BACTrack: A Surveillance Technique for Detecting and Locating Bioagent Attacks

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# BACTrack: A Surveillance Technique for Detecting and Locating Bioagent Attacks

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An Example Scenario

**Attack Phase – day 0**
- Covert Anthrax attack on T station
- Victims are infected but show no signs of illness

**Early Symptom Phase – day 2**
- Some victims show non-specific symptoms
- Victims are widely distributed geographically

**Treatment Phase – day 5**
- More victims begin to show signs of illness
- The sickest victims report to ER and doctors offices

Localized population
- Timely
- Not detectable

Cannot detect
- Cannot localize

Not Localized
- Not Timely
- Detectable
BACTrack

Biological Attack Correlation Tracker

- **Sampled Population**
  - Participants log a history of location versus time
  - When a participant feels ill, they download their symptoms and track history to a central processing facility

- **BACTrack processing**
  - Tracks of people reporting current symptoms are played back in time
  - Attack detection based on finding area with high concentration of symptomatic participants
Unique Aspects of BACTrack

- **BACTrack performs epidemiology in reverse**
  - First postulate a common point of infection, then follow-up to discover nature of ailment
  - Yields simultaneous detection and localization

- **Utilizes non-specific symptom information**
  - Filters noisy symptom data through geographical correlation
  - Allows automated self-reporting

- **Location tracking can yield signal-to-noise gain**
Comparison Of Detection Techniques

Resolution of Attack Localization:
- City
- Zip Code/Census Tract
- Block
- Building

First Symptoms
- Bedridden
- Hospitalized

Time to Detect

- Environmental Point Sensors
  - High False Alarm
  - High Cost/Maintenance
  - Local Coverage
  - Selected Diseases

- Medical Diagnosis
  - Syndromic Surveillance

- National Coverage
  - Low Cost, Dual Use
  - Full Range of Disease

- National Coverage
Comparison Of Detection Techniques

- **Environ-mental Point Sensors**: High False Alarm, High Cost/Maintenance, Local Coverage, Selected Diseases
- **BACTrack**: National Coverage, Low Cost, Dual Use, Full Range of Disease
- **Medical Diagnosis**: First Symptoms
- **Syndromic Surveillance**: Bedridden
- **City**: Building, Block, Zip Code/Census Tract

Resolution of Attack Localization

Time to Detect
Key Questions

• Detection sensitivity and false alarm rate
  – Attack size
  – Size of instrumented population
  – Ambient background illness
  – Time to detect

• Concept of operations
  – Tracking methods
  – Surveillance algorithms
  – Response
BACTrack Performance

Location – Med Surveillance

Detection - Med Surv.

Number Infected

Probability of detection = 0.9
Probability of false alarm = 10^{-5}
Infection rate = 50%
Background illness = 2%
First symptoms uniformly distributed 1 to 6 days

Initial victim symptoms

Days After Attack

Percent Instrumented with BACTrack

Number Infected

500
1000
2500
5000
10000
Building Attack Case

Detection Map

- Scenario: Anthrax is introduced into HVAC system of supermarket at peak shopping hour
- Simulation statistics
  - 10% of population BACTrack instrumented
  - 2% background illness
  - BACTrack detection based on report from 63 victims

To play movie please see attached file: s1.AVI
Water-Borne Contamination Case

Evaluation 5 days after contamination
2.5 days after first symptom

Evaluation 7 days after contamination
4.5 days after first symptom

- Waterborne attack detectable < 3 days after first symptom
- Simulation demonstrates public health benefit
BACTrack User Implementation

- **Location History**
  - Location tracking/storage using cell-phone network (geo-location mandated by 2006)

- **Subscription Services**
  - BACTrack location available as a phone provider service
  - Interactive Location Based Service forecast to grow to $4B/year market by 2006

- **User Reporting**
  - User reports symptoms through automated cell-phone interface using password
    - Individual reports only releasable with password
    - Summary information available to health department and all users

- **User Benefits**
  - User receives public health information including attack alerts and natural disease outbreaks
## Response Sequence

### Increasing Confidence

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<th>Obtain additional site information</th>
<th>First responders</th>
<th>Docs/Hospitals</th>
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- **First responders**
  - Forensics
    - Check local events
    - Phone calls
    - Site visit
    - On-site bio-analysis
    - Lab tests
    - Deny site Access
    - Declare as crime scene
    - Search for perpetrators

- **Docs/Hospitals**
  - Public Health
    - Increase patient testing
    - Look for other medical indicators
    - Order CDC push-pack
    - Prepare treatment centers
    - Treat most likely victims
    - Treat public at large
Summary

• BACTrack offers a new way to detect and locate bioagent attacks

• The study has shown the utility of coupling location history with health information
  – Earlier detection and location relative to medical surveillance

• The cell-phone location based service market can offer a means to implement BACTrack and to distribute its costs