Attacks at the Sensor:

Standards Development on Presentation Attacks and Liveness Detection

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How can we reliably reject spoof attempts, while giving access to legitimate users?

Biometric Security Issues

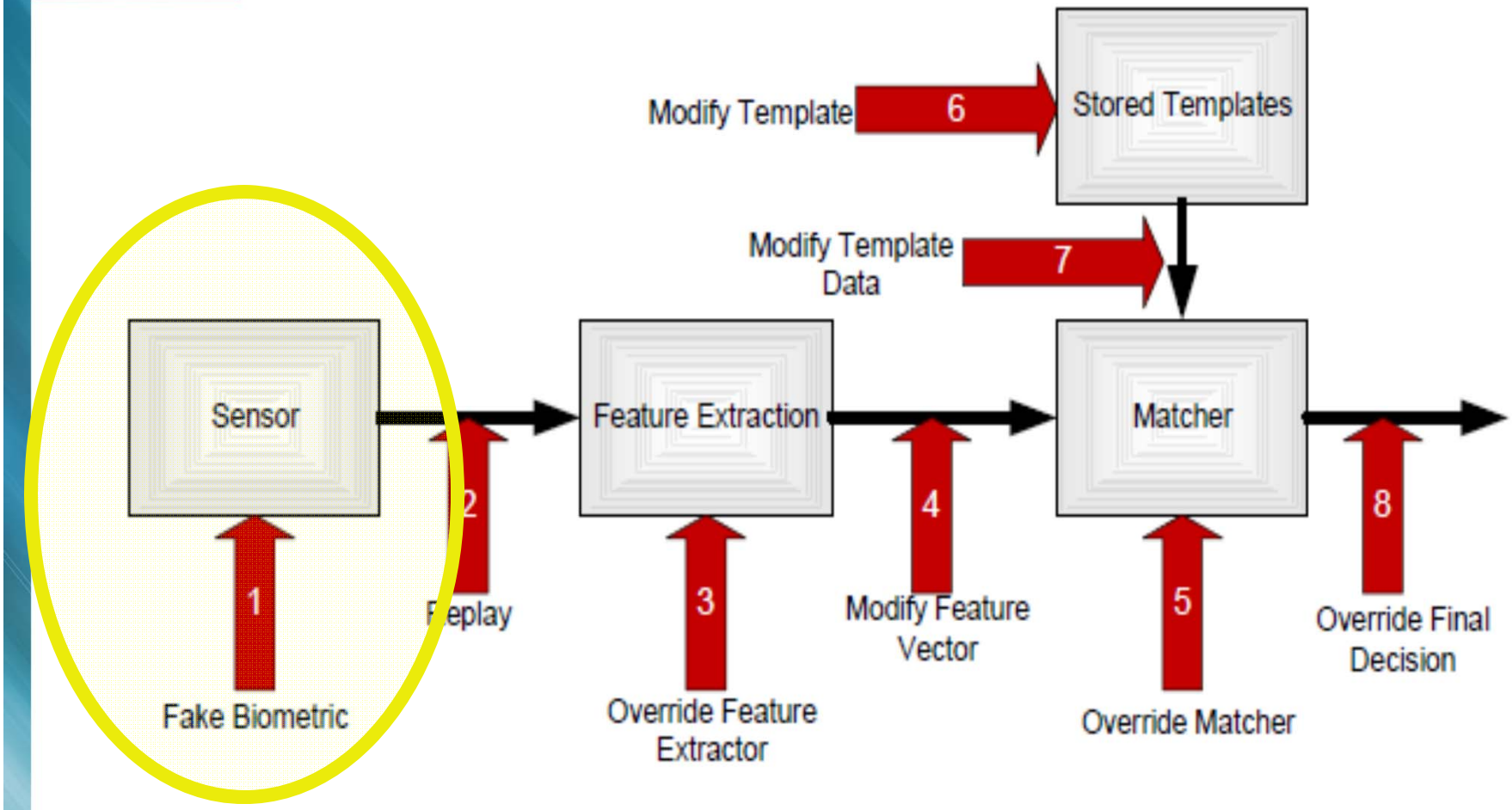


Figure by Nalini Ratha, IBM, 2001

We're not in Kansas anymore…

- Increasing use of online and mobile apps and need for more complex & secure ID management
  - Exemplified by the National Strategy for Trusted Identities in cyberspace, released April 2011

"On the Internet, nobody knows you're a dog."

From the *New Yorker*

- Recognized need by groups of potential users:
  - Financial Services Technology Consortium
  - The Drug Enforcement Administration (DEA)
  - The US National Science and Technology Council report on the "The National Biometrics Challenge."

Authentication Use Case Comparison

For law enforcement, immigration, etc.

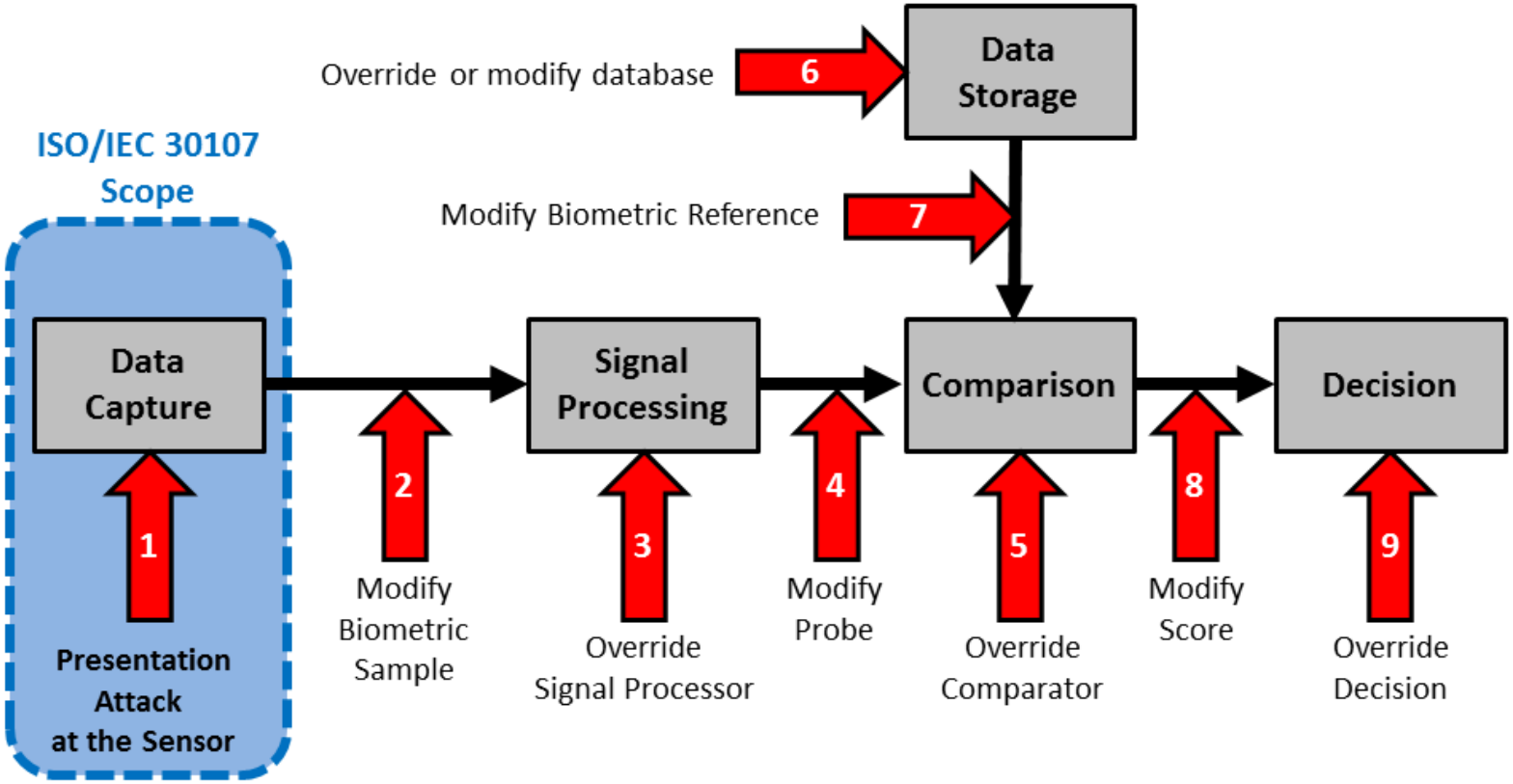
- Enrollment and subsequent recognition attempts
  - highly controlled
  - Supervised / Attended
- Successful recognition
  - Answers the question, “Has this person been previously encountered?”
  - Is a unique pattern

For online transactions, e.g. banking, health, etc.

- Enrollment
  - Less controlled
  - Probably not in person
- Subsequent recognition attempts
  - Unattended
- Successful recognition
  - Answers the question, “How confident am I that this is the actual claimant?”
  - Is a tamper-proof rendering of a distinctive pattern

Existing International Standards or Best Practices Documents on Liveness Detection or Countering “Fake Biometrics”

Examples of Points of Attack in a Biometric System



From the 1st Committee Draft of IS Project 30107-1, inspired by figure by Nalini Ratha from 2001 and Standing Document 11 of ISO/IEC JTC1 SC37.

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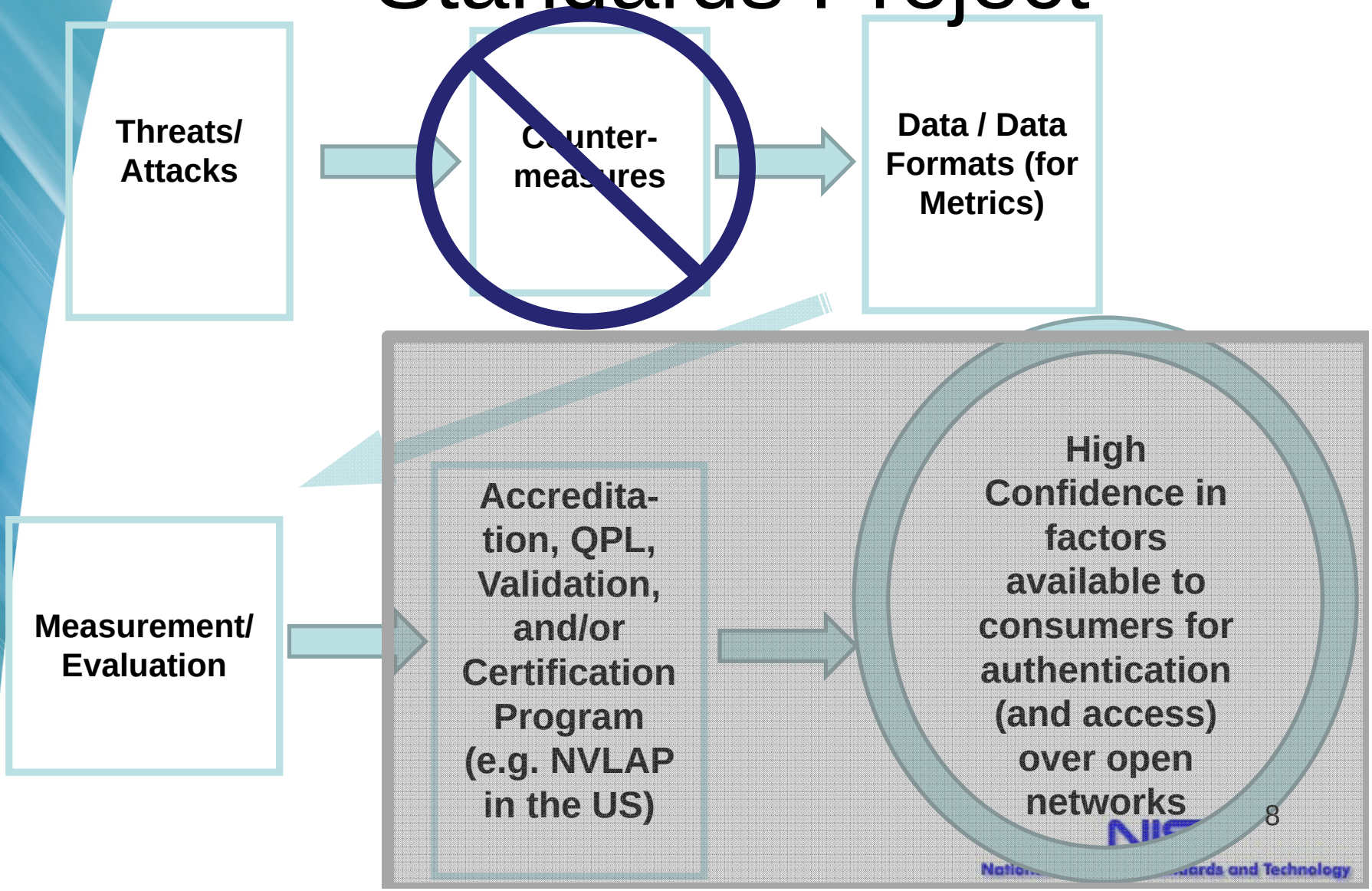
Presentation Attack Detection Standards Project



Scope of All Parts of 30107 (as of January 2014) (1 of 2)

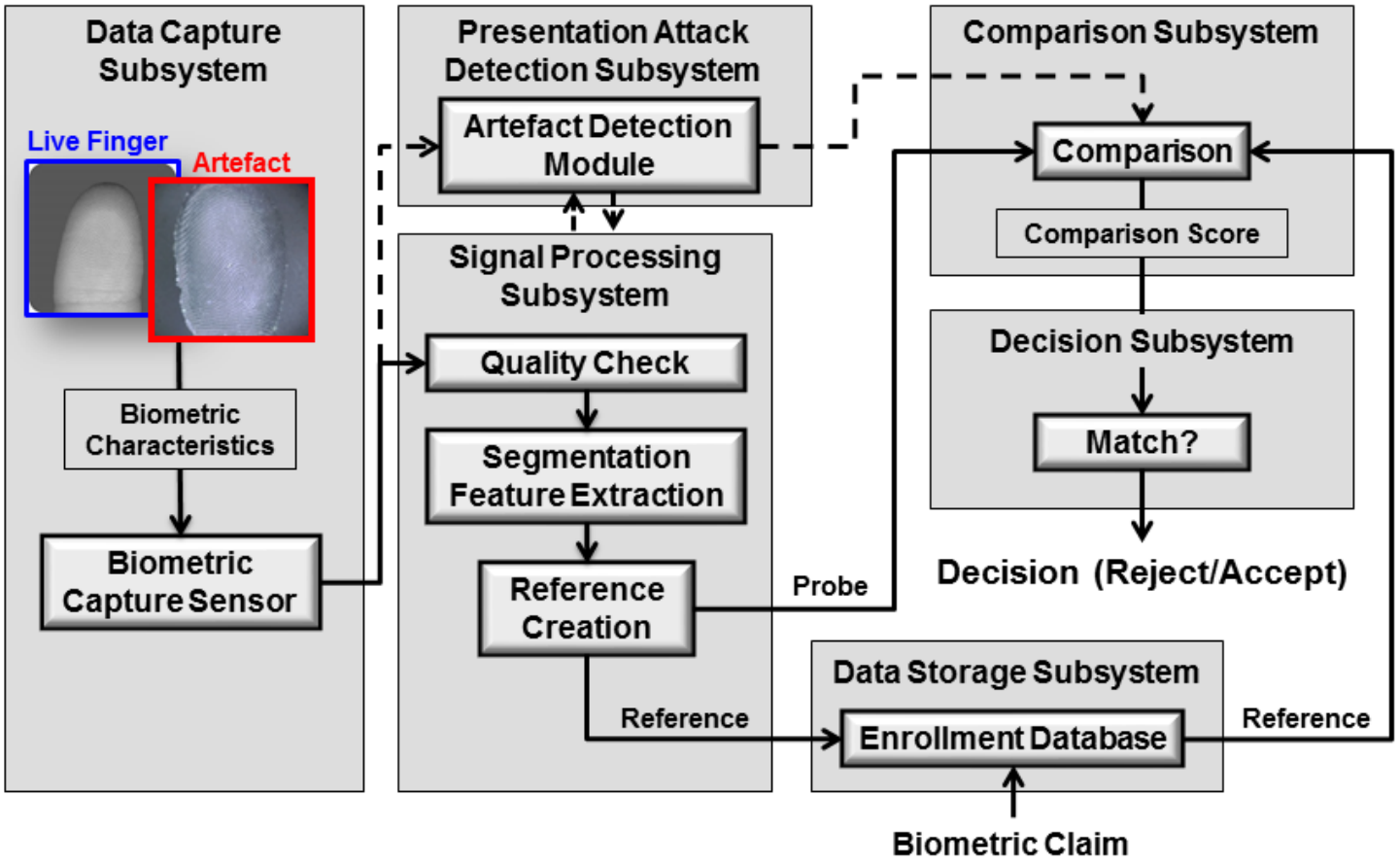
- Part 1 establishes terms and definitions that are useful in the specification, characterization and evaluation of presentation attack detection methods.
- Part 2 establishes a common data format for conveying the type of approach used and the assessment of presentation attack in data formats.
- Part 3 establishes principles and methods for performance assessment of presentation attack detection algorithms or mechanisms, and it includes an informative annex with a classification of known attacks types.

Scope of All Parts of 30107 (as of January 2014) (2 of 2)

- Outside the scope (of all parts) are
  - standardization of specific PAD detection methods;
  - detailed information about countermeasures (i.e. anti-spoofing techniques), algorithms, or sensors; and
  - overall system-level security or vulnerability assessment.
- The attacks to be considered in this standard will take place at the sensor during the presentation and collection of the biometric characteristics.

  Any other attacks are considered outside the scope of this standard.

General biometric framework with Presentation Attack Detection



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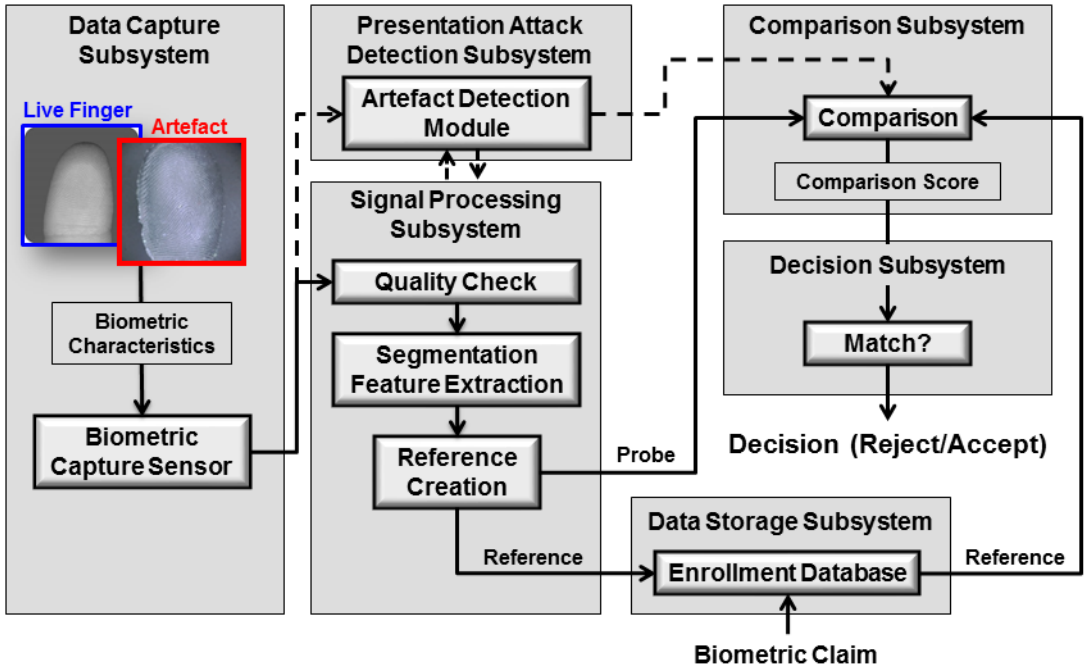

Where can PAD take place?

The sub-system which detects attack presentations may be located:

- following the data capture subsystem
- within the data capture subsystem,
- following the signal processing sub-system, and/or
- after the comparison or decision subsystems (not shown) or at several points in the system.

The different components could be in different locations (client versus server or front end versus back end).

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Examples of Presentation Attacks

	gummy finger, video of face
	glue on finger, sunglasses, artificial/patterned contact lens
	cadaver part, severed finger/hand
	mutilation, surgical switching of fingerprints between hands and/or toes
	facial expression/extreme, tip or side of finger
	unconscious, under duress
	zero effort impostor attempt

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Terms (1 of 3)

- **Presentation attack**

presentation of an artefact or human characteristic to the biometric capture subsystem in a fashion that could interfere with the intended policy of the biometric system.

- **Presentation attack instrument (PAI)**

biometric trait or object used in a presentation attack.

NOTE The set of PAI includes artefacts but would also include lifeless biometric characteristics (i.e. stemming from dead bodies) or altered biometric characteristics (e.g. altered fingerprints) that are used in an attack.

- **Presentation attack detection (PAD)**

automated determination of a presentation attack.

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Terms (2 of 3)

- **Liveness**

the quality or state of being alive, made evident by anatomical characteristics (e.g. skin or blood absorption of illumination), involuntary reactions or physiological functions (e.g. iris reaction to light, heart activity – pulse), or voluntary reactions or subject behaviors (e.g. squeezing together fingers in hand geometry or a biometric presentation in response to a directive cue).

- **Liveness detection**

detection of anatomical characteristics or involuntary or voluntary reactions, in order to determine if a biometric sample is being captured from a living subject present at the point of capture

Liveness detection methods are defined to be a sub-set of presentation attack detection (PAD) methods.

From the 1st Committee Draft of IS Project 30107-1

Terms (3 of 3)

- **Spoof**

to subvert a system by presentation of an artefact

- **Artefact**

artificial object or representation presenting a copy of biometric characteristics or synthetic biometric patterns

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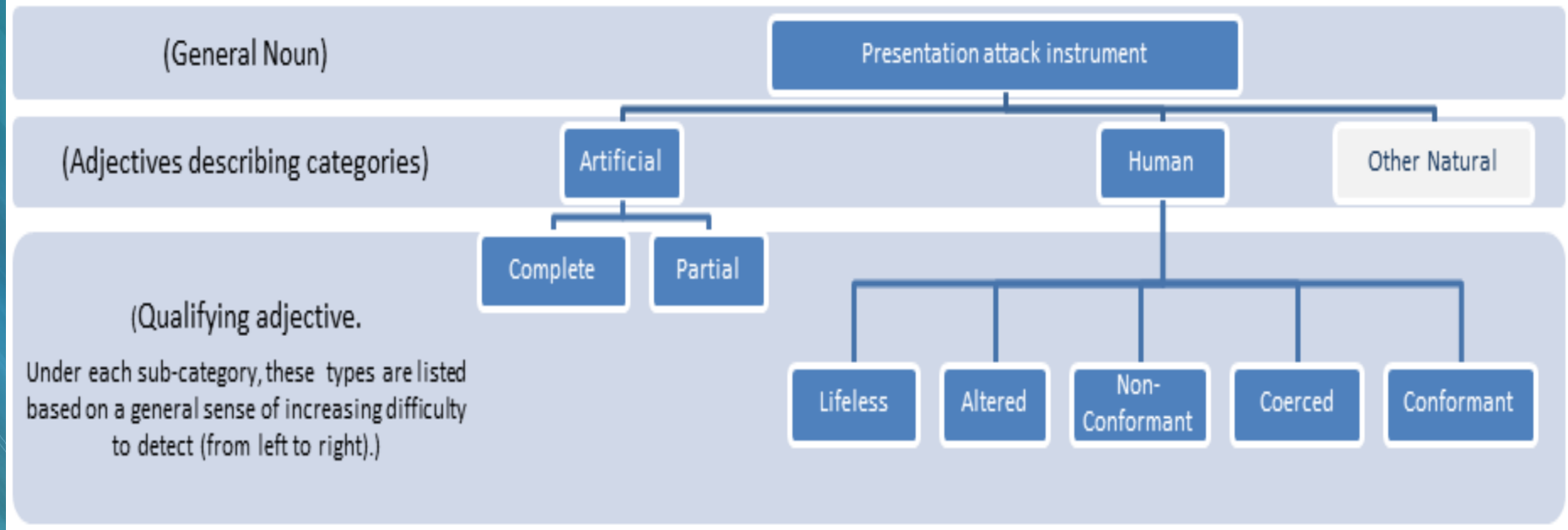
Types of Biometric Presentation Attacks



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Types of Detection

Through a biometric System	Artefact Detection
	Liveness Detection
	Alteration Detection
	Non-conformance Detection
	Coercion Detection
	Obscuration Detection
Through system security policies	Failed attempt detection counter
	Geographic
	Temporal
	Video Surveillance

Examples of Data Types for Detecting Presentation Attacks

These are all options in the draft standard:

- The local PAD decision (pass/fail)
- A score between 0 and 100 provided by the PAD mechanism, with lower scores being indicative of spoofed samples
- Identifier for technique specific data (to identify a vendor and algorithm);
- Level of supervision / surveillance during capture (qualitative categories)

Data Format Topics

- WD of Part 2 contains many options for PAD data that could placed in a 19794 header in TLV format.
- A Special Group considered encoding/including extended data in 2013.
  - Questions that still need to be addressed:
    - a definition of extended data,
    - use cases, and
    - how to encode the extended data (does it belong in Part 2 or should it be handled another way such as a new data format type).

Where We Are At Today wrt Testing

- **Terms & Concepts**: Focus on the device; ignore intent of the attacker.

- **Testing Metrics and Reporting**:
  - Different approaches around the world.
    - Can we strike a balance between encouraging progress versus a hard line or exhaustive/expensive method?
  - Flexibility in the standard for different approaches and agility to deal with new threats, and use testing reporting to deal with differences.

How to Participate in the Development of 30107

- In the US, interested parties participate through INCITS M1
  - http://standards.incits.org/a/public/group/m1
- In other countries, interested parties participate in their country's mirror committee, called a Technical Advisory Group (TAG), to ISO/IEC JTC1 SC37

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Future Guidelines Need to Address

- How can the vulnerability at the sensor be mitigated at different levels of risk (i.e. different security levels)?
  - Is there a way to quantitatively or qualitatively rank options?
- What are equivalent means for mitigating this risk through the biometric system versus system security policies or some mix of the two?
  - Example: can liveness detection methods based on some material testing be considered equivalent to use of second factor such as a password of strength 1:10^x?

Thank you

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Co-Editor for Parts 2 and 3

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