Countering Weapons of Mass Destruction

S&T and Architecture for "Loose Nukes"

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CWMD PSC Membership

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Navy	William Thompson
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OUSD(P)	Jessica Cox
OUSD(I)	Michael Spence
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DTRA	Stephanie Vaughn
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"We must ensure that terrorists never acquire a nuclear weapon. This is the most immediate and extreme threat to global security."

President Obama, Prague, Czech Republic, April 5, 2009

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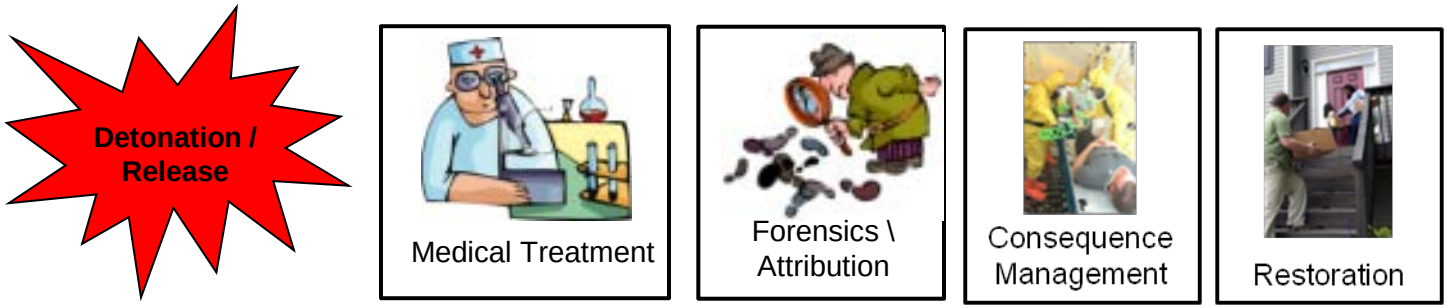
Scope of CWMD Challenge Problem

Challenge Problem



Systems Performance Goals

- Broad Area Search
- Persistent Monitoring
- Tagging and Tracking

Technical Challenges

- Systems Integration
- Activity Recognition
- Advanced Signature Detection & Tracking
- Advanced Radiation Detection

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CWMD Problem Statement

Scenario: Imminent theft of nuclear weapon from a foreign storage facility by terrorist cell with insider assistance

- The U.S. needs improved capability to deal with a potential future "loose nuke" emergency involving a foreign nuclear weapon or significant amount of special nuclear material (SNM)
  - Earlier cue that a plot is afoot or a theft has occurred
  - Faster access to the area
  - Improved monitoring ability and TTL
  - Higher confidence in containment and search
- Radiation detectors alone will not solve the problem
- ISR technologies, lower latency, networks of networks, and social media may be part of the solution

What S&T investments are central to loose nuke problem and in what architecture would new technologies be deployed?

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Loose Nukes Parameter Space

	Technical Challenge	Objectives	Technical Approach
3-5 years	Existing data fusion	CWMD community in complete concert	Global CWMD Analysis System; sensor fusion
5-7 years	Alternate signature exploitation	Locate, monitor and track WMD at strategic distances	HSI, IR, FTIR, GPS, radar, lidar, RFID, nanoparticles, etc.
7-10+ years	All-source Information Integration	Pre-event cues, real-time activity detection	Net-networks; beyond physics sensing

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Parameter Space: Signatures

Target Class: Vehicle

Sub-Class: Passenger Car, Light Truck, Heavy Truck, APC, Tank

Source: DTRA

Observable	Signature	Sensor
color	absorbance	HSI
material	reflectance	HSI
heat	thermal gradient	IR
chem emission	hydrocarbons	FTIR/chem
size	pixels/return/reference scale	EO/radar
motion	doppler/angular change/GMTI/GPS*	Radar/lidar/FMV
weight	seismic/magnetic	geophone/accelerometer/magnetometer
sound	acoustic/seismic	microphone/accelerometer
Location	Georeference/GPS	EO/SIGINT
EM	EM	EM (inductive/capacitive)
RF	RF	RFI/DF

And similar sets for payloads, people, facilities, sites…

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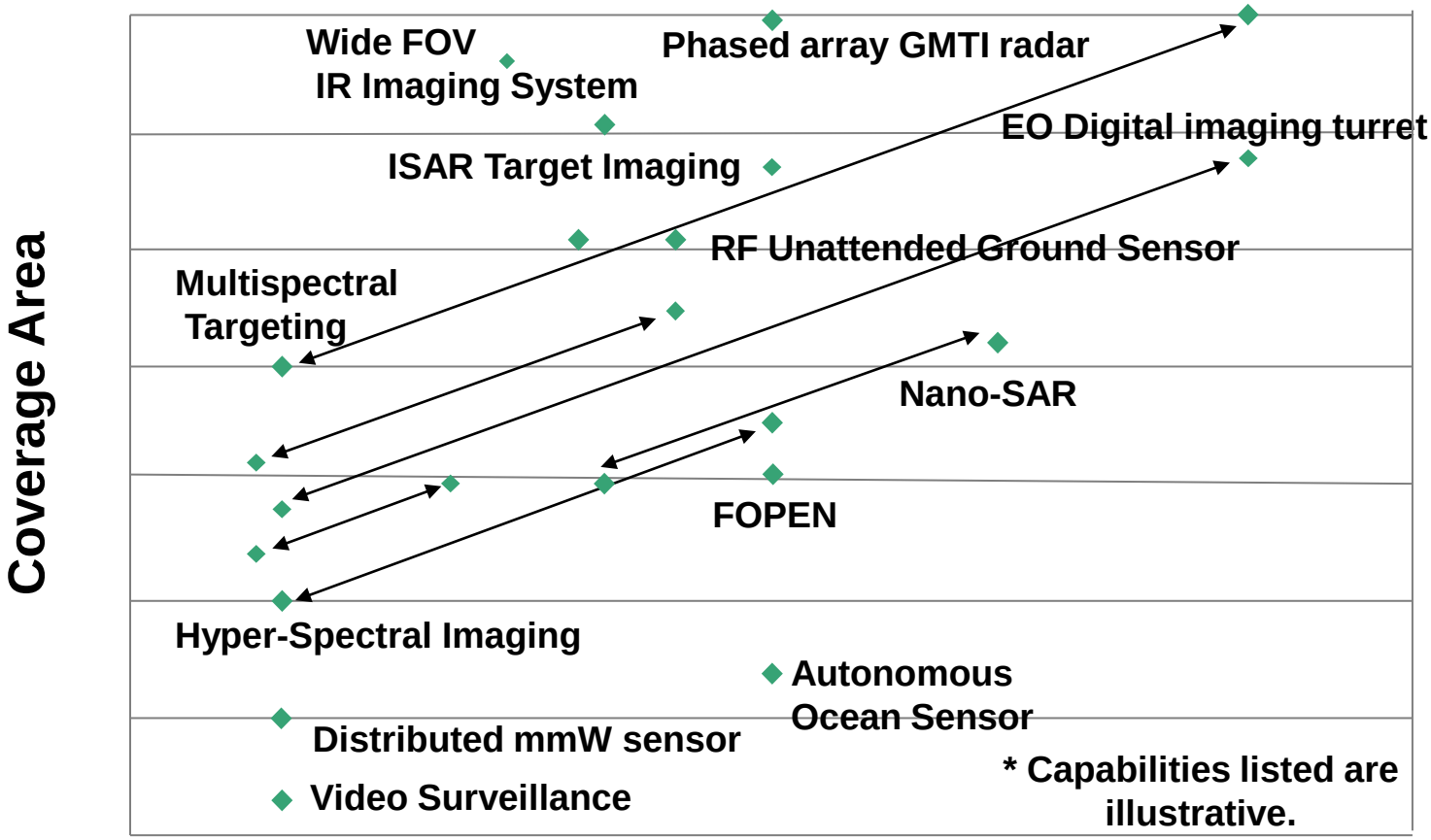
Parameter Space: Sensors



Source: The Technical Cooperation Program

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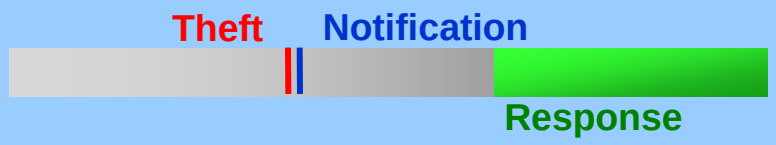
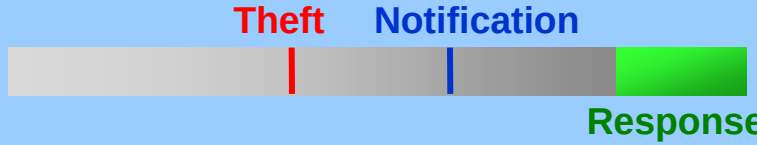
Parameter Space: Architecture

(#) *Increasing Level of Difficulty*

Notification of "Theft"

Access to Region	Immediate	Delayed
Immediate	**1** • Search begins immediately • Search region small 	**2** • Search delayed by notification • Search region large
Delayed	**3** • Search delayed by access • Search region large 	**4** • Search delayed by notification & access • Search region large 

- Delays in response to theft (caused by late notification or access) increase the "level of difficulty" in recovering SNM

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Technical Challenges & Metrics

- **Confidence in getting a cue**
- Sense change in SNM/NW state
- SNM rad detection
- Alt signature readiness
- **Sensor deployment latency**
- Sensor handoff
- **Data/network fusion**
- Persistent surveillance
- Tracking confidence
- Broad area search (km^2/hr)
- Behavior/intent detection
- **Social network exploitation**
- **Architecture maturity**

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CWMD "Loose Nukes" Roadmap

Needed Operational Capabilities

Pre-Positioned Assets, Intel Fusion, Cue, Containment, Locate, Recover

Technology Development Areas

Rad Detection **Persistent Monitoring/ISR** **TTL BAS** **Intent/Behavior** **Architecture**

Science and Technology Development

FY 15-17	FY 17-19	FY 19-22+
Systems Integration **Activity Recognition**	**Advanced Signature Detection** **Advanced Tracking**	**All-Source Information Integration** **Advanced Signature Detection and Tracking**
Integration of all-source intel and human reasoning, multi-sensor **data fusion**, pathway analysis, automated behavioral analysis	HSI, IR, FTIR, radar, lidar, RF, FMV, GPS, accelerometers, RFID, reduced data latency, **network fusion**	Integration algorithms, matrixed detectors, networks of networks, beyond physics: social network analysis, **automated all-source information fusion**

Revolving integration, demonstration and transition to meet operational needs

Note: These are not currently funded initiatives

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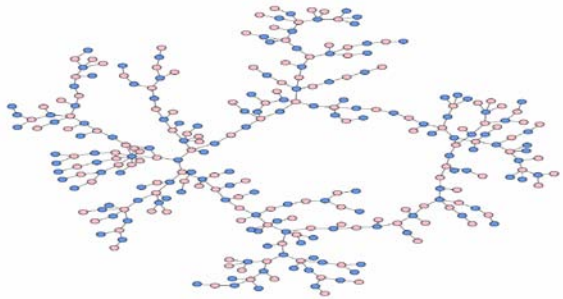
Big Gaps: Opportunities for NDIA

- Next gen rad detection, e.g. nanomaterials; ionized air; HSI
- Alternate signatures related to weapon activity
  - People, programs, communications, facilities, behaviors…
- Persistent intelligence, surveillance and reconnaissance
  - Sensor development and platform integration
  - Technical, intelligence and social data fusion

- Data-to-Decision Tools
  - Next-generation reachback and information sciences capabilities
  - High performance computing
- Architectures for prompt access and low latency
- Beyond physics
  - Human behavior and intent detection
  - Social network analysis



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BAAs and SBIRs

BAAs:

ARL Postdoc Fellowship Program	W911NF-11-R-0010
RDECOM-STTC	W91CRB-08-R-0073
ARO	W911NF-07-R-0003-04
ARL/ARO	W911NF-07-R-0001-05
DARPA	DARPA-11-34: I2O Office-Wide BAA
AFOSR	AFOSR-BAA-2009-1
AFOSR	AFOSR-BAA-2011-01
DHS	DHSS-TLRBAA11-03
DTRA	HDTRA1-11-16-RDIS-BAA
DTRA	HDTRA1-11-16-BRCWMD-BAA
ONR	BAA 12-001

also Special Notice 11-SN-0004 under this BAA, titled “Data to Decision”

SBIRs:

Army: https://www.armysbir.army.mil/default.aspx

DoD: http://dodsbir.net/solicitation/default.htm

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CWMD Summary

- Capability against loose nukes needs improvement
  - There is no silver bullet
  - Heavy reliance on early cue
- Radiation detection alone is not enough
- Many other signatures/sensors can be brought to bear
  - Substantial capability already exists
  - But data needs to be integrated
- Sensor handoff/sensor fusion/network fusion essential
- Opportunities in ISR for persistent surveillance, tracking, and broad area search in scenario-specific architectures
- Greatest gains may be in automating synthesis of sensor data, intel analysis, all networks including social networks, and non-physics based detection of behavior and intent

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Backup slides

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Technical Challenges: Human Identification and Tracking

Target Class: Human

Sub-Class: Men, Women, Military, Civilian

Source: DTRA

Observable	Signature	Sensor
size	pixels/return/reference scale	EO/radar
motion	doppler/angular change/GMTI/GPS*	Radar/lidar/FMV
weight	seismic	geophone/accelerometer
Heat	Thermal gradient	IR
Location	Georeference/GPS	EO/SIGINT
Clothing	Absorbance/reflectance	HIS
ID	Facial/gait	EO
RF	RF	RFI/DF

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Technical Challenges: Building Identification

Target Class: Building

Sub-Class: mess hall, barracks, motor pool, administrative, PX, weapon storage, unknown

Source: DTRA

Observable	Signature	Sensor
size	pixels/return/reference scale	EO/radar
motion	doppler/angular change/GMTI/GPS*	Radar/lidar/FMV
weight	seismic	geophone/accelerometer
Heat	Thermal gradient	IR
Location	Georeference/GPS	EO/SIGINT
Clothing	Absorbance/reflectance	HIS
ID	Facial/gait	EO
RF	RF	RFI/DF

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Technical Challenges: Payload Identification and Tracking

Target Class: Payload

Sub-Class: crate, weapon

Source: DTRA

Observable	Signature	Sensor
size	pixels/return/reference scale	Radar/lidar/FMV
motion	doppler/angular change/GMTI/GPS*	Radar/lidar/FMV
weight	seismic	geophone/accelerometer
Heat	Thermal gradient	IR
Location	Georeference/GPS	EO/SIGINT
Chem emission	Foams/adhesives/HE	FTIR/chem
EM	EM	EM (inductive/capacitive)
RF	RF	RFI/DF

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Technical Challenges: Site Identification

Target Class: Site

Sub-Class: low security, high security

Source: DTRA

Gestalt	Macro-observables	Fusion Elements
Security	Personnel, armament, dogs, fences, lighting, cameras	Sensors + activity
Function	Association, movement patterns, emissions	Sensors + activity + reason
Status	Gates/doors open, lights on	Sensors + activity
Pace of operations	Movement patterns	Sensors + activity + reason
Location	Georeference/GPS	EO/SIGINT

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