Department of Homeland Security
Science & Technology

How Technology Can Address Homeland Security Challenges:
Ecosystem of Innovation

September 28, 2012
How Can We Build a Culture of Innovation in S&T?

A. How can S&T attract, retain and nurture top caliber staff from diverse disciplines?
   1. How do we attract the best scientists and engineers into government service?
   2. How do we keep S&T staff technically up-to-date, conversant with cutting edge developments?
   3. How do we develop and protect time to think and learn within the federal bureaucracy?

B. How do we build a learning organization and encourage multi-disciplinary, team-based approaches?

C. How do we encourage risk-taking and reward success in times of budget constraints?

D. How do we capture, share and use the knowledge we have and lessons learned?

E. How do we balance short-term R&D focus vs. strategic vision of transformational possibilities?
Historical Record: How Scientific Revolutions Happen

Not just about discovery

1. Something in the air – willingness to think anew; 18th century Enlightenment rationalism


3. New instruments, more widely available

4. Prosperity – time to think, experiment

5. Population – critical density willing to share information and failures

6. Domain shifts in application of technologies
“All technologies harness and exploit some phenomenon or effect (usually several) to human purposes.”

Technology: Three Themes

1. All technologies are combinations
2. Each component is itself a miniature technology
3. All technologies capture and exploit some natural phenomena, usually several

“Technology builds out not just from the combination of what already exists, but from constant capturing and harnessing of natural phenomena.”
Compound S-Curves

Product Performance

Time or Engineering Effort

First technology

Second technology

Third technology
Arthur: “In the cases I have studied, again and again I am struck that innovation emerges when people are faced by problems – particular, well-specified problems.”

Kelly: “When web of supporting technical species are in place, an event will erupt such that many people will have same idea at once. This is the Technium’s imperative.”
## Inverted Period of Invention

<table>
<thead>
<tr>
<th>Inventors</th>
<th>Stage</th>
<th>Task</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000-1,000</td>
<td>Think of Possibility</td>
<td>Recognizing an opportunity for solutions</td>
<td>We should use electricity for lighting</td>
</tr>
<tr>
<td>1,000</td>
<td>Idea of How</td>
<td>Imagining the crucial elements of the solutions</td>
<td>An incandescent wire in a sealed bulb!</td>
</tr>
<tr>
<td>100</td>
<td>Details Specified</td>
<td>Selecting specific solutions</td>
<td>Welded tungsten, vacuum pump, solder exhaust port</td>
</tr>
<tr>
<td>10</td>
<td>Working Device</td>
<td>Proving your solutions work reliably</td>
<td>Prototypes by Swan, Latimer, Edison, Davy, etc</td>
</tr>
<tr>
<td>1</td>
<td>Enabling Adoption</td>
<td>Convincing the world to adopt your solutions</td>
<td>Edison’s bulb (and electric system)</td>
</tr>
</tbody>
</table>
Innovation Advantages at S&T

“Top heavy bureaucracies remain innovation sink holes.”

–Steven Johnson, *Where Good Ideas Come From*, 2010

- Compelling missions, problem rich environment
- Capacity to leverage investments by others
- Opportunities for test beds, pilots
- Capacity to partner with private sector, universities, other federal agencies and other countries
- Convening power of government
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How Technology Can Address Homeland Security Challenges:

Emerging Threats

September 28, 2012
Emerging Threats Questions

- What are the most critical challenges, constraints, and opportunities presented by science & technology in the next 5-10 years?

- How can S&T best position itself to assist the HSE with emerging threats?

- How can S&T promote a proactive approach to threats within DHS instead of a reactive approach?

- Is it possible to position for emerging threats when operational partners are only concerned on existing threats?
Environment: Greater Use of Technology, More Threats, Less Resources

- Globalization & Transportation
- Border Security & Immigration
- Violent Extremism
- Cyber Domain
- Nature of Innovation
- Misuse of Technology
- Natural Disasters & Pushing Beyond Design Limits

- History Perspective
- Low cost of entry
- Strategic potential
- Both sides get to innovate
- Predictive & Reactive
- Tenuous balance
- Small Groups with State-like capability
- Insider Threat
- Aviation as an example...

MORE THREATS
Dimensions of Emergencies

Existential

Psycho-Social Impact
(Fear, Societal Cohesion, Survival)

Low

High

Minor Emergencies

Disasters (big emergency)

Catastrophes (really big emergency)

State threatening (ability of government to function/survive in doubt)

- Chernobyl
- 9/11
- Katrina

Natural Disease Outbreak
Unintended Consequences
Accidents
Negligence
Vandalism, Sabotage
Deliberate Use of BW

Cyber Dimensions of Possible Future Emergencies

Extent of Damage (Life, Property, Economic)

SLTT Response
PPD 8 Utility
Federal Lead
Catastrophic Incident Annex

2001 Anthrax
1995 Aum Shinrikyo
2003 SARS
2009 Flu Pandemic
2001 UK Foot & Mouth Disease Outbreak

2001 Anthrax
9/11
Katrina

Spanish Flu
Haitian Earthquake
Japanese Earthquake & Tsunami

2009 Flu Pandemic
2001 UK Foot & Mouth Disease Outbreak

2001 UK Foot & Mouth Disease Outbreak
1995 Aum Shinrikyo
2003 SARS
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SLTT Response
PPD 8 Utility
Federal Lead
Catastrophic Incident Annex
S&T was under-represented in QHSR 2010
QHSR 2013 provides an opportunity to showcase the value and impact of technology on the HSE
- Challenges, Threats, Risks
- Constraints
- Opportunities

QHSR 2013 provides an opportunity to pave the way to the future and look at the how of the mission
- How does the HSE approach the most important things?
- How the Department & S&T are organized …

**DHS Executive Steering Committee**
- Alice Hill/Alan Cohn chair
- Reps from components (S&T Rep: Deputy U/S)
- So far listed most significant trends
  - Challenges
  - Constraints
  - Opportunities
- Next steps:
  - Define capabilities needed
  - Resource type between comp.
  - Develop common metrics
  - Define success

**S&T Executive Steering Committee**
- Deputy U/S Gerstein chairs
- Reps from groups (Deputies), CKO, SPO
- Crafting tech foraging queries
- Next steps:
  - Meet regularly with team and the S&T leadership group
  - Examine role of technology within the HSE missions
- Goal:
  - Serve as a though leader within the Department
Top Trends for QHSR 2013: Per DHS ESC

Data Privacy & Security
Non-State Actors Filling Void in Weaker States
Increased Use of Connected Technology by Individuals

Increased Digitization & Transmission of Data
Decay of U.S. Infrastructure
Increased Extreme Weather

Increased Role of Non-State Actors
Global Disease
Growth & Increased Efficiency of Global Supply Chain

Consolidation of Global Supply Chain

In

Three categories considered -- Challenges, Constraints, Opportunities

Legend:

- Three categories considered -- Challenges, Constraints, Opportunities
- Ratings: Green = 3/3 in the top ten, Blue = 2/3 in the top ten, Red = 1/3 in the top ten
- Font size = number of votes
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Department of Homeland Security
Science & Technology
Presentation at Sweden-U.S. Bilateral
Dr. Daniel Gerstein
Deputy Under Secretary
Science & Technology Directorate
August 27, 2012
Department of Homeland Security Science & Technology

How Technology Can Address Homeland Security Challenges:

Big Data

September 28, 2012
What are the elements of the Big Data issue?

What are the challenges, constraints, and opportunities presented by Big Data?

To what degree must a Big Data solution rely upon proprietary data versus social media and data scraping?

To what degree will bureaucratic requirements and hindrances inhibit incorporation of Big Data solutions? Are there ways to mitigate inertia?
Big Data
Dimensions of Big Data in the HSE

**Volume:**
HSE Big Data Sources are by nature measured in terabytes or greater and exceed current storage/analysis infrastructures.

**Velocity:**
HSE Big Data Delivered over entire time spectrum (seconds to days).

**Variety:**
HSE Big Data come in myriad forms and types complicating data synthesis, analysis and visualization.

**Veracity:**
HSE does not always believe Big Data’s validity.

**Examples:**
- Command and Control
- Sensor Networks
- Passenger and Baggage Movements
- Security Threat Pattern Recognition
- Intelligence and Analysis
- Import and Export Data
- Cyber Threats
What are the DHS opportunities for next gen Big Data?

- DHS has access to high volume, high velocity and high variety data sets that can be used to define gaps, improve mission accuracy and increase efficiency.
  - USVisit – 42M biometric signatures
    - 4-6 second response needed to process, 1.2M screens per day (CBP)
  - USCert
    - 1M to 1B Transactions reviewed per day
- Current DHS data systems offer proprietary and limited access to specific pools of data.
- Emerging distributed capabilities are more accessible now in the IT market place.
- Building a good non-proprietary data architecture will enable DHS component missions
Working with components to define and implement operational Big Data architectures across DHS

- HSARPA has unique authority to experiment and examine opportunities for Big Data solutions

- Cross component architecture supports multiple missions:
  - Within a component:
    - ICE Counterproliferation -> Human Trafficking
  - Cross Component
    - ICE: Investigations -> CBP: Interdictions
    - USVISIT -> TSA, CBP

- Analyzing large data sets in motion and at rest: Cyber

- Leverage DHS CoE Command, Control & Interoperability Center for Advanced Data Analysis (CCICADA)
  - Large data set visualization, algorithms, scalable architectures
How should the Department prepare for big data solutions?

- What strategies will support the transition of S&T capabilities to operational Big Data architectures?
  - Privacy & Accreditation associated with spiral deliveries of capability on a 6 month cycle or less.
  - S&T Authorities to Experiment -> ICE Authorities to Operate

- What strategies might S&T use to convince components that big data solutions require a cultural change within their organizations?
  - Hire data analysis talent instead of agents
  - Career paths for data analysts
Big Data Questions

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Accelerating Innovation Through Systems Analysis

September 28, 2012
How do responsible offices promote a culture of systems thinking within the broader organization?

What are effective strategies for eliciting accurate, measurable requirements from elements within the organization?

How do we deal with the creative tension between a rigid systems approach and a more amorphous approach to innovation?
S&T’s Value Added Proposition

Value Added Proposition for Supporting the Homeland Security Enterprise

- S&T provides the HSE with strategic and focused technology options and operational process enhancements
- S&T seeks innovative, systems-based solutions to complex homeland security problems
- S&T has the technical depth and reach to discover, adapt and leverage technology solutions developed by federal agencies and laboratories, state, local and tribal governments, universities, and the private sector - across the US and internationally

Requirements Development
- Mission Needs Analysis
- Operational Requirements Development
- Key Performance Parameters
- Technology Foraging

Studies & Analysis
- Analysis of Alternatives (AOA)
- Consulting on capabilities, technology and processes
- CONOPS Development
- Technology Foraging

Research & Development
- R&D (Basic & Applied)
- Prototyping
- Concept Development
- Test & Evaluation
- Technology Foraging

Acquisition
- Systems Engineering
- Acquisition & Commercialization Support
- Contracting Strategies
- Program Management
- Formal Acquisition Test & Evaluation
- Transition Support

Lifecycle
- Lifecycle Support
- Consulting
- Logistics Planning
- Knowledge Management & Process Improvement

Partnership between S&T and Components
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- Knowledge Management & Process Improvement

Partner: Science & Technology
Science & Technology’s Resource Allocation Strategy (STRAS)

Gain Component Head & USST Support
• Agree upon Mutual Goals
• Agree upon Co-Ownership
• Commit organizations to solution development and transition

Work with Component to validate:
• Mission, priorities and gaps
• Assist in developing requirements
• S&T investment in the correct solutions

GO / NO-GO DECISION

Systems Analysis & Technology Foraging

Write Formal S&T/Component Support Strategy
• Document understanding
• Document expectations
• Document approach

Write Formal S&T/DHS Support Strategy
• Document understanding
• Document expectations
• Document approach

Current Portfolio

DHS/S&T

Component

Gain Component Head & USST Support

GO / NO-GO DECISION

Work with Component to validate:

GO / NO-GO DECISION
Science & Technology’s Resource Allocation Strategy (STRAS) -- S&T View

Led by:

**ASOA**
- Systems analysis to …
  - Better understand the environment
  - Identify questions for analysis
  - Identify requirements
  - Identify gaps

Led by:

**HSARPA / FRG**
- New Starts
- Understanding Systems
- Review Current Capabilities

**Questions for Analysis**

**Process of Learning Questions**

**Foraging Questions**

**Benefits:**
- “System” definition
- Situational Awareness
- Speed of Execution
- Strategic Partnerships
- Portfolio refinement
- Resource Management
- Points of Contact

**Led by:**
- RDP to Assist PMs
- All participate

**OCC**

STORE System Analysis

1. Identify Preliminary Mission Need
   - Establish Partnership
   - Gain Mission Understanding
   - Assess Operational Need
   - Document As-is Operational Context

2. Requirement Defined?
   - YES
   - NO

3. Validate Mission Need
   - Conduct Table Top (TTX)
   - Analyze TTX Findings
   - Update Operational Req’s

4. Identify Potential Solutions
   - Technology Foraging
   - Alternatives Analysis
   - Propose Technology Candidates

5. Understand Technology Impact?
   - NO
   - YES

6. Assess Potential Solutions
   - Plan Modeling and Simulation & Analyze Results

7. Prepare Acquisition Recommendation
   - Prepare Candidate Technology Business Case
   - Document To-be Operational Context

8. Component Acquisition Decision?
   - YES

9. Develop & Demonstrate Technology

10. Technology Accepted?
    - YES

11. Transition to Partner

12. Integrate into Mission Space
Project Sequence

1. Problem parsing and definition
   - Mission objectives, scenarios

2. Articulation of present-day operational scenarios & Concept of Operations (CONOPS)
   - Agent roles
   - Environment and constraints
   - Technological tools

3. Assessment of potential technology solutions, impacts on CONOPS
   - Understand “art-of-possible”
   - Filter, synthesize approaches
   - Consider COTS, GOTS, State-of-the-art

4. Synthesize solution options and provide guidance to potential Analyses of Alternatives and acquisition/procurement decisions

5. Solution development, technology assessment, transition, and implementation.
**OCC – Ag Screening Tools**
(Before/After extracted from Detailed OCC)

**Before AST:**
- **FAD**
  - “Healthy” Animal
  - Quarantine Affected Location(s)
  - Visual Detection (~21 days)
- Analyze at PIADC (~1-3 days)
- Confirm?
- No
- NAHLN Surveillance (Regional & Nationwide Scope)
- Yes
- Stop ALL Movement Nationally
- Depopulate Animals (All? / Sick?)
- Re-Start Movement (Nat/Int TBD)

**Clear?**
- Yes

0 days 21 days 25 days 2-4 months 6 -9 months 1-2 years?

**After AST:**
- **FAD**
  - “Healthy” Animal
  - AST Detect ongoing surv. (~7 days)
- Analyze at PIADC (~1-3 days)
- Confirm?
- No
- NAHLN Surveillance (Reduced Scope)
- Yes
- Stop ALL Movement Nationally
- Depopulate Sick Animals (regional)
- Move Healthy Animals Domestic
- Move Healthy Animals International

Clear?
- Yes
- Yes

0 days 7 days 10 days 25 days 1-2 months 3-6 months

Systems Analysis Questions

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Leveraging Industry for Impact

September 28, 2012
Industry Questions

- How might S&T improve the sharing of capability gaps, technology needs or other requests with industry partners?

- How can S&T gain insight into industry trends and investment spending?

- How might S&T leverage virtual tools to promote increased awareness with industry partners?
DHS S&T Commercialization Paths

Cooperative R&D Agreements (CRADA)  Year-In-Review
Long Range BAA  SBIR
Safety Act  Secure

Tech Foraging
Systems Analysis

S&T Priorities:
- Biodefense
- Cybersecurity
- Home-made Explosives
- First Responder Support

Informs
- LRBAA & White Papers
- CRADA
- Centers of Excellence
- International

1: Early
2: Mid
3: Late

Tools
Industry Collaboration

1: Early
S&T R&D
Industry Partner through CRADA
Joint S&T and Industry Effort
Transition to Industry

S&T Value Added Proposition
Operational Relevance …
Innovation …..
Partnerships …

Examples
- ARMOR
- FMD Vaccine
- CIRT
Multi-Use Technology

Multi-Use Product Lines

S&T develops technologies for homeland security to address catastrophic events that have no viable commercial business case

- Examples of Unintended Applications of S&T Products:
  - Levee Plug has components that are of interest to underwater manufacturing.
  - Chemical detectors meant for cell-phones to provide ubiquitous sensing are finding significant commercial application as a personal carbon monoxide (CO) detector.

- How can S&T leverage commercial markets to help accomplish the homeland security mission?
  - Minimize producing “one-offs” or very low quantities such that products remain cost prohibitive to transition and/or maintain
  - Support a broader manufacturing base without diminishing the availability and capability for a product’s intended homeland security use
Investigate multiple use products that have a nexus with the security and ancillary commercial applications

- Recommend best practices for planning and executing programs that lead to multiple use product lines.
- What industry networks might better support multiple use products?
- What venture firms are sensitive to multiple-use scenarios?
- How does HSARPA ensure that security products remain supported by multi-use application manufacturing long term?
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