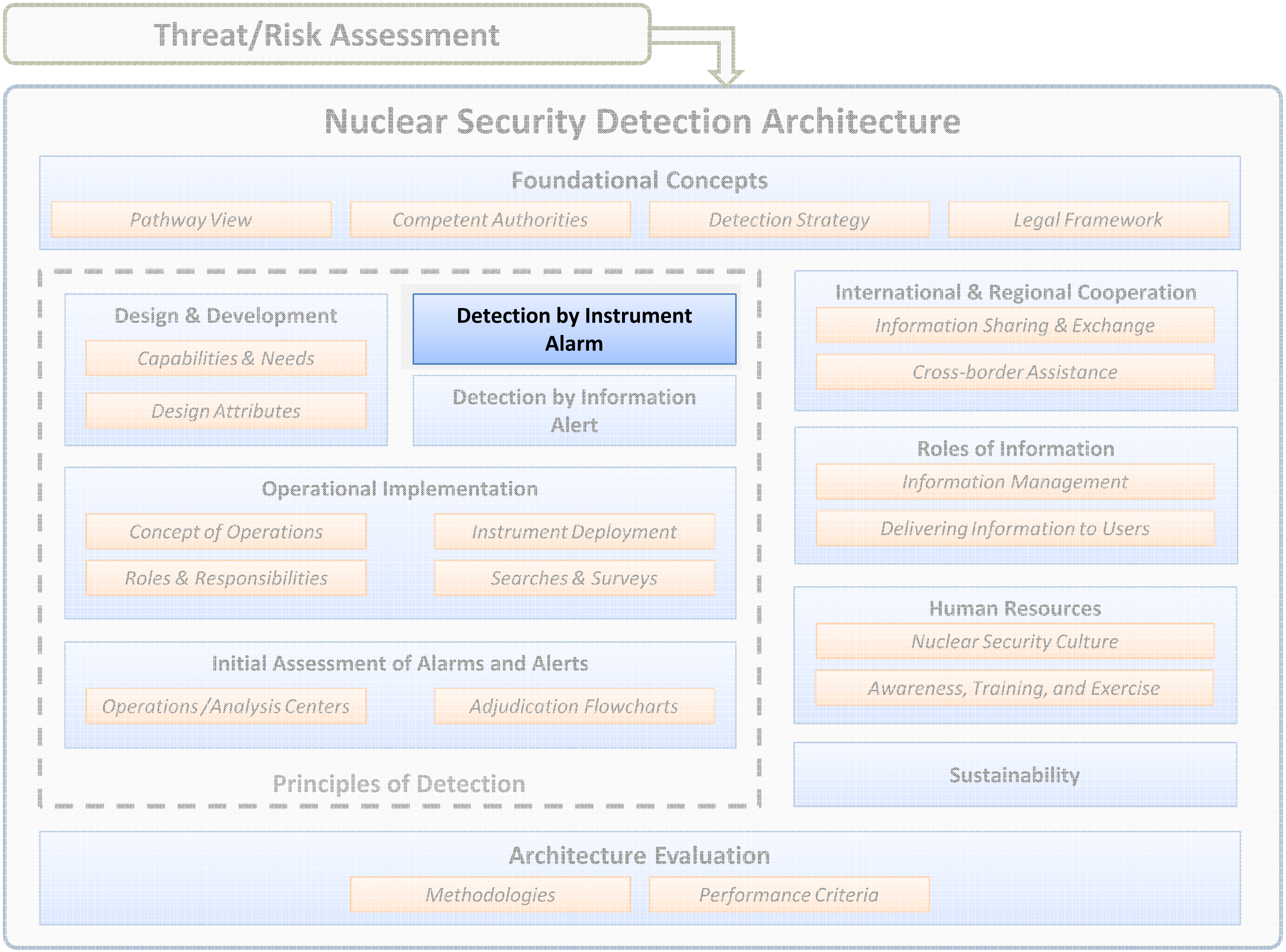
SAND2012-8135P

The Concept of Detection by Instrument Alarm

Nuclear Security Detection Architecture

Module F


Threat/Risk Assessment
Nuclear Security Detection Architecture
Foundational Concepts
Pathway View
Competent Authorities
Detection Strategy
Legal Framework
Design & Development
Capabilities & Needs
Design Attributes
Detection by Instrument Alarm
Detection by Information Alert
Operational Implementation
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Delivering Information to Users
Human Resources
Nuclear Security Culture
Awareness, Training, and Exercise
Sustainability
Architecture Evaluation
Methodologies
Performance Criteria

Module Objectives

Participants will have an understanding of key considerations related to instrument-based methods for detecting nuclear and radioactive material out of regulatory control, including:

- Overview of types of detection instruments
- Detection data networks
- Technology investments and operational requirements
- Evaluating detection technologies

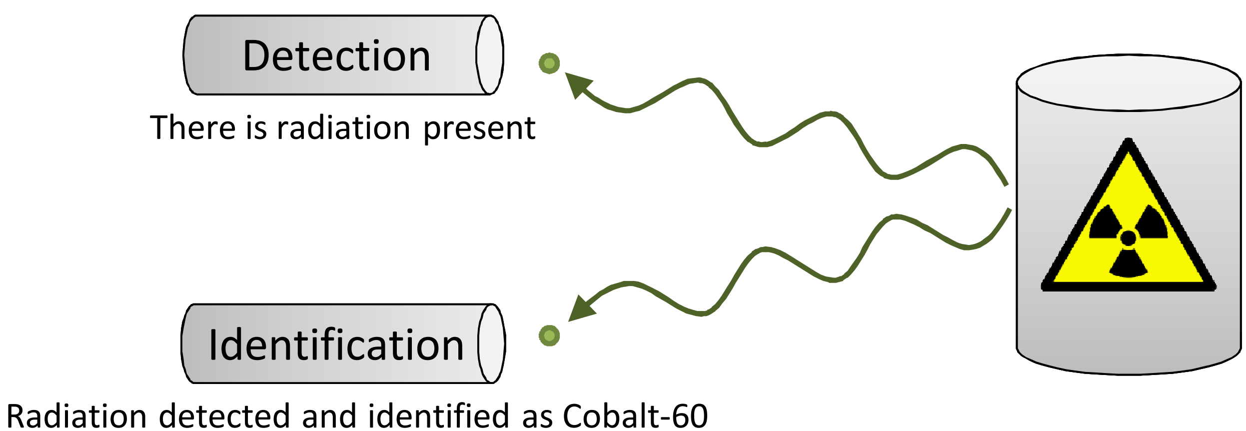
Country Self-Assessment Checklist

This module will enable or motivate the following questions:

1. Have all forms of detection instruments been considered in implementing the detection architecture?
2. Were complementary technologies considered in the development of the architecture?
3. Was networking detection capabilities considered and/or implemented as part of the architecture?
4. Were operational requirements considered when investing in technologies?
5. Were the technical attributes and limitations of detection instruments understood when implemented?
6. Were all detection instruments tested and evaluated in accordance to their operational requirements?

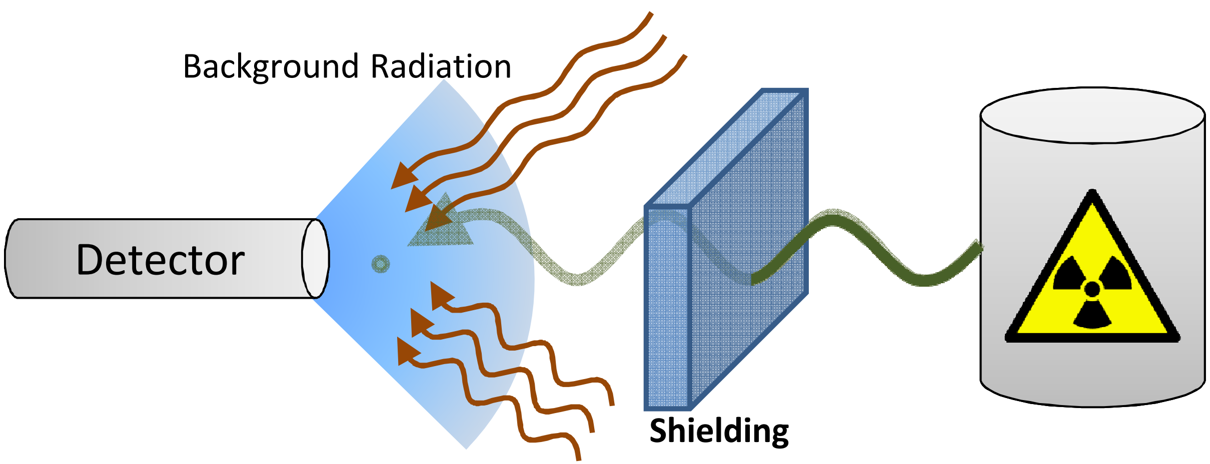
Basic Principles of Detecting Radiation

- Radioactive and nuclear sources emit radiation
- Instruments have been developed to both ***detect*** radiation and ***identify*** the material (isotope) that emitted the radiation (Cesium-137, Cobalt-60)
- Instruments can also be used to ***localize*** the source of the radiation, by determining the highest rate of radiation emissions



Radiation Detection Challenges

- Innocent alarms can originate from:
  - Naturally Occurring Radioactive Material (NORM) that exists naturally in the environment (cosmic radiation)
  - Cargo that may naturally emit small levels of NORM(ceramics, kitty litter, etc.)
  - People having recently received medical treatments using medical isotopes
  - Declared legal radioactive sources for industrial, medical, or scientific applications
- Difficult to find a specific radiation signal in a "noisy" environment with other, benign, radiation signals
- Radioactive or nuclear sources can be shielded by intervening material, which makes radiation more difficult to detect and identify

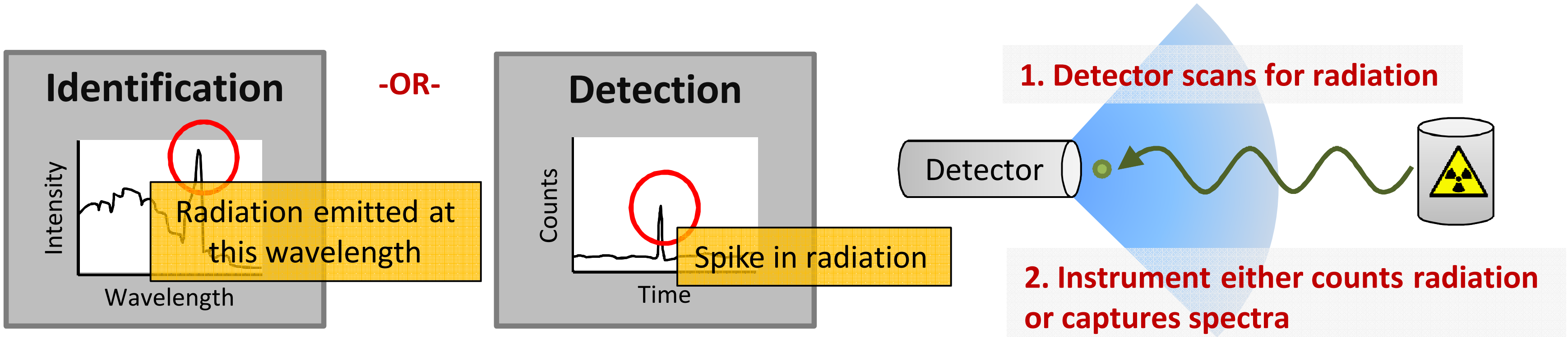


Instrument Form Factors

- Gross detection and identification instruments come in many form factors for use in different operational environments
  - Handheld
  - Backpack/wearable
  - Portal monitors
  - Vehicle-based
  - Helicopter-based
- Each form factor has tradeoffs that need to be considered when developing the architecture, for example:
  - A small detector may be inexpensive, but its sensitivity to sources may be less than a larger detector
  - A backpack detector may be good for localizing a source in the field, but could be burdensome on an operator to wear for extended periods of time

Passive Detection Methods

- Generally less expensive
- Measures natural emission of radiation
- Requires material to emit radiation greater than background
- Common passive detectors include:
  - Personal Radiation Detectors
  - Radiation Portal Monitors
  - Radionuclide Identification Devices



Personal Radiation Detectors (PRD)

- Relatively small devices (typically around the size of a pager or smartphone)
- Typically worn by front line officers as part of routine operations
- Alerts to the presence of radiation by flashing a light, using an audible tone, or vibrating, newer models may also capture spectra
- Due to size detection of shielded sources may be difficult and may require more time to scan than larger detectors

PRDs in Action

Radiation Portal Monitors (RPM)

- People or objects are passed through monitors consisting of one or more pillars
- Measures radiation from items near or between pillars
- Have the ability to alert at the presence of radiation, some instruments capable of identification
- Used for continuous screening of personnel, vehicles, packages, and other cargo
- May have difficulty detecting radiation in densely packed containers or from well-shielded sources

RPMs in Action

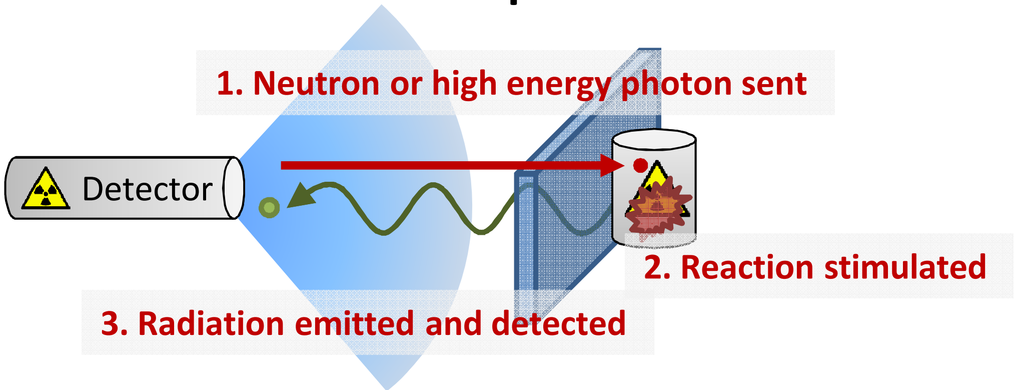

Radionuclide Identification Devices (RID)

- RIDs are used to collect and analyze an energy spectrum to identify an isotope
- Larger than a PRD, RIDs can be used as survey instruments and to locate nuclear and radioactive material
- A common form factor for RIDs is handheld, but backpack and vehicle-based are also available
- Typically used after an alert from a PRD or RPM, RIDs can confirm the source as being a threat or an innocent alarm
- RIDs are generally more expensive than other detectors (such as PRDs) and may require additional training to operate
- Longer integration time is needed in front of object to identify sources compared to gross detection instruments

RIDs in Action

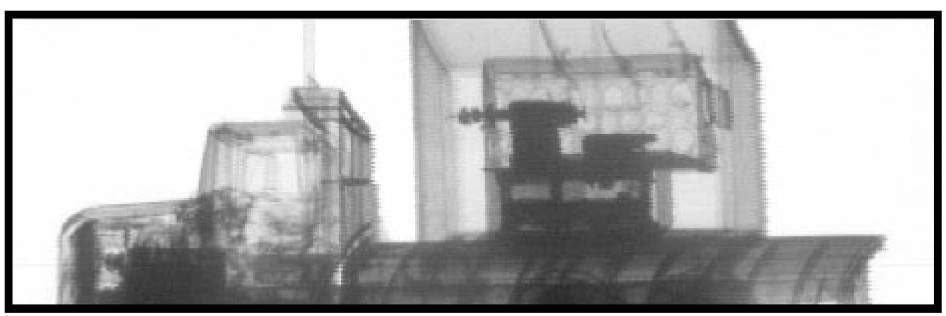
Active Interrogation of Radioactive Materials

- Detects nuclear material by stimulating a reaction and measuring the resultant radiation
- Better at detecting through shielding
- Generally more expensive
- Instruments tend to be larger than passive detectors
- May pose health risk to personnel



Active Interrogation: Radiography

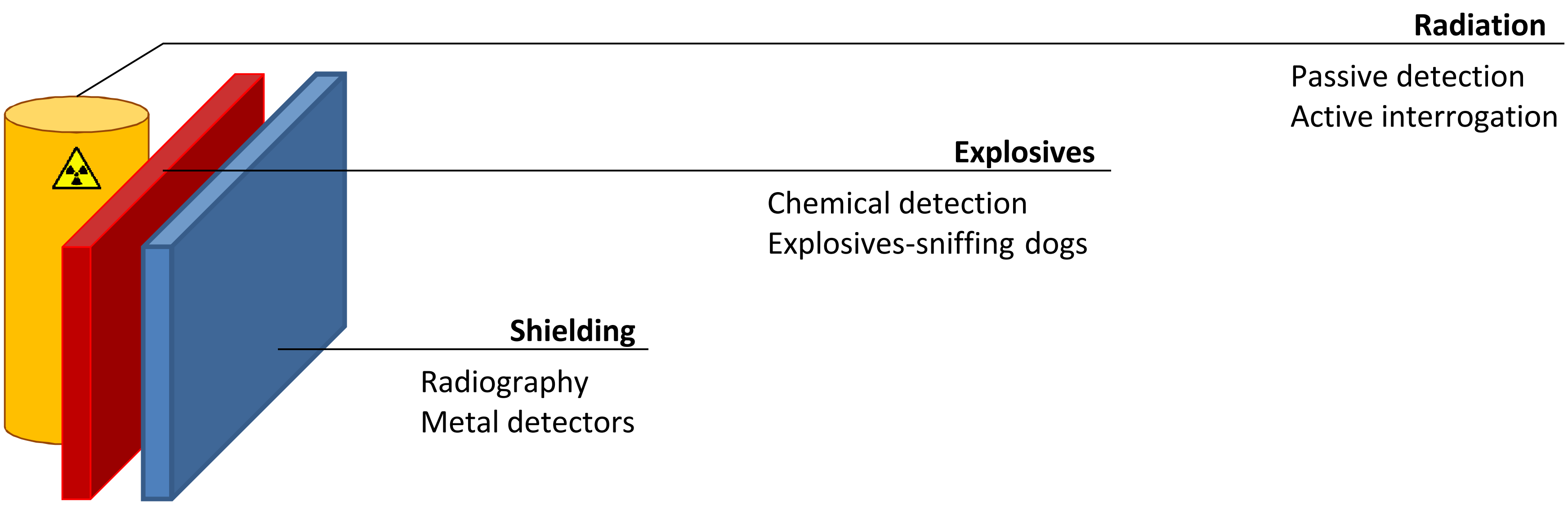
- Radiography is used to distinguish between low and high density material, which enables the detection of shielding
- There are a variety of advanced radiography systems that can help to identify materials of concern, although these tend to be more expensive.
- Does not directly detect radiation
- Can be used to scan for other contraband such as people and drugs (multiple-use technology)



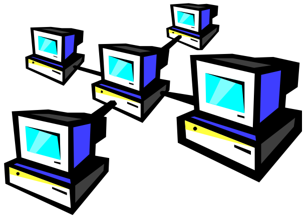
Radiographic image of a truck and cargo

Complementary Approaches to Detection

Threat devices may be comprised of shielding, explosives, and radioactive material. These components can be trafficked as a completed device or as components. Using complementary approaches to detection can improve the chance of detecting the threat.



Detection Data Networks

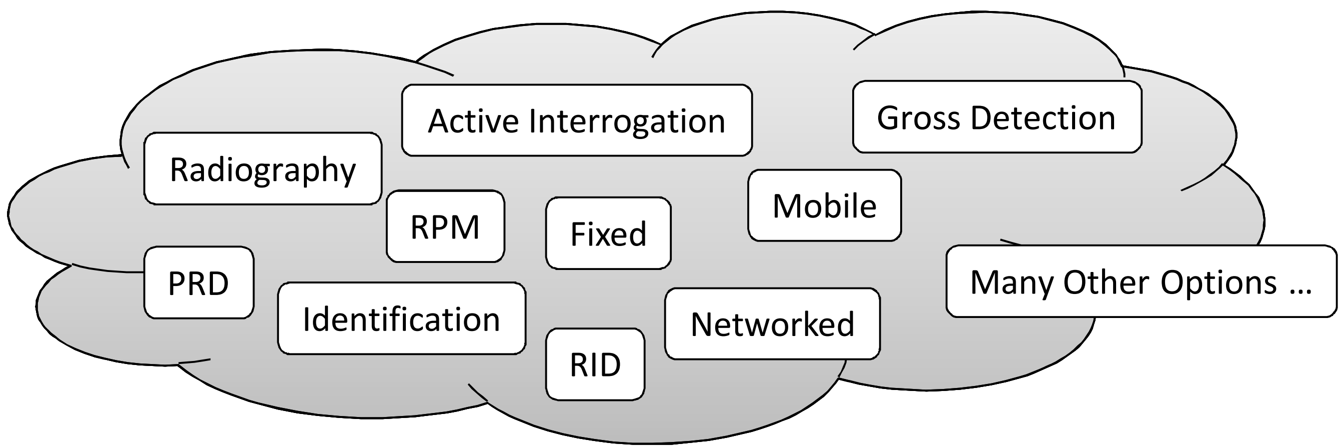


- Integrating detection systems into information networks can have many benefits, including:
  - Providing situational awareness and monitoring system health
  - Facilitating the sharing and transmitting of information
  - Automating data collection for future analysis
  - Tracking cargo to reduce duplicative inspections
- Options for networked instruments include:
  - All instruments networked in a big-picture view of the architecture
  - Integrating multiple detectors in a small area to improve detection

Determining Detection Technology Investments

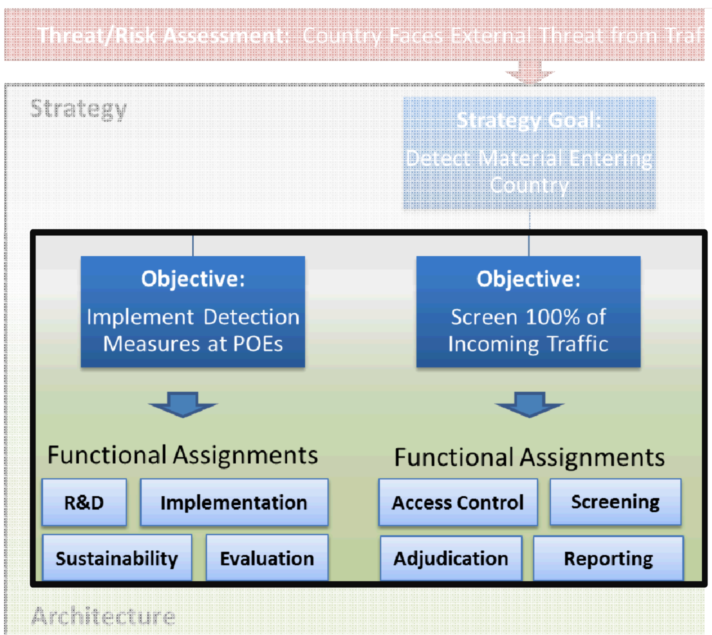
There are many considerations when deciding among technology options for the nuclear security detection architecture. The following slides focus on:

- Developing operational requirements
- Instrument specifications that should be considered
- Methods of evaluating detection technologies



Operational Requirements

- Informed by the national nuclear detection strategy
- No single technology will meet all operational requirements



Example Operational Requirements

- All cargo, vehicles, and personnel must be screened
- Detection instruments must integrate with existing infrastructure
- Screening should be completed in under 10 seconds to minimize impacts to commerce
- Instruments should be ruggedized and able to operate in inclement weather

Instrument Specifications

- It is important to consider a wide array of technical, operational, and financial factors when developing instrument specifications
- Specifications are based off of operational requirements and constraints (e.g. budgets)

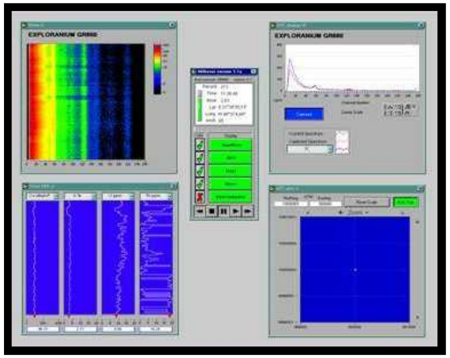
Specifications must be detailed enough to be evaluated against

Types of Specifications

- Specificity
- Sensitivity
- Standoff distance
- Dwell time
- Probability of detection
- Instrument mobility
- Ruggedness
- Energy consumption
- Ease of use
- Costs: initial, maintenance, replacement, training
- Compatibility with existing systems

Evaluating Technologies

- Once the requirements and specifications have been developed, evaluations should be conducted to determine appropriate technology options
- Technology that is currently available and those under development should be considered
- A rigorous and objective evaluation methodology should be developed and executed
- Evaluations can be conducted in laboratories and in the field
- International collaboration and sharing of evaluation results can lower costs by avoiding duplication of test and data collection activities



The evaluation should ensure that instruments meet the operational requirements and specifications

Technology Investment Summary

Architecture Objective

Screen 100% of all containers at land Points of Entry

Possible Operational Requirements

- Minimize impact to commerce
- Integrate with existing national data network
- Be able to screen through densely packed cargo containers

Example Specifications

- Have a network connection
- Able to be redeployed
- Scan objects 2.9m tall and 2.5m wide
- Perform detection on a truck driving 8km/s

Testing and Evaluation

RPM
Passive
Active
PRD
Radiography
RID

Additional Considerations

- Financial constraints
- Environmental concerns
- Training requirements or ease-of-use

Possible Technology Investment Recommendations

PRD + RID
RPM + Radiography
RPM

Research and Development

- If possible, States should support active research and development of new capabilities
- International collaboration can be leveraged to share improvements in technology that will benefit all states and improve the global architecture
- Research areas can include:
  - Detector material
  - Identification algorithms
  - Detection range
  - Mobility