Smart Sensing and Tracking with Video and Mote Sensor Collaboration

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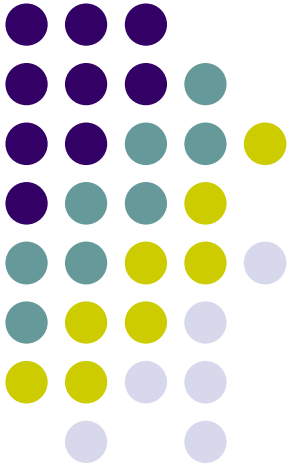

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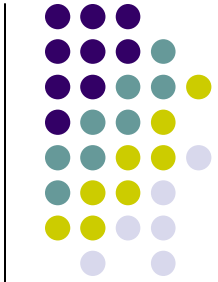
Introduction



- **Smart video surveillance in a sensor web framework augmented by auxiliary sensors to provide efficient real time situational information for security of our borders and critical infrastructures.**

- **Issues with large area automatic video surveillance:**
  - **Expense related with dense video camera coverage of the area**
  - **Large volumes video of data would need to be**
    - **collected/stored (power/storage requirements)**
    - **processed/analyzed (intelligence, information, awareness)**
    - **Distributed in a timely fashion to be acted upon (bandwidth demand)**

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Promise of Our Solution:
Smart Sensing and Video Understanding in a Sensor Web Environment

- **Use of inexpensive ad hoc netted sensors (motes) to cue and task video cameras to collect and process video only when a mote field detects and verifies activity,**
- **Embedded video analytics processing with camera (i.e., Smart Video Node) to push processing of video to the sensor edge for efficient use of bandwidth,**
- **Employ a Sensor Web platform to:**
  - **quickly discover sensors that are available,**
  - **seamlessly integrate and collect data from disparate sensors,**
  - **automatically task various sensors based on events,**
  - **receive and disseminate alerts from multiple sensors.**

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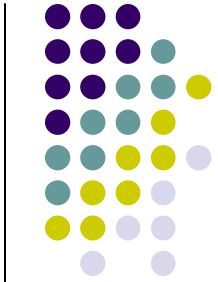
Components and Approach



- **Inexpensive Sensor Motes augment and cue video sensors**

- **Smart Video Node for fully automated extraction of video content, detection of anomalous and pre-determined events for enhanced situational awareness**

- **Sensor-web Framework integrating smart video and various inexpensive mote sensors**
  - **Information transparency between sensor modalities through the use of standards OGC (Open Geospatial Consortium)**

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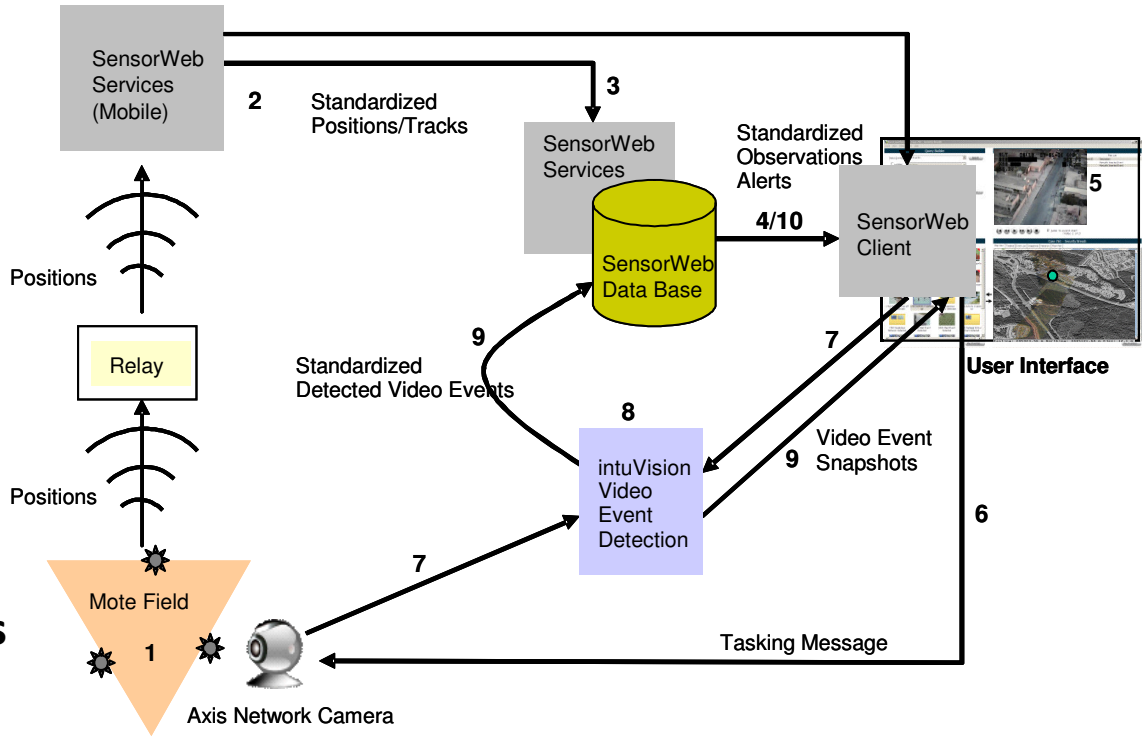
Concept of Operations

1. The Auxiliary Sensor Field detects movement.
2. Detected movement position is relayed to Sensor Web Services.
3. The new alert is disseminated within the sensor web.
4. The Sensor Web Client receives the new alert.
5. The Alert location is highlighted on the Client GUI.
6. The Client automatically tasks a camera to the location.
7. Video from the tasked camera is processed to detect events.
8. If detected the Event Alarm is reported to Sensor Web service.
9. Detected Event is published by the Sensor Web Service.



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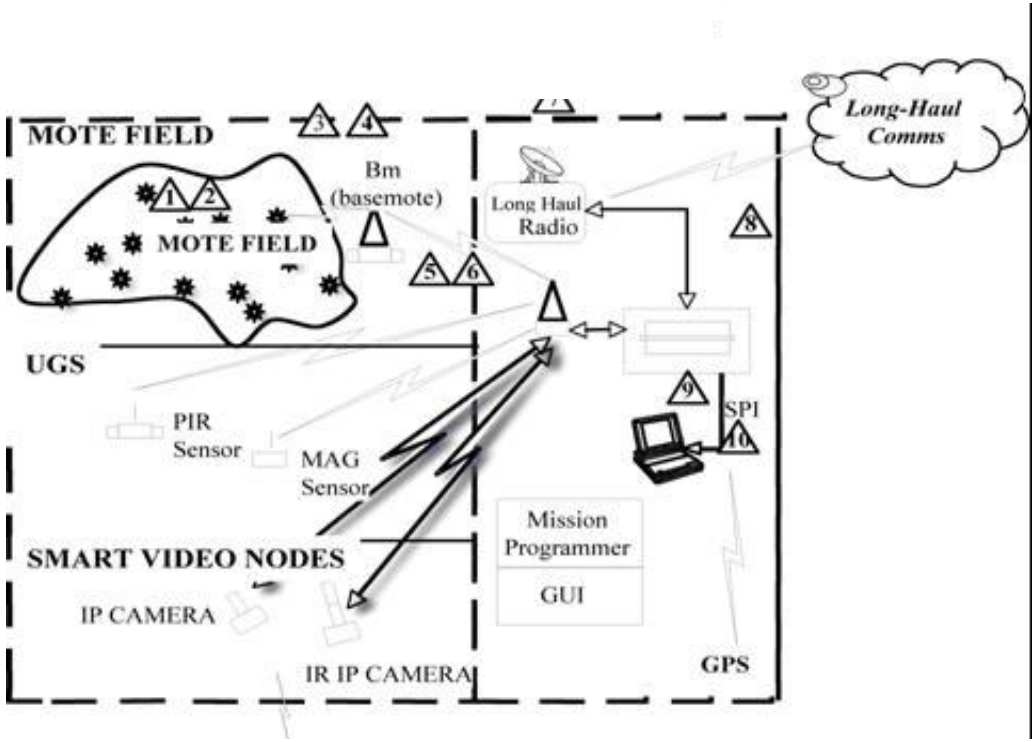
Video and Mote Sensor Collaboration with EIP's

Sensor Motes

- Sensor mote: a wireless sensor device that constitutes a single node in a wireless sensor network
- Each node consists of a small microcontroller, radio and sensing unit (e.g., pressure, motion, tripwire)
- Low-power sensors when used in a network of geometrical patterns can provide approximate location information on potential targets-of-interest

Sensor-Mote Field

- Sensor mote field is a network of motes to cue and direct the smart video nodes.
- Wireless sensor networking enables *ad hoc* mesh networking of small sensor devices, extending the internet to the physical world
- When a mote is powered on, it forms a network with any neighboring nodes that are in range.



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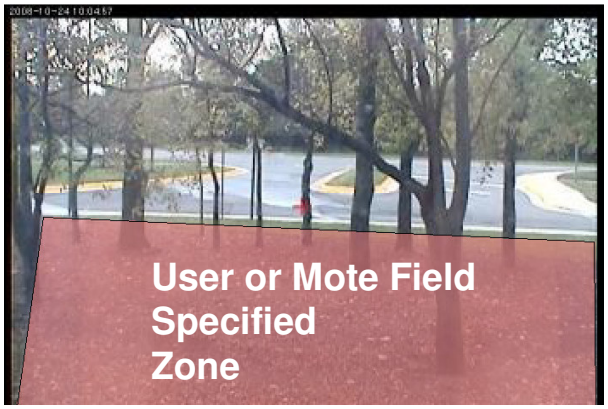
Video Event Detection for Large Area Surveillance

- **Detection and Tracking algorithms need to accommodate**
  - occlusions in wooded areas
  - low frame rates of network cameras,
  - camera panning and zooming as slewed by other sensor cueing.
- **Event Detection algorithms**
  - Dynamically respond to real-time triggers from different sensor observations;
    - Detection parameters (zones or direction)
    - Type of objects (vehicle, person)

  maybe determined by mote sensor alerts



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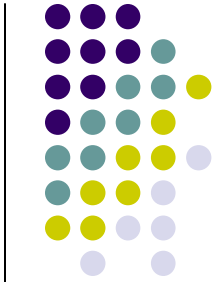
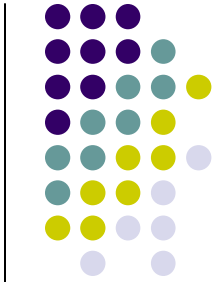
Sensor Web Framework



- **A software framework with open standards-based suite of web services and encodings that enable:**
  - **Remote discovery of compliant sensors**
  - **Storage and retrieval of sensor observations**
  - **Subscription to and notification from desired sensor alerts**
  - **Remote sensor tasking based on observed alerts**
  - **Filtering sensor alerts and data based on temporal and geospatial constraints**

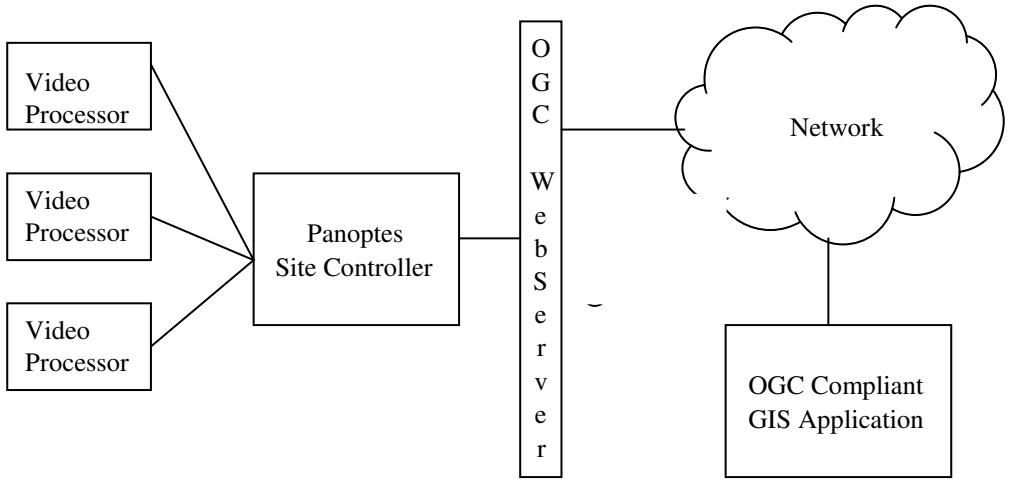
Why OGC and IEEE Sensor Standards as a Sensor Web Foundation?



- **Increasingly supported and used across government, industry, and academia.**
  - **Strongly supported by NGA used in Empire Challenge**
  - **Currently used in sensor web efforts by NASA, DIA, and other agencies**
- **Net-Centric – based on XML, web services, and Service Oriented Architecture (SOA) concepts**
- **Flexible – the standards can be applied to legacy or new sensor systems**

Intelligent video surveillance as an OGC compliant “sensor”

- **Developed an OGC compliant Video Event Detection OGC sensor**
- **Sensor Observation Service is used for managing deployed sensors and retrieving sensor data (observations)**



- **Implemented all mandatory SOS interfaces: GetCapabilities, DescribeSensor, GetObservation.**

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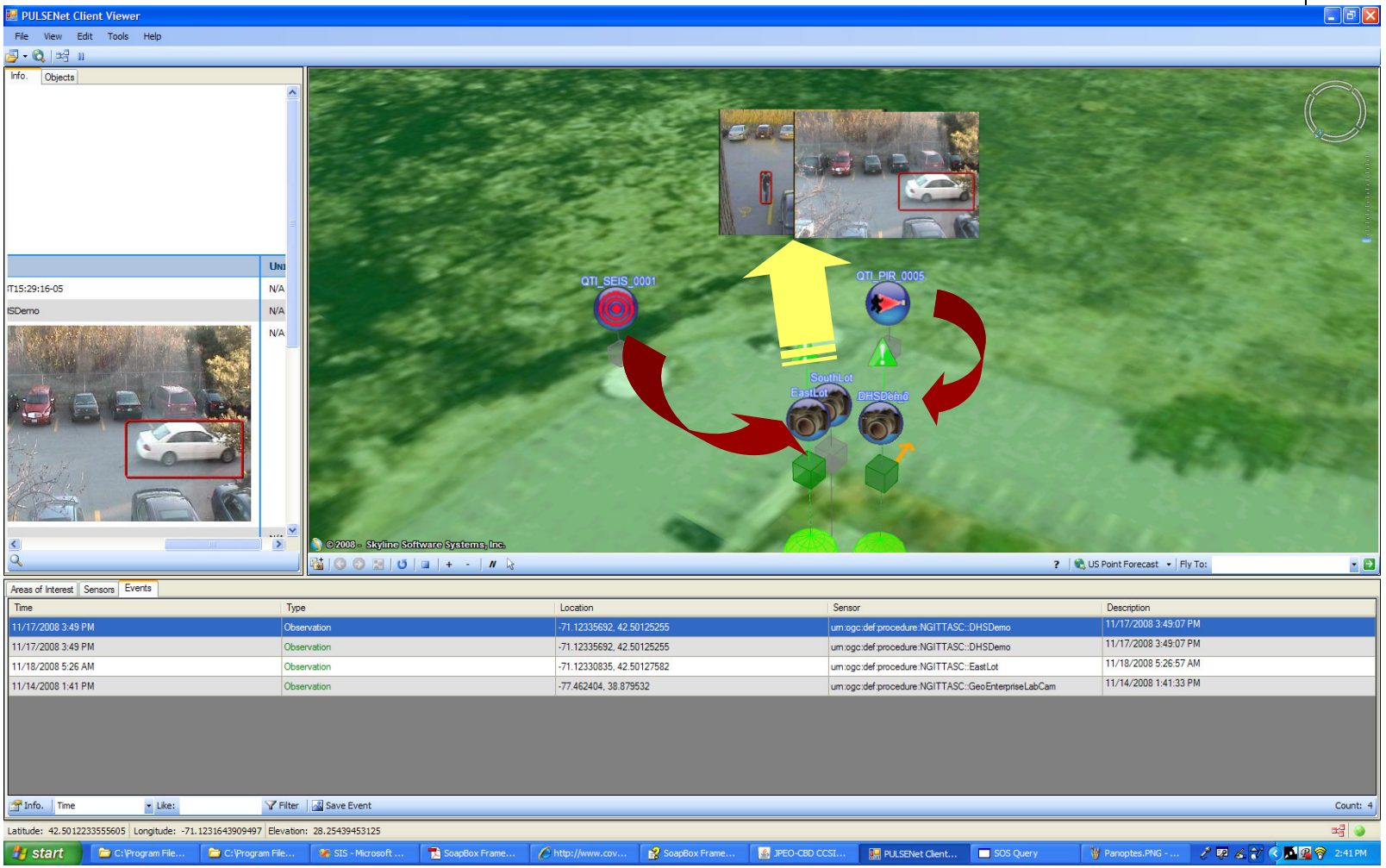
Sensor Web Event Initiated Procedures

Dynamic initiation of preset procedures on sensor observations or alerts



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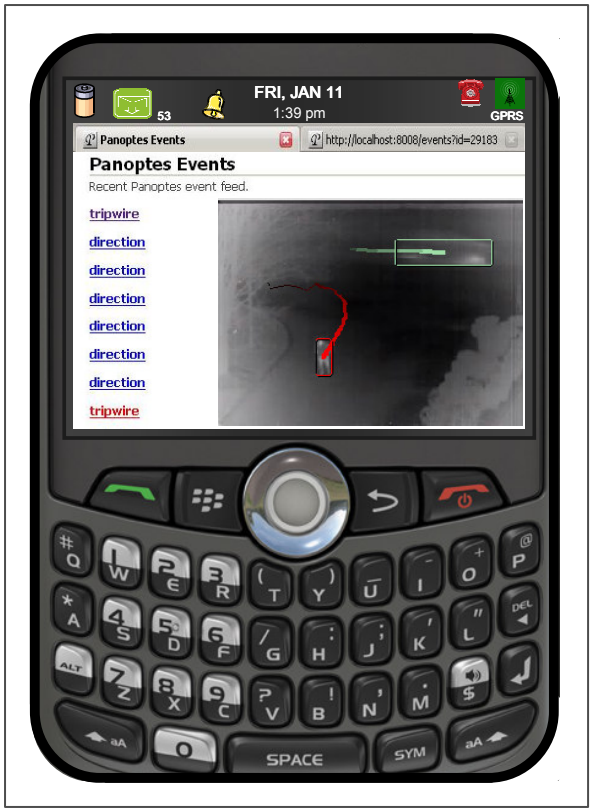
Video Event Alarms on Mobile Device

- A light web server offers access to different forms of output
- Marked-up MJPEG video streams
- RSS feed for alarm event information
- Can receive video events through a mobile Sensor web Client



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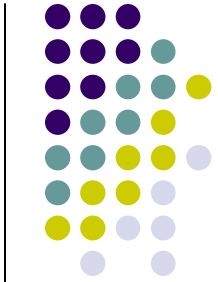
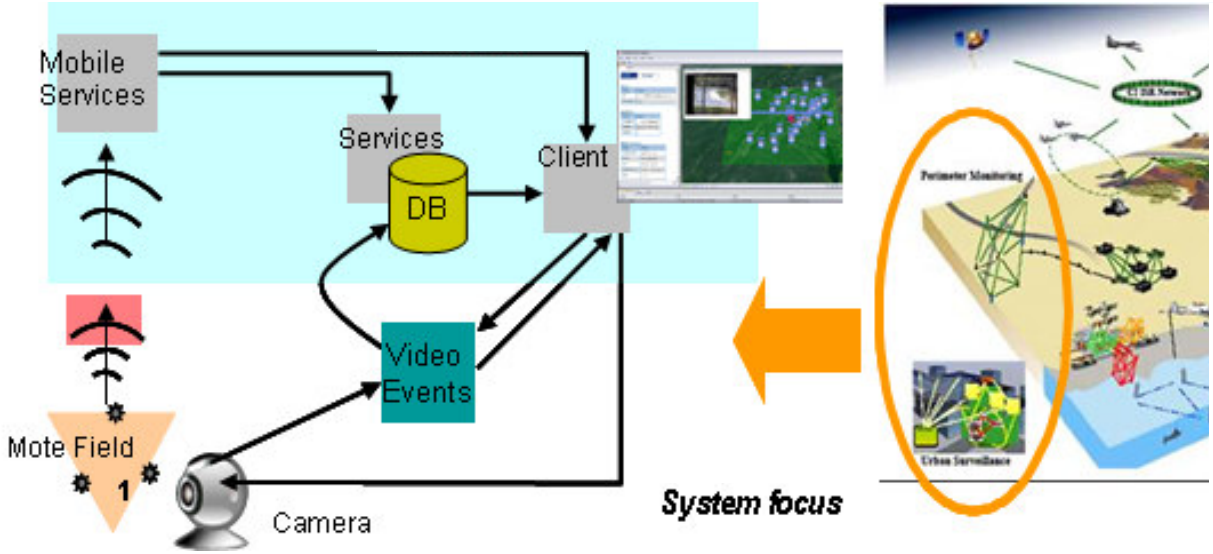
Conclusions



- Collaboration of inexpensive auxiliary sensors to cue video cameras provide a cost effective approach to surveillance video collection, storage, processing and information extraction
- Sensor Web platform provides an efficient means to manage sensor assets, observations and alarms, automatically task sensors and timely sharing of sensor data and extracted knowledge
- OGC compliant Smart Video Node enables Video Event Detection in a Sensor Web Environment.

Prototype System



- sensor web environment
- tripwire mote sensors cueing network video cameras
- automatic tasking of video event detection
- detecting threat events from video
- dissemination of alarms from the sensor web clients

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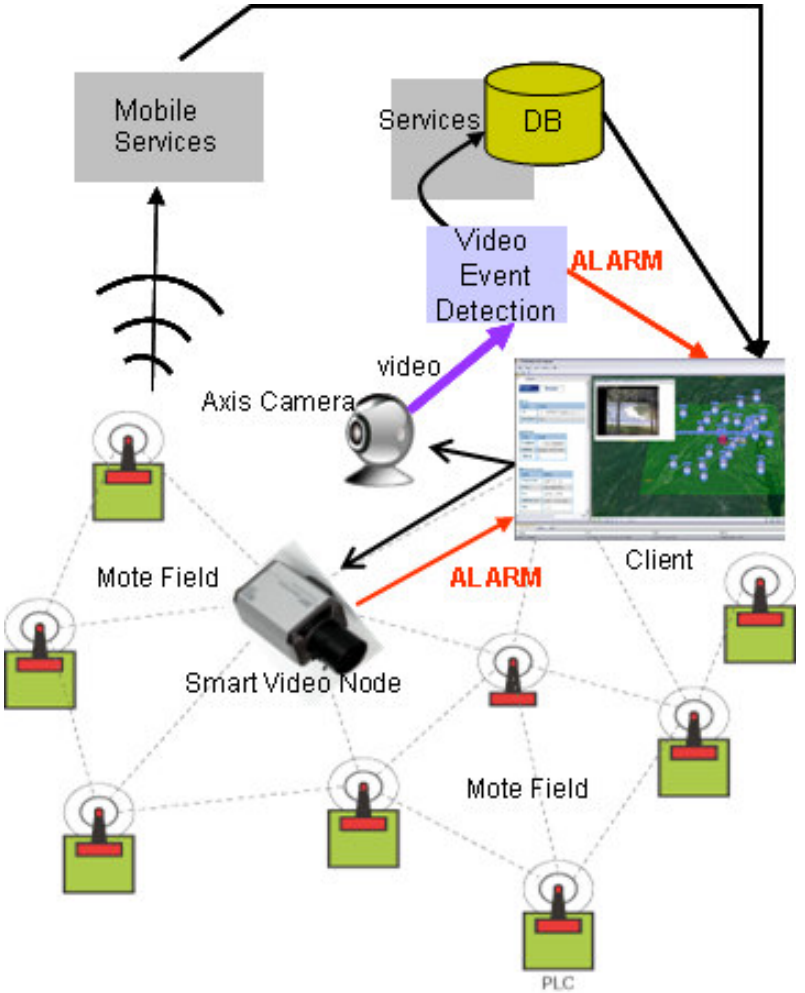
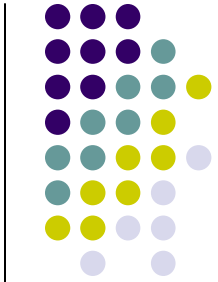
Ongoing Work

Full Functional Prototype to address the needs of CBP applications with a smart video and mote sensor based event and threat detection in an operational Sensor Web platform.





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Thank you!

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