crime scene. The highly variable characteristics of latent prints complicate the identification process.

When law enforcement agencies first began using fingerprints in investigations, the comparison process was entirely manual and based on visual inspections of features found on both the latent print and the fingerprint records. AFIS, first introduced in the 1970s, uses image processing algorithms to generate a list of potential candidates that share fingerprint features similar to an encoded image of a latent print. The algorithms assess “minutiae” and other friction ridge features found on the underside of the finger and on the palm.

Developers of AFIS software differentiate themselves from their market competitors by independently creating algorithms to extract features and match images of varying latent print quality. These proprietary approaches have resulted in insufficient interoperability among different AFIS systems to meet the needs of law enforcement agencies.

“Interoperability” is the ability of two or more networks, systems, devices, applications, or components to use standardized encoding to seamlessly and electronically share information on demand and as authorized, without special effort and without loss of accuracy. Interoperability of AFIS software would allow law enforcement agencies to search fingerprint records beyond those within their own jurisdictions in support of efforts to identify suspects and protect public safety.

True interoperability requires technical compatibility, network connectivity, proper governance, and performance testing and training within and between systems. A national effort to improve interoperability in pursuit of public safety objectives is underway in each of these areas.

Technical compatibility. Technical compatibility is necessary for AFIS systems to communicate electronic data. It has been mostly achieved for ten-print searches and is advancing for latent fingerprint searches through the development of standards. Two recent standards that have advanced technical compatibility are the Extended Feature Set (EFS), which defines a common feature format, and the Latent Interoperability Transmission Specification (LITS), which delineates what information is needed in a transaction between systems.[1] The Federal Bureau of

[1] EFS refers to the definitions of fingerprint and palm print features incorporated in the ANSI/NIST-ITL standard starting in 2011. (U.S. Department of Commerce, National Institute of Standards and Technology (NIST), *Latent Interoperability Transmission Specification* (LITS), NIST Special Publication 1152, January 2013.) The FBI’s Electronic

Investigation (FBI) recently introduced the Next Generation Identification (NGI) system, which has incorporated the EFS as the standard submission format for all of its latent print searches. The success of these standards now depends on their adoption by state and local agencies, which is presently underway.

Network connectivity. Law enforcement agencies' coordinated efforts to identify suspects across jurisdictional lines depend on the connectivity of different AFIS systems through established networks. At present, latent print data sharing is limited. State agencies have an AFIS that has direct access to the NGI system via the Criminal Justice Information Services (CJIS) Wide Area Network (WAN), a network capable of transmitting latent searches to and from the NGI system. Efforts are being explored to connect state agencies to one another and to connect local agencies to the NGI system through their State Identification Bureau (SIB) for latent searches.

Proper governance. Proper governance is required for interoperable sharing agreements so that agencies are transparent about their search activities, respect relevant privacy laws, and outline the conditions of cross-jurisdictional data sharing. Interagency coordination has been facilitated by guidelines on the process for developing agreements between agencies and the recommended language for these agreements, but many jurisdictions have not yet pursued agreements.

Performance testing and training. Underpinning the effectiveness of an interoperable system is assurance that the examiners are adequately trained and that the software complies with newly adopted standards, provides accurate results, and functions properly. Quality assurance of examiners has improved through the introduction of an online EFS training tool that allows examiners and AFIS vendors to explore the functionality of the EFS.

Education and outreach. Education and outreach are important overarching components for bringing about interoperability. Expanding outreach will support other Federal efforts to ensure AFIS interoperability and speed the adoption of standards.

Biometric Transmission Specification is compliant with LITS. (U.S. Department of Justice, Federal Bureau of Investigation, *Electronic Biometric Transmission Specification (EBTS) Technical and Operational Update (TOU) 10.0.2*, June 2, 2014.)

Introduction

This report, *Achieving Interoperability for Latent Fingerprint Identification in the United States,* provides the current landscape of latent Automated Fingerprint Identification System (AFIS) interoperability, outlines recent advances in the field, and provides a high-level strategic plan for Federal agencies to implement the necessary requirements for interoperability to enhance public safety. The report addresses five essential elements of interoperability—technical compatibility, network connectivity, proper governance, performance testing and training, and education and outreach. It also examines existing mechanisms for sharing information and coordinating fingerprint searches and outlines a path for building on best practices to achieve a national latent print interoperability infrastructure.

For over a century, fingerprints have been used to identify criminal and terrorist suspects, to perform background checks, to monitor immigration status, to support public safety, and for other purposes. In the context of a criminal investigation, prints found at the scene of a crime, referred to as latent prints, are compared with fingerprint records of known individuals who have been convicted of or arrested for a crime. When law enforcement agencies first began using fingerprints in investigations, the comparison process was entirely manual and based on visual inspections of features found on both the latent print and the fingerprint records.

Law enforcement agencies began working with industry to automate this comparison process in the late 1970s and early 1980s by employing AFIS systems. After a latent print search has been initiated, AFIS systems use image-recognition algorithms to generate a list of potential candidates who share similar fingerprint features to an encoded image of a latent fingerprint. The algorithms assess "minutiae" and other friction ridge features found on the underside of the finger and on the palm. To submit a search, fingerprint examiners manually encode ("markup") an image to indicate the locations of minutiae on a digital image of the print. Law enforcement agencies have benefitted from the adoption of AFIS systems because potential suspects can be identified more quickly and accurately, often when no suspect was identified through other investigative methods.

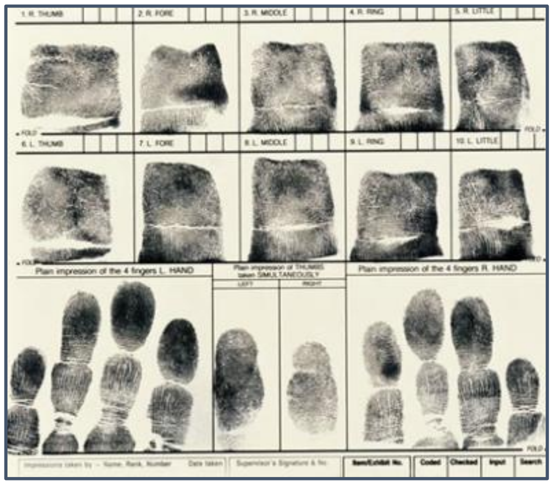

1. R. THUMB
2. R. FORE
3. R. MIDDLE
4. R. RING
5. R. LITTLE
6. L. THUMB
7. L. FORE
8. L. MIDDLE
9. L. RING
10. L. LITTLE
Plain impression of the 4 fingers L. HAND
Plain impression of THUMBS taken SIMULTANEOUSLY
LEFT
RIGHT
Plain impression of the 4 fingers R. HAND

Figure 1. Example of a ten-print record

Law enforcement agencies perform two types of fingerprint identification using AFIS systems: exemplar searches (more commonly known as "ten-print" searches) and latent print searches. A ten-print record contains fingerprint images of up to ten fingers captured by law enforcement agencies or private entities in a controlled environment as a result of arrest, conviction, or other civil requirements. Consequently, these images are typically high quality and uniform, resulting in consistency within and across agencies. Ten-print records are used in civil applications such as background checks and to determine immigration status; they are also used in the intelligence arena to identify known or suspected terrorists, and in the criminal justice system to identify arrestees and perpetrators of crime. Modern AFIS systems use automatic methods to encode a new ten-print image and search it against existing ten-print records, facilitating fast and accurate searches.

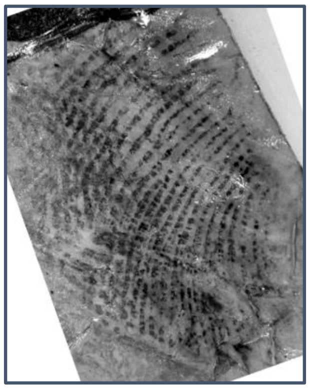


Figure 2. Example of a latent print

By contrast, a "latent print" (Figure 2) refers to a transferred impression of friction ridge detail, and includes those fingerprints recovered in whole or in part from a crime scene or other item of evidence. The highly variable characteristics of latent prints complicate the identification process. Latent prints are often incomplete or smudged, as they are usually created in an uncontrolled environment, thus reducing their quality and uniformity. Further chemical and physical processing and photographing or scanning of latent prints may be necessary to visualize the latent print before a search can be run using the image. When fingerprint examiners perform a latent print AFIS search, they mark up the features that can be identified on the image. This process is inherently subjective, and may be vulnerable to human error, especially in cases where the latent print is distorted or smudged or when the examiner is improperly trained or rushed.

Developers of AFIS software have independently created different methods for encoding the features of latent prints and algorithms for comparing latent prints to previously recorded ten-print records. These different approaches have made it difficult for the encoding features used in one vendor system to be used by another vendor system, resulting in insufficient interoperability among different AFIS systems to meet law enforcement agency needs.

Identification of Missing Persons

Fingerprints can be useful in identifying missing persons or victims of mass fatalities. Unidentified, burned, or fragmented fingerprints can sometimes be captured and used to make identifications. In some cases, medical examiners and coroners may be able to obtain ten-print records from bodies found at the scene of a crime or recovered from an accident. In other instances, latent searches can be performed on fragmented prints to assist with identification.

Modern AFIS systems create electronic data that, if standardized, can allow for interoperability. “Interoperability” is the ability of two or more networks, systems, devices, applications, or components to use standardized encoding to seamlessly and electronically share information on demand and as authorized, without special effort and without loss of accuracy. Interoperability is essential for law enforcement agencies to effectively investigate crimes and improve their ability to solve more crimes than stand-alone systems because it allows law enforcement agencies to search latent fingerprints against sets of ten-print records beyond those that are contained in their own databases within their own jurisdictions. While data sharing is a major component of interoperability, it is not the only criterion that is required for making interoperability possible. True interoperability requires technical compatibility, network connectivity, proper governance, and performance testing and training. It can be achieved only when an examiner can encode a latent fingerprint once and search the desired AFIS databases seamlessly, in accordance with relevant privacy laws, without having to re-encode the print or compromise search accuracy. Latent fingerprint examiners should be able to use the same machine for all of their searches and should not have to rely on manual re-encoding of images. This ability requires an integrated network of AFIS systems nationally that enables the exchange of fingerprint records to occur on demand as necessary.

Progress toward achieving interoperability has been made to date in each of these areas as follows:

- **Technical compatibility** has been mostly achieved for ten-print searches and is advancing with respect to latent fingerprint searches through the adoption of a common feature format, the Extended Feature Set (EFS), and the development of a transaction standard, the Latent Interoperability Transmission Specification (LITS).[2] The Federal Bureau of Investigation (FBI) introduced the Next Generation Identification (NGI) system (described at right), which has incorporated the EFS as the standard submission format.[3]
- **Network connectivity** and data sharing at present, are relatively limited. State agencies have direct access to NGI via the Criminal Justice Information Services (CJIS) Wide Area Network (WAN), a network designated specifically for transmission of extensive law enforcement information including AFIS searches of FBI records and some local agencies may search NGI without going through their states. Efforts are being explored to connect state agencies to one another and to connect local agencies to NGI through their State Identification Bureau (SIB) for latent searches.
- **Proper governance** has been facilitated through interagency coordination and guidelines on the process for developing agreements between agencies and recommended language for the agreements. A few localities have set up regional task groups to improve interoperability within their jurisdictions, but many jurisdictions have not yet pursued such agreements.
- **Performance testing and training** has improved through the development of standardized guidelines for feature markup and the introduction of an online EFS training tool that allows examiners and AFIS vendors to explore the functionality of EFS.[4] NIST conducted standardized AFIS performance tests in 2011 and 2012 to assess the accuracy of systems using interoperable features, but tests have not been revisited since 2012.[5]

Federal Bureau of Investigation: Next Generation Identification

The FBI's NGI allows access to the Repository of Individuals of Special Concern (RISC), a palm print repository, and access to other Federal biometric databases. NGI's fingerprint friction ridge feature encoders and matchers represent the latest generation of recognition technology, and the accuracy and speed of the system achieve optimal levels. Additionally, several of the factors that previously limited searches of the Integrated Automated Fingerprint Identification System (IAFIS) (*e.g.,* complex and proprietary encoding methods) have been eliminated or substantially mitigated.

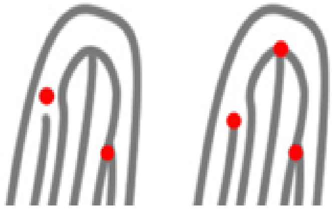


Figure 3. Encoding latent prints for two different AFIS systems by different vendors

Despite these efforts, several core challenges to achieving true latent fingerprint interoperability remain. Few agencies have upgraded to systems that comply with the recently developed file format and transmission standards. In the interim, latent fingerprint examiners often forgo additional searches or must manually re-encode their prints on co-located workstations to perform searches on other jurisdictions' systems because they do not employ the same vendor to administer their AFIS systems. The re-encoding process takes time and requires additional personnel training. If not re-encoded properly, small differences can lead to a missed identification. Given the high volume of latent fingerprint examinations, the time burden resulting from re-encoding dissuades investigators from searching other databases in all but the most high-profile cases. Yet when additional searches are not performed, fewer matches are made,

[2] National Institute of Standards and Technology (NIST), *Latent Interoperability Transmission Specification*, NIST Special Publication 1152, January 2013.

[3] U.S. Department of Justice, FBI, *Electronic Biometric Transmission Specification (EBTS) Technical and Operational Update (TOU) 10.0.2*.

[4] NIST, *Markup Instructions for Extended Friction Ridge Features*, NIST Special Publication 1151, January 2013. The training tool is available at www.nist.gov/forensics/EFSTrainingTool.

[5] M. Indovina, R. A. Hicklin, and G. I. Kiebuzinski, "ELFT-EFS Evaluation of Latent Fingerprint Technologies: Extended Feature Sets, Evaluation #1," NISTIR 7775, March 2011; M. Indovina, V. Dvornychenko, R. A. Hicklin, and G. I. Kiebuzinski, "ELFT-EFS Evaluation of Latent Fingerprint Technologies: Extended Feature Sets, Evaluation #2," NISTIR 7859, May 2012.

meaning that relevant suspects may go unidentified. The accuracy of image-only searches, in which the AFIS encodes the features, has increased greatly, but agencies' AFIS systems often do not provide a means for these transactions to be exchanged among agencies.

While re-encoding enables limited technical interoperability, seamless data sharing across networks or systems can occur only after adoption of information sharing policies between agencies and the integration of software to support the exchange of data. Absent these agreements or memoranda of understanding (MOUs) and technical infrastructure, remote searching cannot occur and even partial interoperability cannot exist.

Case for Latent Print Interoperability

In 2012, 53.2% of violent crimes in the United States went unsolved.[6] While it is not possible to predict what portion of these crimes might have been solved with a truly interoperable latent AFIS network, interoperability would certainly have aided investigations for some of them. Further, interoperability would help with investigations of unsolved non-violent crimes where latent prints have been recovered and where individuals have been criminally active in other jurisdictions. AFIS interoperability, if fully implemented for latent prints, would also improve the speed and efficiency of broader searches.

Many cross-jurisdictional searches have led to the identification of individuals that would have been missed if the law enforcement agency had searched only records contained in its own AFIS. Latent print examiners investigating a 2008 murder in Detroit, Michigan, searched both the Michigan State AFIS and the FBI IAFIS, but neither system generated a candidate suspect. In 2010, Michigan reached out to the Department of Homeland Security's United States Visitor and Immigrant Status Indicator Technology (US-VISIT) and sent a printed copy of the latent print. US-VISIT identified a potential match to the print that was not on file in either the Michigan State database or IAFIS. This ability to search multiple databases, which was facilitated by data sharing agreements, allowed the Detroit police to identify a suspect in the case. Remote searches have also led to the identification of suspects affiliated with Al-Qaeda, suggesting that interoperability would support both public safety and national security efforts.

The current lack of full interoperability has allowed criminals to remain free, and in some cases, commit additional crimes. An example that dates back to when the State connectivity to IAFIS was not complete highlights how these gaps challenge public safety efforts. In the 2002 "DC sniper" case, a series of shootings in the Washington, D.C. metropolitan area resulted in ten fatalities and three critical injuries. A month prior to the shootings, the scene of a homicide and robbery at a liquor store in Alabama produced fingerprints that were searched against the State AFIS with no match. At the time of the crime, the Alabama laboratory had not implemented a connection to IAFIS, nor had it forwarded the unknown latent prints from the case to the FBI. Nearly a month later, the FBI requested the prints following a call from a tip line indicating that the suspected sniper may have been connected to the Alabama crime. The latent prints from Alabama matched prints known to belong to an individual in the Immigration and Naturalization Service (INS) database. This INS search helped lead to the identification and subsequent apprehension of two suspects in the case, but the delay in identification, caused in part by the lack of system interoperability, contributed to the loss of life.

Since then, the FBI's NGI system has been improved and intentionally designed to provide state and local law enforcement agencies with the opportunity to conduct a latent fingerprint search by submitting additional information such as photographs, palm prints, and iris images.

Historical Background of Fingerprinting and the Development of AFIS

Prior to the 1970s, latent fingerprint identification units within law enforcement agencies relied on a manual and laborious process to search latent fingerprints against ten-print records using the Henry Classification System.[7] This system of visually matching card-cataloged paper records to latent print features of ten-print records was time consuming and often did not result in an identification.

Individual state and local jurisdictions began purchasing AFIS systems in the 1970s and 1980s from various private vendors. Vendors capitalized on the fact that AFIS systems improved the likelihood of identification and dramatically reduced the amount of time necessary to identify or

[6] U.S. Department of Justice, FBI, "Offenses Cleared," *Uniform Crime Reports: Crime in the United States, 2012*, Fall 2013.

[7] The Henry Classification System was in place through the 1990s, and may still be used today by agencies without AFIS databases.

exclude a subject by searching against a database of electronic ten-print records of arrested and convicted offenders.[8] AFIS systems also allowed examiners to search both latent and ten-print prints against a greater quantity of ten-print records contained in an AFIS's computerized database.

Each vendor developed its own software and searching algorithms, which, over time, resulted in a stove-piped system of AFIS systems procured throughout the country. AFIS procurements were not coordinated among even geographically close law enforcement jurisdictions, and states did not require local agencies to purchase compatible systems. Independent purchasing decisions by agencies from the three major vendors and several smaller vendors created a national system where neighboring jurisdictions and even partners within the same state had vastly different systems. These stove-piped procurements resulted in an inability to automatically share electronic fingerprint data between state and local jurisdictions, even among agencies in geographic proximity and, more importantly, with a shared criminal pool. This lack of interoperability is in large part due to the lack of industry standards, which led to variability of vendor specifications and a lack of an integrated network supporting connectivity between two or more jurisdictions. These issues continue to impede crime-solving efforts, and while AFIS systems are interoperable for ten-print record searches, latent fingerprint interoperability has not been achieved because of the proprietary nature of the encoding schemes integrated into the different AFIS systems.

Efforts in the 1990s supported the development of standards that would enable state systems to communicate with the FBI's IAFIS, the system that preceded NGI. IAFIS became operational in 1999 and provided a national system that enabled ten-print records to be shared with the FBI. Through IAFIS, all State-level law enforcement agencies have the capability to submit civil, criminal, and latent prints to the FBI via the CJIS WAN, a collection of Virtual Private Network (VPN) links and near point-to-point T-1 and higher class data lines connecting the FBI CJIS Data Center in West Virginia to selected points throughout the United States and Canada."[9]

In creating IAFIS, the FBI had to accommodate technical limitations at the time of development. While prints could be submitted directly for searching against the system, as is currently done with ten-print searching, automated feature extraction algorithms were not advanced enough to achieve sufficient accuracy. As a result, latent examiners had to manually re-encode shared prints. This re-encoding process had the potential to introduce systematic human errors when the FBI's feature definitions differed from those required by the state or local AFIS. It also decreased the likelihood an FBI search would be made because to perform these extra searches, examiners had to re-encode images to comply with the IAFIS submission requirements.[10]

Figure 4. Latent print examiner. Source: FBI, "Houston Cold Case Solved," October 2011.

To standardize submissions to IAFIS (and now to NGI), the FBI required compliance to EBTS.[11] EBTS is based on a standard developed by the American National Standards Institute (ANSI) and the Information Technology Laboratory of NIST (ANSI/NIST-ITL 1-2000). These standards included specifications on image resolution, common field names, and how to include personal information and details on why the fingerprint record was created. EFS was incorporated into ANSI/NIST-ITL in 2011 and into EBTS in 2012. More recently, NIST has developed the LITS specification to specify how EFS features are to be organized and marked up for interoperable data exchange between latent AFIS systems. LITS is fully compatible with the FBI's EBTS.[12]

As more biometric matching capabilities became available, the FBI developed the NGI system, which expanded search capabilities and improved speed and accuracy. A recent major development in NGI was the implementation of a palm-matching capability which significantly extends the

[8] Early AFIS users continued to use the manual Henry Classification System. In the 1980s, AFIS databases were developed to meet the growing demands for identification and began incorporating functionality to search latent fingerprints against a complete database. This increased capacity became a major selling point to the fingerprint community.

[9] U.S. Department of Justice, FBI, *Privacy Impact Assessment Integrated Automated Fingerprint Identification System (IAFIS)/Next Generation Identification (NGI) Repository for Individuals of Special Concern (RISC)*, July 10, 2012.

[10] Kenneth R. Moses, Peter Higgins, Michael McCabe, Salil Probhakar, and Scott Swann, "Chapter 6—Automated Fingerprint Identification Systems (AFIS)," in *The Fingerprint Sourcebook* (Washington, D.C.: U.S. Department of Justice, 2010): 6-1–33.

[11] When first introduced, EBTS was known as the Electronic Fingerprint Transmission Specification.

[12] NIST, *Latent Interoperability Transmission Specification*.

ability of the examiner to identify latent prints. NGI’s adoption in 2013 has provided the latent fingerprinting community with an additional incentive to improve interoperability in order to benefit from the FBI’s system upgrades.

Existing Mechanisms for Fingerprint Search Coordination and Sharing in a Tiered and Fragmented System

The current limited landscape of AFIS interoperability highlights and reinforces the need for interoperability. Multiple tiers of law enforcement agencies perform uncoordinated searches, inhibiting criminal investigations in contrast to an interoperable environment (Figures 5 and 6).

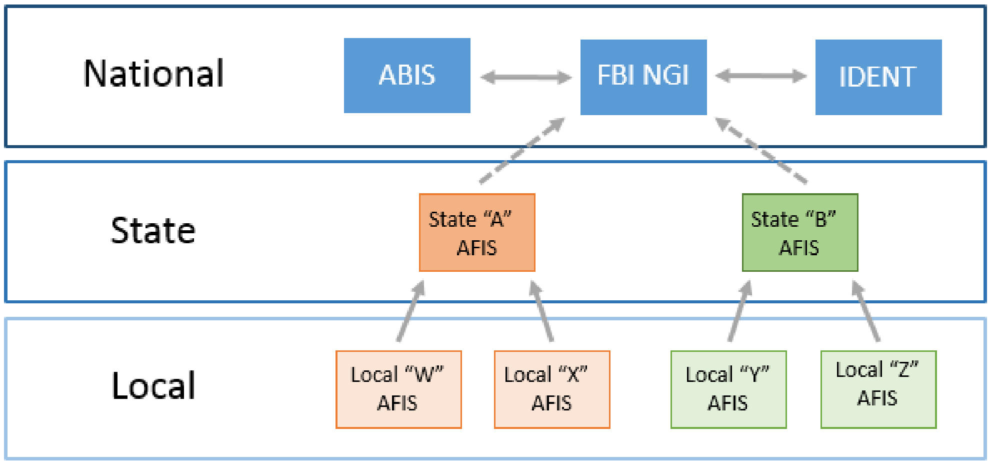


Figure 5. Current AFIS sharing environment

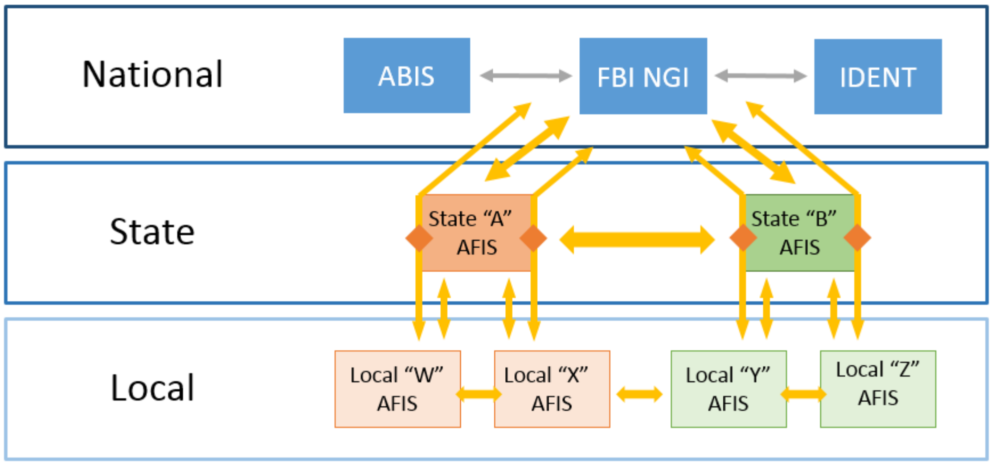


Figure 6. AFIS interoperable environment

Although built primarily by three major vendors, the majority of the estimated 600 disparate AFIS systems at the Federal, state, and local levels are not interoperable from a technical or governance standpoint. As a result, data sharing is infrequent and case-specific, rather than routine. The sharing that does occur happens primarily through siloed channels in an established hierarchy from local to state and state to the FBI's NGI. Local law enforcement agencies often search only their own AFIS, sometimes search their state's AFIS, and rarely share data with neighboring jurisdictions. At the next tier of the hierarchy, state law enforcement agencies rarely submit latent print searches to neighboring states (with the exception of some unique regional agreements). States report low levels of searching against the NGI or neighboring jurisdictions' AFIS databases, even for unsolved cases. While most crimes are solved at the local level and would not require broader sharing, there is some hesitancy to share when appropriate, in part because of limited adoption standards for compliant systems and outmoded examiner practices.

Table 1 highlights agencies' perceptions of their current data sharing levels, and their predicted level of sharing if all of the technical barriers were removed. Significant variability exists among state and local data retention laws and policies.[13] Therefore, innovative governance structures would also need to be introduced to harmonize data retention laws and facilitate data sharing while respecting civil liberties. Without these changes, agencies would have great difficulty conducting an independent search on another local or state AFIS.

Table 1. Percentage of Latent Interoperable Searches by Select Jurisdiction

	% Searches Sent to FBI		*% Searches Sent to State*		*% Searches Sent to Neighboring Jurisdictions*	
Geographic Area	**Current**	**If Seamless**	**Current**	**If Seamless**	**Current**	**If Seamless**
LOCAL AGENCIES						
Northern Virginia	1%	40–50%	1%	40–50%	80–90%	Already seamless
STATE AGENCIES						
Baltimore, Maryland*	0%	0%	—	—	0%	0%
Kansas City, Missouri	10%	20–30%	—	—	0%	20–30%
Michigan	3–5%	100%	—	—	Rarely	100%
New York	80%	80%	—	—	10%	80% (All non-identifications on State AFIS)
REGIONAL AGENCIES						
Portland, Oregon (Western Identification Network)	15%	20–25%	100%	100%	All non-identifications on State AFIS	All non-identifications on State AFIS
Las Vegas, NV (local AFIS & WIN)	Very rare	All non-identifications on local AFIS	All non-identifications on local AFIS	All non-identifications on local AFIS	All non-identifications on local AFIS	All non-identifications on local AFIS

Source: Noblis, Inc. *Latent Print Interoperability: State and Local Perspectives*, April 2, 2012.

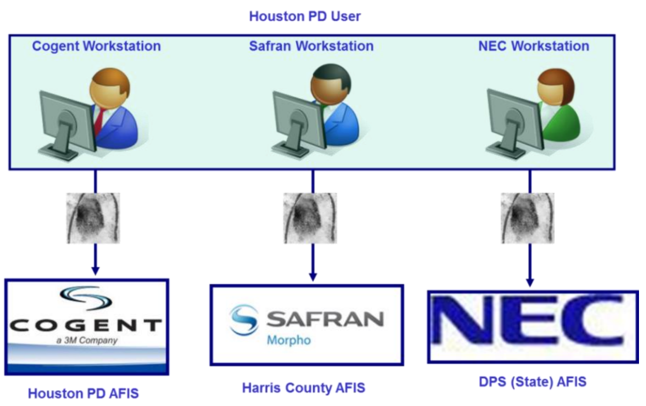
* Representatives from Baltimore indicated that, given the current latent print examiner staffing level, they could not use interoperability even if it were available.

[13] Reasons beyond interoperability initiatives result in IAFIS not mirroring other ten-print databases. Some of these reasons involve policy or legal issues, such as lack of data sharing policies.

Sharing at the Local Level

Many cities, counties, and metropolitan areas have independent AFIS systems that are not interoperable with their own State systems. Most of the local agencies that had their own AFIS databases and responded to a 2013–2014 National Institute of Justice (NIJ) survey on latent fingerprint interoperability reported that they frequently searched their state agencies' data.[14] However, according to state agencies, local agencies in only about half the states forward their unsolved latent prints to state agencies.[15] The survey also found that only 15 states reported that local law enforcement agencies forwarded all unsolved latent prints to the state agency, which is likely due to policy limitations.[16] While some local AFIS systems are directly connected to the state AFIS, a substantial proportion are not, especially those developed by different vendors.[17] This lack of connectivity weakens the investigative power of the local law enforcement agency, because most state AFIS systems do not contain the sum of all local AFIS data within the state. As a result, suspects who operate in multiple counties may avoid identification.

If local agencies routinely shared fingerprint data among themselves, some of the concerns about the comprehensiveness of state AFIS records would be assuaged. But local-to-local sharing is infrequent and especially difficult when neighboring jurisdictions cross state lines. Searching neighboring AFIS systems is conducted ad hoc and depends on personal relationships among colleagues. Only 19% of responding local law enforcement agencies reported frequent searching of their neighboring jurisdictions.[18] When cross-jurisdictional searches occur, many local agencies prioritize searches by severity of the offense, and 85% of agencies in the NIJ survey who reported prioritizing latent searches based on "criteria associated with the criminal offense under investigation," also reported that "major crimes are prioritized regardless of the jurisdiction" of origin.[19] Law enforcement agencies face similar challenges partnering with other local jurisdictions governing the same geographic region. Some larger municipalities with their own independent AFIS do not have the same AFIS vendor as the county agency and must re-encode latent prints on a separate workstation to search the county AFIS.



Barriers to Sharing and Interoperability in Houston, Texas

The city of Houston is the largest city in Texas and the fourth-largest in the country. Houston is within Harris County, which is the most populous county in the State and the third-most populous county in the country.

Until recently, Houston and Harris County maintained separate AFIS databases administered by different vendors that were incompatible. The State of Texas also maintained its own AFIS database administered by a third (different) proprietary vendor. For a latent print examiner within the Houston Police Department to access the Harris County AFIS database and the Texas State AFIS database, the examiner had to physically access different workstations, each requiring a different method to re-encode the latent print before conducting the searches. Now latent fingerprint examiners can use the Universal Latent Workstations or export a compliant transaction from their proprietary AFIS that can be submitted to the FBI, through the Texas Department of Public Safety, without re-encoding.

[14] Mark Persinger, Lars Ericson, and Mark Greene *Latent Fingerprint Interoperability Survey: A National Study of Automated Fingerprint Information Systems (AFIS) Maintained by Law Enforcement Agencies. Summary Reporting of Data Provided by Responding Agencies* (hereafter referred to as *LFIOS*) (Washington D.C.: Department of Justice, August 2014), Local Addendum Question 28 and State Addendum Question 8.

[15] *LFIOS,* State Addendum Question 8.

[16] *LFIOS*, Question 9.

[17] Among responding local law enforcement agencies, 43% do not have a system compatible with their State AFIS, and 45% have an AFIS made by the same vendor as the State. *LFIOS,* Local Addendum Questions 4 and 5. According to Question 1 of the State Addendum of *LFIOS*, the local law enforcement agencies of 14 states do not maintain independent AFIS databases.

[18] *LFIOS*, Local Addendum Question 16.

[19] This figure was consistent across both state and local responding agencies (*LFIOS*, Questions 162 and 63).

State and Local Access to Next Generation Identification

Every State in the Nation has direct access to IAFIS through the CJIS WAN, a dedicated network connecting state and local agencies to the FBI. Further, about 50 local law enforcement agencies are able to directly submit searches through Direct Local Connectivity (DLC). Despite this connectivity, when asked if they ever searched latent prints on IAFIS or NGI, five state agencies reported that they had not, though 31 states responded that they searched IAFIS routinely.[20] This access is primarily through a state law enforcement agency, using separate Universal Latent Workstations (ULWs), which use free software provided by the FBI that prepares fingerprint data to be sent to the FBI's secure network CJIS-WAN. Among local agencies that reported submitting searches to IAFIS, about half reported submitting them directly and the other half reported submitting them through their state law enforcement agencies.[21] When IAFIS was first implemented the state-level daily query limit for latent searches exceeded states' current utilization of the system. In fiscal year 2014, 13,000 remote searches were performed on average per month. The submission rate was influenced by workflow issues that arise from examiners needing to re-encode minutiae because of lack of AFIS interoperability. The need to re-encode makes searching NGI time-consuming and requires additional training. State examiners may also be less likely to pass along local searches to the NGI unless they are relevant to state law enforcement agency investigations.

Regional Interoperability Agreements

According to the NIJ survey, the majority of states (77%) receive latent requests from law enforcement agencies with an AFIS from outside of their state, but just over half of all states described these requests as being routine.[22] Some regions have formalized these sharing relationships to facilitate routine cross-border sharing. Other states have developed bilateral sharing agreements, though these agreements fall short of specifying interoperability (see box on the Western Identification Network below). Such agreements often do not support reciprocal sharing and can be invalidated if one agency switches to another AFIS vendor or upgrades to a newer version of its existing vendor's software.

Western Identification Network

The Western Identification Network (WIN) is the most comprehensive regional sharing agreement. Eight western states share a common Automated Biometric Identification System (ABIS) Service Bureau and maintain reciprocal search agreements with the California Department of Justice, Las Vegas in Nevada, and Riverside-San Bernardino counties in California. State WIN agencies that are part of the central service bureau and participating interface agencies have access to more than 30 million fingerprint records and search WIN's AFIS without re-encoding searches. Local agencies can access WIN via a WIN workstation or through the standards-based Universal Latent Workstation (ULW) and ten-print submissions from any authorized workstation. In 2012, there were 7,000 daily ten-print submissions and 500 latent print submissions to WIN.

For agencies that have switched or plan to switch AFIS vendors, reciprocal search agreements will remain in place and allow agencies to either maintain a WIN workstation or use the recently adopted EFS specification accessed via the ULW. Regional connectivity continues to be supported by maintaining a dedicated WIN workstation or implementing ULW software or rapid-standards-based ten-print searches. The WIN workstation supports full system capability (e.g., registration, archive access, latent case management, etc.), while the ULW supports only searches of WIN's database.

[20] While this would suggest that 31 agencies routinely searched NGI at the time of data collection, the FBI was still using IAFIS (*LFIOS*, State Addendum Questions 30 and 31).

[21] *LFIOS*, Local Addendum Question 39.

[22] *LFIOS*, Question 169 and Question 170.

Regional systems such as WIN and the Northern Virginia Regional Identification System (NOVARIS) have successfully implemented data sharing agreements. These arrangements reveal the benefits and difficulties of full-scale interoperability. Largely, the interactions among the members in these systems have developed in areas where law enforcement agencies shared common vendor or co-located workstations. Unique contractual agreements—usually an MOU that has been developed with the help of the incumbent vendor—have formalized data sharing. If an agency within the network were to change vendors, the data sharing mechanism would likely be broken, because most of these agencies have not yet implemented the data sharing standards necessary for interoperability. Smaller regional interoperability agreements have also been implemented across the United States.[23] As with larger sharing networks, these can be jeopardized if an agency changes its vendor.

Fingerprint Sharing among Federal Systems

At the Federal level, three agencies maintain AFIS systems that are semi-interoperable. . The FBI's Next Generation Identification (NGI) system operates in parallel with national fingerprinting databases maintained by the Department of Homeland Security (DHS) and the Department of Defense (DOD).

DHS maintains the Automated Biometric Identification System (ABIS) called IDENT, which is a program of the Office of Biometric Management (Figure 7).[24] IDENT is the central DHS-wide system for storage and processing of biometric and associated biographic information for national security, law enforcement, immigration and border management, intelligence, and other DHS mission-related functions. IDENT was originally developed in 1994 for the Immigration and Naturalization Service (INS). With the incorporation of the INS into DHS in 2002, the use of IDENT was expanded to be DHS's primary biometric identification system. Today, IDENT helps DHS meet many of its statutory requirements under the ''Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism (USA PATRIOT) Act of 2001,[25] the Homeland Security Act of 2002,[26] the Enhanced Border Security and Visa Reform Act of 2002,[27] and the Intelligence Reform and Terrorism Prevention Act of 2004.[28] IDENT holds over 170 million individuals' fingerprints provided by DHS agencies such as Immigrations and Customs Enforcement, Customs and Border Protection, United States Citizenship and Immigration Services, Transportation Security Administration, and the United States Coast Guard, as well as other Federal agencies. In addition, IDENT contains over 220,000 latent prints.

Latent interoperability between NGI and IDENT is limited because DHS has not adopted EFS and therefore must re-encode latent prints received from NGI for search in IDENT to ensure the highest level of search accuracy. These re-encoding burdens restrict the number of searches between the two systems based on available manpower and time for manual throughput. In contrast to most cross-jurisdictional submissions where latent re-encoding is required, DHS will re-encode prints upon receipt, as opposed to requiring the submitting agency to re-encode the print to ensure the highest level of search accuracy within IDENT. The need to re-encode could be eliminated if DHS were to adopt the EFS specification.

The Biometrics Identity Management Activity (BIMA), which falls under the Defense Forensics and Biometrics Agency in DOD, operates the authoritative multimodal biometric database known as DOD ABIS. What began in 2004 as a suite of technologies for securing access to military installations is now recognized by warfighters as an innovative tool for identifying and tracking known or suspected terrorists. For example, in Iraq and Afghanistan, the data contained in DOD ABIS helped counter the threat of improvised explosive devices by tracing latent fingerprints back to those who made or detonated these weapons. In 2009, DOD extended the capabilities of DOD ABIS to include face and iris matching, which, when

[23] Kansas Bureau of Investigation, New Hampshire, Vermont, North and South Dakota, Minnesota, Connecticut, Rhode Island, Las Vegas, and other jurisdictions have also employed regional interoperability approaches.

[24] The Office of Biometric Management was formerly known as United States Visitor and Immigrant Status Indicator Technology.

[25] The USA PATRIOT Act of 2001 (P.L. 107-56) required the Attorney General and the FBI to make available to the Department of State and the INS (now the U.S. Citizenship and Immigration Services) records for determining whether or not a visa applicant or applicant for admissions has a criminal history.

[26] The Homeland Security Act of 2002 (P.L. 107-296) required DHS to oversee and coordinate DHS programs for and relationships with state and local governments.

[27] The Enhanced Border Security and Visa Entry Reform Act of 2002, (P.L. 107- 173) required an interoperable law enforcement and intelligence data system and the ability to update IDENT with known and suspected terrorist information.

[28] The Intelligence Reform and Terrorism Prevention Act of 2004, (P.L. 108-458) required creation of an information sharing environment to share terrorism information across the homeland security, law enforcement, and intelligence communities at all levels of government and the private sector. It also accelerated development of an integrated electronic biometric entry-exit screening system (i.e., the Entry/Exit system).

combined with fingerprint data, reduce response time and human intervention and increase identification accuracy. The DOD ABIS database currently contains more than 12.3 million biometric files and over 300,000 latent prints collected from military theaters of operation.

In support of homeland security, BIMA shares ABIS data with NGI and IDENT. As of December 2013, DOD ABIS achieved compliance with the FBI's standard for ten-print submissions, but has not yet done so for latent prints. In practice, DOD latent print submissions are encoded utilizing the FBI's ULW to ensure interoperability. NGI latent print submissions to DOD ABIS are performed by an internal translation system that converts NGI encoded prints into DOD-compliant submissions. DOD's latent prints are pushed to IDENT via the FBI where they must be manually re-encoded prior to searching. DHS notifies the DOD via email of any identifications made in IDENT to DOD latent prints.

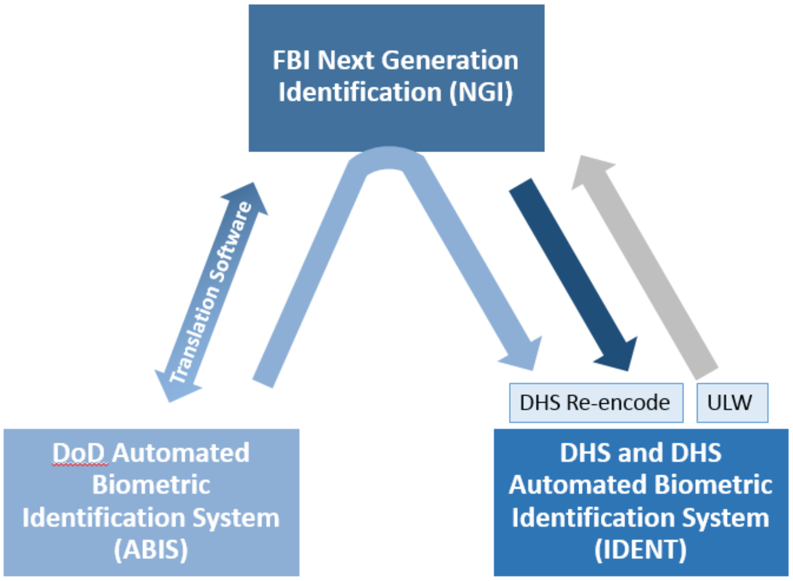

FBI Next Generation Identification (NGI)
Translation Software
DHS Re-encode
ULW
DoD Automated Biometric Identification System (ABIS)
DHS and DHS Automated Biometric Identification System (IDENT)

Figure 7. Interoperability among Federal agencies

The connections between states and these Federal agencies primarily occur through NGI. While most states routinely search NGI, only six states have ever directly requested a latent print search from another Federal agency database, only one state is directly connected to other Federal systems, and three others connect through NGI.[29]

Interoperability Pilot Programs

Several pilot programs seek to provide local law enforcement agencies with direct access to NGI and other Federal AFIS systems. By providing an interoperability solution to localities, the capabilities offered by Federal databases can be used more effectively for specific investigatory purposes. These pilots also serve to demonstrate the value of interoperability and mitigate challenges by identifying potential technical and operational solutions.

Latent Interoperability Pilot Program

In an effort to expand the availability of latent fingerprint services of DHS's IDENT, DHS and the Texas Department of Public Safety (TXDPS) are developing a Letter of Intent that would permit TXDPS to electronically submit searches to IDENT. Once the agreement is finalized, TXDPS will be able to use existing connectivity provided by the CJIS-WAN to electronically search DHS's IDENT, as TXDPS now does with the ABIS and NGI. Current

[29] *LFIOS,* State Addendum Questions 51 and 54.

searches submitted to DHS by TXDPS are done so by non-electronic means. The pilot will help evaluate IDENT's expanded latent print services and its value to the greater law enforcement community at the local level, especially in jurisdictions along the U.S. border.

Other National Pilots for Latent Interoperability

Recent initiatives have focused on introducing latent search capabilities to new users that might benefit from fingerprint identification. These initiatives have allowed the following users to have access to AFIS systems:

- Medical examiners and coroners (ME/C),
- Customs and border protection agents, and
- Patrol officers attempting to identify subjects with fingerprints of reduced quality.

Mobile handheld fingerprint scanning devices with access to an AFIS database have made it possible for these users to incorporate fingerprint identification into their investigations and duties. Most of the data captured by these mobile devices is searched using an automated ten-print or two-print identification process. But some subjects, such as decedents and individuals whose fingerprints are collected in less than ideal conditions, can result in poor quality fingerprint images and require the ability to search using latent fingerprint encoding methods to enhance accuracy. Once these are properly encoded, multiple databases may need to be searched to identify a match.

In most cases, ME/C offices do not have direct authority to access a local jurisdiction's AFIS and must go through a law enforcement agency to perform a search, which impedes their ability to identify decedents. Several pilot programs have placed AFIS workstations and the proper governance in place in ME/C offices to allow them to search the ten-print records maintained at the local or state level.

To achieve interoperability and to take advantage of the information contained in different AFIS databases, changes in laws and policies governing access will need to be considered, and special provisions may need to be included in MOUs established between jurisdictions to allow for access by ME/C and other authorized persons outside law enforcement agencies.

AFIS Searches at the Medical Examiner's Office

A Harris County, Texas, morgue employee used a mobile scanner (and a traditional table-top model) in an attempt to identify and confirm the identification of decedents. The use of the mobile device greatly facilitated the fingerprint capture process, allowing the non-expert to scan all fingers. After receiving the scanned prints, the Harris County Sheriff's Department AFIS database searched for a match and, if available, returned mug shots for identity confirmation. Several identifications against the unsolved latent fingerprint database maintained by Harris County were also obtained as a result of this project.

Recent Progress toward Interoperability

Technical Compatibility through the Establishment of Standards

Many interoperability problems arose out of the variable and proprietary nature of individual agencies' AFIS system encoding specifications for latent prints. In particular, minutiae used for identification in one vendor's AFIS might be unreadable or irrelevant in another AFIS. NIST and the Committee to Define an Extended Fingerprint Feature Set worked extensively to establish a standard set of friction ridge features and minutiae that must be included to search other systems, as an interoperable AFIS exchange format. The EFS specification provides comprehensive and consistent definitions of minutiae for use in fingerprinting. It also specifies methods for encoding features found on fingerprints and palm prints as well as how to annotate the quality of the features.

In addition, NIST and ANSI specified which EFS features need to be incorporated to submit or receive a remote search regardless of which vendor made the systems. This vendor-neutral transaction standard is known as the Latent Interoperability Transmission Standard (LITS). Since incorporation of LITS into the fingerprint and biometric ANSI/NIST-ITL 1-2011 standard in 2011, there has been mixed success in adoption of the feature set and transmission standard by vendors because localities generally are not making it a requirement of the contractual agreements with their AFIS vendors.[30] Long-term procurement cycles also make it difficult to update all of the AFIS. In a 2013–2014 survey, the average state and the average local agency reported that their AFIS was upgraded or became operational in 2008.[31] Over 60% of states have reported that they plan to update their system or release a procurement announcement for a completely new AFIS in the next 3 years, which presents a unique opportunity to influence the procurement process.[32]

EFS and LITS

The EFS specification provides comprehensive and consistent definitions of fingerprint and palm print features for use in fingerprinting. This standard defines the features to be used in both ten-print and latent print searches. It refers to the fingerprint and palm print features incorporated into the ANSI/NIST-ITL standards.

The LITS specification describes what information is required for a latent print search transaction to occur across jurisdictions, regardless of originating and destination AFIS vendor. LITS is compatible with the FBI's EBTS.

Transition to Next Generation Identification

The FBI's transition to the NGI incorporates functionality that will benefit the latent print examiner community. By implementing the recently adopted standards, NGI will create a more formal channel for local agencies to submit searches to the system and will add palm prints and other biometric identifiers such as facial and iris recognition into records, which will likely increase search and identification accuracy. In early 2013, as part of the third increment of NGI implementation, latent print functionality was migrated from IAFIS to NGI. The new system allows for faster searches, a simplified and standardized encoding process, and the ability to prioritize the most pressing searches.

NGI permits latent print examiners to search against the entire criminal database or a particular subset of records such as the Repository of Individuals of Special Concern (RISC).[33] For example, law enforcement officials can submit a search to the RISC from remote locations, such as during a traffic stop, with a small handheld device to quickly identify high-interest individuals. Officers are notified of a match probability for each potential candidate in the RISC, using a stoplight color-coded system, (red, yellow, and green). Searches submitted to RISC are also cascaded (automatically searched) against the Unsolved Latent File (ULF), a group of unsolved cases,[34] which may help identify suspects in older, unsolved cases. Unlike ten-prints in the RISC system, the ULF search does not immediately return the personal information related to a match. Instead, RISC notifies the examiner and forwards potential matches for verification. RISC contains only a subset of NGI's records.

Beyond some of the technical limitations that still remain with NGI as law enforcement agencies transition to standards compliant systems, the overall challenge with the transition to NGI is the limited capacity of latent examiners to run an additional search in the NGI system or compare the resulting candidate lists. A number of states do not routinely submit searches to NGI due to time and resource constraints.

Improving Latent Print Algorithms

While vendor competition has hindered collaboration and cross-jurisdictional compatibility, it has encouraged vendors to strive for more accurate search algorithms. Advances in latent print identification algorithms have allowed latent print examiners to identify more suspects, especially with poor quality prints due to increased accuracy of image processing and matching algorithms. Vendors are also starting to use more robust ensemble methods to combine multiple search algorithms to generate more precise candidate lists. Ongoing research is investigating methods for more

[30] The ANSI/NIST-ITL standard underwent minor revisions in 2013. Localities including LITS in their contracts are Orange County, California, and the WIN.

[31] For states and local agencies that responded that they had upgraded their systems (*LFIOS*, Question 25), this average included the year they had upgraded (Question 26). For those that had not upgraded their AFIS, the average included the year the system became operational (*LFIOS*, Question 11).

[32] *LFIOS*, Question 24 and Question 35.

[33] When authorized, examiners may search latent prints against civil records.

[34] James J. Landon, *Privacy Impact Assessment Integrated Automated Fingerprint Identification System (IAFIS)/Next Generation Identification (NGI) Repository for Individuals of Special Concern (RISC)* (Federal Bureau of Investigation, July 10, 2012).

effective candidate list management, including fusion algorithms to limit the number of candidates reviewed and merge candidate lists from multiple searches.

These recent technical advances have allowed the law enforcement community to work towards building an interoperable system capable of quickly and efficiently solving more crimes. Much more needs to be done to bring the system from a fragmented system of ad hoc sharing to one that is fully interoperable. The next section provides a path forward from the current landscape to an interoperable latent print system. Image processing algorithms that encode latent prints are approaching the accuracy of human examiners and soon may eliminate the need for human encoding in most cases, which would likely speed up the latent print search process. Improved encoding, while speeding up the submission process, does not eliminate the need for the examiner to compare candidate lists returned as a result of a particular search.

Path Forward: Essential Elements for Interoperability

An alternative to the current multiple AFIS databases would be a system whereby all law enforcement agencies in the United States submit every latent print to a central repository of biometric information, within the bounds of standardized privacy laws. Ideally, this system would be a single interface that accesses all law enforcement systems, allowing users to select to run a search against a local, state, or national database, when appropriate. Such a system could provide seamless technical compatibility, network connectivity, a comprehensive governance framework that ensures secure transfers and respects privacy laws, and rigorous quality assurance mechanisms for both technology and staff that use and manage the system.

Maintaining a centralized system would likely be infeasible given the cost of procurement and retraining and the logistical concerns associated with connecting every law enforcement agency. The elements necessary to maintain an effective single system are the same as those in an environment of distinct interoperable systems.[35] Additionally, education and outreach are necessary to promote advances in these other areas. The Federal Government and state and local agencies have made varying progress on implementing these elements. The following sections define the requisites for each component, enumerate progress that has been made toward incorporating each element, identify outstanding challenges, and provide recommendations to address these challenges.

Technical Compatibility

Interoperability depends on the technical compatibility of electronic data submitted and received between two or more agencies' software systems. In the context of latent print searches, compatibility requires consistent fingerprint feature definitions and designation of a minimum set of features that must be encoded on the digital image to conduct a latent print search. These "feature sets" allow for latent prints to be compared to both ten-print records and other latent print records within an AFIS.

The AFIS market has always been competitive, allowing multiple vendors to successfully market their products to different law enforcement agencies. Engineers from different vendors built systems that had varying algorithms to define requirements for identifying and weighting the features of a latent fingerprint image. In response to the requirements specified in law enforcement agencies' Requests for Proposals (RFPs), engineers prioritized accuracy and ease of use within a single AFIS, instead of compatibility with other AFIS. Vendors, furthermore, often did not include legacy compatibility, thus making newer AFIS systems incompatible with older versions from the same vendor.

Recent Progress on Compatibility and Remaining Challenges

Recognizing the need for compatibility, the Committee to Define an Extended Fingerprint Feature Set,[36] composed of a broad spectrum of stakeholders, including law enforcement officials, latent fingerprint examiners, academics, and engineers from major AFIS vendors, set out to establish a features encoding standard to be incorporated in the ANSI/NIST-ITL 1-2011 standard, which was updated in 2013. The result was the EFS, which created standardized minutiae and friction ridge feature definitions and standardized data field names and indexing. This updated standard defines the features to be used in both ten-print and latent print searches and is consistent with the FBI's broader biometric standard,

[35] An environment of distinct systems may encourage better search algorithms through vendor competition. Models, however, that directly encourage vendors to compete for a single procurement, such as those employed by the Indian Government, may be especially effective at spurring advancing AFIS accuracy.

[36] At the ANSI/NIST ITL 1-2000 Standard Workshop I in April 2005, the Scientific Working Group on Friction Ridge Analysis, Study, and Technology was tasked to identify, define, and provide guidance on additional fingerprint features beyond the traditional ending ridges and bifurcations defined in the ANSI/NIST ITL 1-2000 standard. (NIST, *Data Format for the Interchange of Fingerprint, Facial, & SMT Information*.)

EBTS. EBTS has been incorporated in major systems including NGI and DOD's ABIS.[37] NIST testing of the EFS has demonstrated that it provides the basis for a common set of features that all major vendors can use.[38]

Building on this standard, the NIST Law Enforcement Standards Office, now the Office of Special Programs Forensic Science Program, developed the LITS document that describes what information is required for a search across jurisdictions.[39] LITS requires that latent print submissions include transactional meta-data, the latent print image, and minutiae data. By incorporating LITS directly into the local and state AFIS, law enforcement agencies will reduce the need to encode latent prints on multiple workstations. In doing so, it will remove many of the technical and workflow barriers that limit fingerprint data sharing and interoperability while ensuring compatibility with EBTS and EFS standards previously established.

The LITS designates two different search profiles that are required across all interoperable systems: the image-only search and the quick minutiae search.[40] These profiles are vendor-neutral and can be used across systems that have adopted the LITS or are compatible with EBTS (NGI). Additional information can be encoded for use by specific vendors or future systems by submitting additional markup details through optional profiles (such as the detailed profile markup shown in Table 2). The additional profiles may allow examiners to increase their accuracy by encoding additional features, including vendor-specific features. Examiners have to weigh the tradeoff between time spent encoding additional features and time to perform comparisons or search additional databases.

Incorporation of the LITS is ongoing and vendors are beginning to build systems that natively use the EFS features and profiles defined by LITS. To support the adoption of LITS-compliant systems, NIST has developed writing guidelines for agencies to use in preparing their RFPs.[41] As of September 2014, few law enforcement agencies had purchased LITS-compliant systems because upgrades are both costly and require substantial training of print examiner staff. Of those law enforcement agencies who responded to the recent NIJ survey and reported having upgraded their systems, the last upgrade occurred on average 6 years ago for State agencies and 5 years ago for local agencies, prior to the adoption of the LITS specification.[42] While over two-thirds of responding state agencies reported that they expected a major upgrade of their systems within the next 3 years,[43] only 35% of responding local agencies expected a major upgrade within that timeframe.

[37] NGI interoperability is ensured because LITS is compliant with EBTS, which includes specifications for many biometric modalities. EBTS specifications can be found at www.fbibiospecs.org/ebts.html.

[38] NIST also developed resources instructing examiners how to properly annotate features using EFS, including the Extended Feature Set Training Tool found at www.nist.gov/forensics/EFSTrainingTool/TrainingTool.html. (Indovina, Hicklin, and Kiebuzinski, "ELFT-EFS Evaluation #1"; Indovina, Dvornychenko, Hicklin, and Kiebuzinski, "ELFT-EFS Evaluation #2.")

[39] For the full specification see noblis.org/media/d58f0f47-37b9-4ea2-81c5-ab5a6972f62f/docs/LITS_v1-0_2012-02-15_pdf and nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1152.pdf.

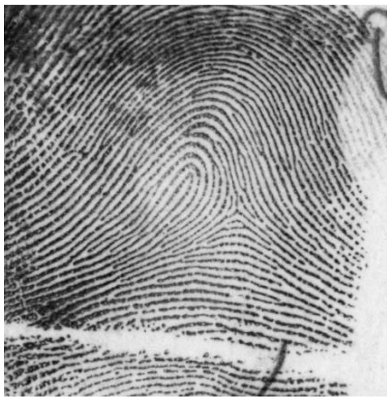
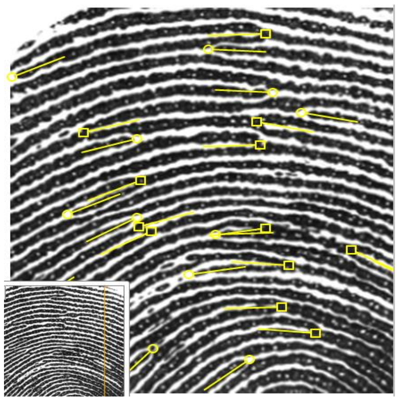
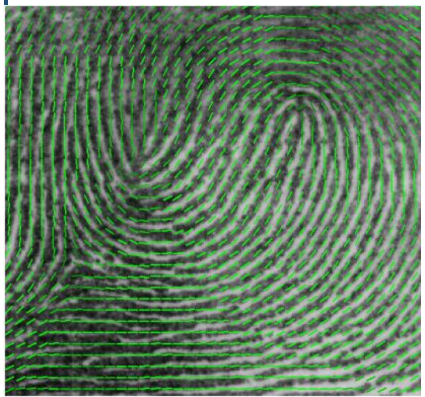
[40] Image-only searches can be supplemented with a minimal markup profile for the purposes of defining a region of interest, orientation, finger/palm print position, pattern class, cores, and deltas.

[41] NIST, Latent Print AFIS Interoperability Working Group, *Writing Guidelines for Requests for Proposals for Automated Fingerprint Identification Systems,* February, 17 2012.

[42] *LFIOS*, Question 25.

[43] *LFIOS*, Question 35.

Table 2. EFS profiles required by LITS and an example of an additional EFS profile supported by LITS

LITS Required		LITS Optional
Latent Image-Only Search	**Quick Minutiae Search**	**Detailed Markup Profile**
		
The image is properly cropped and submitted without markup or annotations.	The latent print examiner must mark region of interest, minutiae, cores, deltas, pattern, and orientation.	Ridge Flow Map is one of the features included as part of the detailed profile.

Source: Austin Hicklin, *Standardizing a More Complete Set of Fingerprint Features* (Noblis, Inc., 2007), prepared for the Committee to Define an Extended Fingerprint Feature Set. Screen shot from EFS Training Tool, www.nist.gov/forensics/EFSTrainingTool/FundamentalAFISSearching/MarkingMinutiae.html.

In the interim, a subset of law enforcement agencies are using the ULW to support their interoperability needs. The ULW software is freeware provided by the FBI that can run on most computers and that allows the examiner to encode using interoperable EFS features. Most states currently receive all search results from the FBI through the ULW.[44] Many vendors have not incorporated export or translation functionality to the ULW. Without this functionality, latent examiners must manually re-encode prints to submit them to NGI. Half of states currently re-encode prints prior to submitting a search to the FBI.[45]

The existence of biometric standards alone is not enough to demonstrate that an AFIS system meets the technical requirements specified in the standards. Conformance testing is also necessary to ensure LITS compliance. Information on an AFIS system's conformance to a particular standard can provide an efficient method of conveying information on the product's suitability. Conformance testing, which captures the technical description of a specification and measures whether the specification has been faithfully implemented, has yet to be developed for LITS and EFS. Future tests should evaluate the data structure (syntactical conformance), the data content and relationships between fields (morphological conformance), and whether the data represent the parent biometric data (semantic conformance).

Path Forward for Compatibility and Compliance

The Federal Government could take several steps to help speed the adoption of LITS-compliant AFIS systems and ensure compliance to newly implemented standards. First, the Federal Government could set a clear example by ensuring that all Federal AFIS systems are made fully LITS compliant without the use of an additional workstation within 3 years. Next, the Federal Government could provide support to state and local agencies through existing grant programs for achieving LITS compliance.

[44] *LFIOS*, State Addendum Question 43. Because most states receive results from the ULW, it may be worth considering whether or not the ULW should be expanded to include "plug and play" proprietary algorithms for search results and to enable latent examiners to have a consistent graphical user interface across agencies.

[45] *LFIOS*, State Addendum Question 38.

Federal funds could be made available to state and local agencies for AFIS procurement or upgrades, provided the systems are LITS-compliant. Finally, NIST should ensure that the recently adopted standards are appropriate once implemented and are reviewed in 3 years. NIST could also ensure that updates to the ANSI/NIST ITL 1-2011 standard are backward-compatible and provide guidance on how to improve interoperability with legacy systems, while agencies upgrade their systems in the interim.

To validate LITS-compliance, NIST should develop conformance testing standards to assess the incorporation of the ANSI/NIST-ILT, EFS, EBTS, and LITS standards and specifications into new AFIS systems. NIST could either develop a conformance testing program or fund independent programs that assess an AFIS's compliance to these standards. (See text box on Recommended Criteria for Conformance Testing Programs.)

Recommended Criteria for Conformance Testing Programs

- A common application programming interface with detailed definitions and requirements to evaluate each component of the AFIS technology
- A neutral third-party organization capable of administering the test, maintaining the secrecy and integrity of the test data and AFIS technology under test, and analyzing and reporting the results
- The implementation of an open-set (one-to-many) identification testing protocol
- A sufficiently large set of sequestered test data—latent prints and exemplars—that are operationally representative of data the system would be expected to process with respect to quality, distribution of impression types, and other factors
- Feature markup in accordance with the LITS and EFS profiles and guidelines produced both with and without the benefit of the associated exemplars as reference sample
- Single- and multi-exemplar sets per enrolled subject

Network Connectivity

The success of law enforcement agencies' coordinated efforts to apprehend suspects of crime across jurisdictional lines depends on the connectivity of different AFIS systems through established networks. Increased connectivity would help overcome the limitations to electronic data sharing that currently exist among local-to-local communications and state-to-state communications. Current methods of sharing fingerprint image data span from transmission over electronic secure networks to delivering CDs through the United States Postal Service.

These gaps arose for many of the same reasons that compatibility issues arose. Individual jurisdictions procured AFIS systems from different vendors without consideration of connectivity with other systems within close geographic proximity. Varying privacy laws also prevented states from creating an interconnected network. Where connectivity does exist, it tends to occur in situations where agencies possess AFIS systems from the same vendor. Vendors, in fact, would have a disincentive for local connectivity because it could result in economies of scale that could have a negative financial impact on the industry.

NGI access aside, fewer than half of states reported having a direct connection to another law enforcement agency's AFIS system, even though over half of state and local law enforcement agencies reported being part of an AFIS network that contained more than one agency, This suggests that many networks do not permit interoperable data sharing.[46]

Recent Progress on Network Connectivity and Remaining Challenges

Three main networks facilitate the majority of latent print communications among law enforcement agencies: the CJIS-WAN, the International Justice and Public Safety Network (Nlets), and the Law Enforcement Enterprise Portal (LEEP), formerly the Law Enforcement Online network.

[46] *LFIOS*, Questions 242 and 243.

Connectivity between the state AFIS systems and NGI is made possible through the CJIS-WAN. Since its adoption the CJIS-WAN has allowed the submission of both ten-prints and latent prints from states to NGI. Most local agencies do not have direct access to NGI, and therefore must contact their state agencies for access. Local agencies that have the ability to directly submit searches against NGI must submit them through LEEP.

Nlets, a not-for-profit organization managed by state law enforcement agencies, runs a network used to share a wide array of criminal justice and law enforcement information, domestically and internationally. The WIN network and New Hampshire, Maine, and Vermont share interstate latent print information through Nlets.

The FBI's LEEP is an online network used by law enforcement agencies to support investigative operations, to send notifications and alerts, and to provide an avenue to remotely access other law enforcement and intelligence systems and resources. It is not intended to support latent AFIS searches, but developers have created a software wrapper to send emails with attached latent images via LEEP.

None of these systems has the capacity to fully support interoperability among agencies performing latent print searches. The current connectivity system landscape creates major hurdles for connecting agencies both horizontally (locality-to-locality or state-to-state) and vertically (locality-to-state). The CJIS-WAN would require major redesign and redeployment to support extensive local-to-local links, but it may be an alternative for linking states to other states. State agencies are already connected to the FBI through CJIS-WAN and the CJIS Advisory Policy Board has already approved the use of CJIS-WAN to route messages between states. Local agencies may only connect to Nlets through their states' connections, limiting local agencies' ability to make use of the system, and the current system does not support interstate local sharing.

Beginning in June 2017, CJIS will no longer allow local law enforcement agencies to directly access NGI. Direct Latent Connectivity (DLC) services had been extended to select local law enforcement agencies as an interim solution while states developed the programming and telecommunications infrastructure to support local connectivity for latent services. Advances in technical compatibility are obviating the need for the DLC services. To ensure the continuity of access for local agencies, connected local agencies were required to work with states to develop and submit a formal Transition Plan to CJIS by December 2014. Once DLC is no longer supported, SIBs will steward additional local connectivity efforts and manage submissions to NGI as is done with other biometric submissions such as ten-prints. The transition process may also help establish a process for SIBs to establish connectivity to additional local agencies.

Overall, in an environment with constrained resources, vertical connectivity will be more feasible than horizontal connectivity across jurisdictions, because agencies can use the existing network infrastructure used for ten-print searches. State-to-state connectivity is of paramount importance, because it will allow for cross-jurisdictional searches that will benefit both state and local law enforcement activities. Connectivity to NGI through LITS-compliant AFIS systems will facilitate state-to-state connectivity.

Once an agency has a LITS-compliant system that is connected to a network, the next step is to facilitate searches against its AFIS. To do so, an agency may make its database more available to searching by registering with CJIS to receive a unique identifier for the Name of Designated Repository (NDR), a field specified in LITS. Once a data sharing MOU is in place, the NDR will facilitate sharing by allowing a law enforcement agency with a LITS-compliant AFIS system to add additional search database destinations into its system, without additional coding.

Path Forward for Network Connectivity

The FBI's CJIS should work to expand CJIS-WAN to incorporate state-to-state connectivity, because it is already used by other Federal agencies and can handle a large bandwidth. The FBI should also look at measures to encourage more agencies to register their AFIS systems with the NDR so that they may be searched by other jurisdictions in relevant investigations. As more local agencies become LITS-compliant, the FBI could review its policies that restrict local agencies' access to NGI.

For some local jurisdictions, the benefit of local-to-local network connectivity may exceed the current challenges because of the cross-jurisdictional nature of crime in those locations. NIST, NIJ, and CJIS should develop guidelines on how to connect inter- and intra-state and local jurisdictions.

Proper Governance

Governance agreements create a regulatory framework where cross-jurisdictional latent print searches are routine, standardized, secure, and compliant with relevant privacy policies. Once executed, generally by way of two or more agencies entering into an MOU, agencies with interoperability agreements can securely exchange electronic data within the bounds of privacy laws. By clarifying limits of use and standardizing sharing procedures, information exchange can advance from ad hoc and informal means to a more profound and integrated collaboration that reflects the complex nature of ensuring public safety today. These governance documents are best used when they are built on the foundation of technical interoperability and network connectivity as discussed in the previous subsections.

The current hierarchical nature of AFIS connectivity means that AFIS systems are integrated more vertically than horizontally and that the potential for horizontal collaboration has yet to be realized. Most local agencies have no formal sharing or governance agreements, even in areas of regional collaboration among states, which is the case for many of the local agencies in the WIN network. An exception is the NOVARIS agreement, which permits regional sharing in the Washington, D.C. area.[47] In response to NIJ's survey, approximately half of state agencies and a third of local agencies with an AFIS reported having an MOU or service-level agreement in place permitting them to use another AFIS.[48] This has resulted in a disparity in search capabilities and efficiencies among and between law enforcement agencies that have AFIS capabilities and a lack of clarity of when it is legal and appropriate to perform multi-jurisdictional searches. AFIS vendors often facilitate the development of MOUs, which means that these relationships often occur only where the agencies involved share the same vendor.

State and local laws regulate the sharing of civil and criminal fingerprint records collected under those jurisdictions. Many state and local jurisdictions have policies that preclude the enrollment of ten-print records obtained in a justice setting into another AFIS if the fingerprints originated from a minor or an individual convicted of a misdemeanor. Likewise, an agency may limit the retention of fingerprints after a certain period of time. These retention and sharing laws may not be consistent with those of neighboring jurisdictions. Better clarity around existing laws could help local law enforcement agencies develop joint policies that protect civil liberties and respect jurisdictions' preferences for privacy while facilitating sharing among agencies with common criminal pools.

Nationally, many of the privacy concerns are governed by the Federal Privacy Act of 1974, which allows for collection of fingerprints for civil or criminal law enforcement, counterterrorism efforts, and public safety matters. In addition, NGI users must abide by CJIS's security policy regarding "protecting the sources, transmission, storage, and generation of Criminal Justice Information (CJI)."[49]

The FBI's Compact Council, established in 1998 by the National Crime Prevention and Privacy Compact Act, has written rules regarding the collection and use of fingerprints for noncriminal justice purposes (such as application for a job or license, an immigration or naturalization matter, security clearance, or adoption).[50] Further research should be undertaken to assess the extent to which state laws vary in terms of collection of fingerprint data and subsequent use.

Recent Progress on Governance and Remaining Challenges

To facilitate more standardized governance agreements, the NIST/NIJ Latent Print AFIS Interoperability Working Group drafted guidelines for developing an MOU between and among agencies that want to become interoperable.[51] The guidelines include a template for latent print processing agreements between two or more agencies, an overview of how to conduct the process, and sample structure and language for the agreement. The guidelines also provide sample language to address security and privacy disclosures. If an agency adheres to these guidelines, it can produce comprehensive and clear Standard Operating Procedures (SOPs) for cross-jurisdictional latent fingerprint searches.

In addition to the MOU guidelines, the Working Group published *Glossary of AFIS Terms.*[52] The glossary provides examiners and AFIS users with a comprehensive list of terms associated with AFIS technology. Not only does this glossary allow examiners to communicate more easily with one another using standard terminology, it also allows others involved with AFIS systems and development, such as procurement officers, vendors, and attorneys, to communicate more clearly.

[47] Even among NOVARIS's partners, examiners must re-encode prints to search their respective state AFIS and therefore have limited access to the NGI.

[48] *LFIOS*, Question 241.

[49] U.S. Department of Justice, FBI, *Criminal Justice Information Services (CJIS) Security Policy*, (Criminal Justice Information Services, August 4, 2014).

[50] U.S. Department of Justice, FBI, Compact Council, "Agency Privacy Requirements for Noncriminal Justice Applicants."

[51] NIST, *Writing Guidelines to Develop an MOU for Interoperable Automated Fingerprint Identification Systems*, NIST Special Publication 1156, May 2013.

[52] NIST, Latent Print AFIS Interoperability Working Group, *Glossary of AFIS Terms*, February 17, 2012.

The FBI is expected to publish a Privacy Impact Assessment on the privacy implications of NGI, including those relevant to latent services. This document is expected to address the additional privacy issues associated with retaining civil fingerprints and searching those prints against incoming criminal prints.

Path Forward for Proper Governance

To encourage cooperation between and among state and local agencies, NIST should host a workshop or webinar series on how to implement the MOU guidelines. CJIS could develop strategies to coordinate the development of interstate local AFIS governance agreements.

The Department of Justice's Office of Justice Programs could conduct an analysis of variability in governance restrictions as a hurdle for interoperability. Such an analysis could begin with the collection and assessment of vertical and horizontal sharing policies, state and local privacy laws, and other policies related to the retention and use of fingerprints. This analysis could also examine best practices among biometric and other interoperable systems in developing policies and system specifications that govern federated access control and authorization systems in bi-directional, human readable, and machine-readable forms.

Performance Testing and Training

Underpinning any interoperable system is the need for assurance that examiners are adequately trained and software complies with newly adopted standards, provides accurate results, and functions properly. Building in performance testing and training not only helps to maintain the integrity of criminal investigations pursuant to searches, but also serves to advance the field of fingerprinting and biometrics. Additionally, automated solutions must be put in place to assist the process of combining and sorting candidate lists so that examiners will have the time to follow up on candidate matches as a result of searching other systems. Inherently, the more data searched, the greater the number of candidates returned. Therefore, interoperability will generate a significant amount of work for examiners on the back end to review the increased number of candidates and will require a mechanism to support efficient prioritization and sorting of the many candidates. Moreover, proper training is needed to ensure that examiners are searching appropriately within the bounds of current privacy laws.

Training and Tools

Latent fingerprint examiner training is a critical component of any latent print operation and is also an essential component of AFIS interoperability. Training will become ever more essential as technological upgrades are integrated into AFIS operations. For example, as jurisdictions upgrade their systems to become LITS conformant, latent print examiners will need to receive comprehensive training to ensure they are proficient in the use of the standard EFS markup and in determining which search profile is appropriate to use. Training can also reduce the risk of print comparison error and increase the standardization of the identification process.

In addition to basic fingerprint processing, examiners must be trained in methods for encoding the EFS latent print features and those required for vendor-specific proprietary AFIS database requirements. Unfortunately, there is no universal training program in the field of latent fingerprints. Agencies are typically responsible for designing and implementing their own training programs, and therefore, examiner training varies widely. While most agencies have some certified staff adjudicating candidate lists, most agencies do not require that all examiners be certified.[53] While some training is provided by the vendor, most training is conducted on the job through a mentoring program. The variability in the quality of mentoring is reflected in the variable quality of the submissions. For instance, among responding state agencies in the NIJ Survey, one-quarter of states had submissions rejected by the FBI because the submission did not meet the minimum quality standard.[54]

Recent Progress on Training and Remaining Challenges

To respond to the demands for standardized training, NIST developed guidelines for EFS markup to provide "instructions for latent print examiners in marking friction ridge features to maximize consistency among examiners."[55] NIST, in cooperation with the FBI Biometric Center of Excellence,

[53] *LFIOS*, Question 270 and 271.

[54] *LFIOS*, State Addendum Question 40.

[55] NIST, "Markup Instructions for Extended Friction Ridge Features."

has also created an EFS online training tool as an interactive guide to latent fingerprint markup.[56] The tool provides an overview on the types of search profiles designated by LITS and allows examiners to practice annotating minutiae.

Further development of training should build on SOPs and proper management and administrative reporting. SOPs complement training programs by improving examiner performance, staff resource allocation, and examiner expectations. But many latent fingerprint operations do not have documented SOPs around searching other AFIS databases in their agencies.

SOPs should establish a framework for allocating examiner and AFIS resources and should include a policy for determining which searches to make depending on the available resources. The procedures should also outline document requirements for any latent fingerprint identification and should offer policies to reduce the risk of a print comparison error, the degree of review required, and the review processes required, based upon levels of comparison difficulty. Finally, the procedures should support the collection and analysis of operations data sufficient for system utilization and upgrade planning (e.g., number of searches made, cases solved, search characteristics, and success factors).

Training materials and programs should include methods for communicating to an examiner how to process latent fingerprints in accordance with established and validated SOPs.[57] Communications training will help demonstrate that the latent print comparison is accurate and admissible in court.

Path Forward for Proper Training and Tools

The Federal Government should produce resources to help examiners efficiently and competently perform interoperable searches. To facilitate dissemination of best practices for LITS-compliant systems, NIST should develop guidelines for writing SOPs that incorporate reporting and best practices into the latent print identification process for searches conducted against other agencies' databases. NIJ or the Bureau of Justice Assistance (BJA) should introduce grant programs to support examiner training activities related to the implementation and use of LITS/EFS, to mitigate the costs of examiner retraining. In addition to these supporting efforts, NIST should develop guidelines on how examiners might communicate accurate results from a multi-jurisdictional search in testimony and reports.

Just as the FBI has provided the ULW freeware to process NGI search requests, NIST and the FBI should consider developing and making available an automated aggregation tool for candidate lists that are returned from multiple searches in one or more systems when simultaneous searches are appropriate. The tool should be able to prioritize the results and identify the most likely candidate from the combined searches.

Testing

Testing AFIS systems helps ensure that they deliver accurate results while conforming to newly implemented transaction standards. Independent assessment of software performance would help ensure that users understand complex issues that underpin the technical aspects of interoperability and latent print identification. Testing could also be used to optimize examiner workflow, which would help address the increasing examiner demands caused by longer candidate lists as a result of enabling the searching of more AFIS systems. Workflow modifications should also account for the differences in algorithmic weighting that occur.

Testing of software has been incorporated into many of the vendors' business models, but not into law enforcement agency workflow. Independent verification of AFIS identification algorithms could help to ensure that vendors' claims about accuracy and reliability are not exaggerated to capture market share.

Recent Progress on Testing and Remaining Challenges

Performance testing measures the accuracy of latent AFIS searches. Such testing will help ensure that reliability and accuracy objectives are not compromised when implementing interoperable standards. Agencies should require vendors to pass performance tests before accepting a delivered system. Performance testing has yet to be standardized, but the Latent Print AFIS Interoperability Working Group has identified a few

[56] The NIST training tool is available at www.nist.gov/forensics/EFSTrainingTool.

[57] The Scientific Working Group on Friction Ridge Analysis, Study and Technology previously developed model Standard Operating Procedures regarding latent print examinations that can be found at www.swgfast.org/Documents.html.

elements that should be included in any performance test. NIST has employed testing to assess the accuracy of a print encoded on another AFIS system to a natively encoded print as a means of evaluating interoperability. NIST conducted two performance evaluations in 2011 and 2012 to assess the accuracy of "latent fingerprint searches using features marked by experienced human latent fingerprint examiners, in addition to automatic feature extraction and matching (AFEM)."[58] The evaluations also assessed which combinations of features were the most accurate search components, finding that "additional features resulted in accuracy improvement" in many cases.[59]

Federal testing efforts would be strengthened by independent third-party assessment of system architecture and performance. Independent assessment of performance and improvements in interoperability requires representative research data sets. These data sets would be especially beneficial if they included new forms of exemplar prints that are being collected by agencies. These emerging reference samples include prints and "slaps" from novel comparison sources such as mobile devices and 3D fingerprint renderings obtained from contactless fingerprint technologies.

Path Forward for Testing

To ensure that interoperability standards do not compromise search accuracy, NIST could consider developing mechanisms to assess the accuracy of natively or remotely encoded prints and include language in the RFP guidance to ensure accuracy.

To encourage independent assessment and validation of system capabilities, NIST could develop and release a new research data set that includes new and novel comparison sources.

Education and Outreach

The decentralized nature of American law enforcement introduces several challenges with dissemination of pertinent information relating to each of the core elements of interoperability. When standards, resources, policy updates, and training opportunities are adopted, developed, introduced, or announced, not all agencies and relevant stakeholders learn of these developments in a timely manner or at all. In particular, some state and local agencies are not aware of how the newly adopted LITS specification should be implemented, the availability of resources about the standard, or the changes to CJIS search and data retention policies. Education and outreach are important overarching components for bringing about interoperability.

Following the adoption of the LITS specification, the Latent Print AFIS Interoperability Working Group worked to develop guidelines for developing MOUs between agencies looking to enter into a latent print sharing agreement and for appropriate RFP language to ensure cost-effective LITS-compliance in a new or upgraded AFIS system. Some state and local agencies have not been informed of these resources, jeopardizing the incorporation of LITS into the next generation of AFIS systems across the country.

When IAFIS was initially introduced, CJIS harbored concerns about exceeding capacity and placed a number of restrictions on what searches could be performed to manage the system. Augmented capacity and the introduction of NGI has enabled CJIS to lift these restrictions. Some state and local agencies maintain the perception that these restrictions are still in place today. This has led to confusion among state and local agencies as to when and under what conditions searches can be performed against NGI. For example, state or local police officers may be uncertain whether they are permitted to search NGI for a suspected leader of a drug syndicate charged with Federal crimes who is being held in a local jail. Outreach to local agencies to clarify CJIS's policies should be made a priority to ensure that law enforcement agencies can search NGI when their investigations call for it.[60]

CJIS staff members work closely with individual agencies to evaluate LITS and EBTS implementation in new AFIS databases. An expansion of these efforts could help translate technical specifications into practice by resource-constrained law enforcement agencies seeking to update their systems.

[58] Indovina, Hicklin, and Kiebuzinski, "ELFT-EFS Evaluation #1."

[59] Indovina, Dvornychenko, Hicklin, and Kiebuzinski, "ELFT-EFS Evaluation #2."

[60] FBI, *CJIS Security Policy*.

Summary of Recommendations

The development of standards for latent print encoding and searching (EFS and LITS) is a major step forward in AFIS interoperability. Now the Federal Government must ensure that these standards are followed by helping state and local agencies build connections across jurisdictions, developing an overall connectivity strategy, fostering better governance, and supporting system-wide quality assurance through testing and training programs. Progress in each of these areas should be evaluated on an ongoing basis.

Interagency Coordination

The Subcommittee on Forensic Science recommends that an interagency group be established to promote AFIS interoperability standards among Federal, state, and local authorities. This group would also be charged with coordinating and facilitating the development and adoption of standards related to AFIS use. Coordination of these activities by an interagency group, with cooperation of Federal, state, local, and tribal partners, as well as advice from industry, will help to ensure that users are provided with an integrated suite of standards to support law enforcement and counterterrorism needs. The suite of standards necessary to achieve interoperability and improve efficiency includes standards for evaluating equipment, training and certifying users, accreditation, and development of SOPs.

Technical Compatibility

The Subcommittee recommends:

- All Federal AFIS should be fully compliant with LITS and EBTS without the use of an additional workstation within 3 years.
- The Federal Government should encourage adoption of LITS-compliant AFIS systems by state and local agencies:
    - NIJ or BJA should make funds available through existing grant programs to support state and local agency procurement of LITS-compliant AFIS.
    - All Federal funds made available to state and local agencies for AFIS procurement or upgrades should specify that the AFIS databases must be LITS-compliant.
- NIST should pursue activities to support the implementation of LITS-compliant AFIS systems through:
    - Periodic review of recently adopted standards;
    - Backward compatibility of the standards following any updates; and
    - Compliance through the development of conformance testing standards and funding conformance testing programs.

Network Connectivity

The Subcommittee recommends:

- The FBI's CJIS should work to improve state-to-state connectivity by expanding the CJIS-WAN and encouraging more agencies to participate in development of a truly interoperable system.
- The FBI's CJIS should support local-to-state connectivity and local-to-local connectivity through technical assistance and develop guidelines with NIST and NIJ on how to interconnect local jurisdictions.

Governance

The Subcommittee recommends:

- The FBI's CJIS should develop strategies to coordinate the development of interstate local AFIS governance agreements.
- NIST should host a workshop or webinar series on how to structure interagency agreements that allow for latent print searches that are routine, standardized, secure, and in compliance with relevant privacy policies.

- The Office of Justice Programs should conduct an analysis of horizontal and vertical sharing policies as well as state and Federal privacy laws and policies that impact fingerprint sharing across jurisdictions and identify opportunities to coordinate the development of joint policies.

Performance Testing and Training

The Subcommittee recommends:

- The Federal Government should support training activities of LITS-compliant systems through the following activities:
    - NIST should develop support materials, including SOPs for examiners.
    - NIJ and BJA should make funds available through current grant programs to support examiner training activities related to the implementation and use of standards-compliant systems.
- NIST should develop performance tests to assess the matching accuracy of natively versus remotely encoded prints and new research data sets to encourage independent testing.
- NIST and the FBI should develop and make available an automated tool to aggregate candidate lists from multiple searches in one or more systems that could lead to improvements in efficacy and accuracy.

Education and Outreach

The Subcommittee recommends:

- The Federal Government should help resource-constrained law enforcement agencies seeking to update their systems by expanding efforts to evaluate LITS and EBTS implementation and translate technical specifications into practice.

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United States Postal Inspection Service

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Abbreviations

ABIS	Automated Biometric Identification System
AFIS	Automated Fingerprint Identification System
ANSI	American National Standards Institute
BIMA	Biometrics Identity Management Activity
BJA	Bureau of Justice Assistance
CBP	Customs and Border Protection
CJIS	Criminal Justice Information Services
DHS	Department of Homeland Security
DLC	Direct Latent Connectivity
DOD	Department of Defense
EBTS	Electronic Biometric Transmission Standard
EFS	Extended Feature Set
FBI	Federal Bureau of Investigation
IAFIS	Integrated Automated Fingerprint Identification System
IDENT	Automated Biometric Identification System
INS	Immigration and Naturalization Service
ITL	Information Technology Laboratory
LEEP	Law Enforcement Enterprise Portal
LFIOS	*Latent Fingerprint Interoperability Survey*
LITS	Latent Interoperability Transmission Specification
ME/C	medical examiners and coroners
MOU	memorandum of understanding
NDR	Name of Designated Repository
NGI	Next Generation Identification
NIJ	National Institute of Justice
NIST	National Institute of Standards and Technology
Nlets	National Law Enforcement Telecommunications Systems
NOVARIS	Northern Virginia Regional Identification System
OSTP	Office of Science and Technology Network
RFP	Request for Proposals
RISC	Repository of Individuals of Special Concern
SIB	State Identification Bureau
SOP	Standard Operating Procedure
ULF	Unsolved Latent File
ULW	Universal Latent Workstation

US-VISIT	United States Visitor and Immigrant Status Indicator Technology
VPN	Virtual Private Network
TXDPS	Texas Department of Public Safety
WAN	Wide Area Network
WIN	Western Identification Network