



Relevant Research and Results . . . Yesterday, Today, and Tomorrow

**Intelligence, Reconnaissance and Surveillance Science and
Technology
Expeditionary Warfare and Combating Terrorism**

Large Tactical Sensor Networks Program

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Large Tactical Sensor Networks

Program Objective

Enable Tactical Persistent ISR, Relevant to the War on Terror

- **Sensor Models**
 - Translate threats to detectable features
 - Translate a specific sensor to its ability to detect relevant features
- **Smart Sensors**
 - Processing at the sensor node to translate raw data to useful information
 - Indexed distributed data structure that enables sensors nodes to have “context”
- **Service Oriented Sensor Network**
 - Hardware and software that enable current or planned sensors to transition to a netcentric environment
 - Enable distributed control of persistent ISR assets

Relevant raw data to useful information for tactical situational understanding

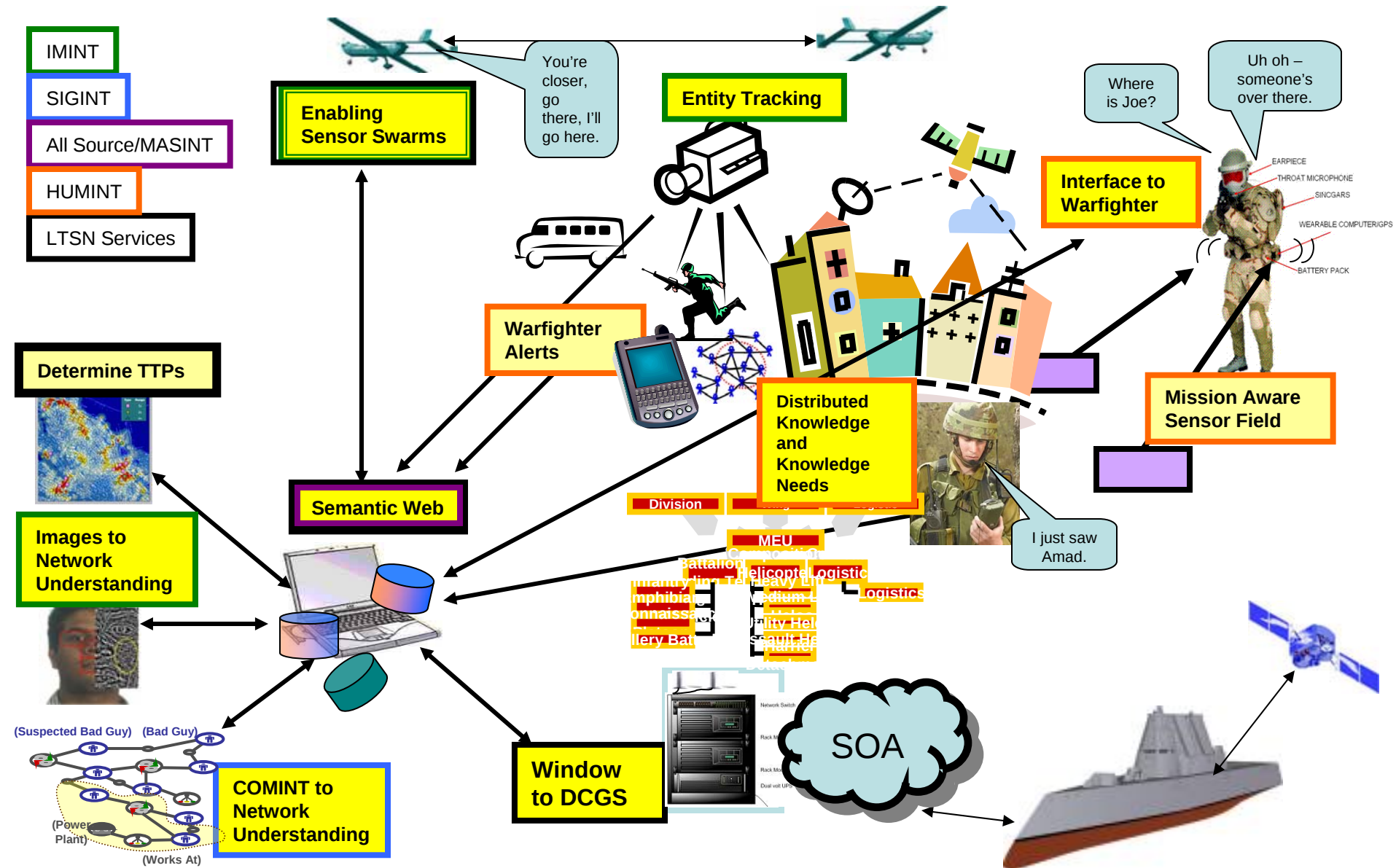
Large Tactical Sensor Networks

- **Fusion**
 - Aggregation algorithms, rules & formulas, pattern definition and analysis, space/time correlation to events
 - Match analytic resources to volume of persistent ISR assets
- **Automated Tactical Platform & Sensor Planning and Management**
 - Algorithms to control and direct persistent ISR assets
 - Aligned set of multi-INT collection plans
 - Software enabling dynamic sensor management
- **Human to Sensor Field Interface**
 - Alert quick reaction forces
 - Interface between the operator and knowledge repository
- **Local Tactical Net & DCGS Integration**
 - Smart agents that manage bi-directional flow of data, useful information and knowledge between DCGS and the tactical user

**Relevant raw data to useful information for tactical
situational understanding**

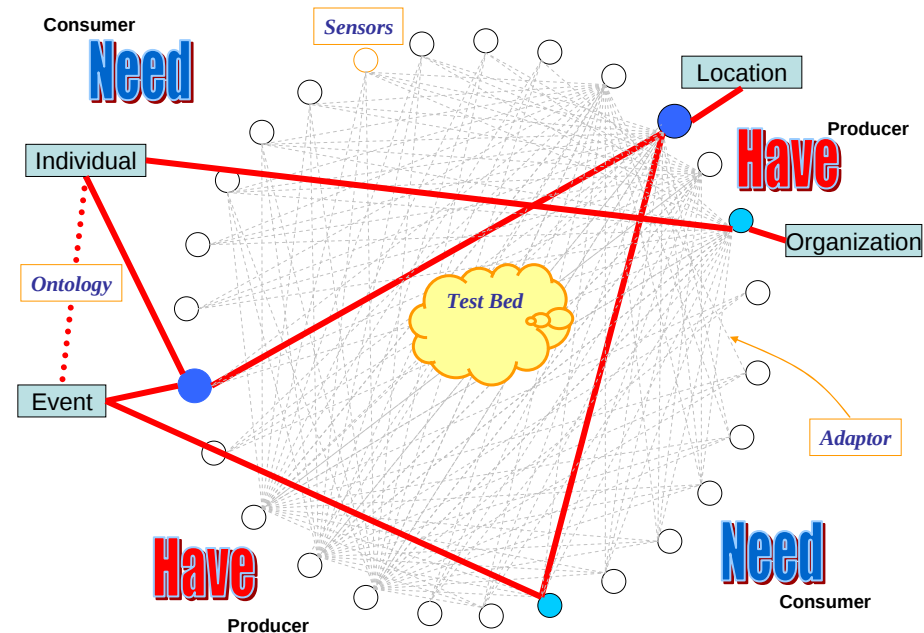
Large Tactical Sensor Networks

Product Integration



Semantic Web

- Create an ontology which provides a standard representation that users can query for meaningful information.
- Create a set of standards, tools and test bed that will demonstrate how a tactical ontology and semantic-based sensor networking can dramatically improve the effectiveness of intelligence resources



Statistically Determine TTPs

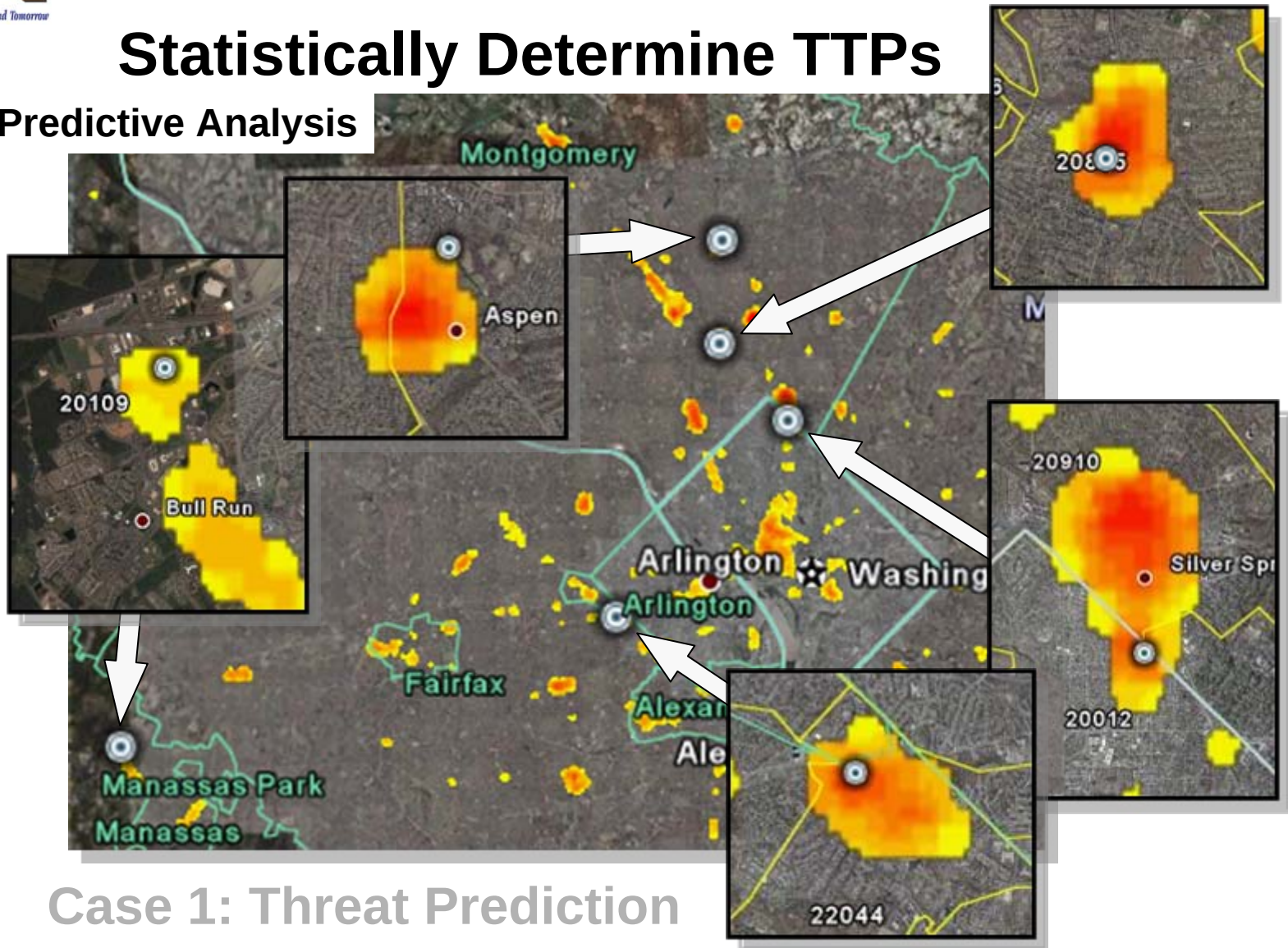
- Create Statistical-based modeling of features to sensor modalities
- **Choice of Features for Reduction**
 - Determination of the importance of each feature required
 - Use metrics that compare the effect that reduced subsets of features have versus using the larger datasets
- **Placement of Sensors**
 - Model the capability of each defined sensor to acquire detectable features and characteristics
 - Optimal placement of sensors, even with full information on existing and expected threat
 - Forecast and visibility models for each sensor
 - Placement algorithm for sensors. Sensor type database with range profiles, sensitivity, uncertainty will be utilized

Statistically Determine TTPs

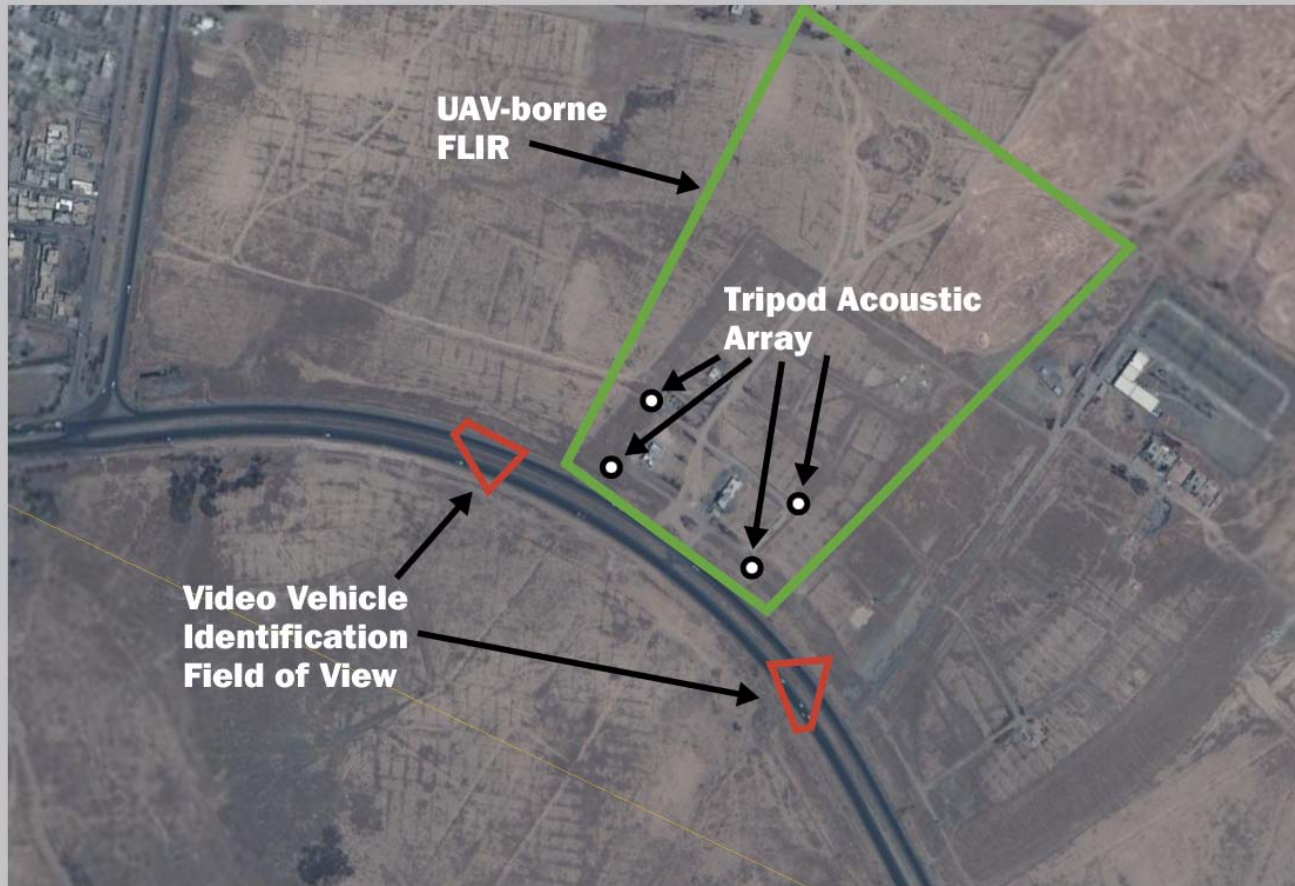
- Innovative geospatial analysis and asymmetric-threat modeling techniques for urban environments
 - Foundation of technique is associations made between event data, sensor data, and contextual information sources
 - Technique excels at indicating:
 - Greatest level of threat for GWOT mission
 - Level of threat expected at each point along a travel path
 - Greatest likelihood collection areas for observing a target
 - Technique reduces the search area required and maximizes the placement of resources

Statistically Determine TTPs

Geospatial Predictive Analysis



Statistically Determine TTPs



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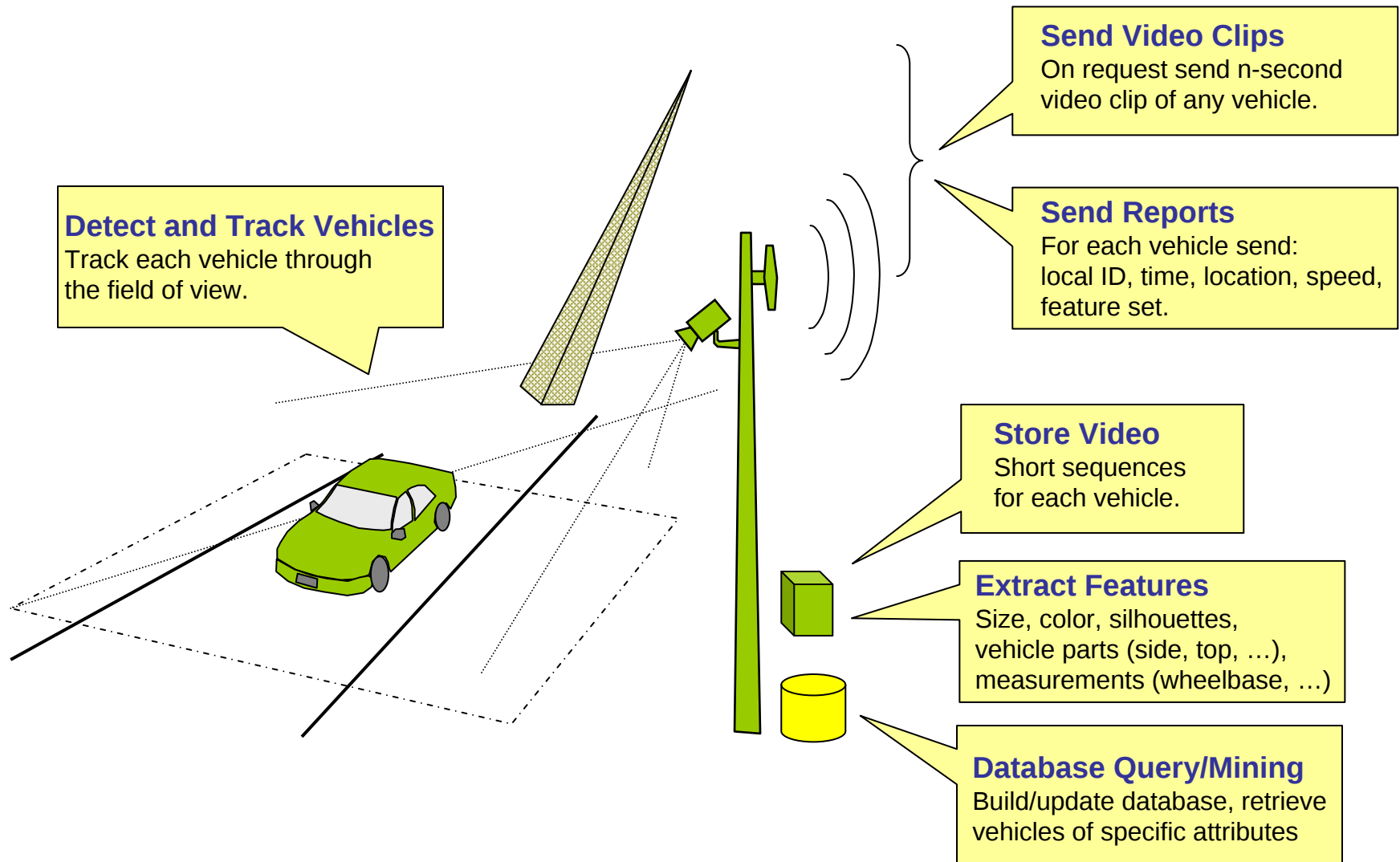
Entity Tracking

- Distributed Smart Sensor EO nodes for Wide Area Surveillance
- Vehicle signature based tracking
- Matching people to HUMINT descriptions
- Integrated system for vehicle tracking and forensic analysis combining multiple sensors (GMTI, EO/IR, IMINT and HUMINT)

Entity Tracking

- **Distributed air-ground collaborative vehicle & people association and data mining system:**
 - Provide persistent situational awareness of an extended area.
 - Provides rapid and reliable sensing and response in the tactical environment.
- **Key Innovations**
 - Smart Sensor Processor for Moving & Stationary Cameras
 - Cross-Sensor Cueing and Vehicle Association across disparate pose
 - Multi-Sensor Multi-Hypothesis Track Fusion and Large Area Data Association
 - Classification, Querying, Mining & Database Functions
 - Distributed Scalable Processing Architecture and System
 - Large-area Common Operating Picture

Entity Tracking



Entity Tracking

- **MHF: Multiple Hypothesis Fusion with map and road network information**
 - Manage and combine multiple local target tracks to form multiple globally consistent tracks with map & road network.
 - Combine multi-camera based video tracks with GMTI
 - Essential for long range and wide area automatic multiple target tracking.



Images to Network Understanding

- Dynamic face recognition watch list
 - Best shot Facial Recognition from video
- Detect suspicious aggregate population or individual activity and provide warnings
- Detect human figures from surveillance video and perform human activity statistical analysis to detect unusual crowd activity
- SNA for terrorist/insurgent networks, identify key individuals in the organization, and analyze the organizational dynamics based on Video-INT

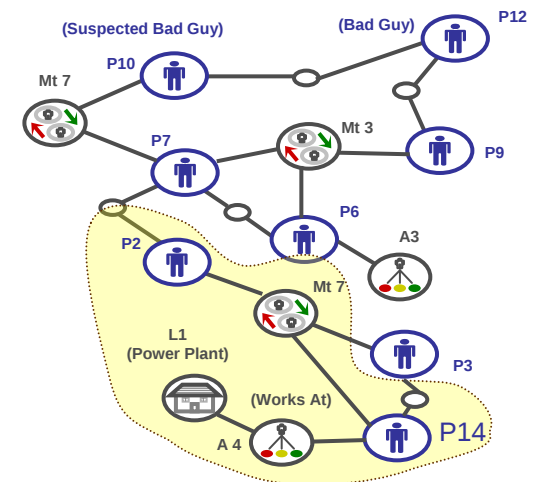


SOA / Local Tactical Network and DCGS-MC

- Service Oriented Architecture
 - Service Oriented Architecture (SOA) for LTSN, based on the DCGS Integration Backbone (DIB)
 - Disadvantaged User Interface
 - Create Software developers toolkit for interfacing to the SOA software framework
 - Sensor visibility
- Link to DCGS-MC
 - Adapt to small tactical unit environments with metadata catalogs at three simulated PoR sensor interfaces

COMINT to Network Understanding

- Detect aggregates from COMINT datasets
- Analyze and propagate suspicion at the entity and aggregate level
- Analyze aggregate evolution over time
- Develop pattern analysis and event correlation tool

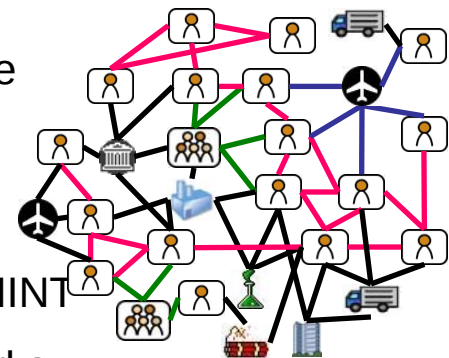


COMINT to Network Understanding

- Detect Patterns in the Data
 - Find threatening activity hidden in the benign
- Address Information Overload
 - Almost all activity is benign
 - Faint signal in lots of noise
- Operate when ground truth is unavailable
 - Incomplete and inaccurate evidence
 - Lack of observability
- Cannot assume A Priori Knowledge

Warfighter Alerts

- Multi-INT Fusion for Detection of Enemy Activities and Threat Networks (Probabilistic Approach)
 - Sensors: Radar GMTI, EO/IR Video, SIGINT, Wide Area EO, SAR, HSI Imagery, Lidar Scans, HUMINT
- Geospatial-temporal Pattern Analysis software system to detect and alert threat activities
 - Exploit multi-INT, kinematic, geospatial and transactional data
- Server-side network analysis technology to:
 - Fuse acquired network information with prior knowledge
 - Characterize networks by type and properties
 - Assess entities and networks
 - Recommend courses of action to collect clarifying HUMINT
 - Recommend courses of action to disrupt enemy networks

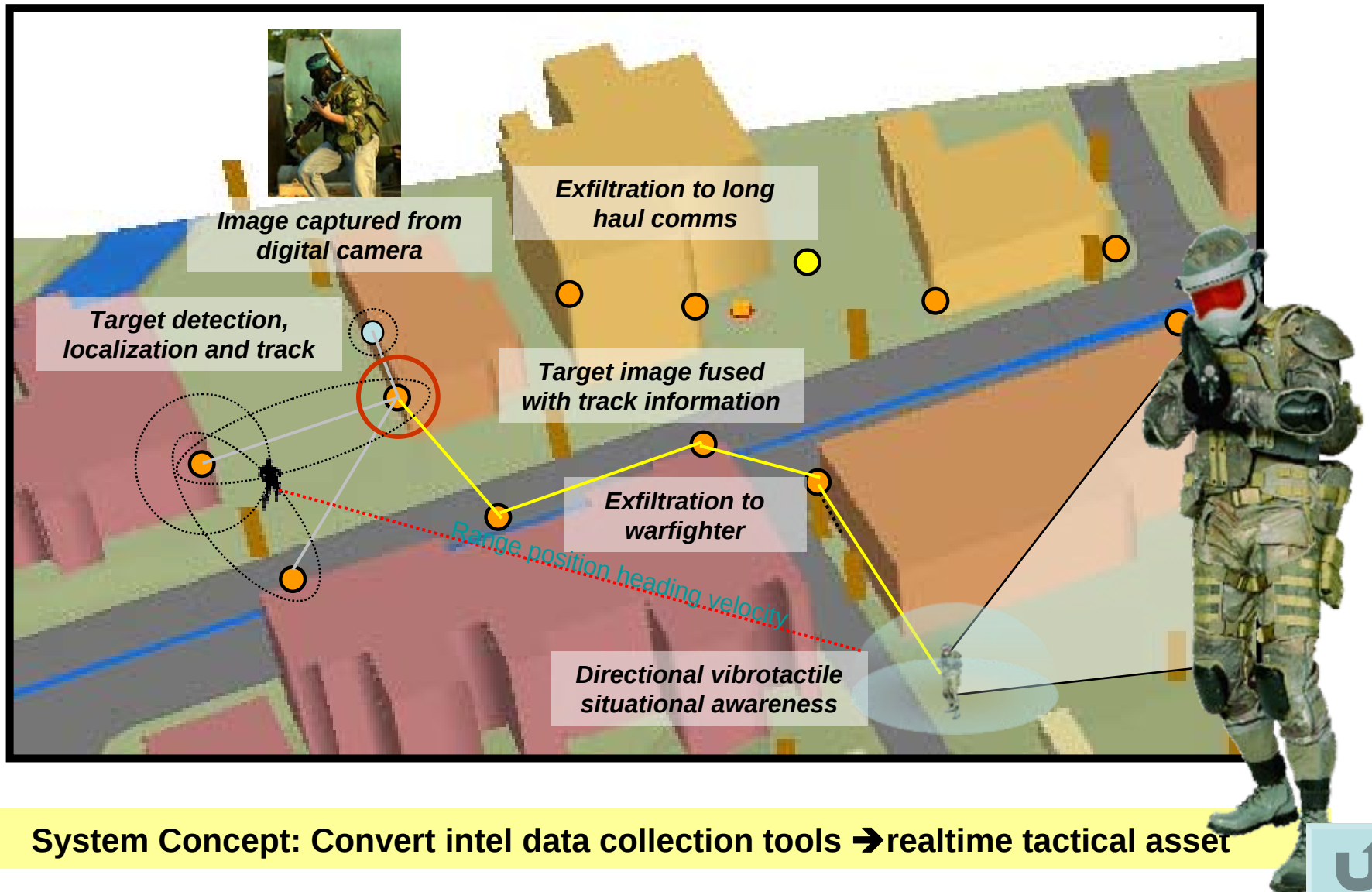


Mission Aware Sensor Field

- Real-time, context dependant situational awareness for the warfighter
- Mission-based I&W to warfighter
 - Investigate methodology for delivery
 - Vibro-tactile, speech, etc
 - Create methods for push of I&W
- CLENS as possible demo sensor



Mission Aware Sensor Field



Enabling Sensor Swarms

- Optimization algorithms and collaborative control protocols for allocation of tasks to UAVs
- Various Airborne platforms with various sensor modalities: lidar, near infra-red, or thermal infra-red
- Geographically Distributed Users with different priority rights on different platforms
- Allow for sensor fusion for multiple intelligence sources (Multi-INT)

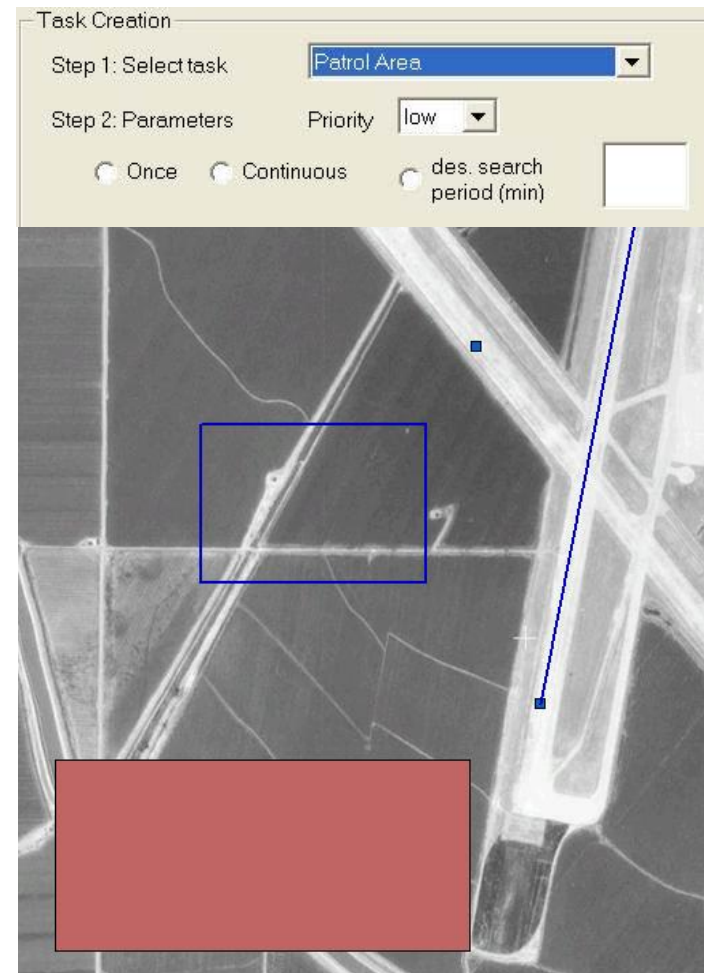
Enabling Sensor Swarms

- User defines the mission
- UAV's define tasks and sub-tasks
- Philosophy

“The user specifies what he or she would like accomplished.

The system decides how to do so efficiently.”

- Previous work has successfully flown four vehicles simultaneously.



Distributed Knowledge and Knowledge Needs

- Tactical Intelligence Ontology Development
 - Ontology for All levels of Command
 - Who needs what data based on what is available and when
 - Smart multicast support for dissemination to maximize bandwidth usage
 - Smart subscription
- Proof of Concept Tactical Intelligence Community Of Interest



Interface to Warfighter

- HUMINT via Spoken Interface, Alerting Agents
- Structuring of HUMINT Reports
- Develop System Architecture, Interaction Paradigms, User Interface Mock-ups and specs for Tactical Users
- Cognitive Task Analysis, Workflows