U. S. Department of Justice
Federal Bureau of Investigation
Criminal Justice Information Services Division

Next Generation Identification (NGI)

Engineering Change Proposal (ECP)
Biometric Modification #3
Interstate Photo Capability

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CDRL NGI-51
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Revision	Change Description	Changed By	Date	Approved By
1.0	Initial draft	SMR	08/12/2011	See Signature Page
2.0	Final	SMR	10/20/2011	See Signature Page

PREFACE

This Engineering Change Proposal (ECP), Biometric Modification #3, was prepared by Lockheed Martin Corporation (LMC) for the Federal Bureau of Investigation (FBI) Criminal Justice Information Services (CJIS) Division Next Generation Identification (NGI) Program Office.

This ECP conforms to Data Item Description (DID) NGI-51. Traceability to the DID is documented in Preface Table 1-1.

This ECP is requested in a letter (*COL-2011-0020, Request for NGI Interstate Photo Capability Biometric Modification*) from Michael Young to Barbara Koenig dated April 12, 2011.

Preface Table 1-1: NGI DID Traceability Matrix

Para No.	DID Paragraph Title	Document Section
10.2	Content Requirements: ECP Figure 1	Figure 1-2: ECP Summary per DID-51

Preface Table 1-2: Statement of Work (SOW) Compliance Matrix

Para No.	SOW Text	Document Section
3.3.3.1 Biometric Search Analysis Studies	Except as specifically described in Paragraph 3.3.3.2 below and unless otherwise directed by the CO, the Contractor shall prepare a Firm-Fixed-Price Engineering Change Proposal [CDRL NGI-51 Engineering Change Proposal] to incorporate the Commercial Off-The-Shelf (COTS) hardware, software, and Original Equipment Manufacturer (OEM) maintenance price associated with the implementation of the selected solution set into the NGI System.	All sections of this document

Preface Table 1-3: ECP Request Compliance Matrix

Item	Request Text	Document Section
Reasonable Facial Recognition Assumptions	The Facial Recognition System (FRS) solution should be sized as a single delivery to accommodate the FY15 workload volumes per the SRD Workload Tables version 4.1 p.	2.1.2.1 Workload
	FRS should exhibit accuracy against a large repository of enrolled frontal facial images consistent with NGI requirements SRS2246 when tested against frontal facial photos whose quality is consistent with FBI data used for NIST MBE testing.	2.1.2.3 Accuracy
	Since SRS2246 states that the correct candidate is in the top 50 candidates, no false match requirement is required. Accordingly, SRS2247 which establishes a 20% false match requirement will be deleted.	2.1.2.4 Removed and Modified Requirements
	NGI requirements for Unsolved Photo File (UPF) (SRS2252) and SPC (SRS2255) accuracy were not tested by NIST MBE. The FBI expects these requirements will be affected by the quality of the images enrolled and searched in these repositories	2.1.2.4 Removed and Modified Requirements

Item	Request Text	Document Section
	Consistent with the Facial Trade Study recommendations, SRS requirements modifications will be required to specify the false match rate for UPF and SPC searches is no greater than 0.1 %.	2.1.2.4 Removed and Modified Requirements
Additional Topics Affecting the FRS Bio Mod	**Human-Machine Interface (HMI) Implementation**: LMC should assume that the facial search HMI needs will be met by the FBI's Universal Facial Workstation (UFW) which will be provided as Government Off-The-Shelf (GOTS) to LMC for incorporation into the NGI system. The remaining service provider HMI requirements currently on contract, and not subsumed by UFW functionality will continue to be developed by LMC (e.g. facial enrollment HMIs). LMC should propose procurement of HMIs necessary to manage and maintain the search engine from the facial recognition vendor. LMC should assess debits and credits for associated labor, hardware and software for the incorporation of the UFW. The details of the debit and credit will be determined and agreed to as a result of a joint working session that will describe how UFW is to be incorporated into the NGI facial solution.	3 Dependencies Discussions and actions regarding debits and credits are outside of the scope of the technical volume. Agreement reached in FBI Letter COL-2011-0035; dated August 8, 2011.
	Workstation Assumptions: The UFW Software will be provided to LMC for installation onto existing Advanced Technology Workstations (ATWs).	1.3 Assumptions
	Material Assumptions: LMC should identify and propose use of available hardware and software proposed/procured in previous Bio Mods, if appropriate (i.e., meets or exceeds technical requirements for this effort), before proposing additional hardware and software. In the event that this hardware and software is applied to Bio Mod 3 and is subsequently required in support of the originally intended effort then the FBI will either provide as GFE or initiate a change proposal.	1.3 Assumptions
	Vendor Security Mitigation (VSM): Due to the pending acquisition of the biometric vendor, LMC should assume the Facial Recognition solution will be subject to the post-IOC approach utilizing object code scanning that was proposed in Bio Mod 1, Part II. The FBI requests these costs to be separable from the base solution in the event that the biometric vendor is exempt from this strategy.	4 VSM
	Capacity Analysis I Technology Refresh: LMC is expected to consider capacity expansion for Facial Recognition as part of its annual support to the FBI for identification fingerprint capacity analysis proposed in Bio Mod 1, Part II. No additional support labor is anticipated for capacity analysis specific to Facial. Technology refresh of the Facial Recognition solution should not be included, rather it should be assumed to be covered by one of the annual capacity analysis activities. LMC should further assume that no updated facial biometric vendor software delivery shall be included prior to Full Operational Capability (FOC).	3.3 Performance

Item	Request Text	Document Section
	Licensing: The FBI is interested in evaluating the value of different licensing options for the Facial COTS product relative to the cost. LMC is requested to share with the FBI the terms for an unlimited license. The FBI then expects to collaborate with LMC on a strategy to obtain licensing terms from the preferred biometric vendor at a cost commensurate with the value beyond the base solution sized for 2015. We do understand that part of exploring unlimited licensing will include collaboration to define reasonable constraints and thresholds that could help control the cost of this strategy, such as an upper bound on future workload expectations.	6 Licensing
	GFx: The FBI anticipates LMC to submit GFx requests for, but not limited to, the following items in support of the FRS Bio Mod: - UFW Source Code UFW Documentation determined appropriate and necessary, by the FBI/LMC team, for the successful integration of the UFW software. UFW Test Artifacts that are determined appropriate and necessary, by the FBI/LMC team, for the successful integration of the UFW software.	3 GFx Dependencies
	L-1: The FBI would like to evaluate an option of having the L-1 SDK delivered, upon definitization of the L-1 contract, for temporary use in the FBI Proof of Concept Pilot. To assist in the FBI evaluation, LMC is hereby directed to solicit information from L-1 regarding the satisfaction of this request. If it is determined that satisfaction of the request would result in an increase to the L-1 cost proposal, then LMC is requested to provide this cost impact as a separately priced option within the BIO MOD 3 proposal.	N/A Discussion and implementation can be found in the Cost Volume.

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1 PROPOSAL INTRODUCTION

1.1 Proposal Summary

Lockheed Martin Corporation is pleased to provide this proposal to add facial search functionality to the NGI system. This represents the next modality in NGI's approach to increase the FBI's biometric capabilities through the addition of best of breed Commercial Off-The-Shelf (COTS) products for each modality. This functionality is based upon a major COTS-based capability, namely, creating and searching repositories of facial photos which will be integrated into the existing NGI framework.

The facial search capability is provided by the Automated Biometric Identification System (ABIS®) Search Engine (SE) Facial Recognition System (FRS) from L-1 Identity Solutions (L-1). L-1 was selected based on the demonstrated performance of their product during the Face Trade Study.

Facial HMI capabilities are not included as part of this proposal as they are being provided through incorporation of the Government Off-The-Shelf (GOTS) Universal Face Workstation (UFW) solution being developed by Noblis under a separate contract, not specific to NGI. The UFW solution includes the client side UFW HMIs and the server side UFW Biometric Integration Platform (BIP).

Figure 1-1 depicts an overview of the NGI facial solution, which incorporates UFW's HMIs and case management and L-1's FRS. The figure also shows the primary interface means for each. UFW will exchange enrollment and search requests/responses and receive unsolved notifications through Electronic Biometric Transmission Specification (EBTS) Extensible Markup Language (XML) messages, much like an external authorized contributor using UFW, but without having to go through the CJIS Wide Area Network (WAN) and firewalls. Additional interfaces will expose NGI configuration information to UFW, such as the list of Special Population Cognizant (SPC) groups, which is needed by Face Examiners to formulate accurate enrollment and search requests. An NGI-developed Java Message Service (JMS) to Simple Object Access Protocol (SOAP) Adapter will translate between NGI's native JMS messaging interface and the FRS COTS' SOAP-based interface. Both products operate within NGI's Common Operating Environment including the Red Hat operating system, hardware platforms, networking, enterprise storage, backup/restore, and systems administration tooling.

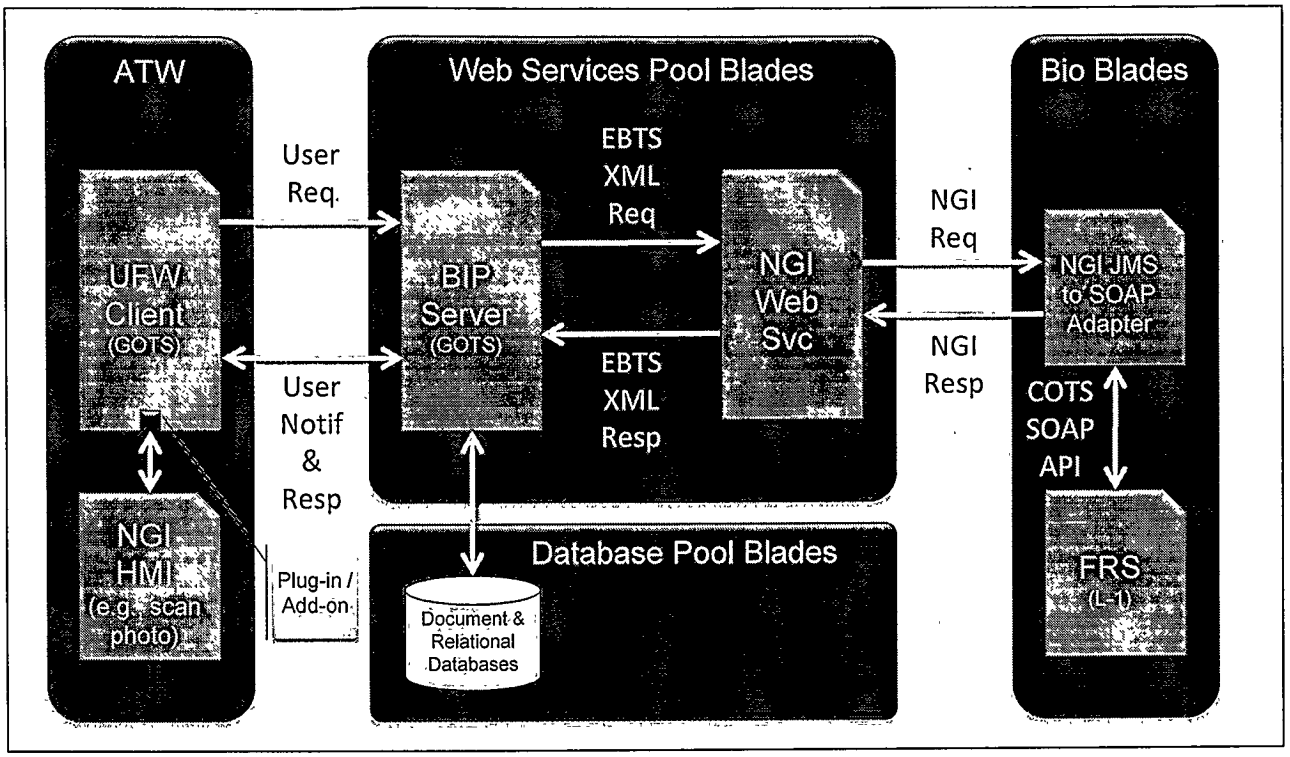


Figure 1-1: NGI Facial Solution Overview

As directed in the ECP Request Letter, this proposal includes the Vendor Security Mitigation approach that has been implemented on NGI post-Increment 1 Initial Operating Capability (IOC). This approach is described in Section 4 and is consistent with the approach proposed in Bio Mod 2.

Figure 1-2 provides an ECP Summary in tabular form per DID-51.

ENGINEERING CHANGE PROPOSAL	DATE PREPARED: October 20, 2011	ECP NO. NGI-ECP-TS-0004	PROCURING ACTIVITY NO.
1. ORIGINATOR NAME AND ADDRESS: Lockheed Martin, 9211 Corporate Boulevard, Rockville, MD 20850			

2. SPECIFICATIONS AFFECTED		3. DRAWINGS AFFECTED		
MFR CODE:	SPECIFICATION/DOCUMENT NO.:	MFR CODE:	NUMBER:	REV:
	N/A		N/A	

4. TITLE OF CHANGE: Biometric Modification #3	5. CONTRACT NO.: J-FBI-08-041
6. CONFIGURATION ITEM (CI) NOMENCLATURE: N/A	7. IN SERVICE: ____ YES _x__NO
8. NAME OF PART OR LOWEST CI AFFECTED: N/A	9. CI IMPACTED: N/A
10. DESCRIPTION OF CHANGE: Facial Recognition Search COTS-based solution	
11. NEED FOR CHANGE: Incorporate product selection for FRS based on the trade study results	
12. EFFECT ON ASSOCIATED EQUIPMENT: New equipment to support the selected product included in this ECP.	
13. PRODUCTION EFFECTIVITY: N/A	14. DEPENDENCIES: Facilities for equipment at FBI locations, Network infrastructure, Enterprise storage, Facial HMI
15. ESTIMATED DELIVERY SCHEDULE: Refer to associated Integrated Master Schedule (IMS) delivery	
16. ESTIMATED OPERATIONAL CUT-IN SCHEDULE: Refer to associated IMS delivery	
17a. SUBMITTING ACTIVITY AUTHORIZING SIGNATURE:	17.b. TITLE:

Figure 1-2: ECP Summary per DID-51

1.2 Description of Work

The focus of this Bio Mod is the implementation in Increment 4 of a COTS-based facial search solution built around L-1's product, which was selected based upon the results of the Face Trade Study. The primary elements of the Bio Mod are the facial search product, the supporting software upon which the facial search product depends or which are necessary to integrate into NGI's system infrastructure, and the blade servers and chassis needed to host the software.

Hardware and software for the facial search solution will be deployed to CJIS's Operational Environment (OE) and Non-operational Environments (NOEs) in Clarksburg and LMC's development and Integration and Test (I&T) labs in Rockville and Fairmont. The hardware is sized to Fiscal Year 2015 (FY2015) workload volumes and described in Section 3.7. The facial search solution is discussed in detail in Section 0.

The VSM approach for biometrics products will, as directed by CJIS's ECP Request Letter, comprise the Object Scanning Approach proposed in Bio Mod 1 Part II. It will use a multi-layered security approach where CJIS is responsible for Object Scanning and Analysis. The primary LMC VSM work included in this proposal is relative to the initial validation of the biometric vendors' build environments (Golden Disk) and assisting the biometrics vendors in creating a debug build for Object Scanning consistent with the requirements of the Object Scanning tool. The VSM solution is discussed in detail in Section 4.

The GOTS UFW solution (includes HMI and server side components) will be integrated into the NGI system, hosted on NGI hardware (ATWs and blades), and using CJIS enterprise network, storage, and backup/restore solutions. LMC does not intend to modify the source code for UFW in any way, preserving the Government's ability to accept future releases from Noblis containing fixes and/or enhanced functionality without having to re-apply NGI-specific modifications. Extensions to the GOTS level of functionality will take advantage of UFW's plug-in architecture and/or other documented APIs. Through ongoing working level technical meetings with CJIS, Noblis, and LMC, these interfaces will be defined, refined, and if necessary extended to completely address NGI's functional requirements. UFW's primary interface with NGI is EBTS XML messages, which for example support enrolling unknown subjects, searching the FRS repositories, receiving search results, and delivering unsolicited notifications of hits against the Unsolved Photo File (UPF). LMC will integrate the UFW solution with NGI's security, management, monitoring, deployment, build, and Configuration Management (CM) solutions.

1.3 Assumptions

This section documents the key assumptions that form the basis for this Bio Mod. Some assumptions will include references to other sections of the document where additional detail or background information is provided.

1.3.1 General Assumptions

1. Maintenance is priced through September 2014, after which the FBI assumes the maintenance costs.

1.3.2 Search Assumptions

1. Accuracy testing and quality recommendations are to be based upon frontal data only, which is consistent with the NIST testing.
2. The system may accept a non-frontal image as a search probe (or any other image that has quality characteristics less than any recommended), though the accuracy would likely be below stated requirements. At this time, full profile images are not expected to yield match results.

1.3.3 VSM Assumptions

1. No allowances are made for critical security findings resulting from the analysis of the code such as a finding that prevents us from continuing to use the biometric product in the NGINet, NOEs and OE. Critical is defined as any finding which results in FBI direction to remove a software release, close network access, or halt development.

2. The security risk and vulnerability analysis is determined to be complete for a particular version of the product once the object code analysis tools have been run, analysis of the identified potential risks/vulnerabilities has been conducted by CJIS, and the risks/vulnerabilities are determined by CJIS to be acceptable.
3. The FBI accepts that the security mitigations put in place through the VSM activities leveraging object code analysis provide a sufficient level and rigor to satisfy those risks and will be treated separately from the Certification and Accreditation (C&A) requirements for FRS. Vulnerabilities found in FRS code through object code scan will not be used to withhold C&A.
4. The purpose of the VSM activities is to identify vulnerabilities which indicate "malicious intent." Neither LMC nor the biometric vendor has an obligation to correct other security vulnerabilities identified. Such vulnerabilities will be reported to the biometric vendor and handled per their commercial practices.
5. In lieu of an LMC Security Liaison, the FBI will provide a liaison to participate in the object analysis activities.
6. Subsequent to the delivery of FRS to the NOE or OE, should "patches" be required on an expedited basis, CJIS will support the special exception process in order to mitigate schedule impact.
7. The additional software license costs do not include support for the "upon request" requirements to support analysis of warnings generated by the object code scanning or to load temporarily the source on the CJIS Vulnerability Analysis Lab (VAL).
8. The biometric vendor has assumed one FBI audit of its secure build environment is performed per increment.
9. Once object code analysis is complete, CJIS shall review and disposition the identified risks/vulnerabilities within 1 week so as not to impact the Inc 4 schedules.
10. No provisions are provided in this Bio Mod for Object Scanning of the UFW.

1.3.4 Facial HMI Assumptions

1. The Facial HMI will be provided by the UFW and will be provided to NGI as a GOTS solution.
2. LMC assumes that the NGI requirements discussed in the May 30th, 2011 meeting with CJIS, Noblis and NGI will met by the UFW in accordance with the Inc 4 schedule. See Appendix A for complete list of requirements.
3. LMC assumes that the Services, Evaluation, and Analysis Unit (SEAU) will retain responsibility for managing and tasking Noblis. Any interaction between Noblis and LMC will be coordinated through the NGI Contracting Officer's Technical Representative (COTR).
4. LMC assumes, similar to other GOTS/COTS solutions, the Increment 4 design will focus on the interface to the GOTS HMI solution and not the internal workings of the provided solution.

1.4 GFx Dependencies

This section documents Government-Furnished Action/Information/Equipment (GFA/GFI/GFE) dependencies on the FBI for facilities, systems, resources (people or materials), and data needed to successfully deploy the capabilities described in this Bio Mod with the corresponding needs dates. GFx process will be followed for all GFx requests, including consideration of time constraints (i.e. installation time, procurement time, board approval, etc.).

Table 1-1: GFx Dependencies

Artemis Identifier (ID)	Item	Source	Rationale for Need
G3-0190-0001	Facial HMI	FBI	The Facial HMI will be provided by the UFW as a GOTS solution and delivered per the Inc 4 development schedule
G3-0234-0258	NOE assets for System Acceptance Test (SAT)	FBI	System acceptance at FBI facility
G3-0234-0438	Power and cooling for new hardware at Clarksburg	FBI	FBI responsible for providing power and cooling
G3-0234-0438	Network bandwidth and connectivity for new hardware at Clarksburg	FBI	FBI responsible for providing network
G1-0225-0363	Primary and secondary storage	FBI	Table 3-2 lists the sizes of Enterprise Storage Area Network (ESAN) Logical Unit Number (LUN) volumes per server-type in the FRS.
G3-0190-0003	Data for UPF testing	FBI	We request the FBI provide us a minimum of 12,000 unsolved facial photos representative of the type and quality expected to be enrolled in the NGI UPF

1.5 Risks

Risk Management (RM) is both event driven and continuous in nature, and occurs throughout the project life cycle. The NGI Project team's risk management process couples risk with schedule and cost to provide a complete view of the complex relationship of schedule, cost, performance, and risk. The key elements of the RM process include risk identification, risk assessment/prioritization, response planning/execution, and risk control. NGI Project team members, NGI Project management, and the NGI Program Office share the responsibility or risk identification by reviewing plans, constraints, and requirements that could impact the project. Risks are assessed and prioritized in terms of their probability of occurrence and the potential impact of their occurrence. In order to ensure that the execution of the risk response plan becomes as straightforward and assured as execution of any other aspect of the project schedule, actionable response plan steps are incorporated into the Integrated Master Schedule (IMS). Risk Radar Enterprise® application serves as the Risk Register and the reporting mechanism and it is accessible via the NGI Portal.

The following subsections contain risks that have been identified for this Bio Mod:

1.5.1 General Risks

1. Eng_329 – If all Free and Open Source Software (FOSS) and COTS specified in this Bio Mod is not approved by CJIS after release from the LMC FOSS approval process, then additional costs and schedule impact will be realized to replace the FOSS/COTS.

   Mitigation Plan

   a. Provide CJIS the FOSS/COTS list as part of the proposal to identify any FOSS/COTS at risk of approval or previously denied; this is included with the delivery package of this document under the file name *103 NGI-ECP-TS-0004-2.0 FOSS List.pdf*

   b. Request early identification by the Facial vendor of FOSS/COTS changes

1.5.2 Search Risks

1. Eng_333 – If the FRS UPF and SPC accuracy requirements cannot be achieved against representative operational data, then the UPF and SPC functions may not meet their operational need.

   Mitigation Plan

   a. Acquire operationally representative test data from the FBI.

   b. Perform lab tests to measure UPF and SPC performance against operationally representative data.

   c. If the measured performance fails to meet operational need, meet with the FBI to discuss available trade-offs to improve performance.

   d. Disposition (waive or modify) accuracy requirements as agreed to with the FBI.

2. Eng_332 – If the quality thresholds on the Facial Investigative File (FIF) gallery and facial searches have to be adjusted to accommodate poor-quality data, then the accuracy results and the size of the repository available for search may fail to meet operational needs.

   Mitigation Plan

   a. Facial vendor to perform quality threshold testing to recommend thresholds for use on NGI

   b. Leverage the FBI facial pilot to evaluate quality thresholds and characterize the quality of the data

   c. Validate the quality thresholds as part of vendor testing against the trade study data

   d. If projected quality thresholds fail to meet operational need, meet with FBI to discuss available trade-offs

3. Eng_336 – If the bulk enrollment and data migration approach and design are immature, then the duration, complexity, and effort could be larger than the baselined plan resulting in cost and schedule impacts for testing and operational data loads

   Mitigation Plan

   a. Coordinate with the Facial vendor to obtain prior customer bulk enrollment performance metrics

   b. Hold design working groups with the facial vendor on data migration and enrollment functions prior to Critical Design Review (CDR)

   c. Evaluate the bulk enrollment performance during the test lab setup effort

4. Eng_334 – If the Facial Pilot drives changes to the COTS ABIS® SE FRS product, then there may be a schedule and cost impact associated with the COTS product delivered to NGI.

   Mitigation Plan

   a. Work with CJIS to understand any potential changes

   b. Review any potential changes with L-1 and clearly understand potential scope impact

   c. Work with CJIS to define impacts and alternatives

1.5.3 VSM Risks

1. Eng_337 – If object code scanning takes longer than expected or produces insufficient outputs, then schedule delays and associated costs will be incurred to perform the necessary analysis to validate the vulnerability posture of the biometric COTS product.

   Mitigation Plan

   a. Complete "pre-flight test" of object scanning service using an early delivery of existing Facial object code

   b. Execute an Early Object Scan and review object scan output with CJIS

   c. Implement process changes to reduce object-scan timelines

2. Eng_338 – If the Object code analysis tool has issues with analyzing the L-1 code, then there may be a schedule impact due to either L-1 making changes to their code or Object code vendor making fixes to the analysis tool.

   Mitigation Plan

   a. Conduct Early Scans

   b. Work with L-1 and Object code vendor to resolve issues

1.5.4 Facial HMI Risks

1. Eng_335 - If the UFW implementation deviates from the agreed to implementation, then integration with NGI may take longer than planned causing both schedule and cost impact.

Mitigation Plan

a. Review UFW design issues at existing CJIS/LMC meetings

b. Manage changes through the existing process

c. Hold regular technical interchange meetings

d. Clearly identify scope of UFW vs. NGI custom HMIs developed by LMC

1.6 Opportunities

1.6.1 Bill of Materials

This section documents opportunities to leverage existing infrastructure to reduce required hardware for this Bio Mod.

1. EngOp_341 – If NGI can use available IdFP blade chassis slots in NOE2-5 environments, then there would be a reduction in the number of new chassis required for this Bio Mod.

   Plan

   a. CJIS to consider alternatives as part of the modification comment cycle

2 FACIAL SEARCH REQUIREMENTS

This section describes the facial search capabilities functional and non-functional requirements applicable to facial search and acknowledgement of requirements to be removed or modified.

2.1 Requirements

This section acknowledges and/or describes LMC's understanding of the functional and non-functional Facial Search requirements that are relevant to the scope of this Bio Mod. Where appropriate, these requirements were flowed down to the COTS vendor through the Request For Proposal (RFP) issued to the vendor by LMC.

2.1.1 Functional Requirements

Functional requirements for Facial Search capabilities were derived from the NGI System Requirements Specification (SRS) and from the NGI architecture. Requirements considered in scope for Increment 4 are based on the set of system threads that were agreed upon between CJIS and LMC as part of the Revised Ten-Year Performance Measurement Baseline issued as Program Office Directive 94 on July 1, 2010. The LMC team pulled the SRS requirements directly from RequisitePro.

The Increment 4 SRS requirements associated with the revised baseline have been reviewed jointly with CJIS, LMC, and L-1 to ensure that the Increment 4 solution provides all required facial search functionality. As the facial search vendor COTS software provides a significant segment of the facial search functionality, LMC has developed a set of applicable requirements for the vendor COTS. These vendor COTS requirements are provided in an Excel spreadsheet included with the delivery package of this document under the file name *104 NGI-ECP-TS-0004-2.0 Tech Rqmts with SRS Trace.xls*. This spreadsheet includes trace information to show the relationship between the vendor requirements and the overarching NGI SRS requirements. Some requirements without direct SRS traces are based on NGI architectural direction. Human Machine Interface (HMI) requirements will not be included as a part of the facial search vendor COTS product delivery. The HMI requirements will be met by using the FBI's Universal Face Workstation (UFW), which will be provided as GOTS to LMC.

The vendor requirements, originally developed for all vendors as part of the facial vendor RFP, have been modified following the face trade study to reflect comments received during the Subcontract Requirements Readiness Level review. These modifications include updates such as the following:

- Use of publicly-available vs. proprietary feature templates
- Biographic filtering
- Biometric and biographic updates
- Use of search and feature extraction algorithms specific to geometric facial feature mapping on frontal images to search a repository of known or unknown candidates
- Repository architecture (facial repositories and identity groups, schema, and data partitioning).

- Peak Hourly Workloads

Some L-1 requirements were also updated to reflect clarification of intent, particularly in functional areas related to integration scope and interfaces. Overall, the L-1 requirements were updated and expanded to ensure that the L-1 solution has the intended functionality, and to ensure correct test coverage.

The changes to L-1 requirements are annotated on a per-requirement basis in the spreadsheet included with the delivery package of this document under the file name *104 NGI-ECP-TS-0004-2.0 Tech Rqmts with SRS Trace.xls*.

2.1.2 Non-functional Requirements

2.1.2.1 Workload

Repository and workload requirements for the FRS Facial Investigative File (FIF) and UPF have been derived from FY2015 values in the System Requirements Document (SRD) Workload Tables version 4.1p. These requirements have been flowed to L-1 to be used to size their solution. The following assumptions are common to all derived FRS requirements (and the source of these noted in parentheses):

The FIF capacity requirements summarized in Table 2-1 are based on the following CJIS direction and assumptions:

- Supports the FY2015 capacities as derived from the CJIS-provided Workload Tables version 4.1p.
- The average penetration rate for facial searches against enrolled facial image templates is 100% (trade study assumption).

Table 2-1: FRS Capacity Estimates for FY2015

Repository	# of Photos
FIF TOTAL	**51,501,010**
Criminal	46,021,052
Civil	4,299,969
Repository for Individuals of Special Concern (RISC)	214,991
SPC	750,000
New repositories	214,998
UPF TOTAL	**9,548**

The FRS workload requirements summarized in Table 2-2 are based on the following assumptions:

- Supports the FY2015 workloads as derived from the CJIS-provided Workload Tables version 4.1p.

Table 2-2: Peak Hourly Photo Workload Estimates for FY2015

FIF Repository	
Searches, full repository	14
Searches, SPC participation group only	3,068
Enrollments	4,602
Deletions	36
UPF Repository	
Searches	3,068
Enrollments	2
Deletions	1

2.1.2.2 Response Times

LMC interprets the requirement for average response times to mean that acceptance testing will be performed with workloads injected at fixed intervals consistent with the relevant average hourly workload as specified in the requirements and measured over a 24-hour period.

- The average NGI response time for facial images is one hour at the average hourly workload measured over a 24-hour period. Fifty minutes of this time is allocated to ABIS SE FRS. Response times may be greater if the workload exceeds the specified average workload.

2.1.2.3 Accuracy

2.1.2.3.1 Frontal Facial Images

FRS should exhibit accuracy against a large repository of enrolled frontal facial images consistent with NGI requirement SRS2246 when tested against frontal facial photos whose quality is consistent with that FBI data used for National Institute of Standards and Technology (NIST) Multiple Biometric Evaluation (MBE) testing. SRS2246 has been updated, consistent with the FRS Trade Study Report and the request for ECP direction, to require NGI to return the correct candidate a minimum of 85% of the time within the top 50 candidates.

2.1.2.3.2 Unsolved Photo Facial Search

The NGI system requirement for unsolved photo facial search accuracy, as stated in SRS2252, is 75% at a False Match Rate (FMR) of 0.1%. Search accuracy using unsolved photos was not evaluated by NIST MBE testing and the FRS vendor does not believe that this level of accuracy is achievable using facial images that are representative of true unsolved photos. This requirement will be evaluated during Increment 4 development using representative GFE data. If it is found that the FRS product is unable to achieve this requirement against representative data, LM will request that SRS2252 be waived. The risk of not achieving SRS2252 is being tracked by NGI program risk Eng_333.

2.1.2.3.3 SPC Facial Search

The NGI system requirement for SPC photo facial search accuracy, as stated in SRS2255, is 95% at an FMR of 0.1%. This accuracy is greater than that demonstrated at the NIST MBE against repositories much larger than anticipated for NGI SPCs. Searches against SPCs containing unknown identities would be expected to meet the UFP accuracy. This requirement will be evaluated during Increment 4 development using representative SPC repository sizes. If it is found that the FRS product is unable to achieve this requirement against representative data and repository sizes, LM will request that SRS2255 be waived. The risk of not achieving SRS2255 is being tracked by NGI program risk Eng_333.

2.1.2.4 Removed and Modified Requirements

This section addresses removed and modified requirements that were not addressed in preceding subsections.

CJIS and LMC have jointly modified the requirements that were flowed down to the vendor. The modifications were to provide corrections or clarifications to the original requirements. These requirements are contained within the FRS SOW and are highlighted below with shall numbering carried over from the FRS SOW.

- The Supplier solution shall (444) return the correct candidate a minimum of 75% of the time, when a correct candidate exists in the UPF for a cascaded facial recognition search of a UPF; and return an incorrect candidate no more than 0.1% of the time for a cascaded facial recognition search of a UPF.
- The Supplier solution administrative functions shall (461) include the ability of adding or removing processing resources to accommodate change in processing workload.
- The Supplier solution shall (475) provide digital image processing capabilities to extract facial structure information to include the geometric identification of the subject's eyes from a submitted image in support of the end user display interface.
- The Supplier solution shall (476) accept EBTS compliant images and variations of NIST-formatted images to support legacy formats as enumerated in the Interface Control Document.
- The Supplier solution shall (585) allow the capability of logging activities related to backup and restore events. The intent of this is to ensure that audit capabilities are turned on in the solution.
- The Supplier solution shall (531) be capable of meeting the projected peak hourly workload for UPF repository searches contained in the FRS Derived Performance Requirements table.
- The Supplier solution shall (586) allow the capability of logging activities related log start and stop events. The intent of this is to ensure that audit capabilities are turned on in the solution.
- The Supplier solution shall (589) operate with NGI protection tools for file integrity checking. NGI integrity checking will be implemented by installing a Tripwire agent on all of the solution servers.

Per Contracts Letter *COL-2011-0020, Request for NGI Interstate Photo Capability Biometric Modification*, the following requirement is expected to be modified as noted:

- SRS2246 will be modified to indicate that the measured accuracy will be for the correct candidate in the top 50 candidates returned: The NGI System shall return the correct candidate a minimum of 85% of the time within the top 50 candidates, when it exists in the searched repository, as a result of a facial recognition search in support of photo investigation services.

Per Contracts Letter *COL-2011-0020, Request for NGI Interstate Photo Capability Biometric Modification*, the following requirement is expected to be removed and is not addressed further in this proposal:

- Since SRS2246 states that the correct candidate is in the top 50 candidates, no false match requirement is required. Accordingly, SRS2247 which establishes a 20% false match requirement will be deleted.
- LMC acknowledges that the HMI needs will be met by the FBI's Universal Face Workstation (UFW) which will be provided as GOTS to LMC for incorporation into the NGI system. Therefore, Human Machine Interface requirements have been removed from this RFP and response.

3 FACIAL RECOGNITION CAPABILITIES

The facial recognition component of NGI's multimodal biometric framework is built around the ABIS® SE FRS from L-1 Identity Solutions. The COTS product relies heavily on industry standards for both its external and internal interfaces. It also relies on standards-based open source implementations for web services and messaging. The ABIS SE is the component responsible for:

- Image processing services, including image quality analysis and feature template extraction from images.
- Gallery management services, including addition, removal, and update of template records and their associated filter demographics to/from/within search galleries.
- Gallery search services, 1:N search of target galleries with image or template probes.
- Pair verification services, 1:1 matching of a pair of biometric template and/or image samples.

NGI defines two facial repositories, the FIF and the UPF. These are similar in purpose to the Latent Friction Ridge's (LFR) FRIF and Unsolved Latent File (ULF), respectively. FIF maintains features for known subjects across event cycles, which the COTS product documentation refers to as "encounters." The UPF maintains features for unknown subjects against which cascaded searches are performed. The search repositories (FIF and UPF) are maintained and managed by ABIS SE FRS.

The NGI facial search solution is composed of ABIS, NGI business services and the UFW. The Increment 4 architecture shown in Figure 3-1 shows the ABIS SE FRS within NGI. The UFW and the NGI developed HMIs are also highlighted but are outside the scope of this Bio Mod. They are shown in the figure as this is how the Face Examiners will access the capabilities of NGI's facial solution.

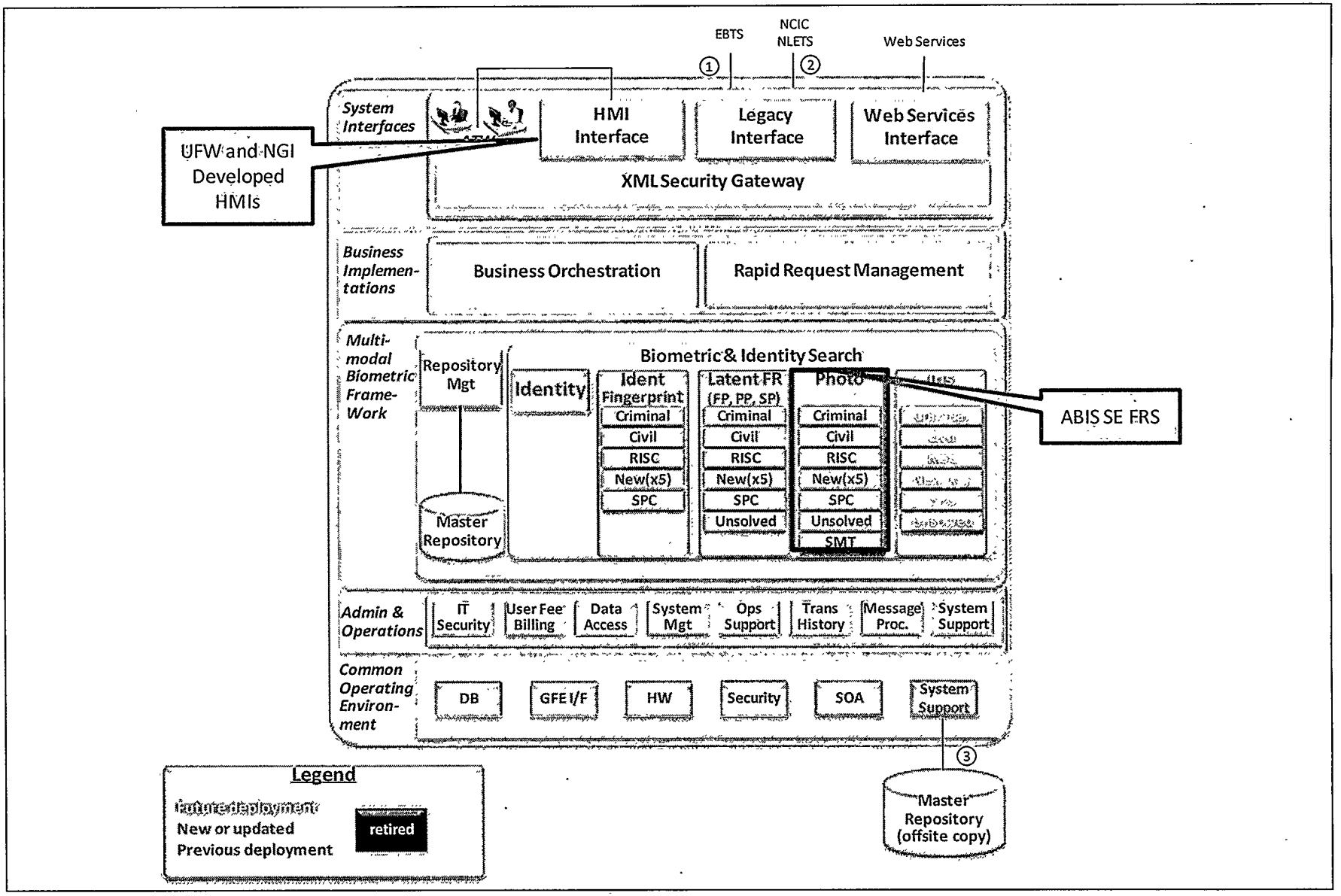


Figure 3-1: Facial Recognition System Within NGI Architecture

This section describes the facial search capabilities to be provided as a result of this Bio Mod. It is organized to address the following subsections – topics:

- **3.1 – ABIS SE FRS Solution Overview**: the technical overview of the L-1 COTS product for maintaining and searching the repositories for facial photos
- **3.2 – ABIS SE FRS Architecture**: the logical architecture of the L-1 COTS product and how it will be physically manifested in its implementation for NGI
- **3.3 – ABIS SE FRS Performance**: the capacity, scalability, and availability of the FRS solution
- **0 – Integration with NGI**: how the ABIS SE FRS solution will be integrated into NGI's Service Oriented Architecture and operations infrastructure
- **3.5 – Interfaces**: how the ABIS SE FRS product interfaces to NGI and to existing systems
- **3.6 – Development and Integration**: how the ABIS SE FRS product impacts the development and integration activities and an assessment of the maturity of the COTS product
- **3.7 – Deployment and Transition**: the actual quantities by site and by environment along with a discussion of what is required to transition legacy data to the new search solution and the impacts to system/support personnel associated with the transition to the new system
- **3.8 – Testing**: the test activities that have or will be conducted to validate the scalability and functionality of the integrated solution.

3.1 Solution Overview

3.1.1 ABIS SE FRS Overview

ABIS SE FRS is a COTS search engine that is architected to be integrated into a larger solution such as NGI rather than working as a stand-alone product. The integration services of the product are compatible with NGI's Service-Oriented Architecture, offering SOAP-based interfaces to biometric services for enrollment, feature extraction, searching, and repository maintenance.

This section focuses on describing the functionality of the off-the-shelf ABIS SE product. As such, not all functionality described will be used in the NGI setting, as noted in the text. Subsequent sections place the COTS product into the context of NGI.

3.1.1.1 Functionality

The functionality of ABIS SE can be grouped into three system service families as shown in Figure 3-2. System Integration services are used to integrate ABIS SE into NGI at the programming level for the purpose of satisfying requests for biometric functions and facilitating administrative operations. System Management Services manage system operation by controlling, recording, or reporting the current state of the system. Biometric Services provide template creation, matching, and gallery management services.

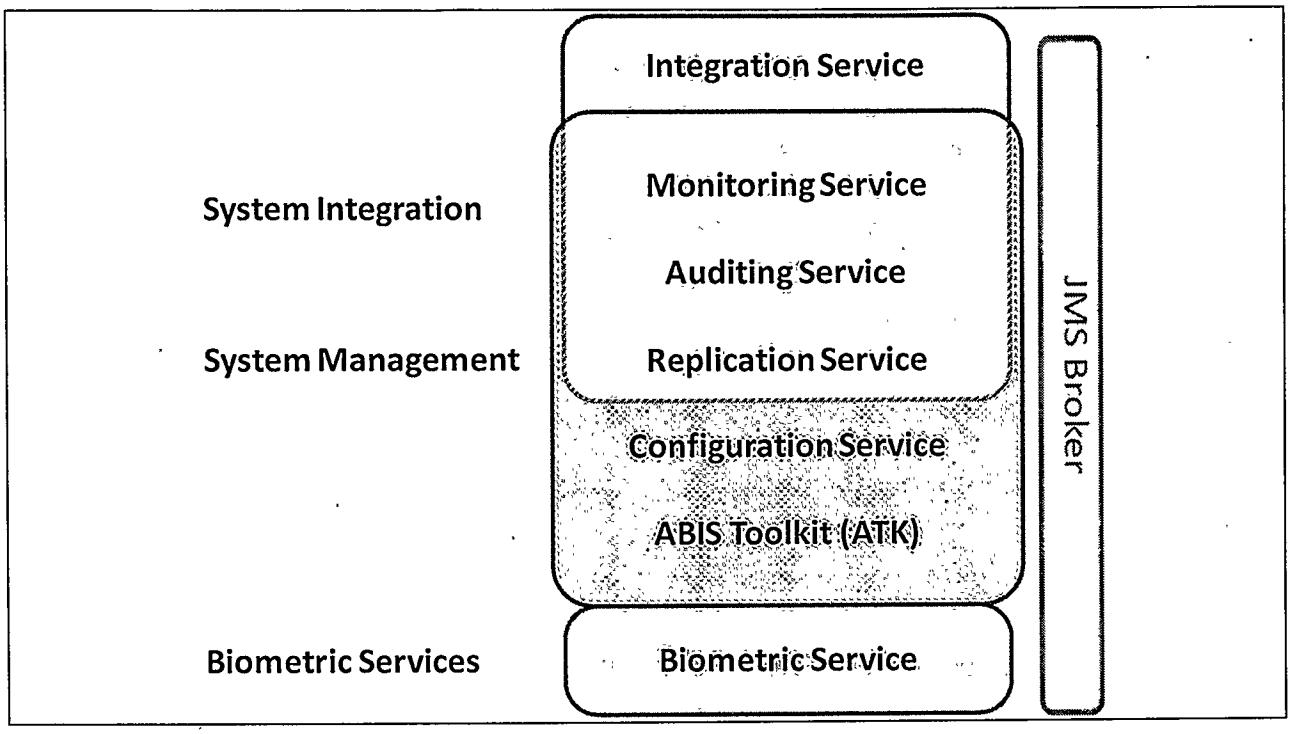


Figure 3-2: ABIS SE Service Families

3.1.1.2 Integration Service

The Integration Service is the primary integration point for Biometric Services. It consists of a SOAP interface that is used to support all of the high-level system biometric functions needed by NGI including: Facial Image Search, Extract Features, Subject Image Add, Subject Features Delete, Subject Features Update, Subject Biographic Data Update, and Subject Associated Data Update. The Integration Service is configured to support multiple clustered instances for high availability.

3.1.1.3 Monitoring Service

The Monitoring Services is a stateless service that continuously monitors all system notification, trace, and performance messages through the JMS queues. It is configured with a number of filters to send administrative alarms and diagnostic messages under specified conditions. It is configurable to add custom alerts based on thresholds and conditions. Email, JMS alerts and customizable alerts are available. Furthermore, the Monitoring Service monitors all known system components for health and status. The COTS Monitoring Service by default listens to all notification messages and for every message at the "alert" level creates a message on a special queue that can be used to track important events. It also tracks statistics on operating performance, which is mostly timing information generated by each component (i.e., template creation time, insert time, search time). By default every hour a report is generated and placed on a reports queue that contains the latest statistics value. An administrator can configure alerts based on any of the statistics that are tracked.

3.1.1.4 Auditing Service

The Auditing Service is the central point of trace, alert, and transaction logging of ABIS SE. In addition to providing central logging of all system notifications, this service allows archiving transactions from the last backup or all transactions from all time. It contains all the information of system backup and restore points. It is coupled with a Hibernate layer for Oracle Relational Database Management System (RDBMS)-based persistence of all data, including trace, notifications, alerts, transactions, and backup and restoration information. Multiple Audit Services and RDBMS storage targets are configured in a completely replicated configuration for high availability. This component may also be used to perform "replay" execution of transactions from a point in time past to present if necessary to recover operational state from the effects of high-impact resource outages. NGI does not anticipate needing to use this service since existing facilities handle log collection and reduction, alerting, backup and restore and ensuring transaction completion.

3.1.1.5 Replication Service

The Replication Service performs both the function of transaction replication to alternate system sites as well as transaction replay to the point of failure in disaster recovery scenarios. This is an integration ready component designed to be used within a customer backup infrastructure in either a manual or automated pattern. The NGI solution does not require the use of this service as there is no alternate system site and the facilities provided by the Enterprise Storage Area Network (ESAN) and System of Services Integrated Tape Storage System (SITS) already provide the required backup infrastructure.

3.1.1.6 Configuration Service

The Configuration Service is the central point of system configuration of ABIS SE FRS. It allows fully automated federation and de-federation of services during normal operations, management of overall licensing, distributed system configuration, and low level biometric operation configurations. It contains an administrative user interface to view current system status and retrieve and update system configurations in the form of XML documents. This service is coupled with a Hibernate layer for Oracle RDBMS-based persistence of system configuration information. The Configuration Service and database storage mechanism is configured using Oracle Real Application Cluster (RAC) to support multiple clustered instances for high availability.

3.1.1.7 Biometric Service

The Biometric Service is the core biometric service provider containing biometric Software Development Kit (SDK) handler processes. It performs all functions of Identification, Verification, Template Creation, Quality Analysis, and Gallery Management to add encounters to or remove them from named galleries. It allows configurable multi-process, multi-pipeline, and multi-threaded implementations. Biometric Service can either be part of a named system gallery or allocated to the Spare Pool for stateless services. As part of a Named Gallery in the system, the Biometric Service contains either all or a subset of the gallery to which it is assigned as part of a Group. As part of the Spare Pool for stateless services, it services all Verification, Template Creation, and Quality Analysis routines, naturally load balancing through request competition against incoming queues. Note that the NGI implementation does not allocate additional servers as explicit spares to the Spare Pool as sufficient servers are included to meet throughput, capacity, and availability requirements.

3.1.1.8 JMS Broker

The JMS Broker is the communications fabric for all internal operations. All messages passing through the system are either plain JMS messages or JMS with Attachments based on the type of service being leveraged.

3.1.1.9 ABIS Toolkit (ATK)

ABIS Toolkit is a Graphical User Interface (GUI) tool for managing distributed ABIS software. This tool allows authorized system administrators to visually edit and modify deployment descriptors and manage low level administrative tasks on large numbers of ABIS servers. Further, the tool permits management of mass-scale Backup and Restoration scenarios, cache management, and transaction replay to point of failure in disaster recovery scenarios utilizing the Replication and Audit Services (N/A for NGI, which has enterprise backup and restore capabilities).

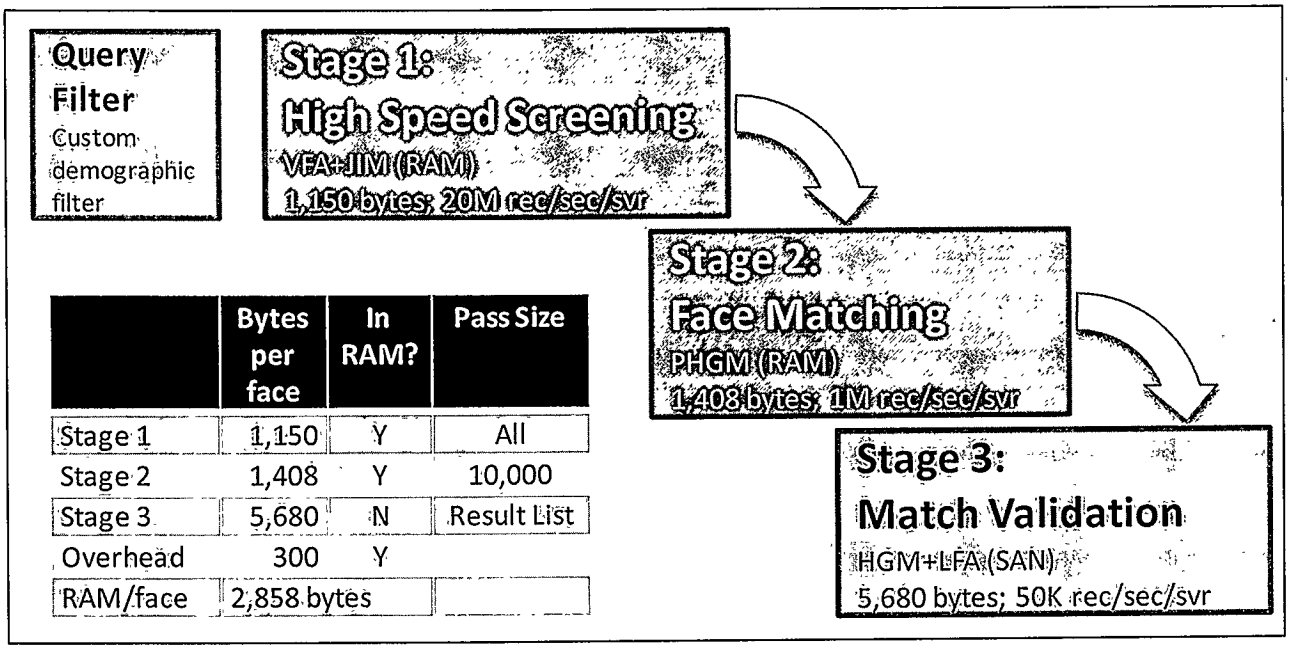
The ATK is a management tool that is useful for installation, configuration management and systems management. There are four categories of tasks that the ATK supports:

1. System based tasks, these operate on the system as a whole, such as connect and monitor, backup and restore (not applicable to NGI)
2. Host based tasks such as install, uninstall, reboot, shutdown, run commands, get/put files and ping tests.
3. Service-based tasks such as start/stop/status of services, get logs, clear logs, and JConsole.
4. ABIS Component-based tasks such as start/stop/status of components, manage components and pause/resume Biometric Services and clear/checksum the cache of the Biometric Services.

3.1.2 ABIS SE FRS Matching Technology

FRS achieves high accuracy and throughput by combining the strengths of three stages of matching shown in Figure 3-3. These three match stages are as follows:

1. High Speed Screening
2. Face Matching
3. Final Match Validation



	Bytes per face	In RAM?	Pass Size
Stage 1	1,150	Y	All
Stage 2	1,408	Y	10,000
Stage 3	5,680	N	Result List
Overhead	300	Y	
RAM/face	2,858 bytes		

Figure 3-3: FRS Matching Stages

Stage 1 uses L-1's patented Vector technology (VFA), (United States [US] Patent 6,920,231) fused with a technology called Joint Image Matching (JIM). VFA is based on transitivity of matching while JIM employs a categorization scheme and membership probability based local features. Together these are 1,150 bytes and match at over 20M records/sec/server. These technologies act as a fuzzy matcher to screen out non-matches. The results of the Stage 1 search are sorted by match likelihood. The number of records passed to Stage 2 (penetration depth) is configurable but is typically kept fixed at a value of 10,000 records.

Stage 2 is the main face matching algorithm. Pyramidal Hierarchical Graph Matching (PHGM) executes approximately 1M matches per second using a 1,408-byte template cached in Random Access Memory (RAM). It is patented (US 7,113,641) and operates on a dedicated grid structure and can be adjusted to the characteristics of the gallery. The match rate is 1M records/sec/server. After this matching stage, the results can be returned from the system. However, for improved Reliability vs. Selectivity performance, the final candidates are passed to the third-stage matcher to validate the match result. In the case of NGI, the number of results returned is expected to be 200.

The final Stage 3 validation uses a combination of the traditional Hierarchical Graph Matching (HGM) approach fused with Local Feature Analysis (LFA). These final matchers are used to ensure a very low false match rate. Though they are relatively fast, the speed is not realized in practice since records are too large to be maintained in RAM. The matchers are typically throttled by the speed of retrieving templates which is typically on the order of hundreds and sometimes a few thousand per second, depending on the actual I/O speeds provided by the ESAN. HGM is similar to PHGM. The technology has proven to be flexible, providing a basis for both 2-D and 3-D face recognition, and shows superior performance in applications with databases of photographs of varying quality. HGM represents the face by means of a flexible grid, called the graph, which is adjusted to the specific face pose and expression by adjusting size, position, and internal distortion. A total of approximately 2,000 characteristics are used for the analysis. LFA works with face images with an Inter-Eye Distance (IED) of as little as 30 pixels, but is optimized for IED of 60 pixels or more. LFA locates and compares specific macro-features of the face such as corners of the mouth and corners of the eyes.

During all stages the scores of the current and previous stages are fused to improve accuracy. This internal matching fusion dramatically improves accuracy because the algorithms leverage non-correlated face feature data.

3.1.3 ABIS SE FRS Architecture

ABIS SE FRS supports partitioning of the facial gallery across multiple servers. This is analogous to the use of multiple servers in a string in Morpho Biometric Search Services (MBSS) in IdFP and LFR each with a different "slice" of the gallery. Based on the size of the gallery and the available memory in a server, the gallery is divided across multiple servers. As the gallery grows, new entries are added to a server. Once it exceeds the capacity of the existing servers, an additional server is added. This is analogous to increasing the string length in MBSS.

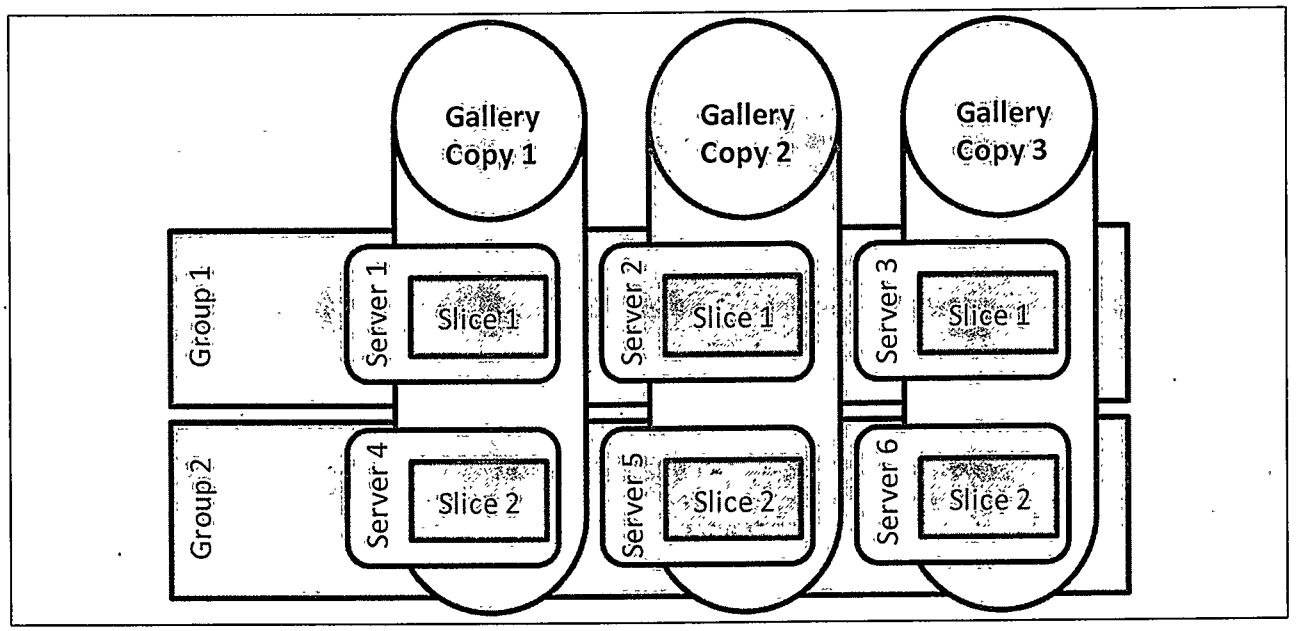


Figure 3-4: ABIS SE FRS Groups

Throughput is increased by creating multiple copies of each slice of the gallery similar to the MBSS approach of adding strings. The multiple servers used to achieve the required throughput are put together in a "Group". If the size of the gallery requires that it be split across multiple servers, then multiple Groups are required. Figure 3-5 illustrates a scenario where the gallery needs to be split across two servers and three servers are required to meet throughput and availability requirements. This example is analogous to an MBSS matching grid of 3 strings of 2 Match Units each. The illustration of the gallery split vertically is only to provide a comparison to MBSS, there is no affinity across groups (i.e., between server 1 and server 4).

The number of servers in a group must also account for the availability and recovery scenarios. So similar to MBSS where an additional string is added, for the Facial System, additional servers are added to each group. The number of servers specific to NGI is discussed in Section 3.3.3.

The Integration Service queues the match request for each Group as shown in Figure 3-5. The first available server in each Group retrieves the search request and processes it. This is a "pull" mechanism similar to the majority of NGI functions, differing from the "push" mechanism of MBSS Match Managers, which explicitly task individual matching unit servers. There is no affinity between Group members or Groups and instances of the Integration Service.

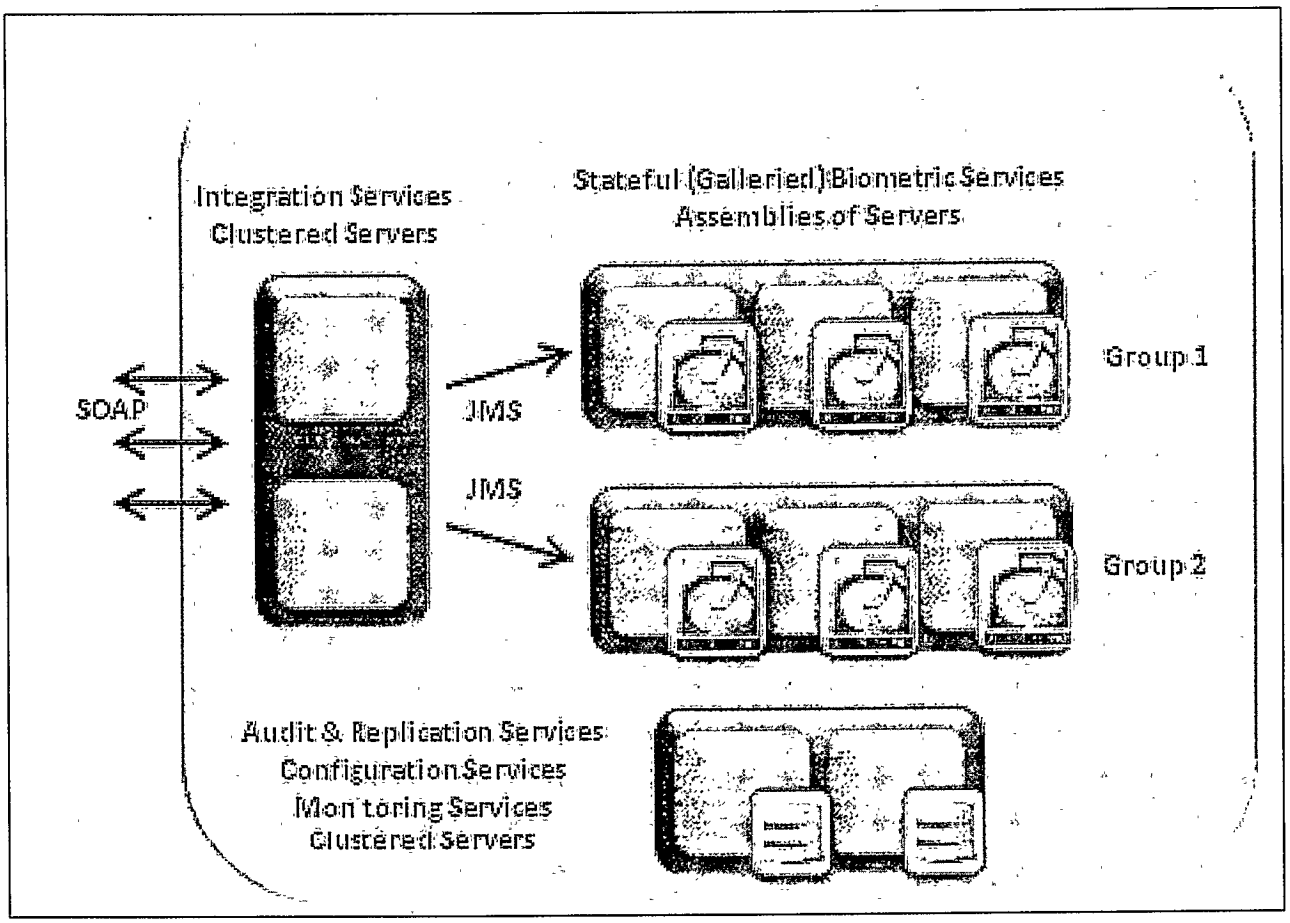


Figure 3-5: ABIS SE FRS Integration Services and Biometric Services

Using the example configuration in Figure 3-4, if a request comes in, one message would be placed in the queue for Group 1 and one for Group 2. Any server in Group 1 could process the request (for example server 1) and perform the match against Slice 1 of the gallery. Any server in Group 2 could process the request (for example server 6) and perform the match against Slice 2 of the gallery. Note that this is different than MBSS, where the request would be explicitly directed to either server 1 and server 4 or server 2 and server 5 or server 3 and server 6.

Search results are collected by the Integration Service, which receives score/id sets from each Biometric Service that participated in the search. A simple merge/sort is done and the top search results are returned.

The COTS product uses Apache ActiveMQ for its default JMS Broker implementation. Internal messaging uses JMS with Attachments for images.

3.1.4 Standards Compliance

The product, as a whole, is heavily standards based as shown in Table 3-1.

Table 3-1: ABIS SE FRS Standards Support

Design Area	Applicable Standards
Client Interface Level	WS-I Basic Profile Version 1.2, Java Enterprise Edition (EE) 6 Web Profile – Ensures interoperability with non-Java web service environments SOAP with Message Transmission Optimization Mechanism (MTOM) – High performance standard SOAP communications, marshalling only Application Programming Interface (API) constituents that are required
Service Level	Java EE 6 JMS with Attachments for all Biometric Operations, System trace logging, and System Performance monitoring Jakarta Apache Commons Statistics for all performance trace diagnostics
Administrative Level	XML based Deployment Plan with XML Schema Definition (XSD) validation for system component installation and management that automatically drives the installation routines regardless of system scope XML based System Map with XSD validation for system component layout and federation guidance by the automatic configuration management XML based Template Matching, Storage configuration for all biometric pipeline stage configurations, algorithm composition SOAP Administrative command interface for deep integration Java EE 6 Java Management Extension (JMX) exposed service internals for low level monitoring of individual components atomically
Operating Environment	All services implemented as Java EE 6 Servlet Container-based processes for simple management, runtime environment flexibility, and breadth of industry management and monitoring solutions Java EE 6 JMS central communications infrastructure for open and readily integrated system internals and choice of provider and management and monitoring solutions Java EE 6 JMS-based self-registration and management of all components through Configuration Service Java SE 6 Language and Runtime-compliant system with process isolated Java Native Interface (JNI)-based Biometric Services integration

Design Area	Applicable Standards
Implementation Standards	Java Servlet (Servlets) 3.0 Java ServerPages (JSP) 2.2 Java Persistence API 2.0 Java Message Service API (JMS) 1.1 JavaMail 1.4 Java API for XML based Web Services (JAX-WS) 2.2 Java Architecture for XML Binding (JAXB) 2.2 American National Standards Institute (ANSI) SQL-99 (Audit Database [DB] Subsystem, Configuration Service) Image Types: Raw (none), BMP, TIFF, GIF, JPEGL (Lossless), JPEGB (both International Organization for Standardization [ISO]/International Electrotechnical Commission [IEC] 10918), JP2 JPEG 2000, JP2L JPEG 2000 (both ISO/IEC 15444-1) Lossless, WSQ 1.0 (FBI Certified), WSQ 2.0.1 (FBI Certified), PNG Version 6, PGM, PPM Note: The ABIS® Search Engine has been designed to either directly support or interoperate with systems that support all of the following: ANSI/NIST Information Technology Laboratory 2008 – Data Format for the Interchange of Fingerprint, Facial & Scars, Marks, and Tattoos (SMT) Information ISO/IEC 19794-2:2005 – Information Technology – Biometric Data
Biometric Standards and Interoperability	ISO/IEC 19794-5:2005 – Information Technology – Biometric Data Interchange Formats – Part 5: Face Image Data ANSI International Committee for Information Technology Standards 385:2004 – Information Technology – Face Recognition Format for Data Interchange Support for CARD COMPACT and ISO RECORD formats

3.2 Architecture

This section describes ABIS SE FRS and how it will be implemented in NGI.

3.2.1 Logical

Figure 3-6 shows the relationships between the services within the COTS product. Synchronous SOAP calls to the Integration Services result in messages being placed on internal JMS queues. A request for stateful services (matching against the content of a named gallery) will be pulled from the queue by the first available Stateful Biometric Services instance. When the service completes its work, it posts its response back to the Integration Services, which respond to the SOAP call. Requests for stateless services follow the same model.

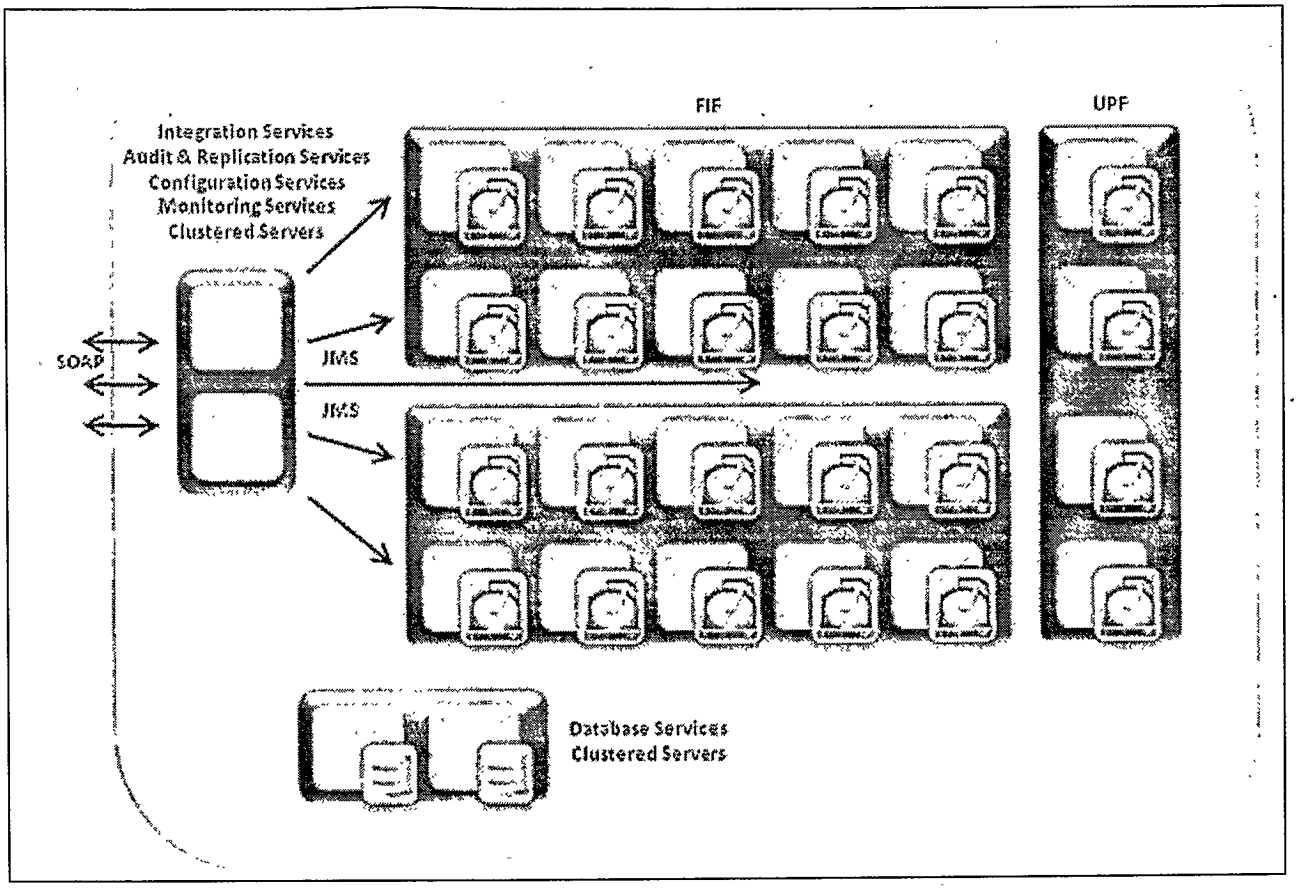


Figure 3-6: ABIS SE Logical Architecture

Stateful services such as searching are performed against the data contained in named galleries. For NGI, two sets of stateful services will be used to contain the FIF and UPF. This provides flexibility to configure and tune each set of services to the characteristics of the data in their respective repositories similar to the two repositories in LFR (FRIF and ULF). Stateless services such as template creation operate independently of retained data and nominally run at a lower priority. Although most stateless transaction requests are handled by Spare Pool services, the stateful services are nominally configured with a stateless background thread to optimize processor utilization.

In the NGI implementation, the RAM required to hold the FIF gallery data slightly exceeds the capacity provided by a single server, this requires the gallery to be split into two groups, each on a separate set of servers. As a result, this provides room for growth beyond the FY2015 projected capacity requirement. The UPF gallery is significantly smaller than the FIF gallery and fits within one server's RAM.

Annual capacity analysis will monitor projected growth in the repositories and workload and recommend any additional or upgraded equipment when warranted.

The Query Language is a feature that is built in front of the search pipeline and allows for construction of a set of query-able data descriptors. These are used for constructing logical partitions of data (as will be used for NGI) or storing various demographic or image metadata. The benefit of this built in Query Language is that rules based filtering occurs at the matcher level ahead of the biometric pipeline, thus reducing the penetration rate for faster response times.

3.2.2 Physical

The ABIS SE FRS in the OE is deployed in two racks for availability. The first rack contains two NGI standard BladeCenter chassis and the second rack contains one NGI standard BladeCenter chassis. Each chassis contains a set of uniform HS22V blade hardware to host the ABIS SE FRS services. Connectivity to these chassis is consistent with the rest of NGI with 1 Gigabyte (GB) Ethernet to the Shared Enterprise Network (SEN) for management, redundant fibre channel interfaces for ESAN and SITS, and redundant 10GB Ethernet to the SEN for all other communications. These servers depend on the ESAN for storage of system images, persistent queues, repositories, and databases. These dependencies will be quantified and characterized in a GFE request.

There are four types of servers in the NGI implementation of the ABIS SE FRS architecture as shown in Figure 3-6:

1. Biometric Services servers – these host the **Biometric Service** and compose the matching grid. They are aggregated into Groups. For the FIF there are two groups. For the UPF there is only one group.
2. Centralized Processing Servers which host the following functions:
    - **Integration Service**
    - **Configuration Service**
    - **Monitoring Service**
    - **Audit Service**
    - **JMS Broker**
3. Database Servers which are used to manage configuration and audit data.
4. Database Management Server used for database management functions (not shown in figure).

The servers hosting the UPF gallery also host the stateless biometric services such as template creation, which by definition do not require access to gallery data.

3.3 Performance

3.3.1 Capacity

ABIS SE FRS loads the data needed by the first two search stages (High Speed Screening and Face Matching) into RAM. Each record consists of 2,858 total bytes of feature data plus overhead. With the server's memory configuration of 144 GB, this limits the number of records per server to ~44.4 million after reserving ~4 GB for the Operating System (OS) and application software overheads. Comparing to the FY2015 capacity requirement of ~51.5 million records for FIF leads to the determination that two server groups are necessary and sufficient to hold the data in RAM.

The third matching stage uses 5,680 byte feature data, but only compares ~200 candidates, making it more cost effective to retrieve this data from disk. Maintaining this data in memory would have required ~40 additional highly available FIF servers, just to provide the necessary RAM capacity with negligible improvement in response time.

Table 3-2 lists the sizes of ESAN Logical Unit Number (LUN) volumes per server-type in the FRS. A full description along with I/O requirement will be developed by L-1 and LMC as part of a subsequent GFE request for the ESAN storage during deployment planning. Each new Biometric Services server will require corresponding LUNs for its OS and biometric cache. These needs will be identified during the annual capacity analysis effort.

Table 3-2: Planning Data for FRS LUNs

Service/Server Type	LUN Size Approximation	Special Considerations
ABIS Central Services, OS and Application Binaries	80GB	
ABIS Central Services, shared ActiveMQ persistence volume	50GB	Volume is shared to each ActiveMQ server, file system is shared via Government-furnished Software
ABIS Biometric Services, OS and Application Binaries	80GB	
ABIS Biometric Services, Stateful Cache	250GB	For each stateful service, this LUN will contain the biometric cache data
Oracle RDBMS server, host OS and application	20GB	Notional, pending final design in accordance with NGI practices
Oracle RDBMS server, Temp and Redo	20GB	Notional, pending final design in accordance with NGI practices
Oracle RDBMS server, data + index Automatic Storage Management (ASM) volume	250GB	Notional, pending final design in accordance with NGI practices
Oracle RDBMS server, Flash Recovery Area ASM volume	20GB	Notional, pending final design in accordance with NGI practices

3.3.2 Scalability

For the FIF, the initial deployment loads gallery records first into the first Group and remaining records into the second Group. Additional records are added to the second group. When these servers reach their capacity, and for each 44.4 million records subsequently added to a gallery, additional servers will have to be added to create new Groups. The feasibility of loading of each Biometric Services server to its full 44.4 million record capacity is pending confirmation through performance testing in L-1's factory in 4Q of calendar year 2011 on the planned code base using servers comparable to those planned for NGI. See the description of minimum group size in the Availability section. Since existing gallery records are not redistributed, the response time to search requests remains fairly constant once the initial servers' RAM is filled based on the amount of time required for one server to search 44.4 million records.

Increasing workloads eventually requires adding servers to Groups, similar to adding strings to the IdFP and LFR solutions. The analysis of when to add groups (for capacity) and/or add servers to groups (for workload) is covered under the annual capacity analysis activity.

3.3.3 Availability

The FRS solution has a predicted availability of .999996 as it is fully redundant, with no single point of failure. This fully supports the NGI system level availability requirements.

ABIS SE FRS is configured with no single point of failure through Active-Active load sharing. Client systems can communicate with any integration point (Integration Service) in the cluster and have full access to all system services. Every component in the system is clustered and fault tolerant, and ensures no single point of failure. The Database Management (DB-MGT) blade is not required for routine operation, so is not considered a single point of failure.

The ABIS SE FRS supports the Apache ActiveMQ JMS Service Provider. The Shared File System Master-Slave configuration is recommended for high resilience with no single point of failure. This configuration has two instances of the ActiveMQ JMS Service Provider. The Master is the instance of the broker that was able to acquire the shared disk lock at startup. It is the Master that makes connections available to clients. The other server enqueues on the disk lock, waiting for it to become available. In the event of failure of the master ActiveMQ server, all the connections of the services in the system fail over to the new Master (former Slave) ActiveMQ server. When the former Master server is restored, it enqueues on the disk lock and assumes the Slave role.

The minimum size of a group is three servers or in the general case, N+2, where N is the number of servers required to handle the workload. If one server can hold the gallery records for a group and has sufficient processing capacity to handle the workload, a second server is needed for redundancy should the first server fail. The third server allows for a server to be paused, relative to satisfying search requests, and used as a gallery donor to repopulate the cache of a failed server in case that server's disk cache has been corrupted and is unusable. While a server is either recovering or functioning as a donor, additions, updates, and deletes to its cache are queued up in JMS until the recovery operation is complete. At that time, the changes are pulled from the server's queue, implemented in its local cache, and the server returned to normal operation, able once again to process search requests.

For the UPF, the gallery only requires one group and only one server is needed to support the required throughput. Using the N+2 availability model a total of three servers would be required. However, since we need to protect against a rack failure, the servers would need to be distributed across two racks. A fourth server is added to allow for a rack failure. Two servers are placed in each rack. Should rack two fail, one of the two servers in rack one will be used as the donor to rebuild the servers in rack two as shown in Figure 3-7.

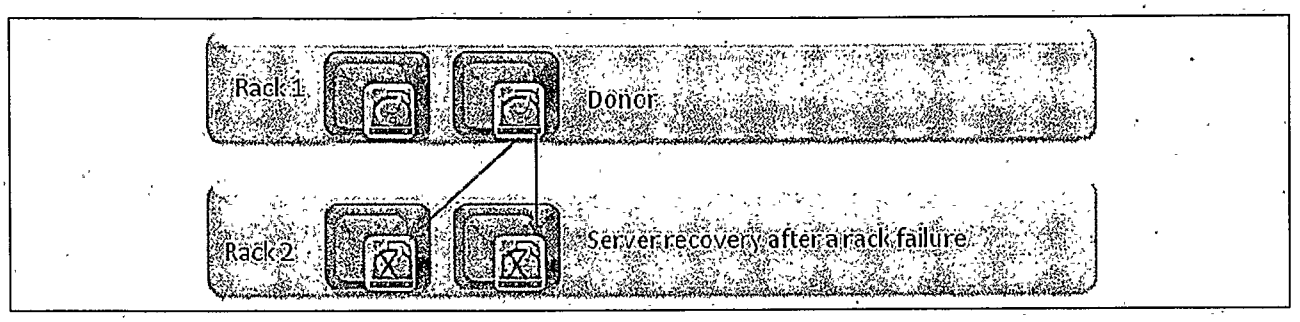


Figure 3-7: Recovery of UPF Servers

For the FIF, the gallery requires two Groups, each with four servers to support the throughput requirements. Rack one will hold five servers from Group one and five servers from Group two. Rack two will have the same configuration. Should rack two fail, one of the five servers in rack one Group one and one of the five servers in rack one Group two will be the donor to rebuild the servers in rack two.

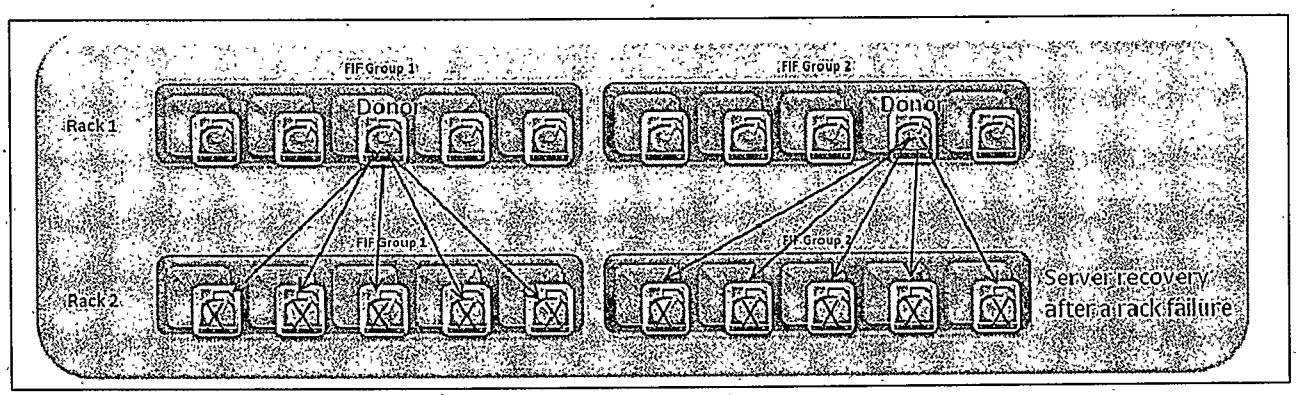


Figure 3-8: Recovery of FIF Servers

Single server failures of the UPF or FIF in either rack can easily be accommodated for rebuild by any server in either rack.

The Audit Service records all system Notifications, Alerts, Transaction Requests, Transaction Responses, and system trace. As each service within the audit service generates the audit data, it is collated into separate JMS queues. The Audit Service application reads the data from the JMS queues and serializes the data into the Oracle RDBMS. The Audit Service is deployed in a redundant configuration with two nodes in the overall system. If an Audit Service fails, that failure does not affect any processing of the other Audit Service nodes or database interactions. The repair of a failed Audit Service consists of simply bringing up the new service, and will result in no service interruption in the system or in Audit Services themselves.

3.4 Integration with NGI

The COTS product provides SOAP interfaces for user oriented services, using MTOM encoding for binary data. As shown in Figure 3-9, NGI will provide a thin front-end interface to the COTS, a JMS to SOAP Adapter, providing the same type of JMS-based interface to the rest of NGI as used by the IdFP and LFR modalities. This maintains consistency in the architecture, design, and implementation across the modalities and insulates the rest of NGI from the COTS product's interface details. This front-end also enables continued support for NGI's JMS-based prioritization mechanism as the adapter will remove higher priority requests from the JMS queue before any lower priority requests.

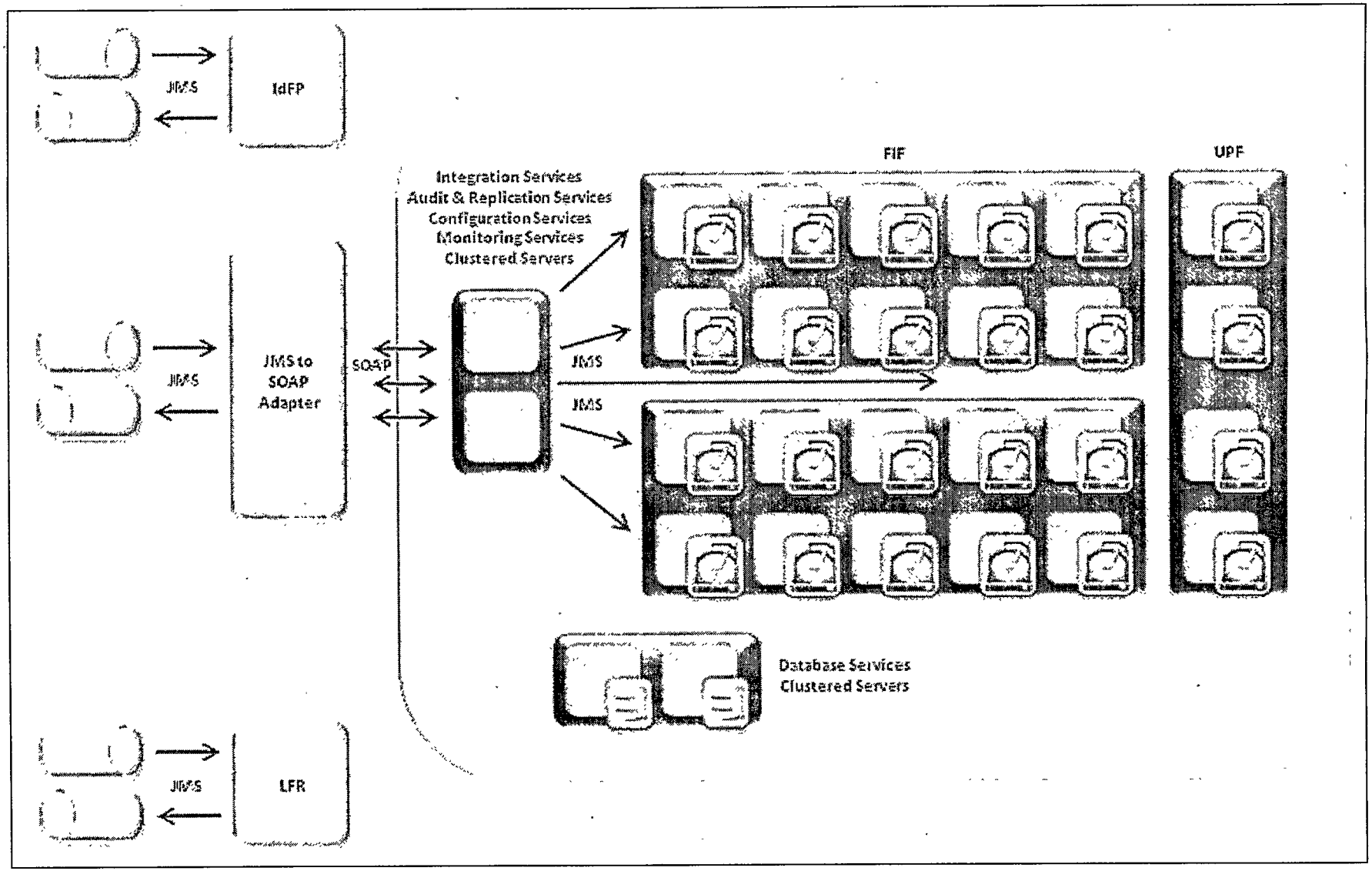


Figure 3-9: FRS Integration with NGI

As with other modalities, the search engine simply handles requests as they are presented to it. Since the SOAP requests for stateful and stateless services are synchronous, the adapter will be multi-threaded to allow concurrent service processing to occur across servers and service instances within the COTS. The number of configured threads will be tuned based upon the number of configured instances of the biometric services. Since the Integration Services do not offer load balancing, an instance of the JMS to SOAP Adapter will be configured to run on each blade running an instance of the Integration Services as shown in Figure 3-10. The JMS to SOAP Adapters will compete with each other for messages on the JMS queue inbound to FRS just as the services within FRS compete with each other for messages internal to FRS. Each instance of the JMS to SOAP Adapter will be identically configured to only make SOAP calls to its "local host" instance of the Integration Services. This creates a self-balancing, fault tolerant configuration.

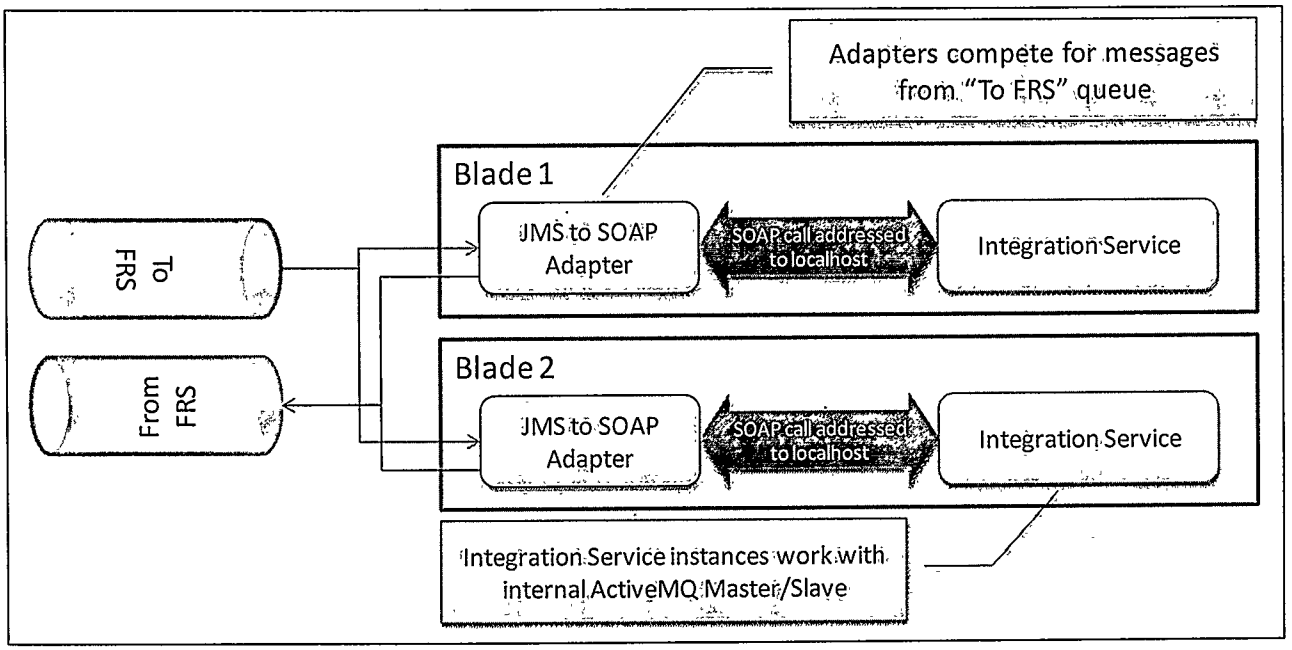


Figure 3-10: NGI JMS to SOAP Adapter for FRS Integration

ABIS SE FRS provides an administrative graphical user interface called the ABIS Toolkit (ATK). This is the prescribed means for System Administrators to configure and manage the COTS. This is a thick client application that runs locally on an Authorized FBI System Administrator's workstation.

Additionally, ABIS SE FRS exposes a number of parameters and functions through the Java Management Extension (JMX), which is the JVM's integral management interface. This provides lower level insight into and control over the running services through a Java management console such as jConsole. This is the same technology used extensively by the JBoss Operations Network (JON). The monitoring service is being enhanced by L-1 to include Simple Network Management Protocol (SNMP) support. It will be configured to generate alerts to Hewlett-Packard (HP) Operations Manager when thresholds are exceeded (e.g., queue depth or response time). The specific alerts will be identified during detailed design.

The auditing services use JMS to aggregate run-time data from across the system and provide an integration point through which that data can be accessed and analyzed for trends using NGI's standard auditing tools.

3.4.1 Security Considerations

There are no new security considerations that are specific to the addition of the proposed FRS search solution to NGI.

3.5 Interfaces

This section describes the planned interfaces from the FRS solution to NGI and to legacy CJIS GFE capabilities.

3.5.1 NGI

NGI will interface with ABIS SE FRS via the integration architecture described in Section 0. All requests for biometric operations on the ABIS SE FRS will be sent over this integration interface. The interface messages between NGI and FRS have been grouped into 8 functions as shown in Table 3-3. Each function includes one request and response message. The FRS functions and corresponding ABIS API services are specified in Table 3-3: FRS Functions. The Interface Control Document (ICD) that documents the specific message details is still under development. NGI FRS functions are mapped to corresponding request and response messages in the L-1 ABIS Search Engine COTS API. These messages will be constructed using the ABIS Search Engine API Web Service Definition Language (WSDL). These services are supported with no changes required of the ABIS SE FRS COTS.

Table 3-3: FRS Functions

FRS Function	Description	NGI BIIC	ABIS API Services
Create Template	Create a template from a passed facial image. The facial template and calculated quality metrics associated with the submitted image will be returned.	Extract Features	Create Templates Request
Add Encounter	Add a facial template and associated biographic data to the designated FRS repository. A unique biometric identifier that is to be used as the primary designation of the record will be provided with the add request.	Manage Identity	Add Encounter Request
Remove Encounter	Remove a designated facial template from a specified FRS repository.	Manage Identity	Remove Encounter Request
Contains Encounter	Return an indication whether a designated facial template exists in a specified FRS repository	Manage Identity	Contains Encounter Request
Get Encounter	Return a designated facial template that is stored in a specified FRS repository.	Manage Identity	Get Encounter Request

FRS Function	Description	NGI BIIC	ABIS API Services
Search	Search a provided facial template against a designated FRS repository. Searches will designate the subset of the repository identified by a set of participation groups, and optionally submitted biographic and quality indicators. The search returns a configurable number of candidates and associated match scores. With appropriate parameters, performs a miss analysis between two subjects, with the miss analysis data returned.	Perform Biometric-Based Search	Search Request
Verify	Compare a provided facial template against a designated template residing in a specified FRS repository. The verification will return a numeric score that is relative to the likelihood the two templates are from the same person.	Perform Biometric-Based Search	Verify Request
Filter Data Update	Replace biometrics and/or biographic data for a designated subject in the FRS repository	Manage Identity	To be specified in ABIS SE 7.3.2

3.5.2 Existing Interfaces

All ABIS SE FRS and NGI servers will reside in the same CJIS Data Center connected to the SEN. As described in Section 3.2.2, FRS blade chassis will have redundant connections to the SEN for highly available inter-processor communications between blade chassis within the FRS solution and to the NGI blades with which FRS interfaces.

The FRS search solution depends on the ESAN for storage of the FIF and UPF repositories and all other FRS file system and system boot image storage. As with LFR, images, features and EBTS files are passed by reference. NGI and ABIS SE FRS exchange images, features or EBTS files via an interface message which will include a pointer to the file on the files system on the ESAN. The interface between ABIS SE FRS servers and the ESAN is 4 Gigabit (Gb) fibre channel from the blade chassis to the ESAN switch fabric.

3.6 Development and Integration

The facial recognition solution is based on the COTS product ABIS. During the period between initial product delivery and acceptance of the product into production, L-1 will release build updates according to their product roadmap. L-1's project plan includes CJIS specific additional development activities, such as adding SNMP alert support. The ABIS SE FRS solution is proposed in one COTS delivery to LMC with full functionality based on the requirements set forth in the SOW between LMC and L-1.

Additional releases will be provided by L-1 based on availability of the fixes and defect priorities. LMC and L-1 will work together in determining a build schedule that balances these needs along with the roadmap of L-1's COTS product.

3.7 Deployment and Transition

3.7.1 Equipment/Software by Environment and Site

The tables in this section provide an overview of the hardware configuration required for the facial search solution.

A summary of hardware and software items to be purchased in this modification is provided in an Excel spreadsheet included with the delivery package of this document under the file name *105 NGI-ECP-TS-0004-2.0 SINGLES LIST.xlsx*. There are 119 total blades required, 13 total chassis and 9 total racks, which is illustrated in Table 3-4 below. The detailed Indented Parts List (IPL), which provides a detailed list of hardware and software by function, location, and environment including GFE software, is provided in an Excel spreadsheet included with the delivery package of this document under the file name *106 NGI-ECP-TS-0004-2.0 IPL.xlsx*. A summary of software associated with each type of server is provided in an Excel spreadsheet included with the delivery package of this document under the file name *107 NGI-ECP-TS-0004-2.0 SOFTWARE COMPONENTS TABLE.xlsx*.

Table 3-4: Totals for Blades, Chassis, and Racks

	OE	NOEs	LM	Total
Total Blades	31	55	33	119
Total Chassis	4	6	3	13
Total Racks	2	4	3	9

The Bill of Materials (BOM) decoder file is provided in an Excel spreadsheet included with the delivery package of this document under the file name *108 NGI-ECP-TS-0004-2.0 BOM DECODER.xlsx*. This file provides the on-contract baseline BOM (pre-Mod) and to-be BOM (post-Mod). All hardware and software components identified for the FRS solution are new and will be captured in the Increment 4 Bio ship groups in the decoder file, consistent with the IPL and singles lists.

The blade chassis for this Bio Mod will use the configuration deployed in Bio Mod 2. Figure 3-11 depicts the nominal deployment of FRF Search functionality across racks and chassis in the OE. This table has been approved by L-1 engineering and deployment/installation staff.

b7E

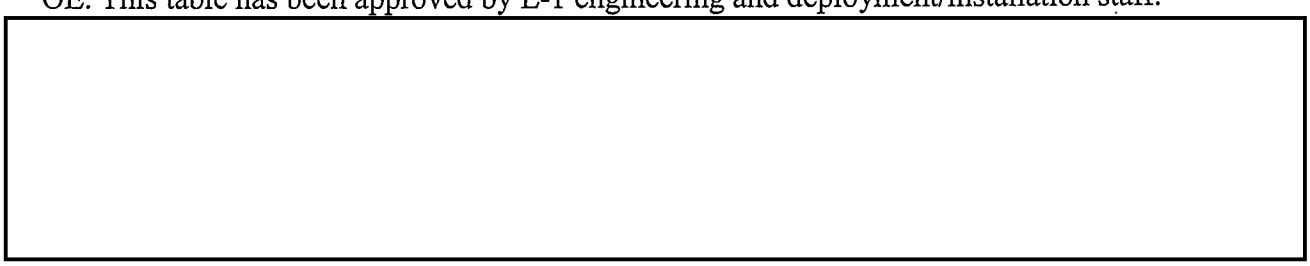


Figure 3-11: FRS OE "Chiclet Chart"

The legend for the Chiclet Chart is provided in Table 3-5. For the FIF search matcher servers, the numbering indicates [redacted] b7E
[redacted] Similarly, the UPF search matcher servers, the numbering indicates [redacted] In the event of a rack failure, a single chassis can still maintain peak workload based on FY2015 projections. A blade is included per FIF and UPF gallery group to account for a donor that is needed rebuild memory cache on a recovering server or set of servers should their disk cache become unusable. Note that a donor, if required, will be dynamically selected by ABIS, thus no donor blade is explicitly called out in the configuration. Remaining slots are occupied by Central Processing Function (CPF), Database (DB), and DB-MGT blades.

Table 3-5: "Chiclet Chart" and Hardware Tables Legend

Symbol	Meaning	OE Quantity	b7E
[redacted]			
CPF	Central Processing Function	2	
DB	Database	2	
DB-MGT	Database Management	1	

3.7.1.1 OE

The tables in this section specify quantities included in this Bio Mod. All blades are HS22V. Shelf-based cold spares are kept in storage cabinets, outside of the data center rack/chassis environment where they will not be subject to heat, vibration, and dust and are guaranteed to remain powered off. They can also be readily located when any blade in any chassis needs to be replaced without disturbing an operational rack/chassis. The FRS solution is fully redundant, with no single point of failure. Therefore, adequate Availability and cold spares ensure throughput can be maintained when blades fail.

Table 3-6: FRS Blades for OE

	Base for OE	Availability	Total for OE
FIF	8	12	20
UPF	1	3	4
CPF	1	1	2
DB	1	1	2
DB-MGT	1	0	1
Total Blades in Rack	12	17	29
Total Chassis	-	-	3
Total Rack	-	-	2
Cold Spares - Blades	2	0	2
Spare Chassis	1	0	1

3.7.1.2 NOEs

NOEs 2 and 3 have minimal redundancy to allow availability features to be tested. NOE5 is minimally configured to support development and testing, exclusive of redundancy/availability features. NOE4 blade and chassis count is identical to OE for full availability and workload testing. These configurations are provided in Table 3-7.

Table 3-7: FRS Blades for NOEs

	NOE2	NOE3	NOE4	NOE5	Total for NOE
FIF	4	4	20	1	29
UPF	2	2	4	1	9
CPF	2	2	2	1	7
DB	1	1	2	1	5
DB-MGT	1	1	1	1	4
Total Blades in Rack	20		29	5	54
Total Chassis	1	1	3	1	6
Total Rack	1		2	1	4
Cold Spares - Blades	0	0	1	0	1
Spare Chassis	0	0	0	0	0

3.7.1.3 LMC Locations

Table 3-8 summarizes the equipment needed for the development (Dev1 and Dev2) and Early System Integration (ESI) environments in Rockville, Maryland (MD), as well as the I&T environment at Lockheed Martin Middletown Mall (LM3) in Fairmont, West Virginia (WV). Dev1 and Dev2 are minimal configurations with no redundancy that are sufficient to allow development and low level testing of interfaces with the COTS product with no ability to test availability features. ESI and I&T have scaled up hardware configurations expanding the scope of testing that can be performed.

Table 3-8: FRS Blades for LMC Locations

	DEV1	DEV2	ESI	I&T	Orlando Trade Study (TS)	Total for LABs
FIF	1	1	4	4	0	10
UPF	1	1	2	2	0	6
CPF	1	1	2	2	0	6
DB	1	1	1	1	0	4
DB-MGT	1	1	1	1	0	4
Total Blades in Rack	10		10	10	0	30
Total Chassis	1		1	1	0	3

	DEV1	DEV2	ESI	I&T	Orlando Trade Study (TS)	Total for LABs
Total Rack	1		1	1	0	3
Cold Spares - Blades	1		1	1	0	3
Spare Chassis	.0	0	0	0	0	0
Accuracy Test – Blades[1]	0	0	0	0	4	4

Note 1: L-1 Accuracy Test will be performed in Orlando using existing Trade Study hardware.

3.7.2 Data Migration

By the time FRS is deployed, the existing Integrated Automated Fingerprint Identification System (IAFIS) photo images will have been migrated to NGI the NGI Object Store. These images will be enrolled into FRS prior to being placed into NGI operations. L-1 estimates that the NGI configuration will be able to enroll at least 200K images every hour, i.e., just over two days per 10 million images.

3.7.3 Operations and Maintenance (O&M)

New software products are being deployed as a result of this Bio Mod. However, the addition of these products will not change the overall software maintenance plan that is being followed. These changes will require that system administrators and software maintainers be aware of the new products, their functionality, and how these changes affect vendor support relationships when supporting the system for ongoing operations and maintenance.

3.7.4 Support

Ongoing operations and management activities include corrective and periodic maintenance. LMC maintainers or the designated Original Equipment Manufacturer (OEM) maintenance personnel perform corrective actions. This includes the diagnosis of hardware problems and removal and replacement of failed components using on site spares.

Equipment from this Bio Mod will be integrated into the existing NGI system management strategy and toolset (i.e., Tripwire, LogLogic, LDAP).

3.8 Testing

Program baseline testing will encompass integration and system level testing of the L-1 ABIS SE FRS COTS solution. The integration phase will validate that interfaces function according to specifications and the L-1's ABIS® Developer's Guide. During system level testing, a disciplined approach to ensure all requirements, functionality, performance, accuracy and documentation is fully validated prior to delivery of the COTS solution is taken. LMC will support the testing effort that L-1 has included in this Bio Mod by observing their large-scale testing and approving their factory acceptance testing.

LMC's system test plans include tasks that will verify installation procedure accuracy, configuration & tuning parameters, administration functionalities, security requirements, subsystem workflow, compatibility, interoperability, and backups. Performance and Throughput tests will be performed which will include tests for determining maximum workload, response times, system endurance, and component failover.

The Lockheed Martin team together with the L-1 project team will ensure that clear and concise requirements have been defined and all the dependencies and constraints revealed. These requirements will ultimately allow LMC and L-1 to agree upon the delivered solution and ensure the COTS solutions will adhere to these requirements and provides a source for validation during testing.

In the case of any COTS updates, the test engineers will perform regression testing during increments. The regression tests will ensure the updates do not have any side effects to the current functionality.

3.8.1 Large-scale Testing (LST)

The large-scale testing of the L-1 FRS COTS solution consists of Performance, Availability, and Scalability testing. As such, large scale testing is performed on the L-1 solution prior to delivery. This testing is performed in L-1's LST environment consisting of 12 blades and a total gallery capacity matching the FY2015 requirements.

Specific Performance and Throughput testing involves Performance Tuning, and Database performance, testing of the NGI Interface (in accordance with L-1s ABIS® Developer's Guide), and mixed workloads. LST Availability testing is on failover of biometric services. The Scalability testing involves adding blades, adding a database server, adding and moving processes, and determining maximum workload.

3.8.2 Availability

LMC personnel are planning on performing recovery testing. The High Availability testing will include testing a blade failure and a rack failure in an LMC facility.

3.8.3 Acceptance

In order for L-1 to have a large enough and representative dataset to validate accuracy requirements, testing will occur in the Orlando Trade Study environment on existing hardware. Since the vendor will not have the proper security clearance, LMC personnel are needed to have hands on keyboard and assist L-1 with their testing. This will ensure that issues can be identified early in the test cycle instead of identifying issues later in LMC System Acceptance Test (SAT).

4 VSM OVERVIEW

This biometric proposal includes the Vendor Security Mitigation (VSM) approach for two biometric vendors:

1. L-1, the Facial biometric vendor and their product ABIS developed in Bloomington, MN, and
2. MorphoTrak, the Latent Friction Ridge vendor and their HMI product, MorphoBIS developed in Anaheim, CA.

Post definitization of Biometric Modification #2, CJIS determined through the Community Acquisition Risk (CAR) process that the MorphoBIS product would also need to be object code scanned. LMC had assumed the following in Section 1.3.3 HMI Assumptions of the Biometric Modification #2 Technical Volume:

> "LMC assumes that the MT HMI (a.k.a. MorphoBIS) does not require Vendor Security Mitigation approach. The HMI developed by MT is developed in Anaheim, California, a United States facility."

Since the VSM approach is identical for both vendors, this section will use "biometric vendor" to apply to either L-1 or MorphoTrak.

The Vendor Security Mitigation approach for the biometric products will, as directed by CJIS, be the Object Scanning Approach proposed in Bio Mod #1 Part II. It will consist of a multi-layered security approach as shown in Figure 4-1.

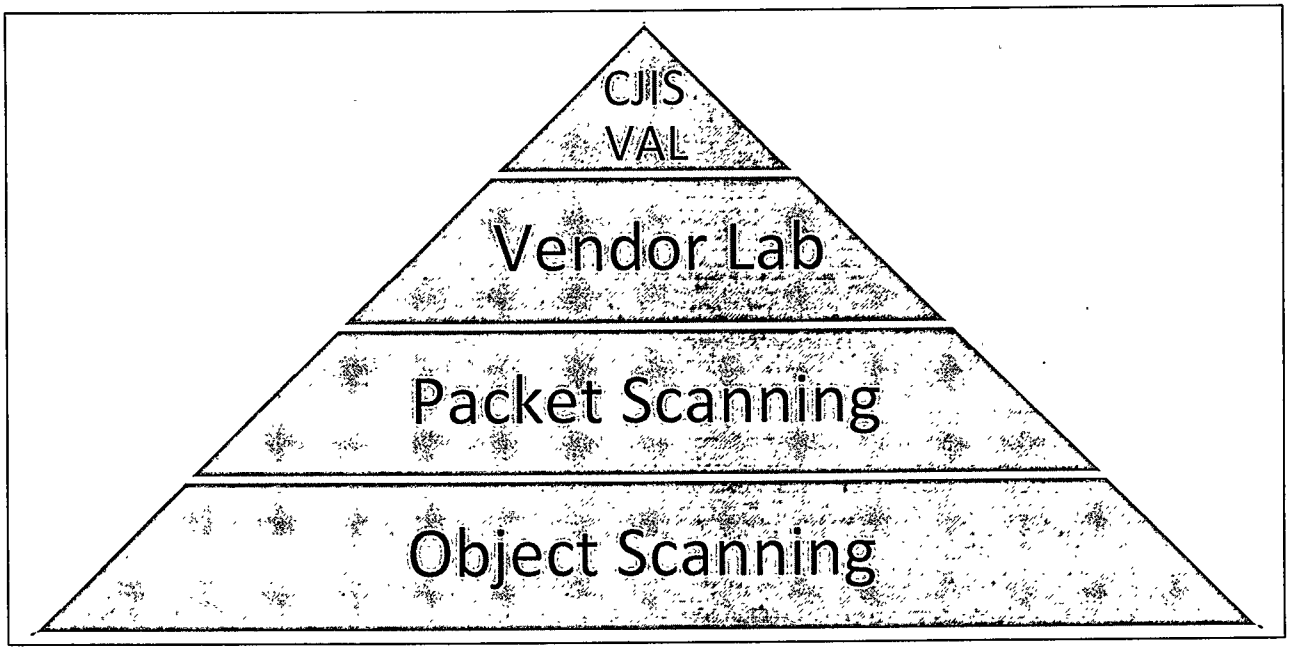


Figure 4-1: VSM Multi-layered Security Approach

- **Object Scanning**: The COTS object code managed and built by FBI cleared biometric vendor's engineers in the vendor's Lab will be delivered to CJIS to be uploaded via secure Internet connection to the analysis engine at Veracode for processing. FBI personnel will work with Veracode to analyze any warnings.

- **Packet Scanning**: The scanning systems currently installed on the NGINet will remain in-place as on-demand assets to assist the FBI with analysis and assurance.
- **Biometric Vendor's Lab**: Should hands-on analysis of the source-code prove necessary, two options are available. The first option is the biometric vendor's factory lab. FBI cleared engineers will maintain a configuration-controlled CM and build environment at the factory. FBI personnel will have access to the full source code for inspection/analysis. FBI personnel will be able to witness the process of any build to ensure that object submitted for object code scanning, matches that installed operationally.
- **CJIS VAL**: The second option for source code analysis is the VAL that has been relocated to CJIS as part of Bio Mod #1 Part II. In the unlikely event that more intensive analysis is required; the FBI will be able to request that a biometric vendor representative temporarily install source code in the CJIS VAL for analysis by the FBI.

A procedure was established during the pre-IOC period for unmodified, non-biometric vendor COTS and FOSS, which is independently obtained by cleared U.S. citizens. These COTS/FOSS items are added to the LMC BOM and vetted by the existing BOM verification process. Should any item of COTS/FOSS not achieve FBI security approval, CJIS may use object scanning to meet security requirements.

4.1 Chronology

The following is a high-level, time-phased summary of the implementation approach.

- The existing Packet Scanning capability will be continued as an on-demand capability under FBI control.
- The object code verification subcontract with Veracode with a period of performance through end of the contract, established for IdFP, will be modified to include the other biometric products.
- In order to establish a baseline to compare to future deliveries, the initial code deliveries will be uploaded to the analysis engine at Veracode by LMC. LMC will work with Veracode to analyze any warnings.
- LMC will work with the biometric vendor to take a snapshot of the build environment used to create the product. The intent is to create a "golden disk" which documents the exact configuration and contents of the factory build environment to support any future resolution of issues, should that need arise. The biometric vendor will then "lock down" this environment and review any changes in-advance with LMC and CJIS. After the environment is established, any changes to the environment will require approval by CJIS.
- As use of the CJIS VAL is a tertiary contingency, no changes or enhancements will be made to this facility for additional biometric capabilities. Any licenses or equipment required to support analysis would be CJIS responsibility upon contingency activation.

For deliveries of the biometric product, the following process will be used:

- The biometric vendor's FBI-cleared, U.S. citizen engineers will conduct the software build. One hundred percent of all products must be built from source, or approved COTS/FOSS modules. The vendor may not accept object-based components from outside sources. The vendor may not add/change COTS/FOSS without authorization via the BOM verification process.
- Veracode analysis requires debug to be enabled in the compile. It also requires optimization to be turned off. The biometric vendor will perform two builds for each delivery if necessary. The biometric vendor will compile the object code in a manner consistent with the requirements of the Veracode analysis. The compile will be automated such that it generates both the object code for analysis and the object code for execution (if two different versions are necessary) from the same source code CM repository.
- The FBI will have the right to monitor this CM and Builds and Controls process in Bloomington. This includes examining the build scripts, make files, and other build tools and processes.
- The biometric vendor will deliver the new object code release to the CJIS NGI repository and will include the object code for Veracode analysis and the object code for execution, per standard procedures and including all COTS/FOSS.
- The FBI will upload the object code to Veracode and receive a "delta" warnings report (new warnings in addition to those revealed by the previous scans). The FBI will review and disposition the report. Any new warnings are documented via the NGI Problem Report (PR) process.
- The biometric vendor will deliver the source code base for each object code delivery directly to the approved escrow agent. No source code will be stored at LMC or CJIS facilities.
- Should the FBI find it appropriate to perform a trace from the object scan warning back to source code, CJIS would do this initially in the factory with the support of cleared biometric vendor engineers. The "golden disk" and any approved environment changes would be utilized by the FBI to ensure the correlation of the factory build. Optionally, CJIS may request that an FBI cleared biometric vendor representative temporarily load the CJIS VAL to support a short-term analysis by FBI security.

4.2 Documentation and Training

None.

4.3 Hardware

None. Packet analysis hardware maintenance was provided under Bio Mod #1 Part II. No additional maintenance is required under FRS.

4.4 Software

The existing CJIS VAL will not be enhanced or extended under FRS. Packet analysis COTS software products will be maintained in accordance with Bio Mod #1 Part II. The impacts for this FRS VSM approach are captured as software costs since it is effectively an incremental update to its license and maintenance fee.

The additional software license costs do not include support for the "upon request" requirements to support analysis of warnings generated by the object code scanning or to load temporarily the source on the CJIS VAL.

5 SCHEDULE AND STAFFING

5.1 Schedule

The schedule being delivered depicts the Increment 4 reprogramming schedule in its planning and review stage. Despite the completion of the reprogramming activities, there are minor changes to the schedule artifacts being delivered. The biometric modification activities will be incorporated into the NGI baseline using normal baselining processes.

The facial search functionality is added to the NGI system during Increment 4 Build G3; for associated Level 2 milestones, please reference the PDF included with the delivery package of this document under the file name *302_NGI-ECP-TS-0004-2.0 R01 Level 2 Milestones.pdf*. The facial tasks are included in Trace ID 0190; please reference the PDF included with the delivery package of this document under the file name *304_NGI-ECP-TS-0004-2.0 R10 Full Schedule.pdf*. The Increment 4 tasks impacted by this modification are flagged in the field "acct_ext_03" with "NGI0190" and are shown in the PDF included with the delivery package of this document under the file name *305 NGI-ECP-TS-0004-2.0 R11 Impacted.pdf*.

In the PDF included with the delivery package of this document under the file name *303_NGI-ECP-TS-0004-2.0 R03 Critical Path.pdf*, the schedule impact analysis has two paths. The first path shows the biometric vendor's functional delivery in support of Delivery Handoff; initial task float is at 90 days. Path two describes the VSM activities.

L-1 has been operating under task order in advance of this modification to support LMC's design activities. The task order was funded by Biometric Modification #2 Latent Friction Ridge. LMC is leveraging efficiencies by allowing L-1 to continue into development without regard to build schedule. The L-1 delivery is in advance of the Build G3 need date as demonstrated in the 87 days of float being reported.

The Microsoft Project file of the schedule is also included with the delivery package of this document under the file name *301_NGI-ECP-TS-0004-2.0 NGI ECP IMS.zip*.

5.2 Staffing

Labor in this modification is included in the discrete Revision (REV) codes "VSM," "VSMHMI," and "BIO."

For analysis purposes, the sum of LMC labor plus subcontractor hours can be divided by the hours in a month (163 hours) to gain a Full-Time Equivalent (FTE) result. Figure 5-1 illustrates the FTEs estimated. The color coding denotes the REV code as described above. A general description of the work effort is below by REV code. Detailed BOEs and cost algorithms may be found in Section 5 of the Cost Volume.

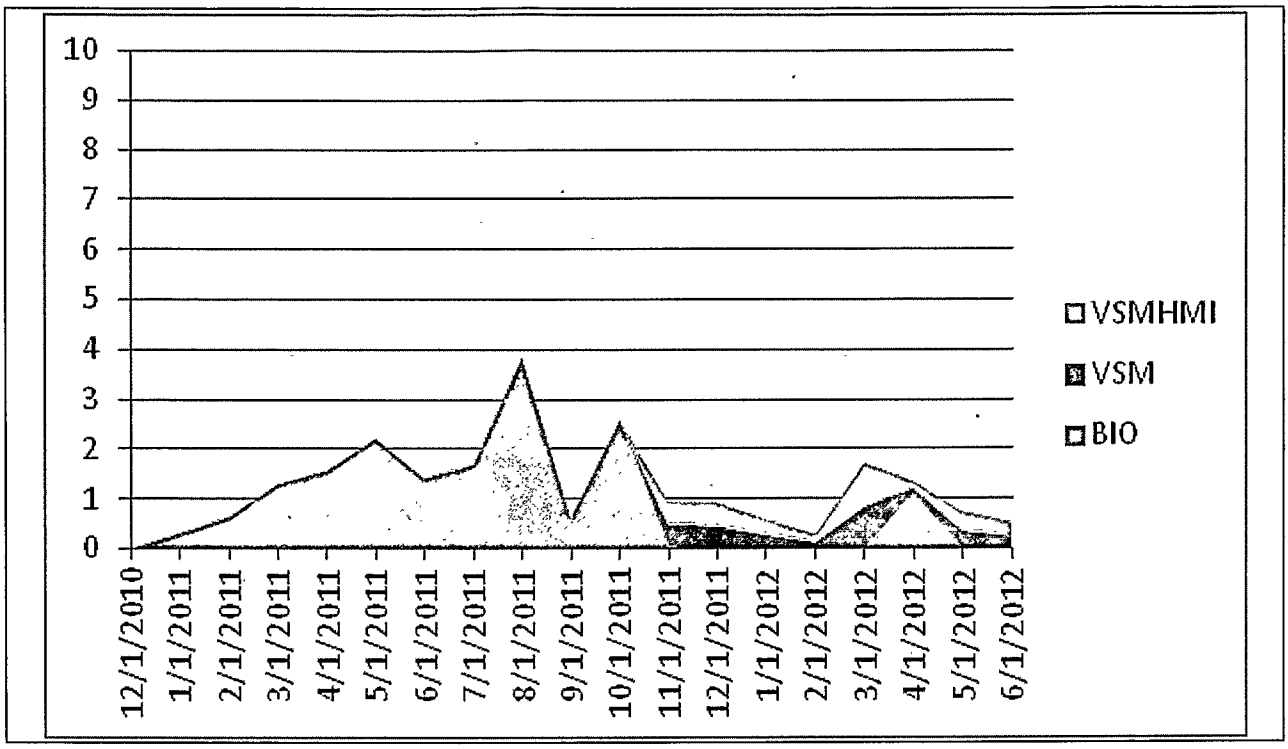


Figure 5-1: FRS Staffing

5.2.1 BIO

Proposal preparation costs are recouped as part of the biometric proposals. The staffing shown is a combination of actuals and estimate to complete. The outlook schedule projects an on-contract date in the beginning of November.

1.4.X.P500 Increment 4 Proposal Preparation

The risk mitigation activities proposed in regards to UPF and SPC accuracy testing have been included in the basis of estimate as set forth below:

1.4.7.120 Increment 4 System Engineering

5.2.2 VSM and VSM HMI

As noted in section 4, there are two biometric vendors included in the VSM approach being proposed. There is minimal impact to adding the vendor's deliveries into the NGI baseline. The primary LMC VSM work included in this Bio Mod is relative to the object code scanning and initial validation by Configuration Management and Quality Assurance of the biometric vendors' build environments. These BOEs are included:

1.3.7.123 Increment 3 System/Sustainment Engineering

1.3.X.X20 Increment 3 Cross Increment Configuration Management

1.3.X.X10 Increment 3 Cross Increment Quality Assurance

1.4.7.123	Increment 4 System/Sustainment Engineering
1.4.X.X20	Increment 4 Cross Increment Configuration Management
1.4.X.X10	Increment 4 Cross Increment Quality Assurance

6 LICENSING

This Biometric Modification proposal includes an unlimited license term for the use of the L-1 ABIS® software and test tools for any NGI program purpose. By purchasing the Unlimited ABIS license, Lockheed Martin and the FBI will be able to use the ABIS® software on the Nine copies of ABIS® in up to four different physical locations on FBI/LMC owned or controlled computer systems located in the US, regardless of the size of the NGI Facial image repositories or the number of transactions processed.

The unlimited license will grant rights to the FBI to permit other U.S. federal government agencies and departments to access NGI-related data in the course of the FBI's licensed use of the ABIS software.

A copy of the L-1 End-User License Agreement will be provided to the FBI under the file name *109 NGI-ECP-TS-0004-2.0 L-1 End-User License Agreement.pdf*. This documentation will be provided with the next delivery of the Technical Proposal.

7 ACRONYMS

Each document shall include a glossary of acronyms and definitions of common terms necessary to understand the content of the deliverable.

7.1 Acronyms

Table 7-1 lists all of the acronyms in this document and their associated meanings.

Table 7-1: Acronyms

Acronym	Term
ABIS®	Automated Biometric Identification System
ANSI	American National Standards Institute
API	Application Programming Interface
ASM	Automatic Storage Management
ATK	ABIS® Toolkit
ATW	Advanced Technology Workstation
BIIC	Business Services, Infrastructure Services, Infrastructure Components, and Common Operating Environment
BOM	Bill of Materials
C&A	Certification and Accreditation
CAR	Community Acquisition Risk
CDR	Critical Design Review
CI	Configuration Item
CJIS	Criminal Justice Information Services
CLIN	Contract Line Item Number
CM	Configuration Management
COTR	Contracting Officer's Technical Representative
COTS	Commercial Off-The-Shelf
CPAF	Cost Plus Award Fee
CPF	Central Processing Function
DB	Database
DB-MGT	Database Management
DID	Data Item Description
EBTS	Electronic Biometric Transmission Specification
ECP	Engineering Change Proposal
EE	Enterprise Edition
ESAN	Enterprise Storage Area Network

Acronym	Term
ESI	Early System Integration
FBI	Federal Bureau of Investigation
FIF	Facial Investigative File
FMR	False Match Rate
FOC	Full Operational Capability
FOSS	Free and Open Source Software
FRIF	Friction Ridge Investigative File
FRS	Facial Recognition System
FTE	Full-Time Equivalent
FY2015	Fiscal Year 2015
Gb	Gigabit – 1,000,000,000 bits
GB	Gigabyte – 1,073,741,824 bytes for RAM; 1,000,000,000 bytes for disk space
GFA	Government-Furnished Action
GFE	Government-Furnished Equipment
GFI	Government-Furnished Information
GOTS	Government Off-The-Shelf
GUI	Graphical User Interface
HGM	Hierarchical Graph Matching
HMI	Human-Machine Interface
HP	Hewlett-Packard
I&T	Integration and Test
IAFIS	Integrated Automated Fingerprint Identification System
ICD	Interface Control Document
ID	Identifier
IEC	International Electrotechnical Commission
IED	Inter-Eye Distance
IMS	Integrated Master Schedule
IOC	Initial Operating Capability
IPL	Indented Parts List
ISO	International Organization for Standardization
JAX	Java API for XML
JAXB	Java Architecture for XML Binding
JIM	Joint Image Matching
JMS	Java Message Service

Acronym	Term
JMX	Java Management Extension
JNI	Java Native Interface
JON	JBoss Operations Network
JSP	Java ServerPages
LDAP	Lightweight Directory Access Protocol
LFA	Local Feature Analysis
LFR	Latent Friction Ridge
LM3	Lockheed Martin Middletown Mall
LMC	Lockheed Martin Corporation
LST	Large-Scale Testing
LUN	Logical Unit Number
MBE	Multiple Biometric Evaluation
MBSS	Morpho Biometric Search Services
MD	Maryland
MN	Minnesota
MTOM	Message Transmission Optimization Mechanism
NGI	Next Generation Identification
NIST	National Institute of Standards and Technology
NOE	Non-operational Environment
O&M	Operations and Maintenance
OE	Operational Environment
OEM	Original Equipment Manufacturer
OS	Operating System
PHGM	Pyramidal Hierarchical Graph Matching
PR	Problem Report
RAC	Real Application Cluster
RAM	Random Access Memory
RDBMS	Relational Database Management System
RFP	Request For Proposal
RISC	Repository for Individuals of Special Concern
RM	Risk Management
SAT	System Acceptance Test
SEAU	Services, Evaluation, and Analysis Unit
SDK	Software Development Kit

Acronym	Term
SE	Search Engine
SEN	Shared Enterprise Network
SITS	System of Services Integrated Tape Storage System
SMT	Scars, Marks, and Tattoos
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol (acronym deprecated as of SOAP Version 1.2)
SOW	Statement of Work
SPC	Special Population Cognizant
SRD	System Requirements Document
SRS	System Requirements Specification
TS	Trade Study
UFW	Universal Face Workstation
ULF	Unsolved Latent File
UPF	Unsolved Photo File
US	United States
VAL	Vulnerability Analysis Lab
VFA	Vector technology (a matching algorithm)
VSM	Vendor Security Mitigation
WAN	Wide Area Network
WS	Web Services
WSDL	Web Service Definition Language
WV	West Virginia
XML	Extensible Markup Language
XSD	XML Schema Definition

APPENDIX A: FACIAL HMI REQUIREMENTS

The following table contains the NSSS facial HMI requirements.

Table A-1: Facial HMI Requirements

NSSS Tag	NSSS Text
UFW_NSSS_01	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to specify the NGI logical Repository, including SPCs that is the target for a facial image search
UFW_NSSS_02	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to indicate that facial images should be added to the UPF as part of an image search.
UFW_NSSS_03	The Infrastructure Component shall allow an Authorized FBI Service Provider to specify the Unsolved Photo File (UPF) as the designated repository for a Facial Recognition Search Request.
UFW_NSSS_04	The Infrastructure Component shall allow an Authorized FBI Service Provider to perform a "quick launch search" on a facial image.
UFW_NSSS_05	The Infrastructure Component shall allow an Authorized FBI Service Provider to manually specify eye position for a facial recogonition search.
UFW_NSSS_06	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to submit a facial recognition search request without manually specifying eye position.
UFW_NSSS_07	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to search known and unknown repositories with one user request.
UFW_NSSS_08	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to scan hardcopy facial images into an electronic format, using the workstation attached scanner.
UFW_NSSS_09	The Infrastructure Component shall provide the capability to scan facial image submissions at 300 pixels per inch (ppi) or higher, at 24bit depth and sRGB.
UFW_NSSS_10	The Infrastructure Component shall support scanning of source media up to dimensions of the attached scanner platen.
UFW_NSSS_11	The Infrastructure Component shall allow an Authorized FBI Service Provider to import facial images on the ATW.
UFW_NSSS_12	The Infrastructure Component shall allow an Authorized FBI Service Provider to import facial images in the following formats: tif, jpg, jpg2000, bitmap, and png.
UFW_NSSS_13	The Infrastructure Component shall provide an indication that no candidates were found as a result of a Facial Recognition Search.
UFW_NSSS_14	The Infrastructure Component shall provide the capability to display search results as ranked by NGI.
UFW_NSSS_15	The Infrastructure Component shall allow an Authorized FBI Service Provider to view the candidate list and the matched image associated with the candidate returned from the Facial Recognition Search Request.
UFW_NSSS_16	The Infrastructure Component shall display an indicator when a candidate returned for a search correlates to a candidate previously returned for a search within a Case.

NSSS Tag	NSSS Text
UFW_NSSS_17	The Business Service shall provide a match score for each candidate returned in response to a facial recognition search.
UFW_NSSS_18	The Infrastructure Component shall display an Unsolved Biometric Notification to an Authorized FBI Service Provider for a candidate that has a match score above the cascaded search match threshold for that biometric when the Service Provider is the owner of the biometric.
UFW_NSSS_19	The Infrastructure Component shall receive from NGI an Unsolicited Unsolved Facial Record Deletion Notification and provide the notification to an Authorized FBI Service Provider.
UFW_NSSS_20	The Infrastructure Component shall display an indication when an error message is produced.
UFW_NSSS_21	The Infrastructure Component shall display the results of a search against known and unknown repositories as separate candidate lists.
UFW_NSSS_22	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to print the image enhancement/manipulation history log for a selected encoding of a facial image.
UFW_NSSS_23	The Infrastructure Component shall provide the capability to print out the search image and the candidate image at reduced or enlarged size with and without line, notations, and marks.
UFW_NSSS_24	The Infrastructure Component shall allow an Authorized FBI Service Provider to save displayed images onto media supported by an Advanced Technology Workstation in the following formats: tif, jpg, jpg2000, bitmap, and png.
UFW_NSSS_25	The Infrastructure Component shall allow an Authorized FBI Service Provider to save the candidate list onto media supported by an Advanced Technology Workstation in EBTS format.
UFW_NSSS_26	The Infrastructure Component shall allow Authorized FBI Service Provider to delete photos.
UFW_NSSS_27	The Infrastructure Component shall display the original facial image with the applied image manipulations and enhancements.
UFW_NSSS_28	The Infrastructure Component shall retain the original facial Image when applying manipulations and enhancements.
UFW_NSSS_29	The Infrastructure Component shall log the history of all of the image processing steps applied to the original facial image to create a search image.
UFW_NSSS_30	The Infrastructure Component shall log the history of all of the image processing steps applied to the facial image that was searched during comparison
UFW_NSSS_31	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to view the history of all image processing steps performed on a facial image.
UFW_NSSS_32	The Infrastructure Component shall manage the relationship to the original version of each image created from manipulations or enhancements by an Authorized FBI Service Provider.
UFW_NSSS_33	The Infrastructure Component shall provide the capability for the Authorized FBI Service Provider to view all intermediate images created during image processing.

NSSS Tag	NSSS Text
UFW_NSSS_34	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to perform photo manipulations.
UFW_NSSS_35	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to markup feature points on both UnSub images and candidate images.
UFW_NSSS_36	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to view the original faical image with the marked facial feature points.
UFW_NSSS_37	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to save facial feature points.
UFW_NSSS_38	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to edit(add, modify, delete) marked facial feature points without impacting the underlying facial photo,
UFW_NSSS_39	The Infrastructure Component shall support the ANSI/NIST ITL standard feature set that applies to facial images.
UFW_NSSS_40	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to add lines, notation and marks to images.
UFW_NSSS_41	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to view the properties or attributes of an image (e.g., resolution, scale, size).
UFW_NSSS_42	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to view marked features superimposed on the facial image.
UFW_NSSS_43	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to perform image comparison through side-by-side display of images for known identity image to known identity image, unknown to known identity image, and unknown to unknown comparisons.
UFW_NSSS_44	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to manage multiple Cases.
UFW_NSSS_45	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to manage multiple Submissions per Case.
UFW_NSSS_46	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to manage multiple Evidence Biometrics per Submission.
UFW_NSSS_47	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to manage multiple Unsolved Subjects per Case.
UFW_NSSS_48	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to manage multiple Evidence Biometrics within the context of an Unsolved Subject.
UFW_NSSS_49	The Infrastructure Component shall manage manually entered biographic information, within the context of the Unsolved Subject for which it was entered.
UFW_NSSS_50	The Infrastructure Component shall provide the capability to uniquely identify each image retained in a Facial Case.
UFW_NSSS_51	The Infrastructure Component shall apply a unique identifier to each case.
UFW_NSSS_52	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to associate an FBI Case Number with a facial case.

NSSS Tag	NSSS Text
UFW_NSSS_53	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to enter and maintain the owner of a facial case.
UFW_NSSS_54	The Infrastructure Component shall store the search parameters for a search in the context of the case from which it was initiated, including information on the requestor and the time/date of the search request.
UFW_NSSS_55	The Infrastructure Component shall provide the capability to retrieve a stored search request including all of the stored information used to initate the original search, from within the context of the case against which it was stored.
UFW_NSSS_56	The Infrastructure Component shall provide the capability to modify user entered parameters of a prior search request in order to submit a new search with the modifications.
UFW_NSSS_57	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to view the list of cases which they support.
UFW_NSSS_58	The Infrastructure Component shall allow the Authorized FBI Service Provider to add an Unsolved Subject to a case.
UFW_NSSS_59	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to manually update their facial Unsolved Subjects when additional data, or images, electronic or scanned, are available.
UFW_NSSS_60	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to ingest additional images into their existing facial Submission when they are received.
UFW_NSSS_61	The Infrastructure Component shall support statistical reporting for user activities in a facial case.
UFW_NSSS_62	The Infrastructure Component shall support facial identification decision reporting.
UFW_NSSS_63	The Infrastructure Component shall retain all facial identification decisions.
UFW_NSSS_64	The Infrastructure Component shall display a visual indicator that specifies the identification decision (identification, non-identification, inconclusive) that has been made for that candidate image.
UFW_NSSS_65	The Infrastructure Component shall update the image information to record the identification decision (identification, non-identification, inconclusive) made for each candidate image.
UFW_NSSS_66	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to indicate a positive identification decision on a candidate.
UFW_NSSS_67	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to indicate a non-identification decision on a candidate.
UFW_NSSS_68	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to indicate an inconclusive decision on a candidate.
UFW_NSSS_69	The Infrastructure Component shall provide the capability for an Authorized FBI Service Provider to initiate a Identity History Summary request from the Facial Examiner HMI.
UFW_NSSS_70	The Infrastructure Component shall allow an Authorized FBI Service Provider to initiate a photo enrollment to an SPC request from the Facial Examiner HMI.

NSSS Tag	NSSS Text
UFW_NSSS_71	The Business Service shall enroll facial images into the Special Population Cognizant file when requested.
UFW_NSSS_72	The Infrastructure Component shall invoke the Physical Evidence HMI when requested.
UFW_NSSS_73	The Infrastructure Component shall display a match score for each candidate returned in response to a facial recognition search.
UFW_NSSS_74	The Infrastructure Component shall allow an Authorized FBI Service Provider to modify the biographic information for an image enrolled into the Unsolved Photo File.
UFW_NSSS_75	The Business Service shall retrieve the biographic information associated with an image enrolled in the Unsolved Photo File when requested.
UFW_NSSS_76	The Business Service shall update the biographic information associated with an image enrolled in the Unsolved Photo File when requested.
UFW_NSSS_77	The Infrastructure Component shall provide the capability to initiate the copying of identity information from other NGI repositories into an SPC file when requested.
UFW_NSSS_78	The Business Service shall copy identity information from other NGI repositories into an SPC file when requested.
UFW_NSSS_79	The Infrastructure Component shall log auditable events in accordance with the 2003 CJIS CAPP.
UFW_NSSS_80	The Infrastructure Component shall log audit event data events in accordance with the 2003 CJIS CAPP.
UFW_NSSS_81	The Infrastructure Component shall receive from NGI an Unsolved Biometric Notification and provide notification to an Authorized FBI Service Provider
UFW_NSSS_82	The Infrastructure Component shall display an Unsolicited Unsolved Facial Record Deletion Notification when received from NGI.