Algorithm Development for Security Applications (ADSA)
Workshop 6:

Development of Fused Explosive Detection Equipment with Specific Application to Advanced Imaging Technology

Fusion Development and Deployment

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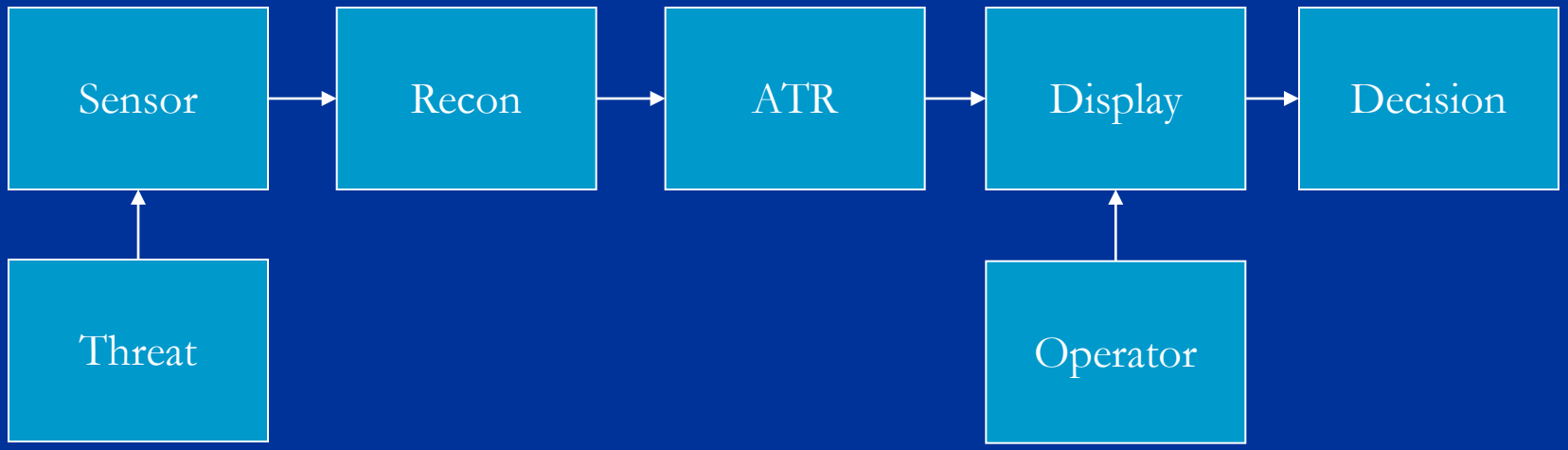
Conclusions

- Present environment for research, deployment, operation and maintenance is not optimized for fused systems
- Modifications are required to the environment to support fusion

General Topics

- Definitions: fusion, orthogonal, technology
- TSA requirements
- Requirement specifications
- Procurement, installation, maintenance
- Interconnections, networking, standards
- Concepts of operation
- Third-party involvement including dealing with classified requirements
- Identification of strengths and weaknesses of existing equipment
- Testing, certification, qualification

Generalized Model



Boxes may mean different things to different modalities.
Some modalities may not have all boxes.

Technologies

- Any source of data or information that is used to support a detection decision
- Includes imaging devices such as CT, transmission x-ray (TRX), millimeter-wave (MMW) and x-ray back-scatter (XBS).
- Non-imaging devices such as explosive trace detection (ETD) and QR.
- Risk assessment: intelligence, humans
- A human is a technology
  - Producing information and consuming data

Assisting Technologies

- Technologies include devices that assist the operation of another technology.
  - Assist = fusion
- Examples of assist
  - Identifying types of clothing worn by a passenger for AIT
  - Features for on-screen resolution (OSR)
- Unclear if reconstruction (e.g., CT) is a technology for the case of fusion

Technology Categories

- Existing
  - Modifications required to support sharing of results and controlling protocols
  - ATR may need to be revised to support fusion
- Future
  - Need to spec
  - Do not have to pass testing on their own

Data Types

- Images
- Spectra
- Analog and binary ATR results
- Features
- Human observations
- Level of risk – both input and output
- Aggregated information from different technologies
- Results from intelligence operations

Orthogonal Definition

- Orthogonal means that entirely different aspects of a given threat are considered
- One has to avoid the situation when the different aspects of a threat are correlated
- When two or more orthogonal technologies are fused, performance is improved.

Orthogonal Technologies

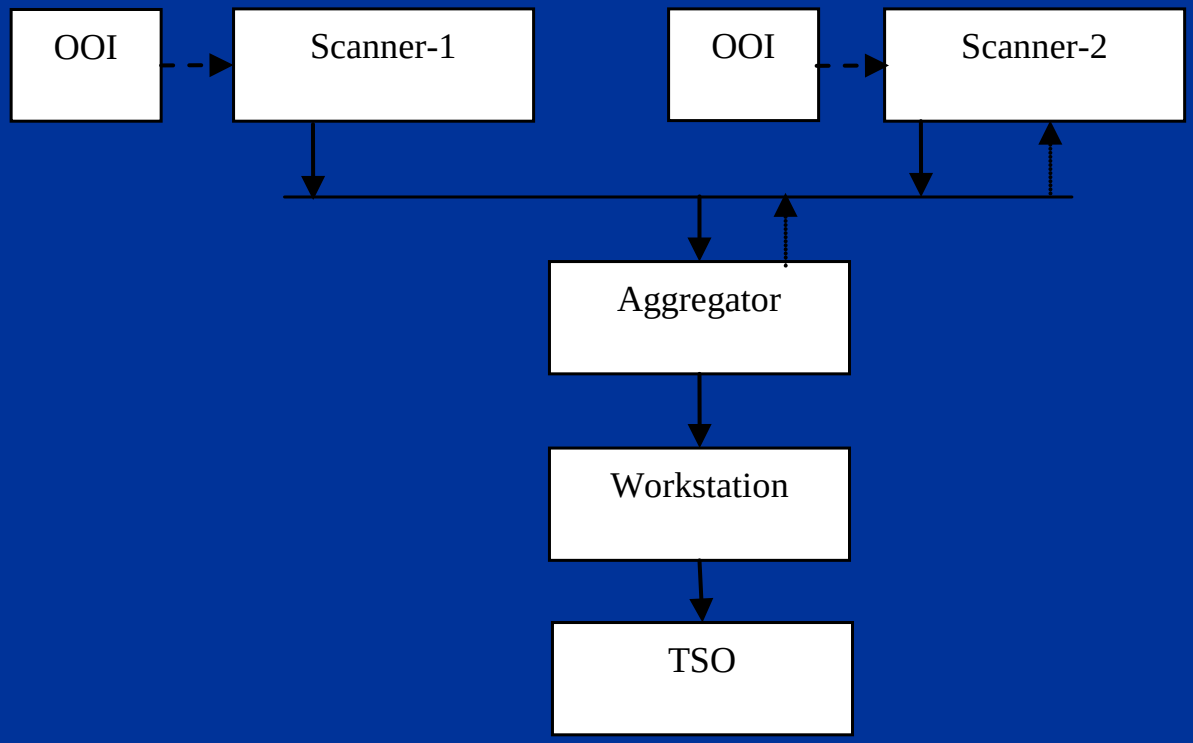
- Orthogonal technologies may be devices that are operated differently based on information supplied to them as changes in operating parameters or protocols. The following are examples of this statement.
  - X-ray devices operating at different kVs.
  - Dual energy v. single energy x-ray
  - Imaging devices operating at different resolutions or signal to noise ratios
  - Protocols set to detect certain types of explosives or certain configurations of explosives.
  - Protocols set based on risk

Negative Results

- It is also known that some technologies, when fused, do not lead to improved detection performance.
- In fact, there is evidence that degraded performance may be obtained.
- It is not well-established why prior attempts at fusion (e.g., CT-XRD) failed.
- We should understand why these attempts failed.
- Review fusion in other spaces, e.g., Department of Defense

Fusion Definition

- Fusion means that multiple technologies are *deployed* to improve detection requirements.
- Deployment types
  - Stand-alone (layered and co-located): only connection may be human
  - Interconnected: protocol and/or results
- Need to bound discussion
  - Single airport v. airport + external environmemt



1. Images, Spectra, ATR, Features
2. Protocol changes
3. Sensors could be human or risk
4. Aggregator could be human
5. Physical connection optional

Look Deeper

XBS

BDO

?

Intelligence

TRX

Common
Network
Protocol

MMW

Data Fuser

Sensor
(Ven. A)

Recon
(Ven. B)

ATR
(Ven. A)

Tactics

- DHS should define terms used by fusion experts in R&D and other fields.
- Need to focus on a particular problem and try to solve it to set precedence.

Need for Fusion

- Improved detection of explosive: decreased probability of false alarm (PFA), increased number of types of explosives and decreased minimum threat mass.
- Fusion of existing technologies and emerging technologies is seen as a way to meet future detection requirements.

Requirement Specs

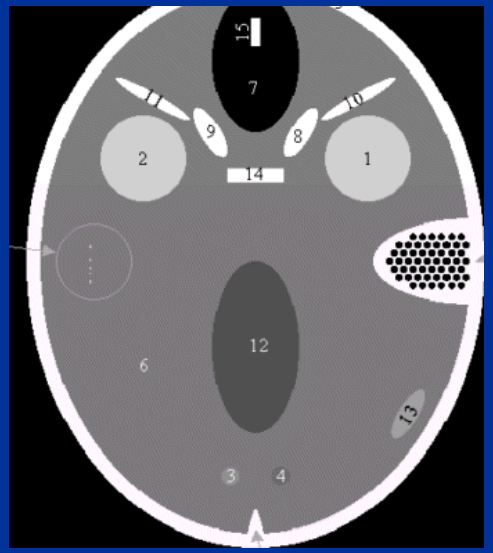
- Current specs based on passing tests for complete set of explosives
  - Counter example may be check point with layered approach
  - Only allows for vendor to supply fused system
  - Does not allow for vendors to develop technologies to be fused at later date
  - Strengths and weaknesses of existing technologies not generally known
  - Support for fusion not required
    - Features not required; only pass/fail

TSA Future Specs

- Need to establish performance metrics to be able to judge effectiveness of individual systems and compare improvements due to fusing two or more systems.
- Complicated if operational protocols can be changed as part of fusion

Funding Changes

- Fund development of technologies that can be fused
  - Prove on paper that fusion will lead to better results
- Fund infrastructure
  - Common communication protocols (DICOS)
  - Scanner simulators and mathematical phantoms



Procurement & Deployment

- Fuse systems in the field
  - Test at TSIF?
- Address issues in field
  - Interoperability
  - Problem isolation

Interconnections

- Need protocols
  - Sharing data (images, ATR)
  - Controlling operation of scanners (changing protocols)
  - Sharing features – language (ontology)
- DHS/TSA programs compliance
  - DICOS, STIP, Common Element Architecture

Concepts of Operation

- Today, may not support fused systems today
- Future may change with fused systems
- Can be advantage
  - Improve passenger experience
- Can be disadvantage
  - Flow of people and divested objects cumbersome
  - Need technology to track
- Must be considered in design
- Footprint, cost issues

Third Party Involvement

- Disclosure of full and partial requirements
  - Partial – who parcels out problem statements
  - Who is director?
- Classification issues
  - ALERT learning to overcome
- Financial incentives for third parties
  - Who will deploy new technologies
- Lack of data
  - Use simulations
  - NDAs with vendors

Vendors

- Financial incentives
  - Better equipment means more sales
- Financial disincentives for vendors
  - Disclosure of proprietary information
  - Loss of system expertise
  - Loss of service revenues
  - Enabling additional vendors
- Vendors should retain system integration
  - May need to provide method to host 3rd party algorithms
  - Vendor-independent workstations may be exception
- Different if 3rd parties hired by DHS or vendors
- Inzight Consulting (Doug Pearl) study

Conclusions

- Present environment for research development, deployment, operation and maintenance is not optimized for fused systems
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