Department of Homeland Security

Importance of Image Quality to US-VISIT and IDENT

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IDENT Summary

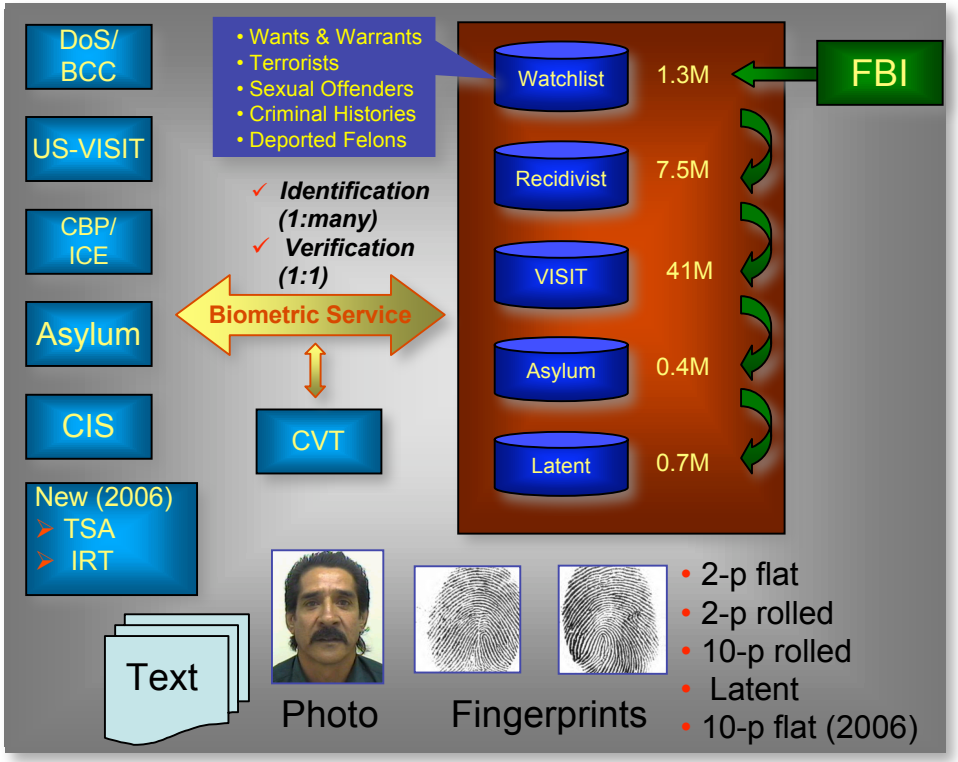
IDENT: Biometric processing system for rapid identification and verification utilizing fingerprints

Highlights

- 50 Million People (FINS)
- 65 Million Transactions (Encounters) Processed
- 125,000 Transactions/Day
- Over 10 Million Identifications
- Over 15,000 Wanted Criminals Identified (Including DC Snipers)
- NIST Certified Accuracy*
- Matcher Power of over 100 Million Matches/Sec
- Inputs From Over:
  - 15,000 Users
  - 5,000 Clients
  - 210 Countries
- Automated Synchronization with FBI IAFIS

ENFORCEMENT

Civilian



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Applications & Fingerprint Capture Types

Application	Purpose	Fingerprint Types
US-VISIT	Entry & EXIT	Live Scan Flat
Department of State	Identity Check for Visa Issuance	Live Scan Flat
Enforcement	Border Patrol & Inspections	Live Scan Flat Live Scan Rolled Inked Rolled
Customs and Immigration Services	Identity Check for Asylum and Immigration Benefits	Live Scan Flat Live Scan Rolled prints
Credentialing	Identity Check of Credential Holders	Ten Print Slaps

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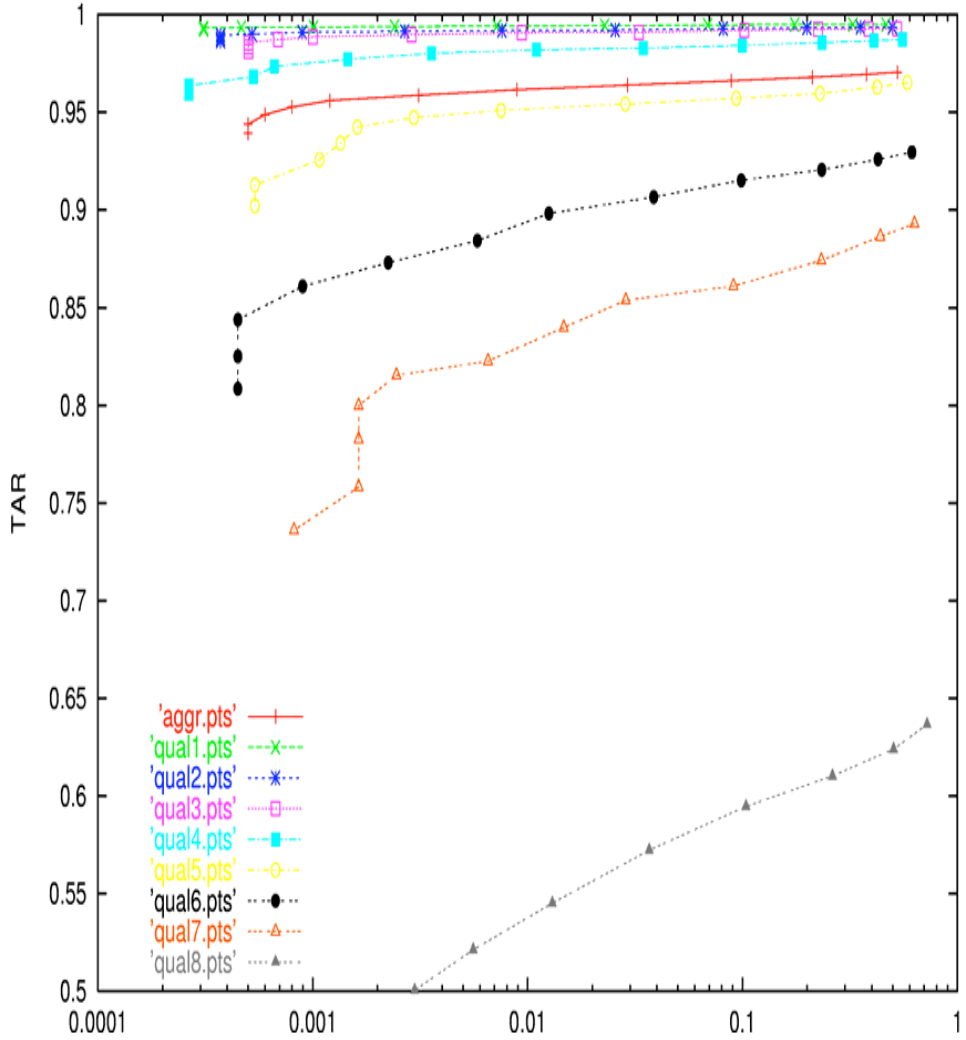
Impact of Image Quality on Matching Accuracy



NIST Studies Results:

- Image Quality Is A Good Predictor of (1:Many) Identification Matching Accuracy
- Good Quality Results In Higher Identification Match Accuracy.

NISTIR 7151

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Manual-Auto Capture Modes

- **Manual Capture (Human Assisted)**
  - Used in IDENT Enforcement Applications
  - Works Well If :
    - Operator is Well Trained and Motivated
    - Operator Has The Time to Capture Good Quality Prints From Subjects
- **Auto Capture (Machine Assisted)**
  - Used in US-VISIT application
  - Fast Capture of Good Quality Prints
  - Automated Real-time Image Quality Assessment of Fingerprint Image Frames
  - Decreases Burden On The Operator

Key Question: "Is The Human or Machine Better at Image Quality Assessment?

Advances In Image Quality Assessment Gives The Edge To The Machine!!

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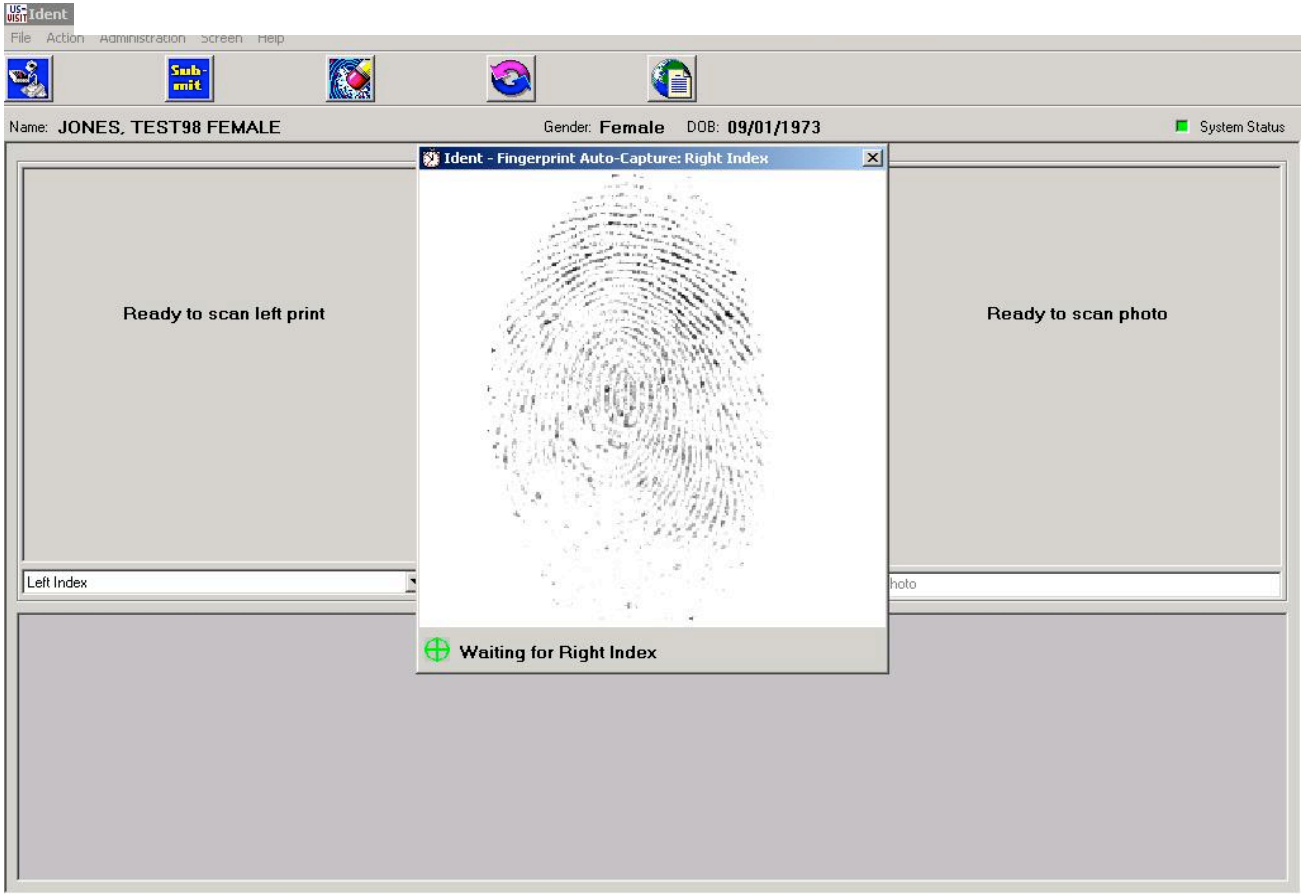
Auto Capture Process



Is finger on scanner?

↓

Begin capture

No

↓

Is image "good quality"?

↓

Yes

↓

Capture next finger

After 5 sec. if no good quality, submit best image

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Cogent Image Quality Analysis

16-byte Image Quality Array:

[0] = Noise level for useful area of image, valid values 0-4.
[1] = Image Contrast information, valid values 0-1.
[2] = Size evaluation for useful area of image, valid values 0-9.
[3] = Core position, valid values 0-1.
[4] = Core Confidence evaluation, valid values 0-4.
[5] = Poor Quality gray image area percentage, valid values 0-100.
[6] = Reserved.
[7] = Average Quality level for minutiae, valid values 0-15.
[8] = Number of Deleted Low Confidence Minutiae, valid values 0-200.
[9] = Number of Minutiae, valid values 0-126.
[10] = Poor Quality binary image area percentage, valid values 0-100.
[11] = Reserved.
[12] = Percentage of Background Image Area, valid values 0-100.
[13] = Reserved.
[14] = Re-Map Image Quality Score for Extraction Library 10.7.2
[15] = Overall Quality Level Weighted Composite of Subordinate Image Quality Attributes – Valid Value 0-127

Image Quality Assurance Process

Capture Client

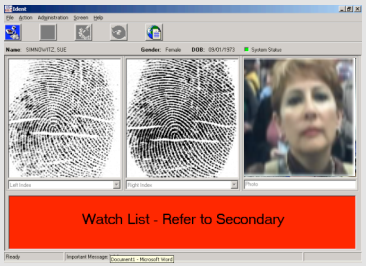
Operator Training

Auto Capture

Capture
Measure

Image Quality Feedback

Enhanced GUI For Capture



QA Process

Optimize Fingerprint Capture

- *Image Quality Monitoring*
- *Weekly Reports*

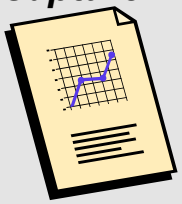
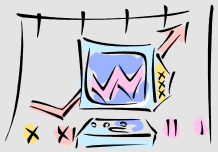


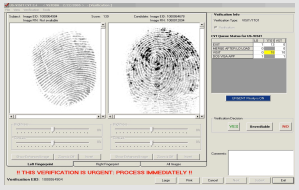
Image Quality Task Force Studies

- *End to End Process Analysis*
- *Identify Problem Areas*
- *Rectify Problem*



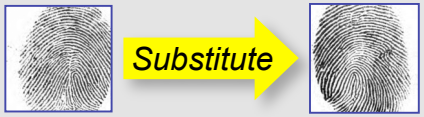
Biometric Support Center

- *Feedback from Examiners*

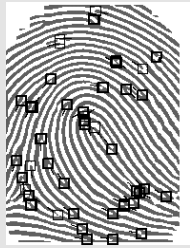


Backend Process

Use of Repeat Visitor Data to Improve Quality : "Best Finger Substitution"



Optimized Image Enhancement and Feature Extraction of Images Prior to Matching.



Use of Advanced Matching Algorithms for Poor Quality Prints

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Image Quality Assurance – Client Side

- Image quality monitoring through weekly capture statistics reports by application, by site, by terminal, by scanner, etc.
- Direct feedback of quality and capture related deficiencies of Client stakeholders to improve quality.
- Integration of DHS best capture practices across the enterprise.

Fingerprint Quality Reporting Hierarchy

(Application)

Application	Total Images	Good Quality %	Average Quality %	Poor Quality %
VISIT Entry	942,932	88.50	5.20	6.30
BIO VISA	198,292	89.70	4.70	5.60
IDENT-IAFIS	73,852	90.48	4.83	4.89
……				

(Application/Site)

SiteCode	SiteName	TotalImages	Good Quality %	Average Quality %	Poor Quality %
WVIR01B	ALEXANDER HAMILTON AIRPORT	288	93.40	2.43	4.17
WDLS04C	DALLAS-FORT WORTH AIRPORT	21612	85.81	6.35	7.83
WDEN20A	DENVER INTL AIRPORT	7724	85.56	6.73	7.70
WDET27A	DETROIT MIDFIELD TERMINAL	15782	85.02	6.36	8.62
WBOS15B	LOGAN INTL AIRPORT	13634	84.85	6.65	8.49
WMIA25Z	MIAMI INTL AIRPORT	127650	87.41	5.32	7.27
WNAS03A	NASSAU INTL AIRPORT	2620	89.01	5.53	5.46
WPHI55A	PHILADELPHIA INTL AIRPORT	9988	86.93	5.28	7.79
WWPB12A	WILLIAM B. HARTSFIELD INTL AIRPORT	12346	83.45	8.80	7.75

(Application/Site/ Terminal)

SiteCode	SiteName	TerminalID	TotalImages	Good Quality %	Average Quality %	Poor Quality %
WDEN20A	DENVER INTL AIRPORT	WDEN20A502	1138	83.83	8.44	7.73
WDEN20A	DENVER INTL AIRPORT	WDEN20A503	1062	87.95	5.74	6.31
WDEN20A	DENVER INTL AIRPORT	WDEN20A504	920	83.91	7.28	8.80
WDEN20A	DENVER INTL AIRPORT	WDEN20A501	926	85.21	6.59	8.21
WDEN20A	DENVER INTL AIRPORT	WDEN20A507	446	85.65	7.62	6.73
WDEN20A	DENVER INTL AIRPORT	WDEN20A510	276	89.13	3.99	6.88
WDEN20A	DENVER INTL AIRPORT	WDEN20A508	150	88.00	4.67	7.33
WDEN20A	DENVER INTL AIRPORT	WDEN20A514	204	90.20	6.86	2.94
WDEN20A	DENVER INTL AIRPORT	WDEN20A511	166	91.57	4.22	4.22
WDEN20A	DENVER INTL AIRPORT	WDEN20A512	286	83.22	7.34	9.44
WDEN20A	DENVER INTL AIRPORT	WDEN20A509	186	87.10	5.91	6.99

Image Quality Assurance – Server Side

Best Fingerprint Substitution

- Maximize fingerprint match accuracy
- Automated fingerprint substitution when new encounter has better quality fingerprint
- Search best possible fingerprint data
- Ensure best fingerprint image stored in database
  - Ensure best fingerprint minutiae stored in matcher subsystem components
- Image Quality score used in criteria for fingerprint substitution

Currently dual finger replacement is supported. Considering single finger replacement option in the future.

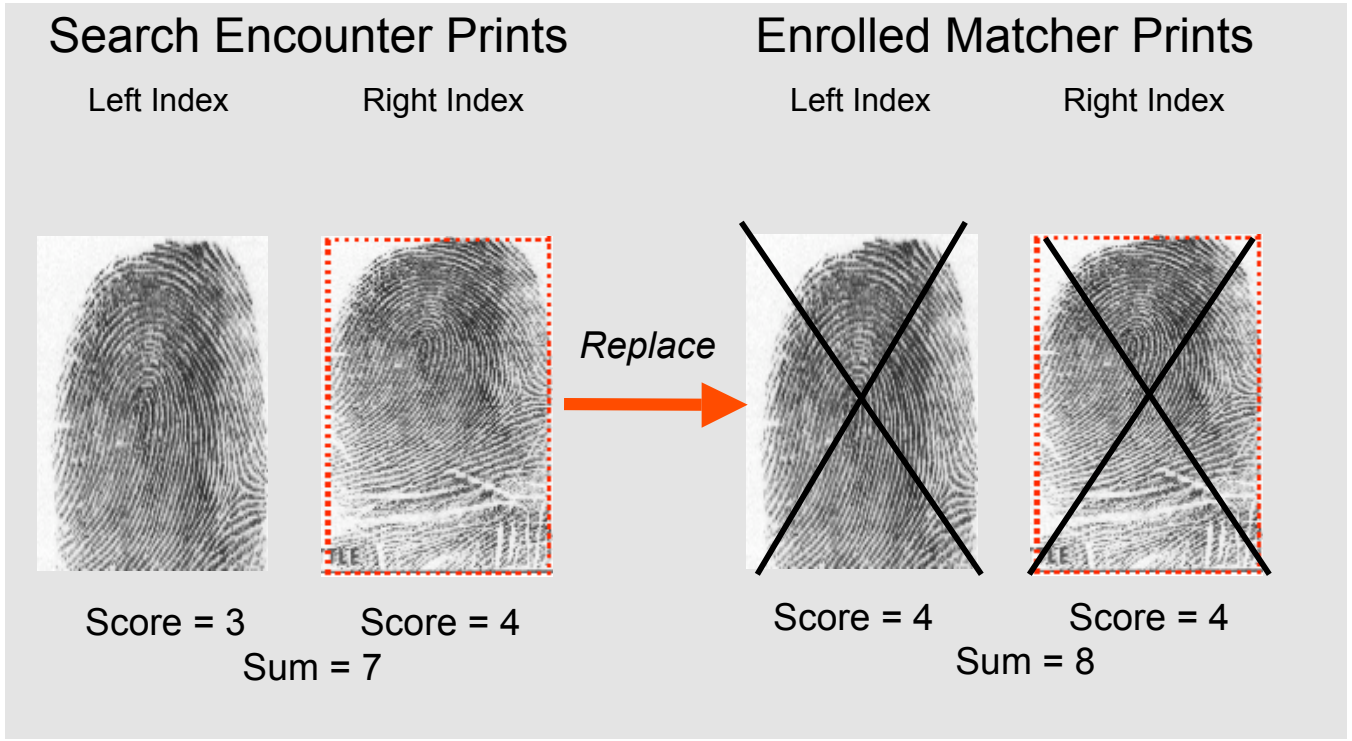
Best Fingerprint Logic – Replacement

Compute Sum of Quality For Left/Right Search Encounter

Determine if Quality Value Lower (Better) Than Enrolled Quality Sum

Yes

Replace New/Improved Minutiae in Matcher



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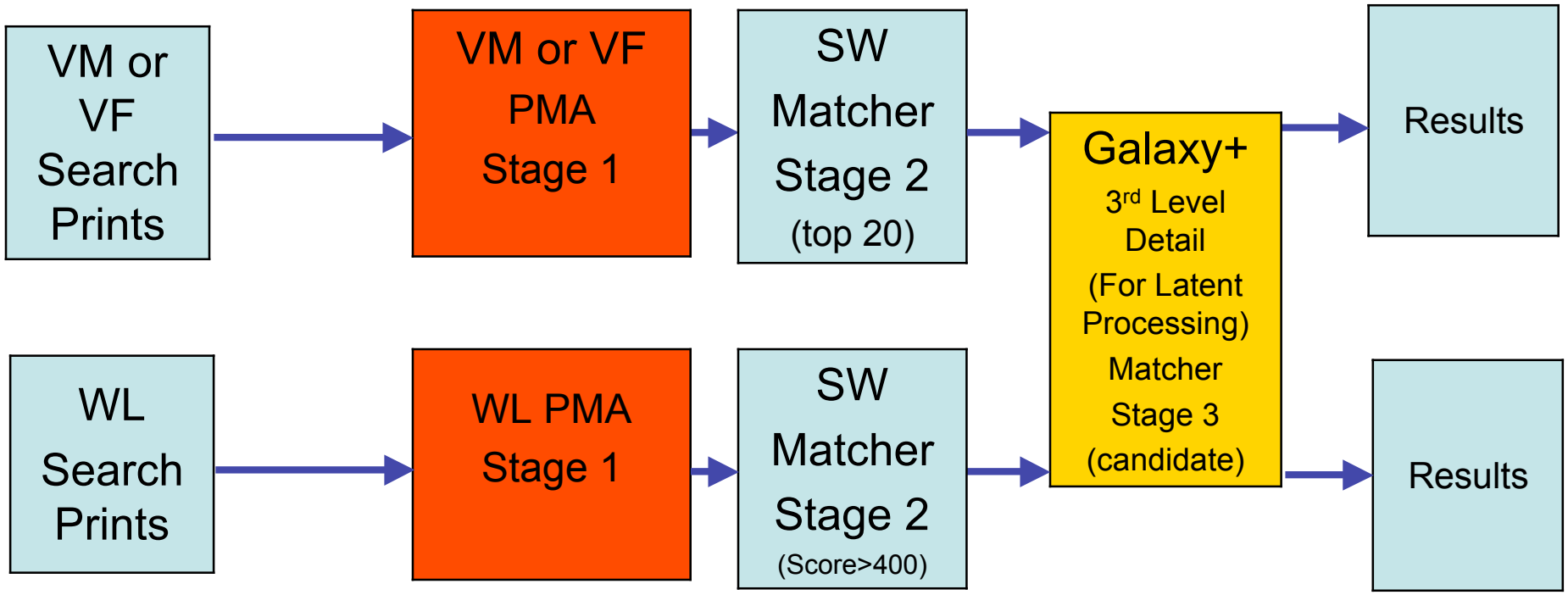
Solution for Poor Quality Images
Multi-stage Matching



Achieve Improved Matcher Accuracy Using Galaxy 3rd Level Detail Match Stage

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2-Print to 10-Print Transition Challenges

- **Challenges**
  - Smaller footprint slap capture devices
  - Faster Slap Capture
  - Accurate Slap Segmentation
- **Multi-Agency User Group Initiatives**
  - Challenge to Industry to meet user group requirements
  - Industry rising to the challenge to meet the user needs
  - NIST to Conduct Slap Segmentation Algorithm Certification
- **Benefits**
  - Achieve DHS IDENT-DOJ IAFIS Interoperability
  - Improved Identification Performance from 10 Prints

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DHS Road Map for the Future

- **Use DHS Best Fingerprint Capture Practices**
  - Ensure optimum quality fingerprint capture
- **Adopt Biometric Capture Standards (BioAPI)**
  - Enable fast scanner interchange capability
  - Enable fingerprint capture technology refresh
    - New technology (Ultra Sound, Touch less) scanners to improve image quality
- **Implement Best Face Capture Practices**
  - Improve facial image capture in the system
  - Facilitate finger-face biometric fusion capability to achieve highest possible identification accuracy