Remote Monitoring and Other Technology Tools

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Missile Retirement Workshop

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National Nuclear Security Administration

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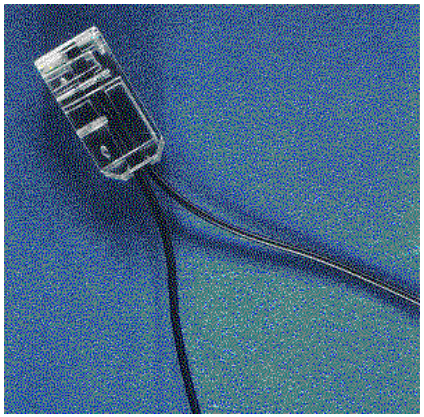
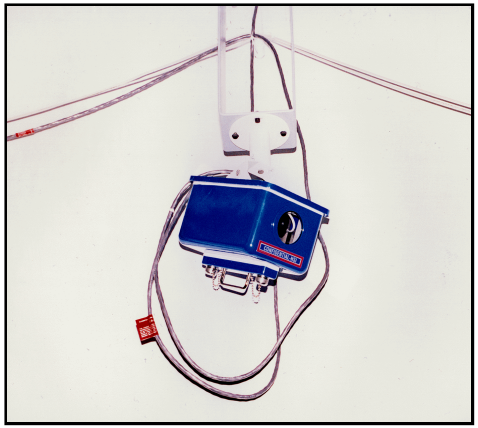
Outline of Topics

- Technology role in transparency
- Tags and Seals
- Video Surveillance
- Other remotely monitored sensors





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Role of technology in missile monitoring/observation

- Determine Presence/Absence of an object
- Identity specific item
- Detect change is condition, position, or other missile parameters.
- Potential to build confidence among parties to an agreement

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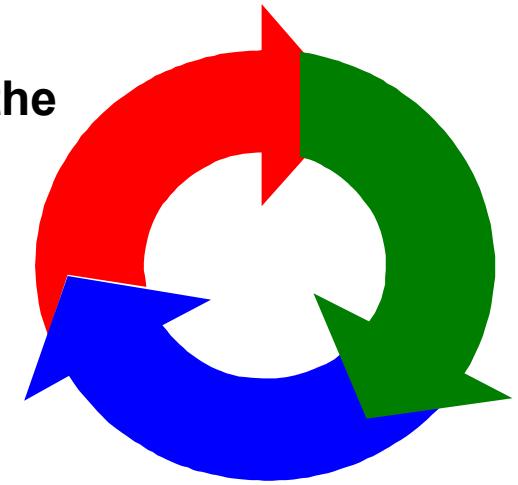
There is a process to establishing the role of technology in missile monitoring

Establish the Objectives

- What needs to be determined or assessed?
- What level of confidence do I need in the information?



Design the System

- Hardware/Software
- Communications
- Blend technical and nontechnical monitoring

Assess and Refine the Design

- **Elements in an assessment:**
  - Performance Testing and Analysis
  - Vulnerability Analysis
  - Cost-Benefit Analysis
  - Design Evaluation

Tamper Indication

- Any measure that can reveal whether someone may have been able to alter something
- Tamper-indication is essential to assure that information is believable and can be trusted
- Incorrect or incomplete information about tamper status could lead to incorrect conclusions
- Potential causes of tampering
  - Accident
  - Test/probe the system
  - Vandalism
  - Intent to mislead
- Tamper protection refers to any measure that makes tampering difficult to accomplish
- Tamper indicating techniques
  - Mechanical
    - Surface coatings, “fingerprint” features, physical features
  - Electrical
    - Switches, membranes

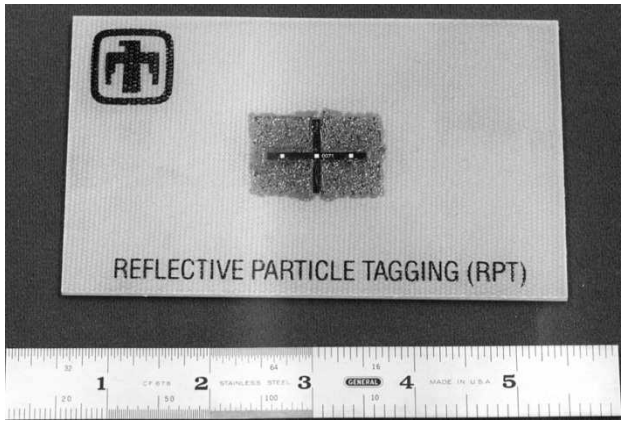
Analysis of tamper indication

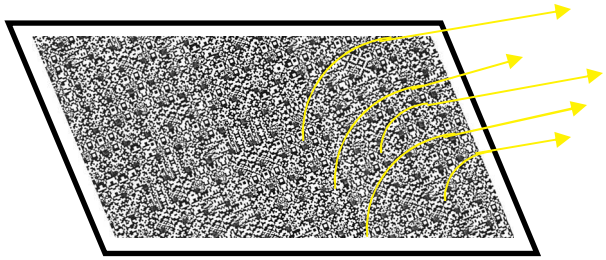
- Any evidence of tamper is an anomaly
- Data may be OK, but only if there are other ways to assure integrity

	Tamper did occur	Tamper did not occur
Positive tamper indication	True Positive	False Positive
No tamper indication	False Negative	True Negative

Tags

- Unique identifiers
- May contain added information
- May include tamper indicating or tamper protection features





System Id.: W-XX
Alt. #: 777
Manufacturing Date: 1/01/11
Loaded on: 2/25/11
Loaded at: Albuquerque, NM
Destination: Washington, DC

Spread Spectrum Tag

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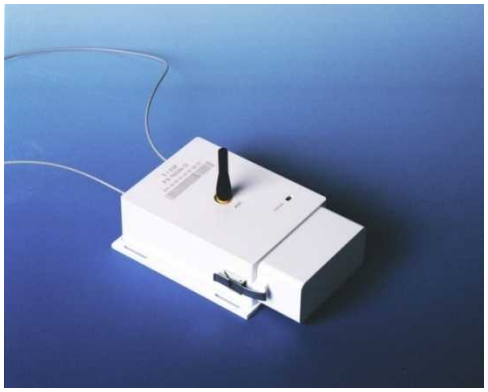
Seals

- Devices designed to reveal tampering associated with opening or breaking the device.
- Passive
  - Tampering detected when evaluated at the time of a visit or inspection
- Active
  - Tampering detected at the time of the tampering.

Passive Seal

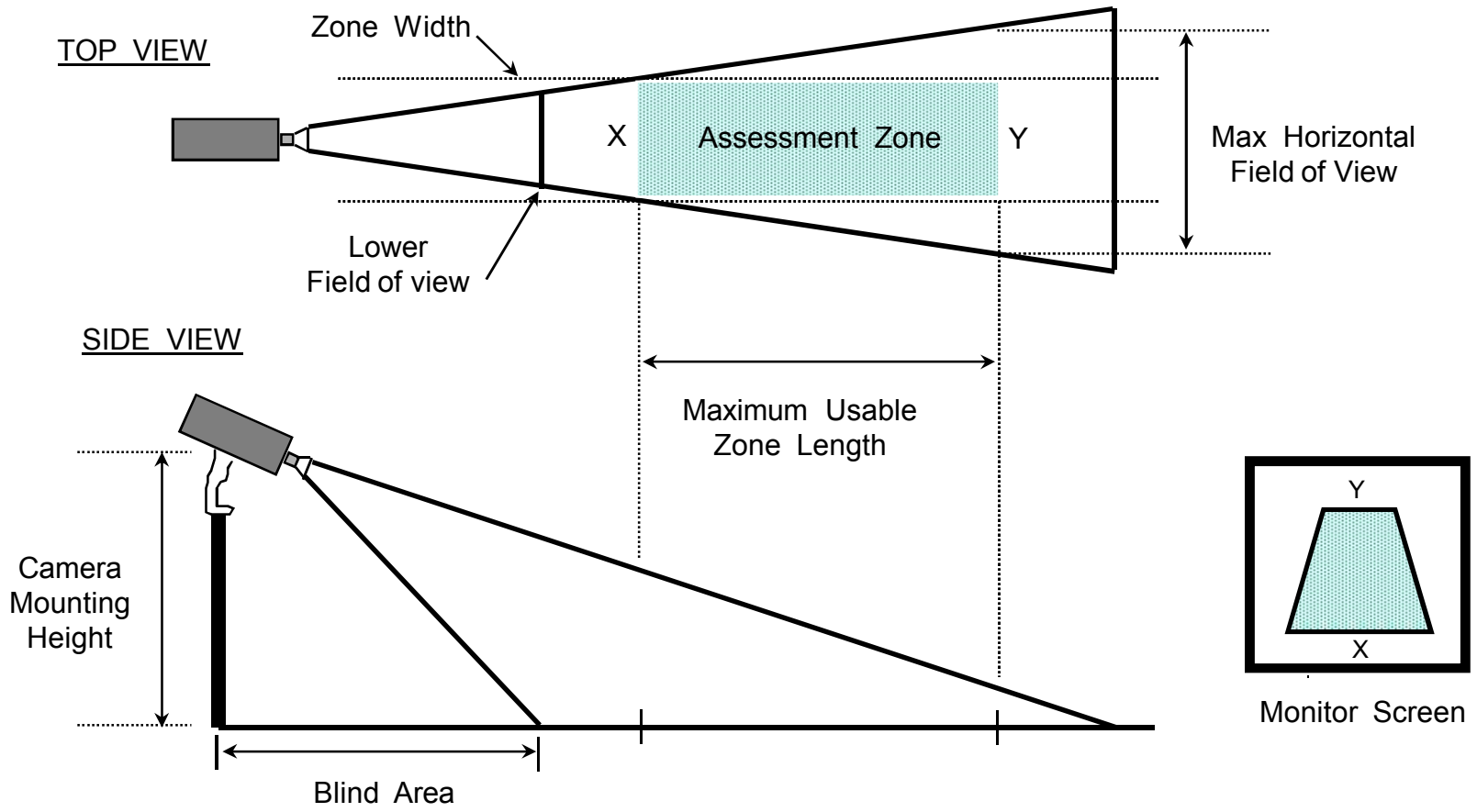


Active Seal

Video Surveillance

- Allows an inspector to monitor a remote location using video images
- Elements of a Video Surveillance System
  - Camera, lens, mount
  - Lighting system
  - Communication system
  - Video monitor for image display
  - Video recorder
  - Video switcher, etc.
- Levels of Resolution
  - Detect- Determine presence of an object
  - Classification- Determine Class of Object
  - Identification- Determine identity of item

Geometry of Assessment Zone



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Video Recording

- Approaches
  - Live video recording
  - Time lapse recording
  - Digital video with compression
- Video Data Authentication
  - Prevent spoof, substitute scene, replay old scene
  - Tamper sensors at remote cameras
  - Digital signatures sent with images

Data Surety

- Encryption
  - Process of disguising message in order to conceal data
  - Also referred to as “enciphering” or “encoding” message
  - Reverse process (decryption, deciphering or decoding)
- Authentication
  - Confirm that the received message is the original sent message

How do you keep a photo you send out from being “manipulated”?

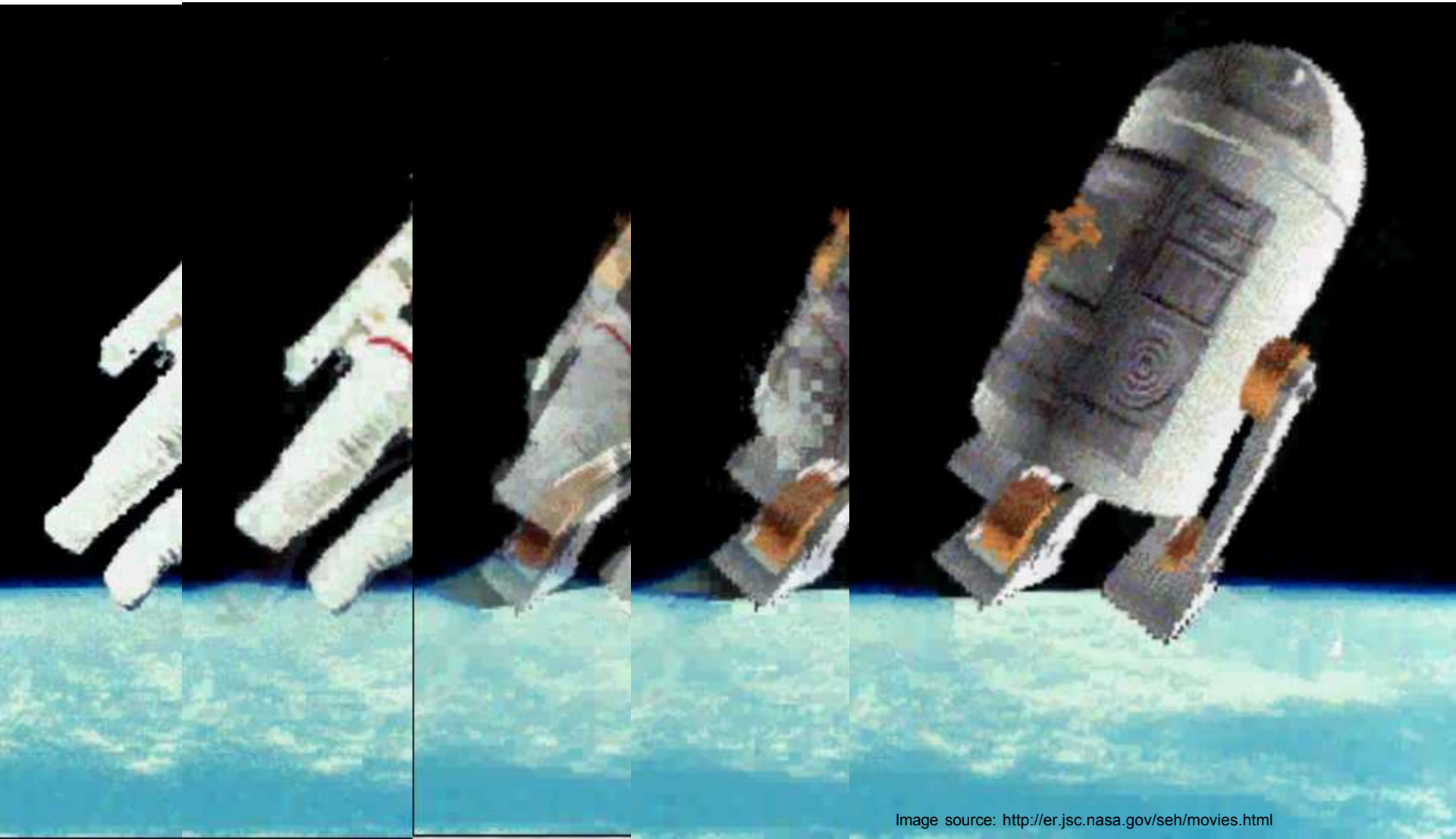
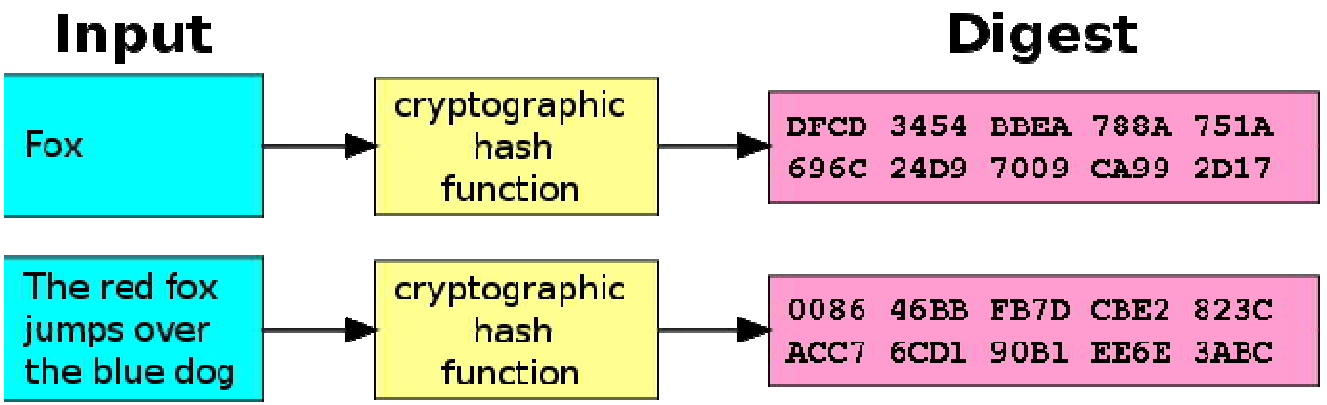
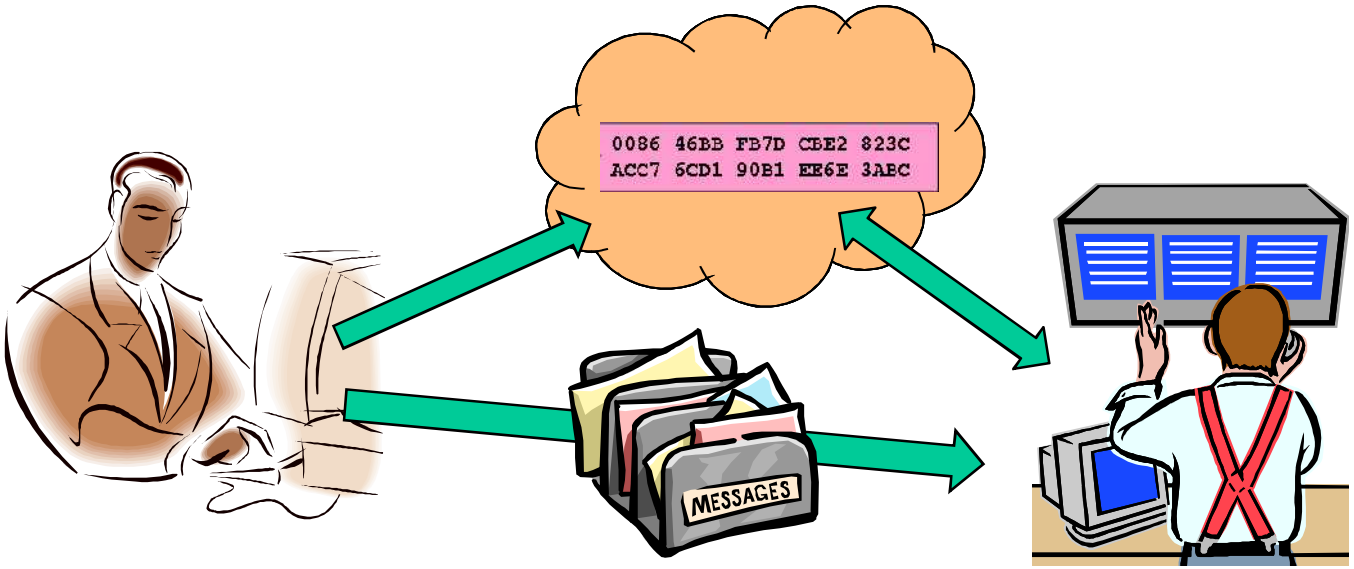


Image source: http://er.jsc.nasa.gov/seh/movies.html

Any computer file can be authenticated

A “hash” file is created that uniquely identifies the bits in the file.

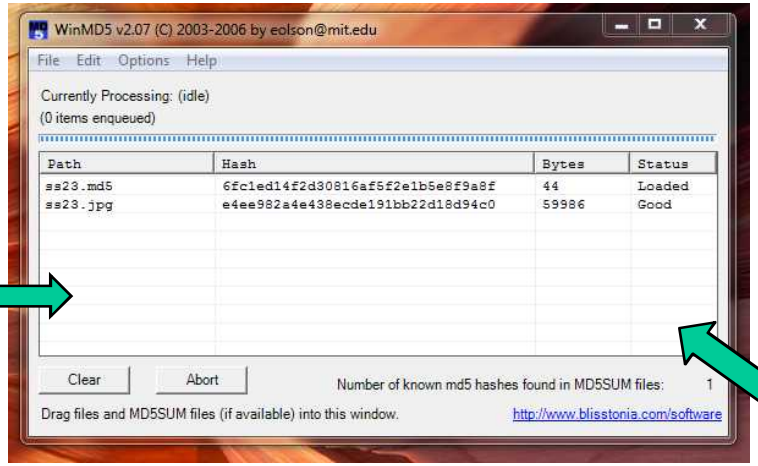


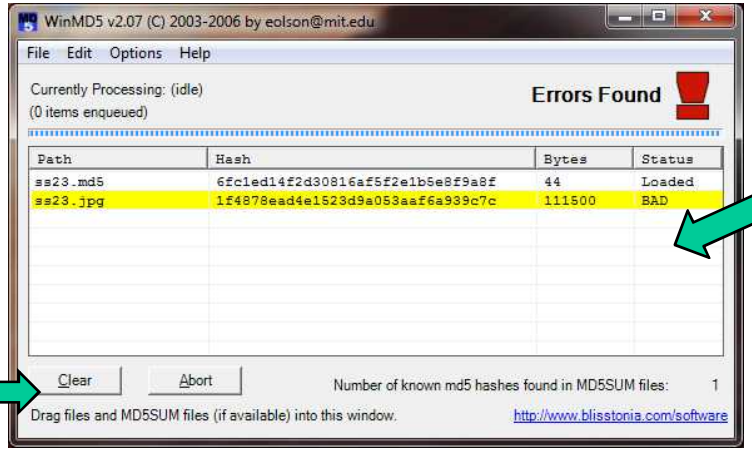


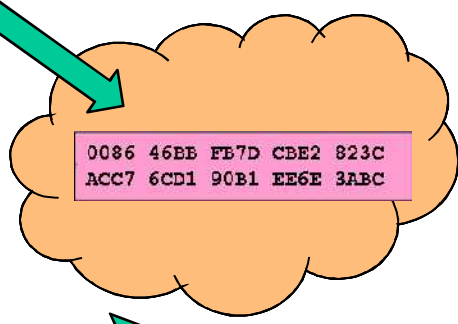
The message (including images) are sent and a “hash” file is posted publicly. Everyone can compare the hash file with the hash of the image.

Image source: clip art and G. Forden

There are a number of programs that are publicly available to check “hash” functions:







Missile images by Doug Tincher (SRNL); others by G. Forden

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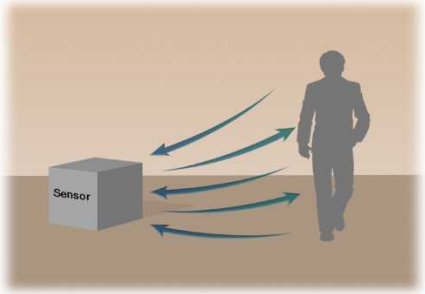
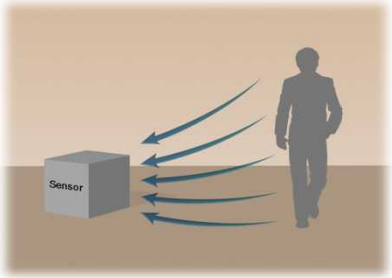
Unattended/Remote Monitoring System

- An unattended monitoring system that provides the capability for retrieving the data collected, discerning the state of health of the system, and modifying system parameters from off-site locations through a secure communication link
- Elements of a Remote Monitoring System
  - Sensors/Devices
  - Data networks/collection
  - Remote data transmission
  - Data surety
  - Information Management/Integration
  - Data analysis/review
    - Characterize Normal Behavior
    - Identify Abnormal Behavior

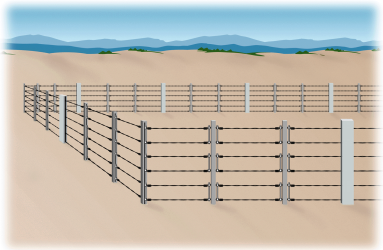
Sensor concepts

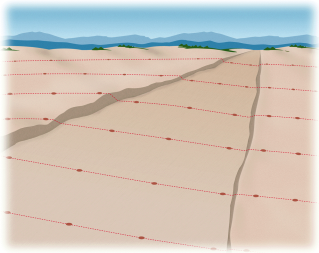
- Active vs. Passive



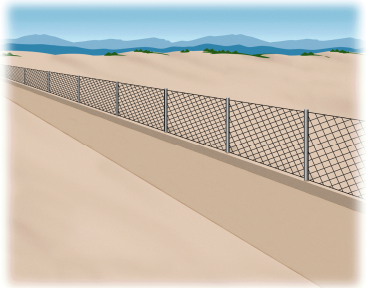


- Visible vs. Hidden

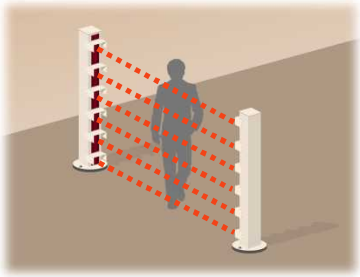


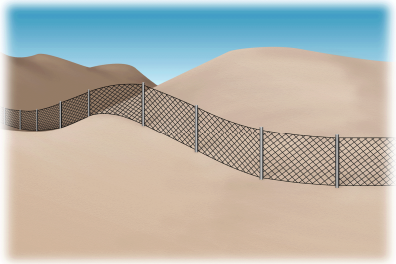


- Volumetric vs. Line



- Line-of-Sight or Terrain-Following





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Ground-based technologies for line and area monitoring

Passive Sensors

seismic, magnetic, infrared, acoustic, buried strain cables, fence sensors, optical systems

Active Sensors

infrared break beams, ground radar, microwave

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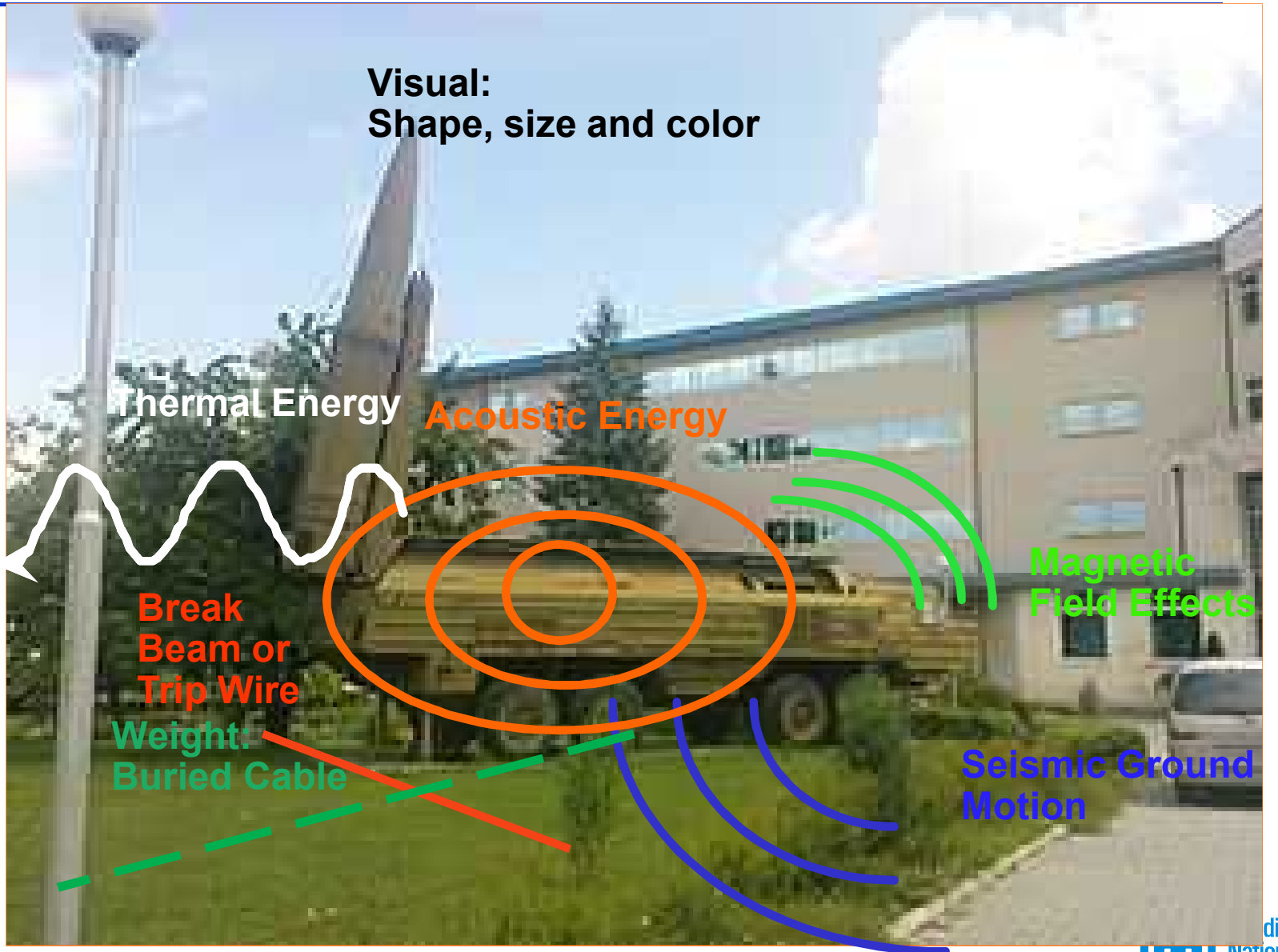
Example sensor measurements



Summary

- Technical tools can provide added transparency in assessing agreements and building confidence
  - Examples: Video assessment, tags, seals
- Tamper-indication techniques are necessary to ensure (to the highest level possible) integrity of information
- Data surety techniques also help to ensure integrity of shared information

Remote Video Surveillance Example: Sandia Outdoor test facility (OTF)

- A flexible test facility for evaluating commercial and prototype border monitoring technologies and systems
  - Located at Sandia on Kirtland Air Force Base, New Mexico.
  - Includes unattended ground sensors and sensor-activated video.
  - Microwave data and video transmission to base station

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