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# Urban Testbed Initiative

**Tim Dasey**  
**MIT Lincoln Laboratory**  
**(781) 981-1903**  
**timd@ll.mit.edu**

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# Outline

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- **Thoughts on Urban Biodefense**
- **Importance of Testbeds**
- **MIT LL Urban Testbed Initial Approach**
- **MBTA subway experiments**
- **Algorithmic approach**
- **Future Work**



# Challenges Associated with Civilian Biodefense

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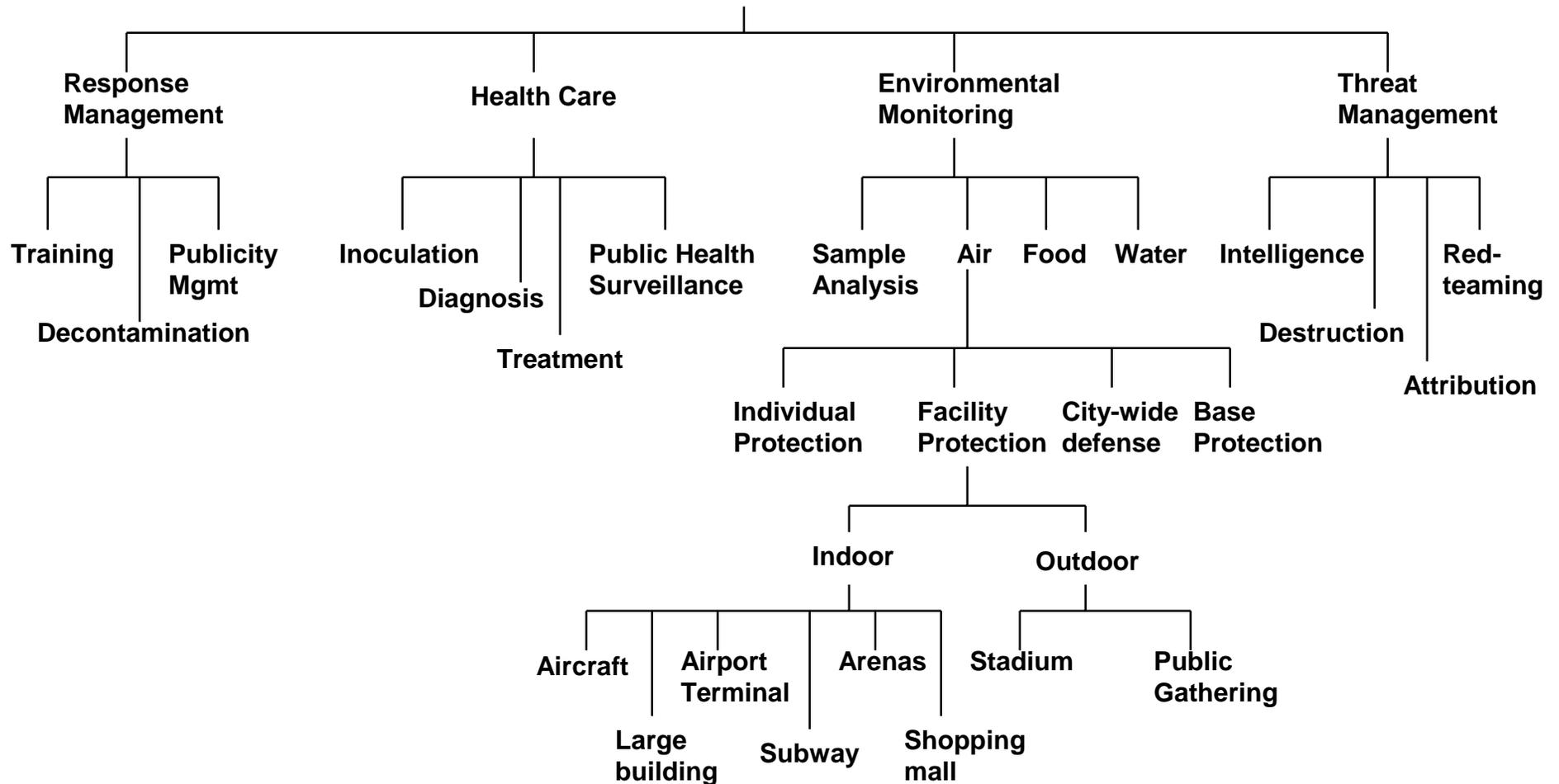
- **Any high-density site (city, airport, facility, building) represents a potential target**
- **Population to be protected is diverse (age, mobility, health)**
- **No environmental sensing systems will be tolerated that have high false negative or false positive rates**
  - **If they alarm too much or miss events, they will be ignored**
- **Current clinical diagnostic technologies and medical infrastructure are not suited to rapid detection of bioagent events**
  - **Advanced diagnostics (e.g., PCR) use is rare, even in large city hospitals**
  - **No medical reporting systems are in use that have real-time detection of infectious disease patterns as their objective**



# Biodefense Components

## Homeland Biodefense

*Numerous relationships between portions of this hierarchy are not shown.*



**Biodefense development must be multi-faceted.**



# Needed Biodefense Investments

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- **Point-of-care and public health not well integrated**
  - Health care system is the current detector
- **System (multi-sensor) environmental monitoring development**
  - Focus has been on basic technology and devices
- **Characterization of environments of high-threat facilities**
  - Sensor technology not universally applicable
  - Helps to set requirements
- **Large-scale urban protection**
  - Sparse sampling/sensing
  - Low probability event with catastrophic consequences (akin to nuclear detonation)
- **Red-teaming**



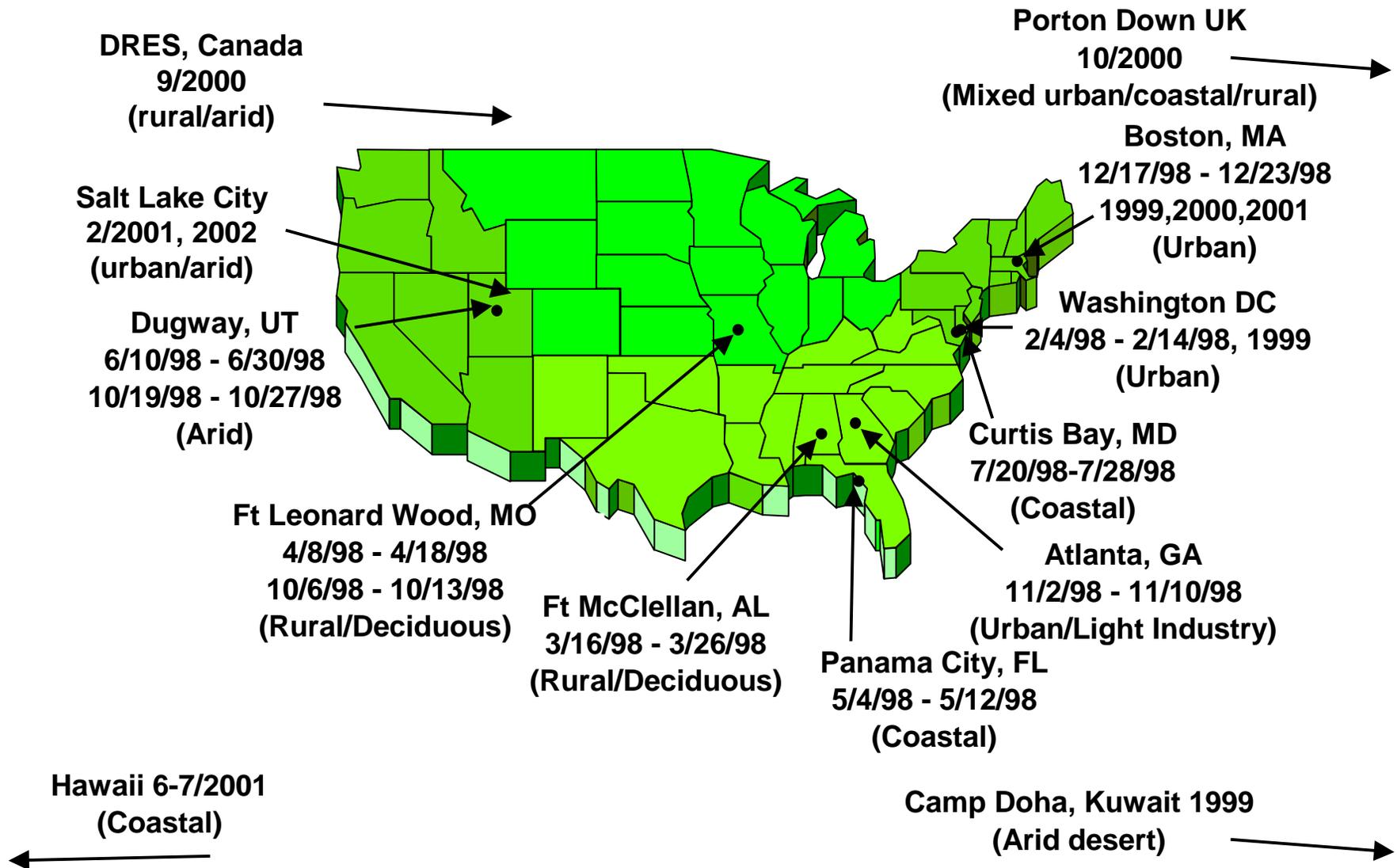
# Environmental Monitors

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- **DoD environmental monitors designed for outdoor force protection**
  - High sensitivity preference
  - Current cost prohibits mass-production
  - Unproven performance in urban or indoor areas where air is filled with interferents
- **Urban Civil Protection has markedly different requirements from military use**
  - Low false alert rate and low cost a priority
    - › Lower sensitivity partial solution may be preferred
  - Wide variation in environments (e.g. stadium vs. subway)
    - › Densely populated areas add to natural biological interferents
    - › Airflow, HVAC are important design considerations

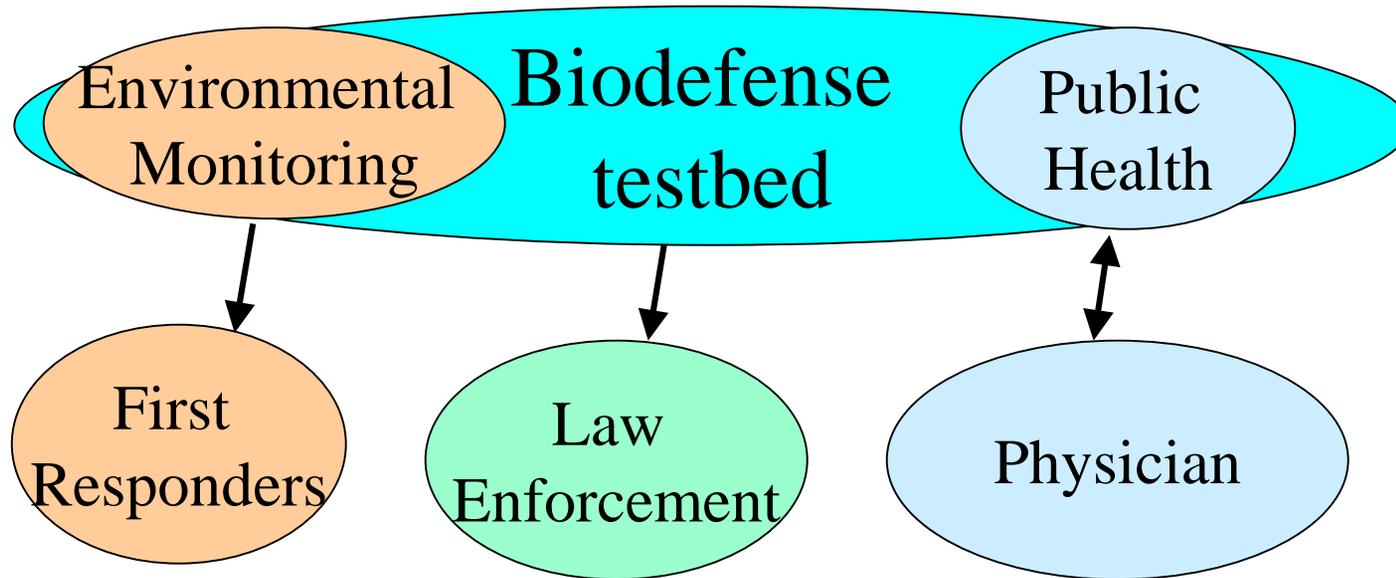


# BAWS III Background Measurement Campaign





# Testbeds as an Important Development Tool

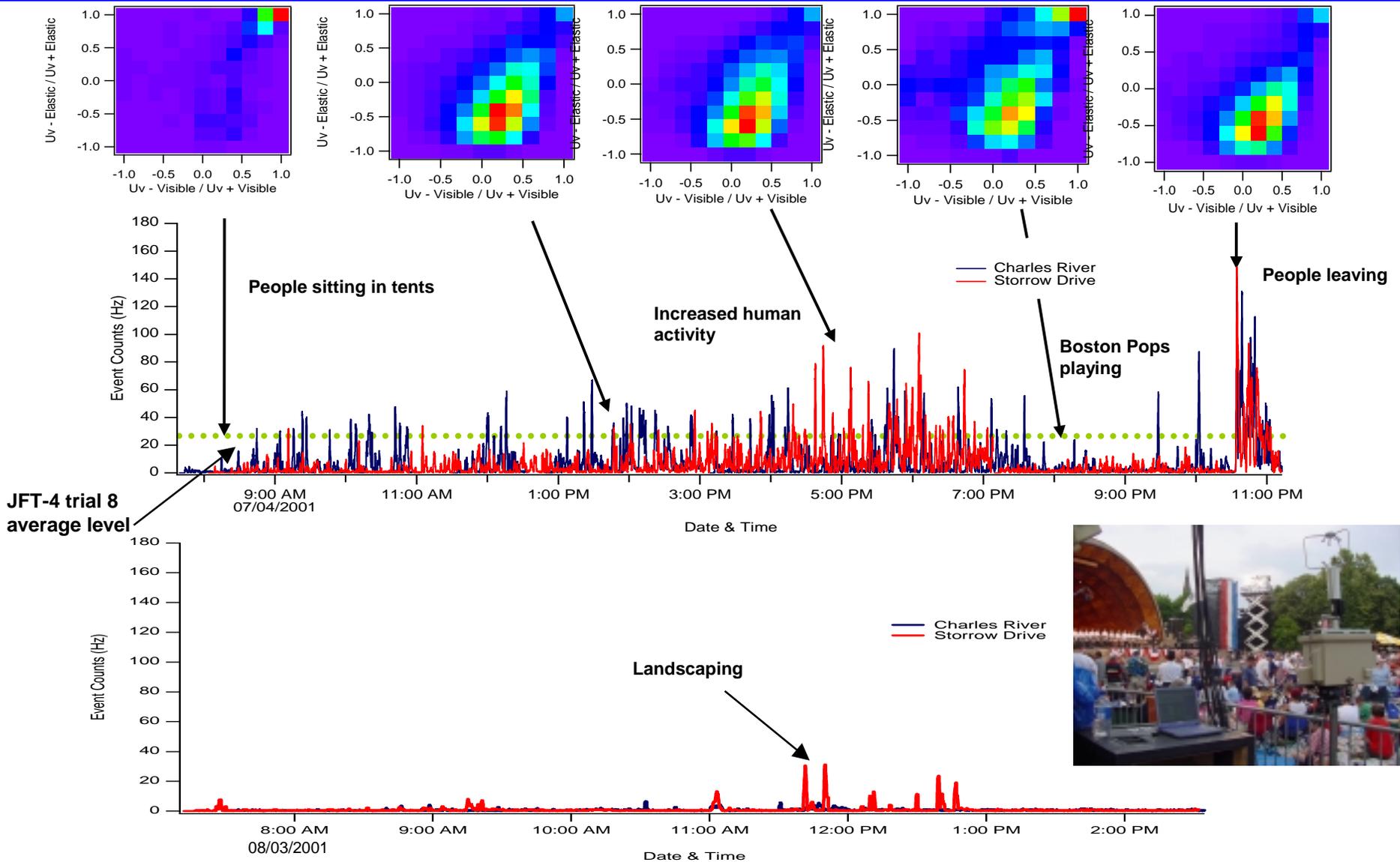


## Testbeds are needed for both public health and environmental monitoring systems

- Understand the problem and set system requirements
- Improve training
- Infuse emerging technologies in realistic settings
- Understand unique environments of various facility types



# BAWS July 4, 2001 Esplanade Measurement





# MIT/LL Urban Testbed Project Goals

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- **Define a system architecture for facility defense using environmental monitors**
- **Understand the natural air composition and the response of existing instruments in those facilities**
- **Develop decision logic methodology that is extensible to other urban defense problems**



# Urban Testbed Status

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- **Project funding began in June, 2001**
- **Coordination with Boston-area authorities for the past 1-2 years**
  - **MA Bay Transportation Authority (MBTA), Boston Emergency Management Authority (BEMA), MA Emergency Management Authority (MEMA), MA Dept of Public Health, National Guard, Logan airport, others**
- **BAWS measurements at Boston Marathon, July 4<sup>th</sup> celebration**
- **Measurements in MBTA subway station; sensors being installed in a station.**
  - **Particle counters, airflow, temperature, humidity, train motion.**
  - **Periodic measurements in other locations or with sensors that cannot be installed for long periods.**
- **Develop alerting algorithm approach**
- **Controlled chamber releases**
- **Discussing measurements in other Boston locations**



# Subway Protection Considerations

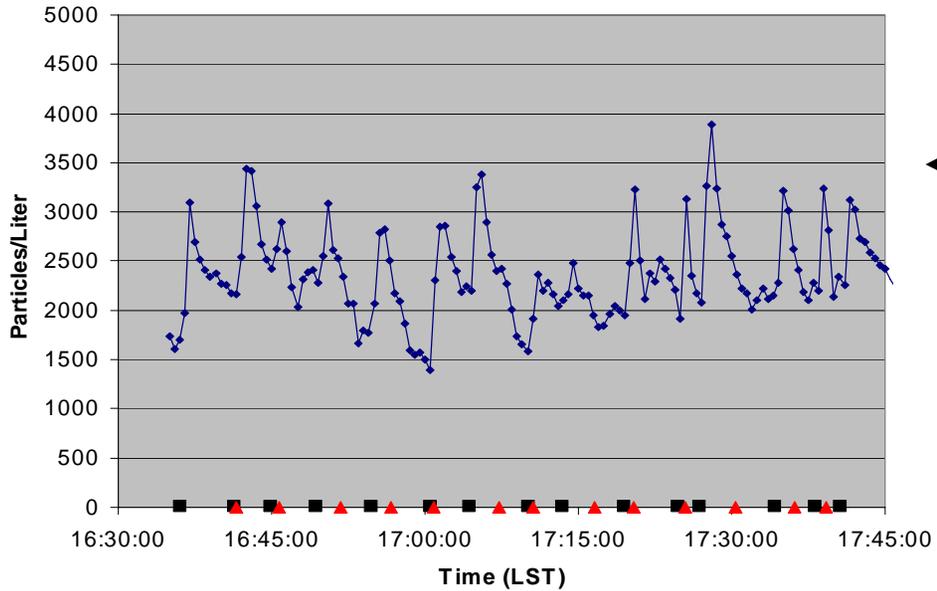
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- **Threat has been established**
  - Aum Shinrikyo Tokyo Sarin gas release
  - Numerous entry points and hiding places
  - Train “piston effect” moves air through the system
- **System is spatially distributed**
  - Many low cost sensors preferred over few high cost sensors
  - Release point cannot be anticipated apriori
- **Important to find dual-use applications for system**
- **Principal response actions**
  - Stop trains (plug tunnels?)
  - Activate vent fans?
  - Evacuate and prevent additional access

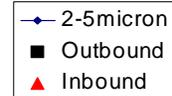


# Station Particle Counts

Particle Counts for 2-5 micron region

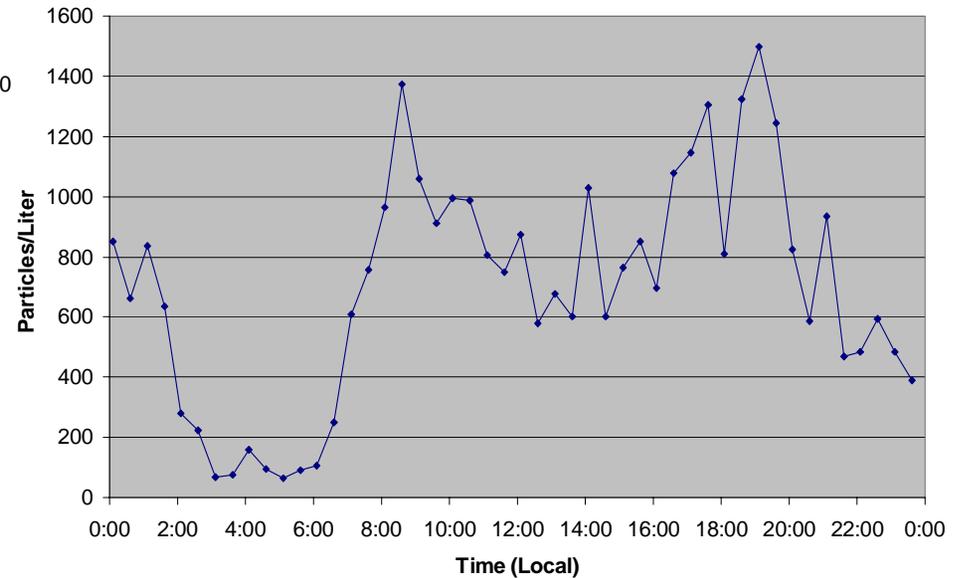


**Train Traffic significantly alters particle counts**



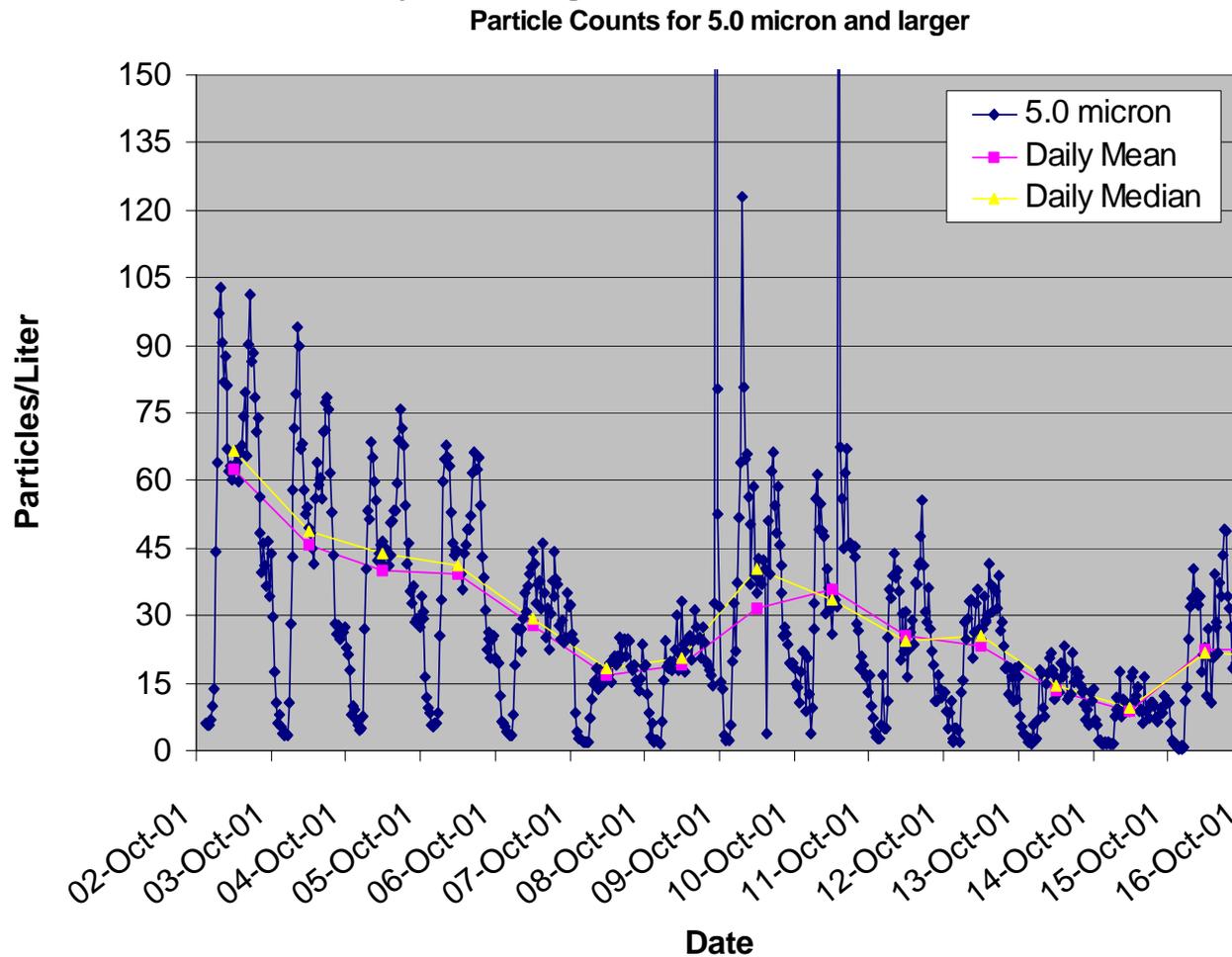
**Diurnal Cycle significantly alters particle counts**

Particle Counts for 2-5 micron region





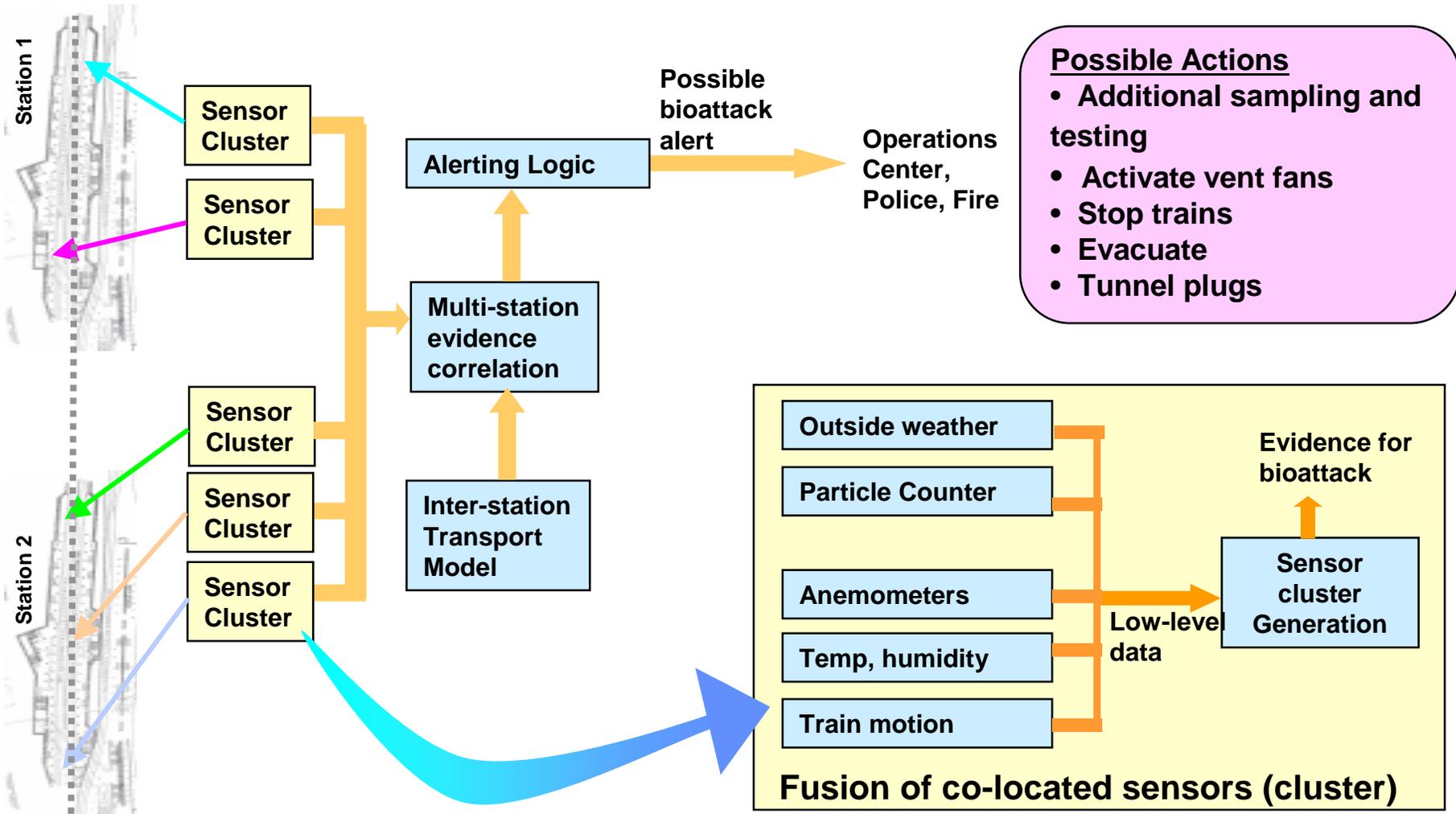
# Subway effects on Particle Counter Sensors



**Particle counter sensors degrade quickly due to laser optics contamination. Full instrument sensitivity regained after cleaning.**



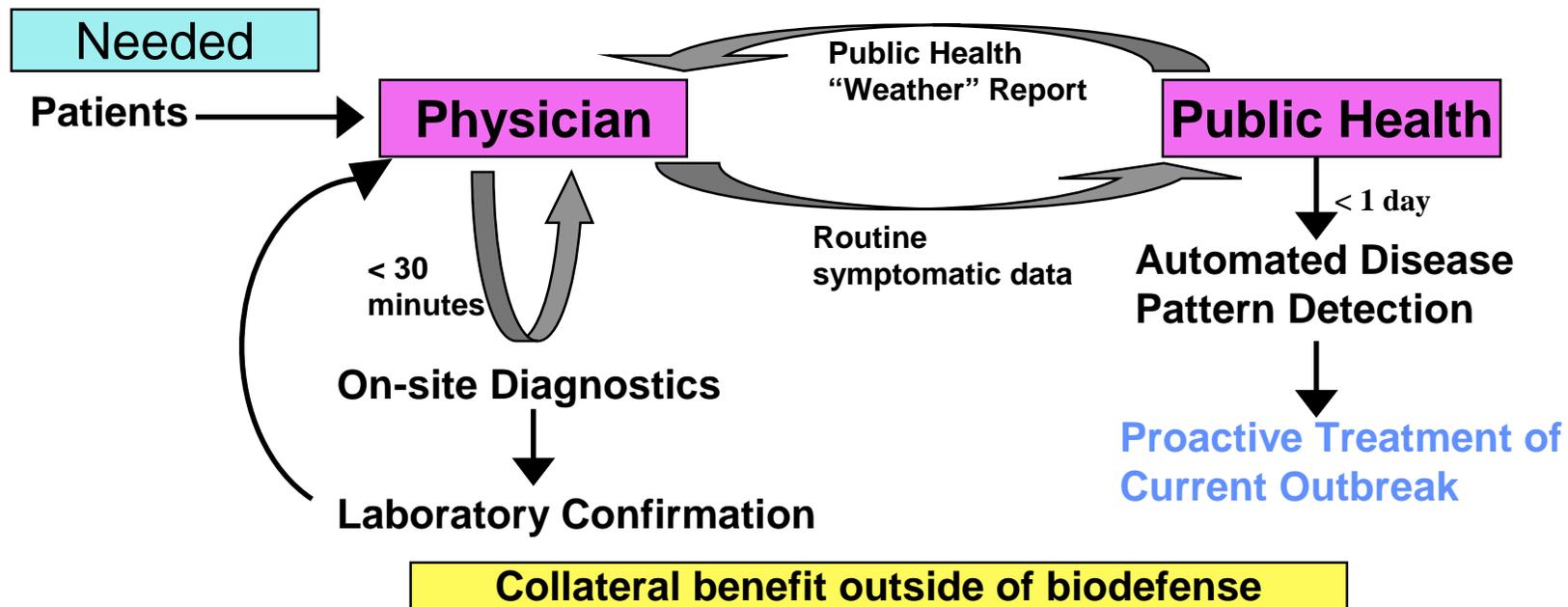
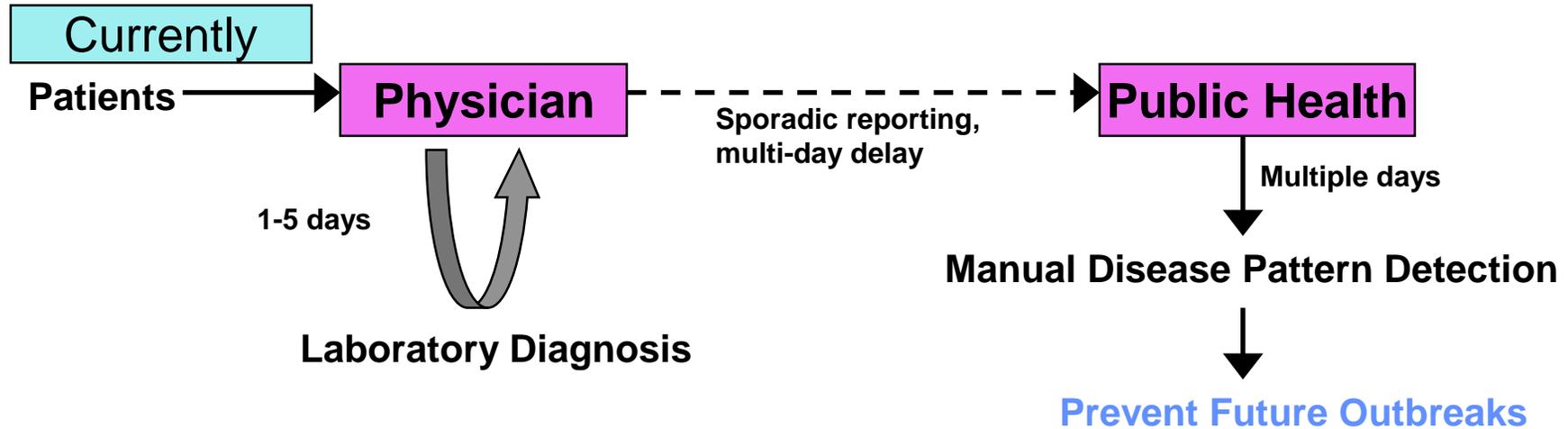
# Subway Alerting Algorithm Architecture



**Multiple sensors required to agree and sensitivity reduced to reduce risk of false alert.**



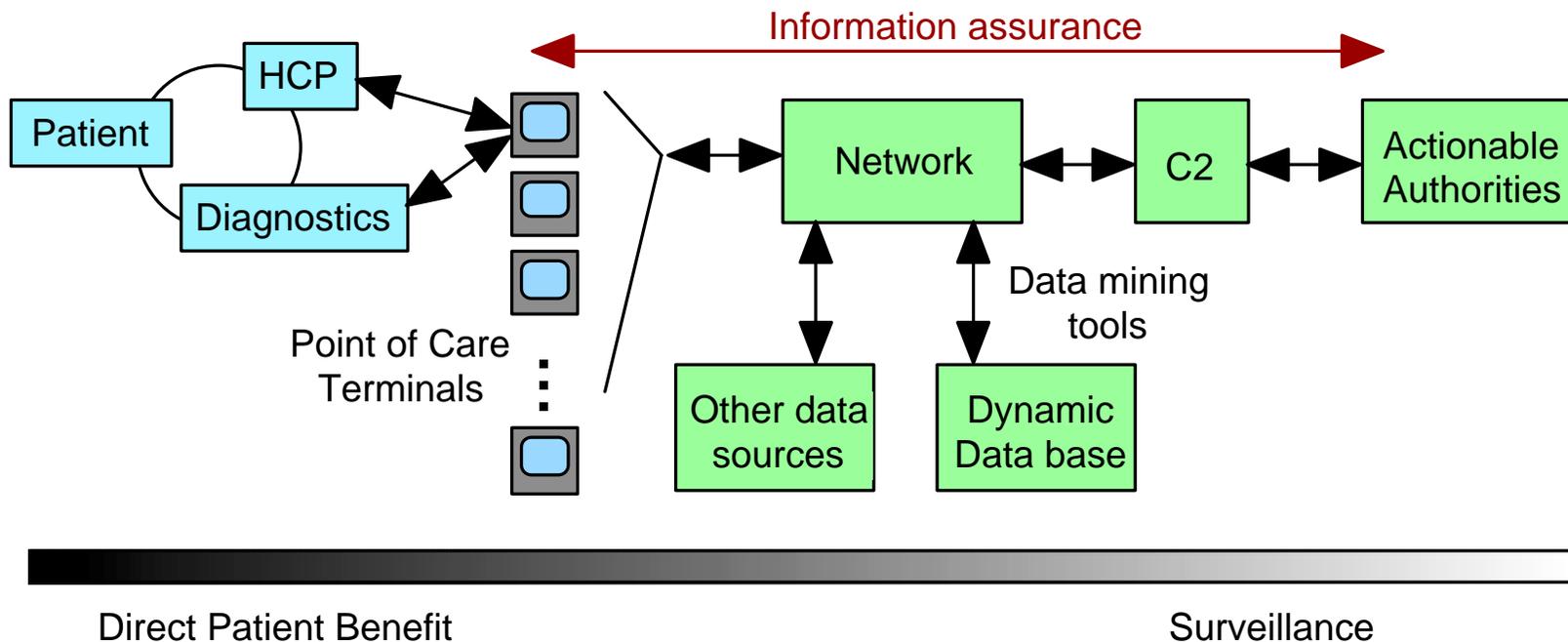
# Health Care Provider and Public Health Integration





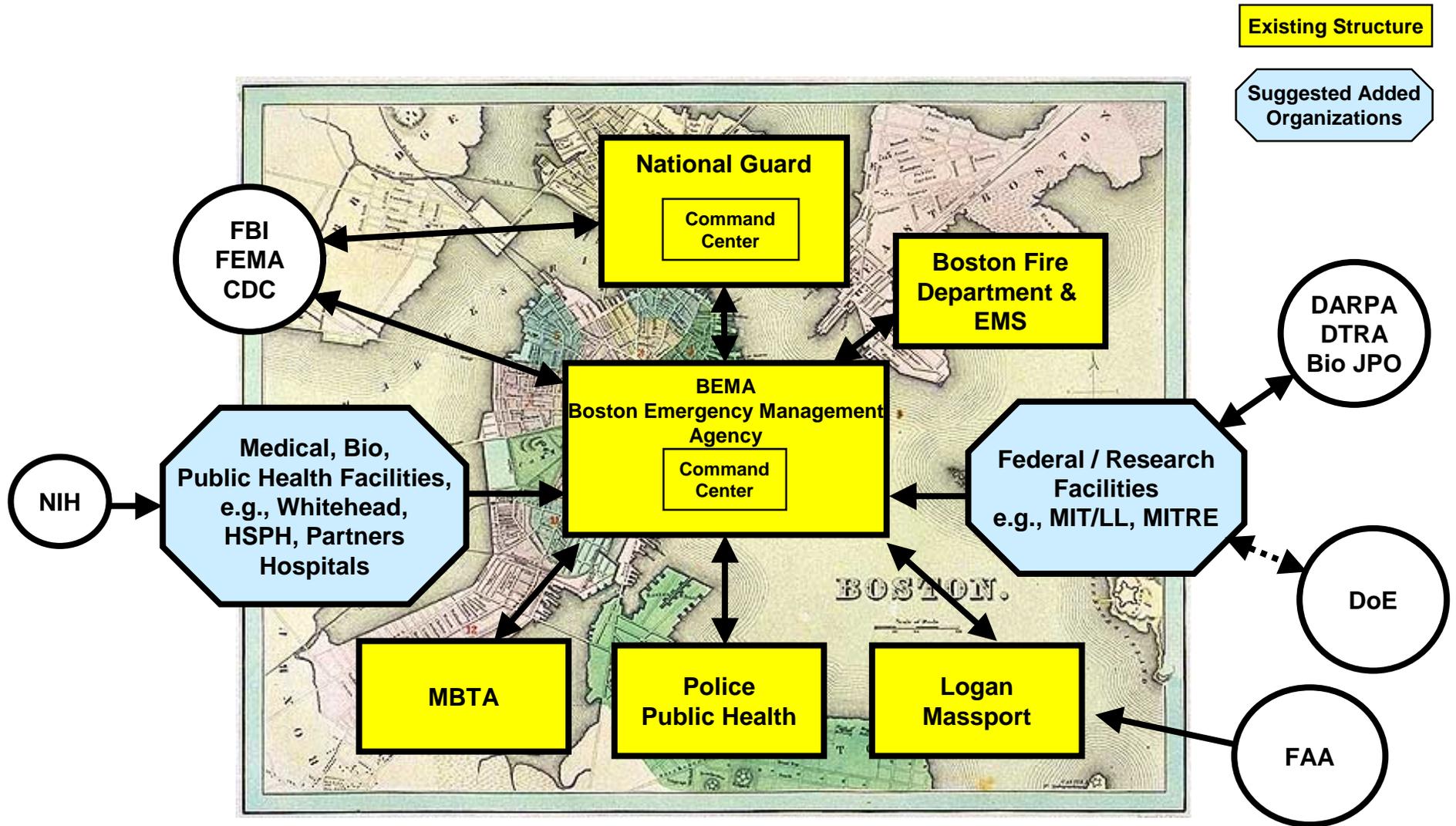
# Merging of Health Care with Defense Against Biological Weapons

- **Concept:**
  - Implement advanced point-of-care diagnostics (including but not limited to gene-chips), into IT networked system
  - Enables rapid determination of biological attack
  - Benefits natural infectious disease diagnosis, effective treatment





# Boston Area Agencies with Biodefense Responsibilities





# Summary

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- **Civilian bioterrorism defense requires that the environment of high-threat locations be well understood**
  - Environment drives sensor & system design
- **Initial testbed being installed at Boston subway station**
- **Measurements to date point out deficiencies of current sensors & software**
- **Modern recognition/data fusion techniques being applied to data**
- **Measurements at additional Boston threat locations under discussion**