

Chem-Bio Protection Without Chem-Bio Sensors:

Low Cost, Dual Use, Alternative Sensor and Information Architectures

Steven S. Streetman
ENSCO, Inc.
October 24, 2005

Overview / Disclaimer

- Current Sensor Capabilities / Limitations / Strategies
- Event Timelines
- Threats and Observables
- Alternate Detection Architectures for Overarching Detection Model
 - Acoustics
 - Radar
 - Video
 - Electro-Chemical
 - Procedural
- Summary

Current Sensor Performance

- Sensors Do Not Provide Protection
 - Sensors provide warning to enable protective measures
 - Warning **MUST** be sufficiently detailed and reliable to allow protective measures to be enabled
- Current Capabilities
 - Chem:
 - IMS / SAW provides detection and ID in seconds to minutes for agent present at sensor
 - FTIR provides detection, ID, bearing/location in seconds for agent at range
 - Bio:
 - Particle Count / UV Fluorescence provide bio/non-bio detection in seconds to minutes for agent present at sensor
 - Active laser provides bio/non-bio detection, bearing/location in seconds for agent at range
 - HHA / PCR provides bio presumptive ID in tens of minutes
 - Lab tests provide confirmed ID in hours

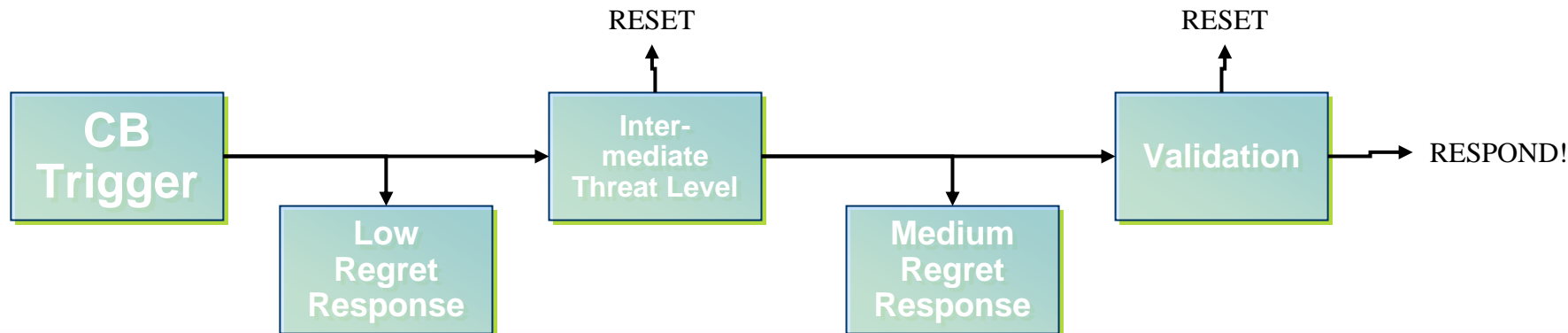
Current Sensor Limitations

- Breadth of Agents Detected
 - Chem: usually CWAs and a few TICs
 - Bio: specific agents tested (usually 5-10)
- Sensor Detection Range
 - Point sensors: range is effectively 0. Agent must be present at sensor air intake
 - Stand-off sensors: 1-50km
- Info Provided / Timeliness
 - No source location for point sensors
 - Id for detection sensors often not specific (e.g. bio vs. non-bio, agent class)
 - Detection / ID time too long
- Cost: Initial Cost High; Lifecycle Cost High
- False Alarms (Nuisance Alarms)
 - Sensors cannot reliably distinguish between normal chemical or biological sources and threat
 - Example: 19 month alarm data from operational system
 - Chemical Alarms: @260,000 alarms; 13,817 events (1 per hr)
 - Biological Alarms: @9,600 alarms; 4,869 events (8 per day)

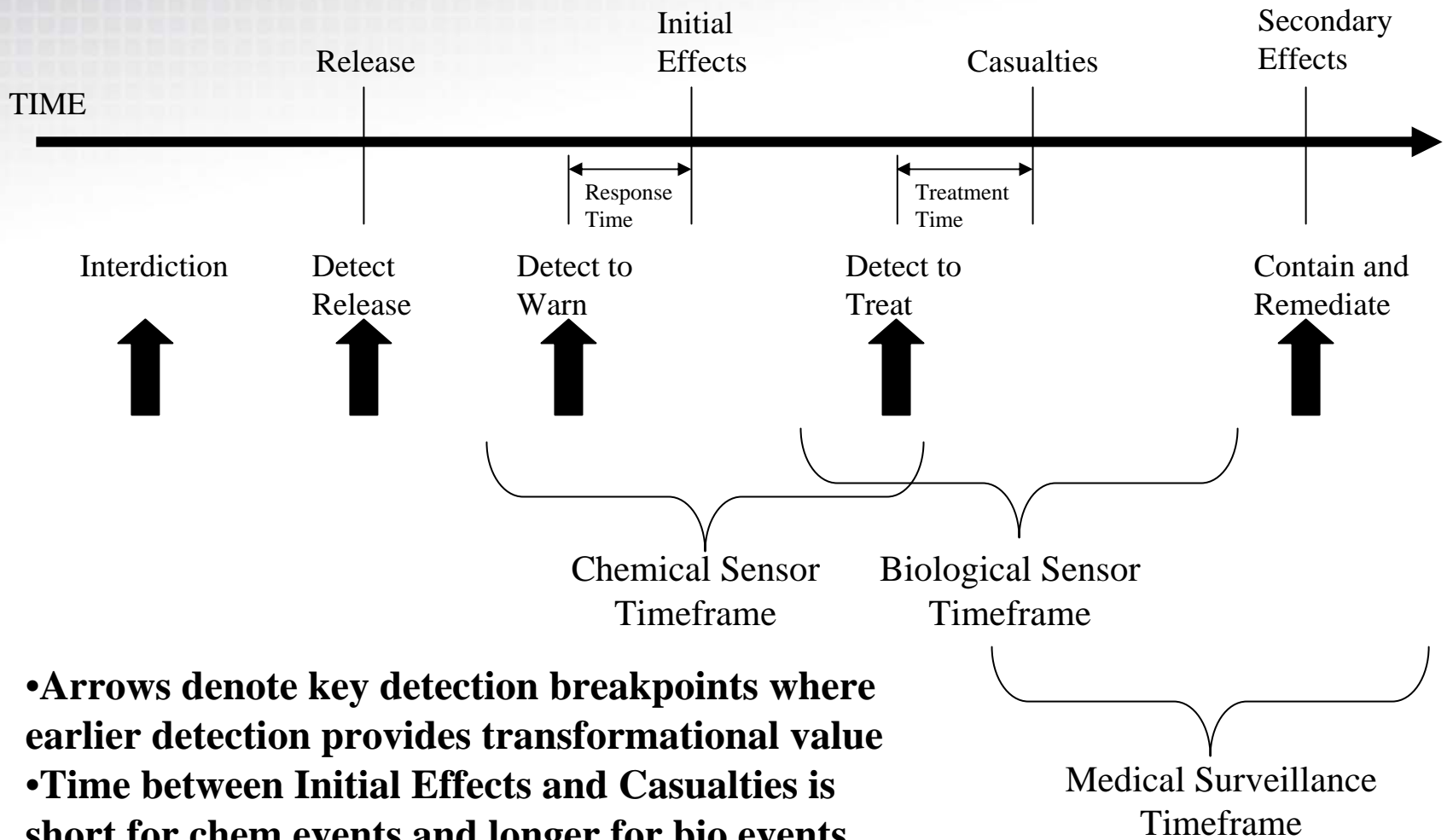
Operational Use of CBRN Sensors

- Cannot Implement Protective Responses Based on Chem-Bio Sensors Alone
- Validation Procedures
 - Threat Levels: graduated responses and information gathering
 - Multiple Phenomenologies:
 - redundant biological ID; lab tests
 - video / investigation for chem
 - Additional / alternate chemical sensors (e.g. handheld)
- Chem-Bio Sensors Become ‘Triggers’ for Validation Procedures

KEY QUESTION: Can We Use Alternative ‘Triggers’?



Sensor Event Timeline



Chemical Threats

THREAT	SIZE	CHEMICAL	LOCATION	AMOUNT	RELEASE
Industrial / Stored Chemical	Large	Known	Known	Known	Explosive
Rail Accident / Sabotage	Large	Known	Restricted to Rail Location	Known	Explosive / Derailment
Tanker Truck	Moderate	Possibly Known	Unknown / Possibly Restricted	Estimated	Spray / Explosive
Chemical Warfare Agent	Small	Unknown	Unknown	Unknown	Spray

Biological Threats

- Non-contagious
 - Large release
 - US Mail
- Contagious
 - Cougher
 - Contaminated products
- Location always unpredictable
- Agent type and amount unpredictable
- Small releases not detectable by any sensor type

Protection Options

- Perimeter Protection
 - Requires polices and procedures to implement; may require restrictions to flow of commerce
 - Pre-Event; not a response
- Collective Protection
 - Passive (not dependent on sensors)
 - Active (low regret response)
- Individual Protection Equipment (IPE)
 - Requires notification before exposure
 - Medium regret response
- Evacuation
 - Requires knowledge of agent location / transport
 - High regret response
- Decontamination
 - Requires knowledge of agent type / location
 - Medium to High regret response
- Treatment (e.g. antibiotics)
 - Requires knowledge of agent type / exposure
 - Medium to High regret response

Observables

- Threat / Intention
 - Communications
 - Web sites
 - Precursor purchase
- Release / Release Mechanism
 - Agent container/release mechanism
 - Smoke / cloud
 - Explosion
 - Traces of agent on container
 - Suspicious behavior
- Agent
 - Spectral signature
 - Florescence
 - Particle size
 - Cloud
- Agent Effects
 - Duress (animal or human)
 - Casualties
 - Treatments (treatment purchase)
 - Bleaching / material effects
 - Death

Alternative Detection Strategies

- Acoustics
 - Detect and locate explosion / derailment
- Radar
 - Detect and locate suspicious behavior in aircraft / watercraft
- Video
 - Detect duress, physical intrusion, smoke, suspicious activity
 - Also used for validation
- Electro-chemical sensors
 - Special purpose detection of known chemicals
- Procedures
 - Perimeter protection CONOPS
 - Data sharing (existing sensor data)
 - Source tracking (large, known chemical sources)

Acoustics

- Description
 - Small arrays of microphones with detection algorithms for explosive events
- Applicable Threats
 - Explosive releases of chem or bio agents
 - Derailments, sabotage using explosives
- Advantages
 - Detects release itself (earliest possible detection of release)
 - Provides standoff detection
 - Provides bearing/location and time of source release
- Disadvantages
 - Ineffective against spray releases or other non-explosive releases
- Dual Use
 - Gunshot / explosion detection
 - Situational awareness
- Cost
 - Low hundreds of dollars for purchase and installation
 - Largely maintenance free

Radar

- Description
 - Existing flight or surveillance radars along with procedures to identify suspicious behavior
- Applicable Threats
 - Air or Water vehicle releases
- Advantages
 - Detects release itself (earliest possible detection of release)
 - Provides standoff detection
 - Provides bearing/location and time of source release
- Disadvantages
 - Ineffective against small releases, planted explosives, or sabotage
- Dual Use
 - Intrusion Monitoring
 - Flight / maritime control and situational awareness
- Cost
 - Expensive, but often already installed in maritime or airport applications

Video

- Description
 - CCTV cameras installed at strategic areas and linked to command center
 - Intelligent video algorithms to identify events of interest
- Applicable Threats
 - Chemical releases with immediate effects on people or animals
 - Visible clouds or smoke
 - Threats that require physical intrusion (e.g into an air intake mechanical room)
- Advantages
 - Cameras are quickly becoming ubiquitous through physical security programs
 - Possible interdiction of event (in intrusion case)
 - Provides detailed visual evidence for situational awareness; may also be used for validation
 - Long range available
- Disadvantages
 - Intelligent video algorithms to detect smoke, visible clouds, or duress are immature and may false alarm
 - Requires line of site to event or event's effects
 - Possible day/night issues
- Dual Use
 - Situational awareness for all types of security and response applications
 - Detection of duress due to other causes than CB event
- Cost
 - Low hundreds of dollars for purchase and installation / Intelligent algorithms more expensive
 - Largely maintenance free

Electro-Chemical Sensors

- Description
 - Arrays of (typically 1-8) electro-chemical sensors each of which detects only a specific chemical
- Applicable Threats
 - Known agent at a known or restricted location
- Advantages
 - Detector placed near agent to detect release near release point (effectively standoff)
 - Extremely low false / nuisance alarm rate
 - Identifies source location through known storage location
- Disadvantages
 - Not effective against bio releases
 - Only effective against one agent per sensor
- Dual Use
 - Safety of hazardous chemical storage
 - Environmental sensing within a facility (e.g. radon / carbon-dioxide)
- Cost
 - Mid hundreds of dollars per chemical for purchase and installation
 - Moderate maintenance

Procedures

- Procedural changes provide opportunities to leverage existing detection capabilities or reduce vulnerabilities
- Examples:
 - Perimeter Interdiction
 - Vehicle Searches: swabbing sprayers or tanker trucks reduces ability to introduce quantities of agent to controlled area
 - ‘Trusted’ Personnel Programs (e.g. trusted shippers): identifies normal use of equipment / activities that are confusing sources for suspicious behavior and reduces impact on those activities from onerous procedures
 - Data Sharing
 - Existing data collection (e.g. chemical sensors at chemical plants) could be shared with EOC as part of situational awareness
 - Source Tracking
 - Implement a source tracking program for large chemical / biological hazardous materials similar to the tracking program for Level 1&2 radiation sources
 - Provides location and load information for large amounts of hazardous materials of all types

Summary

- CB sensors have limitations that, in an operational environment, require them to act as triggers to additional validation procedures
- Other detection capabilities exist that can act as CB triggers and can for some threats:
 - Detect earlier in the event timeline
 - Provide additional useful information such as source location
 - Detect broad spectrum of agents
- Alternate detection capabilities are typically:
 - Already deployed for other uses
 - Lower lifecycle cost than CB sensors
 - Have existing personnel to support
- Procedural additions can provide detection and/or validation capabilities without the cost of additional detectors

Alternate Detection Capabilities Should Be Evaluated To Replace or Augment Traditional CB Sensors in Specific Applications