Network-Aware Wireless Peer-to-Peer Collaborative Environments

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- NPS GIGA Lab Student Team

Research Goals

- *Explore the solutions for an emerging concept of network aware tactical sensor-decision maker P2P collaborative environments. GIG/FORCEnet correspondence:*

  -adaptive multipath collaborative environments,

  -GIG tactical extension
- *Explore the models for network awareness enabling P2P grid nodes to self-organize their collaborative behavior and maintain quality of data sharing.*
- *Explore the multiagent solutions enabling node networking role and status sharing*
- *Explore the human-centric solutions for network awareness facilitation: network of operation centers*

Approach

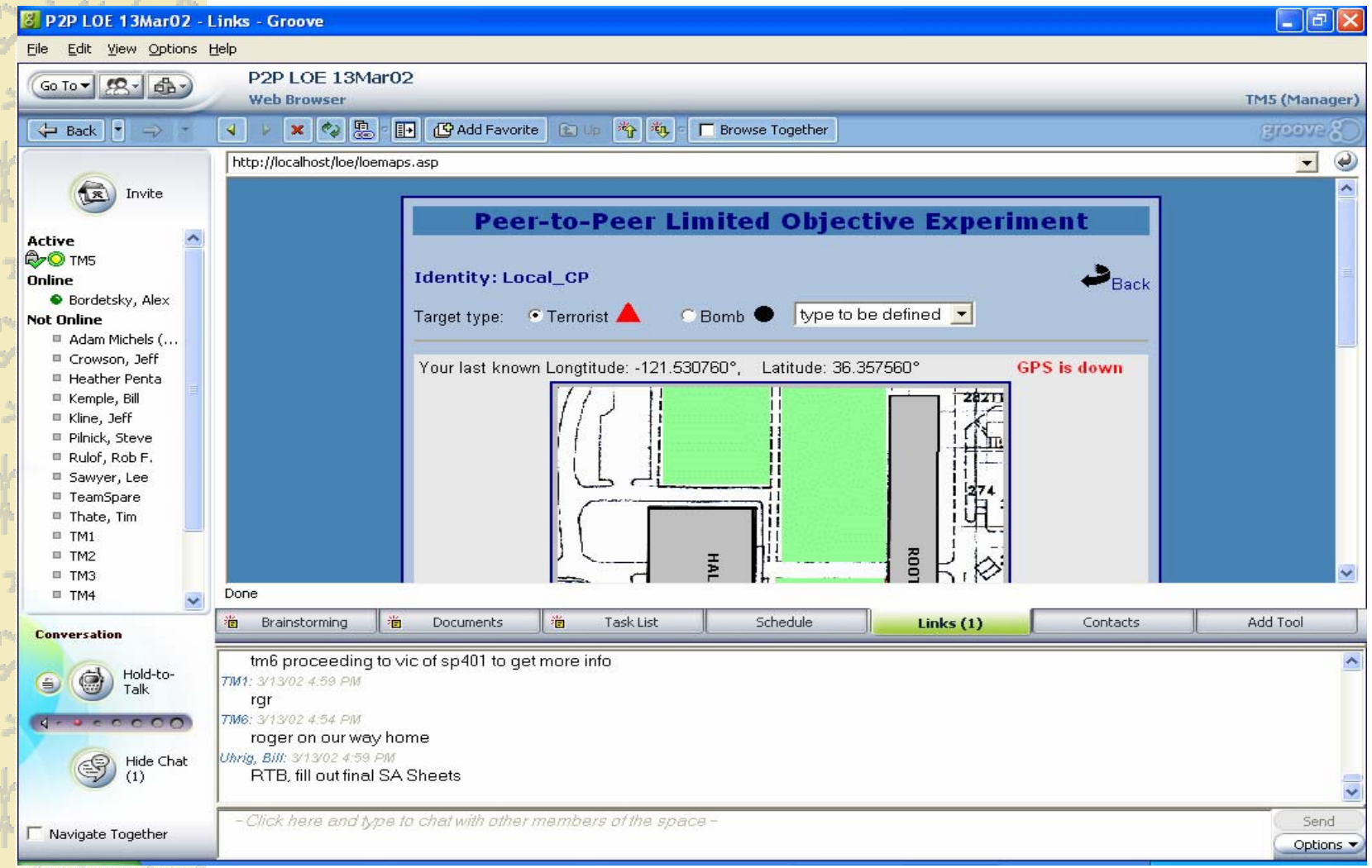
- Three limited objective experiments conducted at the Naval Postgraduate School (NPS), Monterey, CA, Camp Smith, Hawaii, and Camp Roberts, CA
- The first experiment was focused on providing initial data to evaluate the potential impact of using collaborative P2P technology in an urban warfare environment.
- The second experiment was conducted to evaluate the effects of sharing network awareness and common operational picture on the tactical level humanitarian operations.
- The third experiment, STAN-6, was conducted at Camp Roberts, CA, to evaluate tactical sensor-decision maker collaboration and self-organizing capability in the environment of unmanned (UAV, UGV, and AUV) networks
- We used DARPA CoABS agent services approach to evaluate the awareness sharing effects in P2P collaborative environment.

JFCOM Experiment on Peer-to-Peer Surveillance and Reconnaissance Collaborative Command and Control Environments

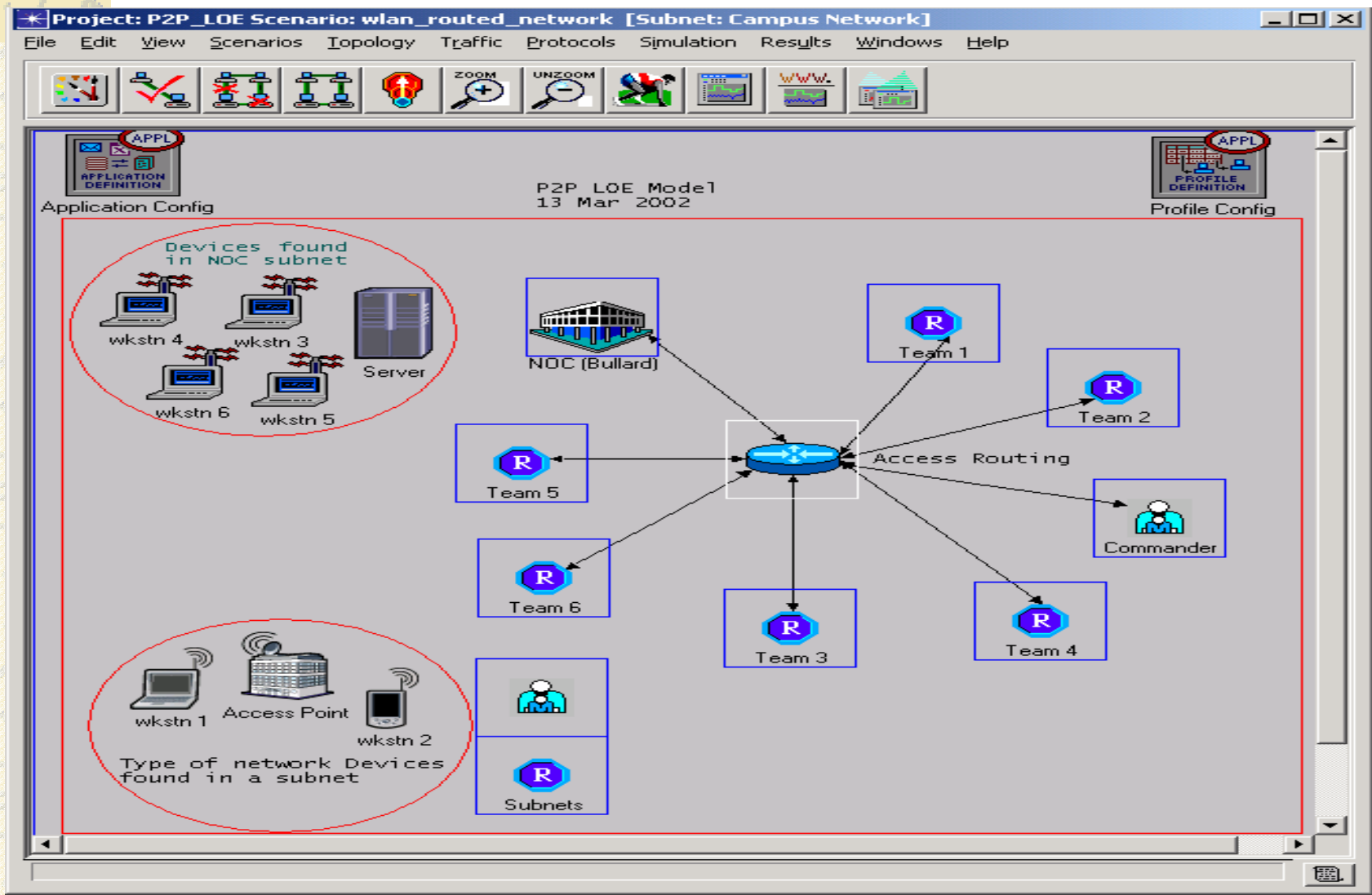
P2P Tactical Grid Nodes: Small Unit Members with PDAs

- Sharing Situational Awareness with Small Expeditionary Unit Members
- Enabling Adaptive Wireless Networking for Support of P2P Collaboration on rescue phase of S&R

P2P Collaboration via Groove: Maintaining Location Awareness Feedback to Small Unit Members

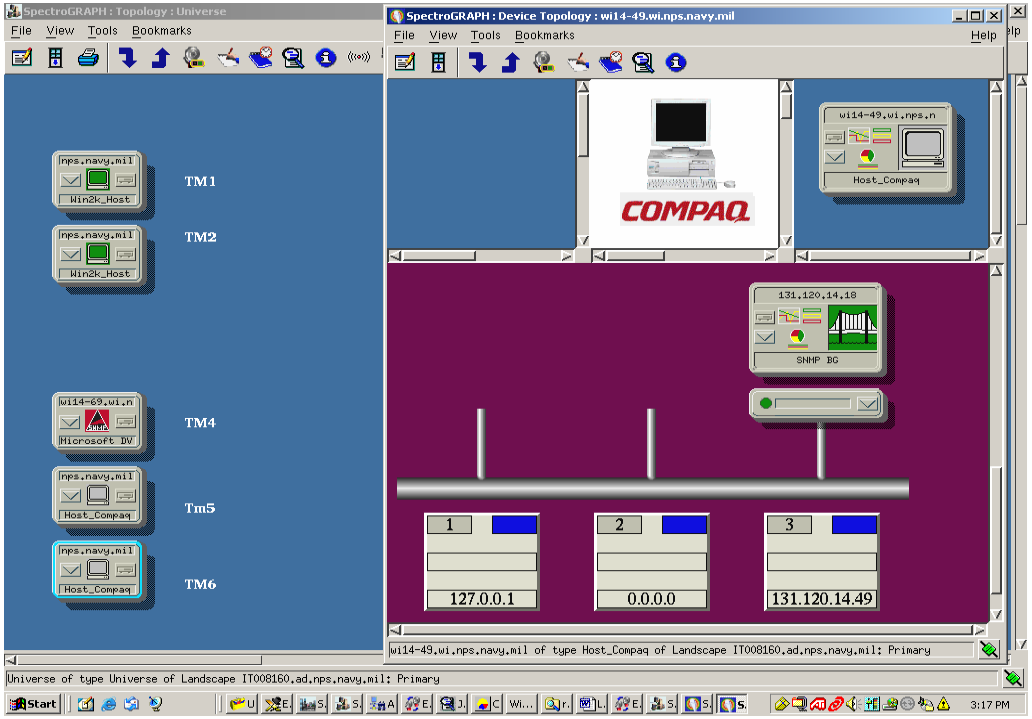


P2P Tactical Collaborative Environment Topology

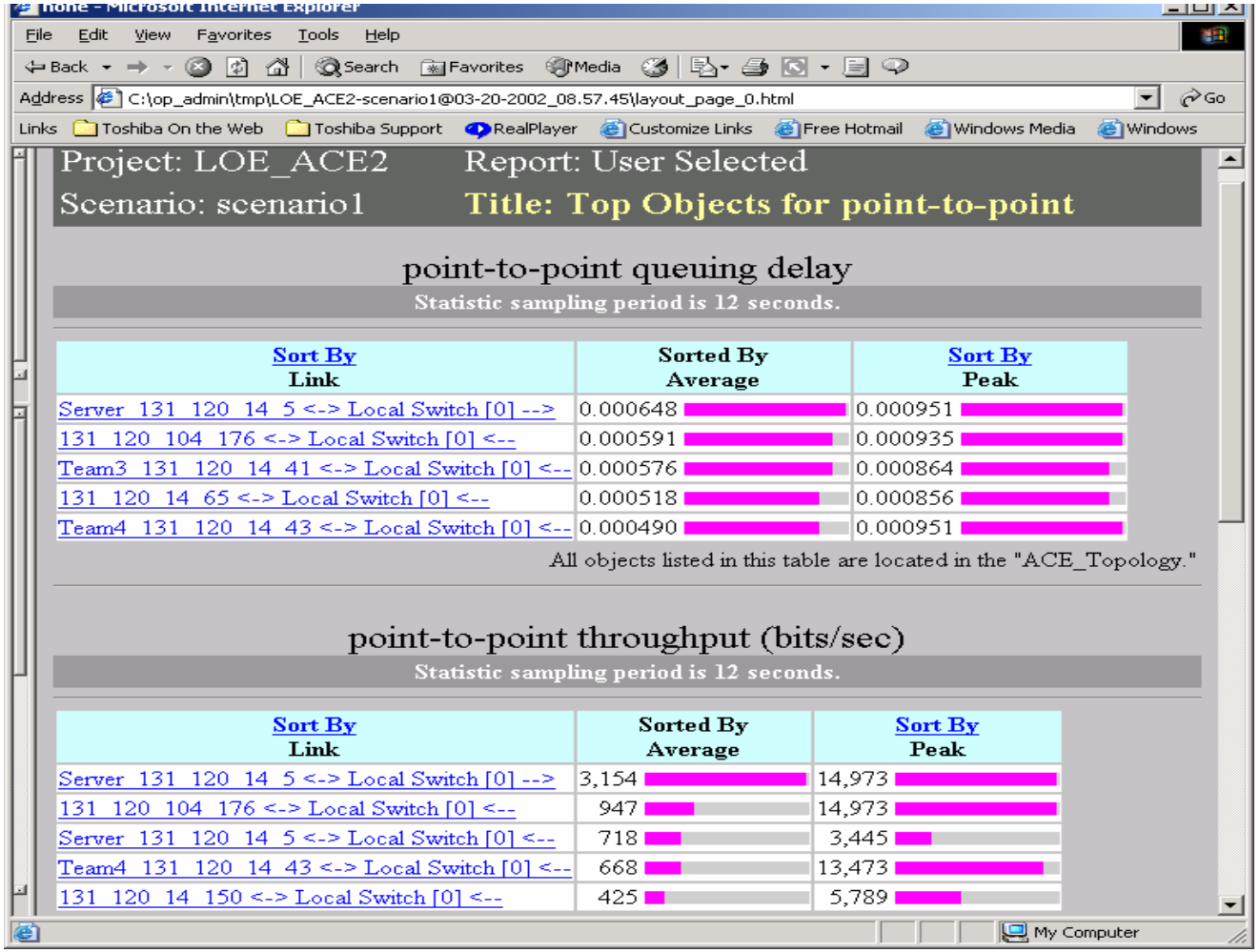


Tactical Operations Center View of P2P Collaborative Network

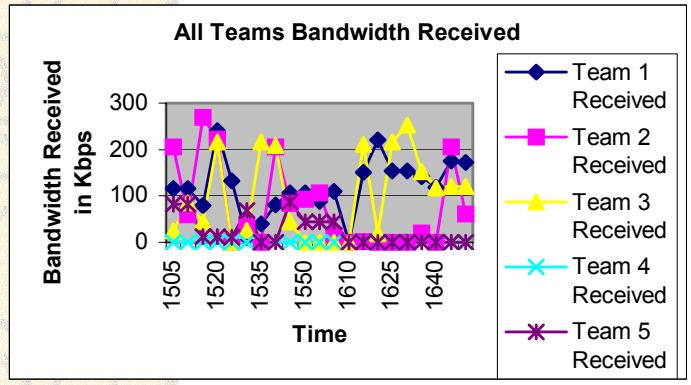
- Network Management System Snapshot of P2P Topology during the experiment
- TM1-TM5 are S&R team members mobile units

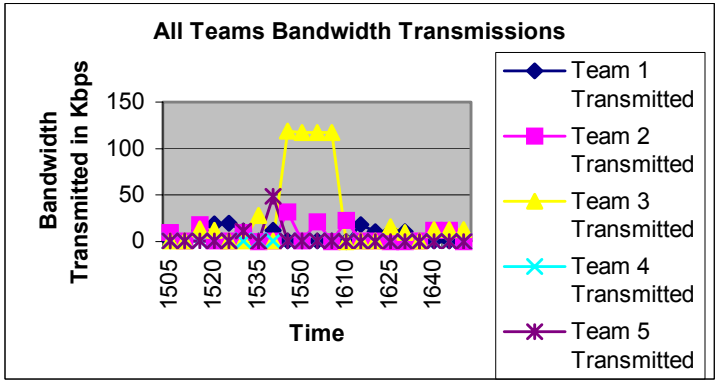


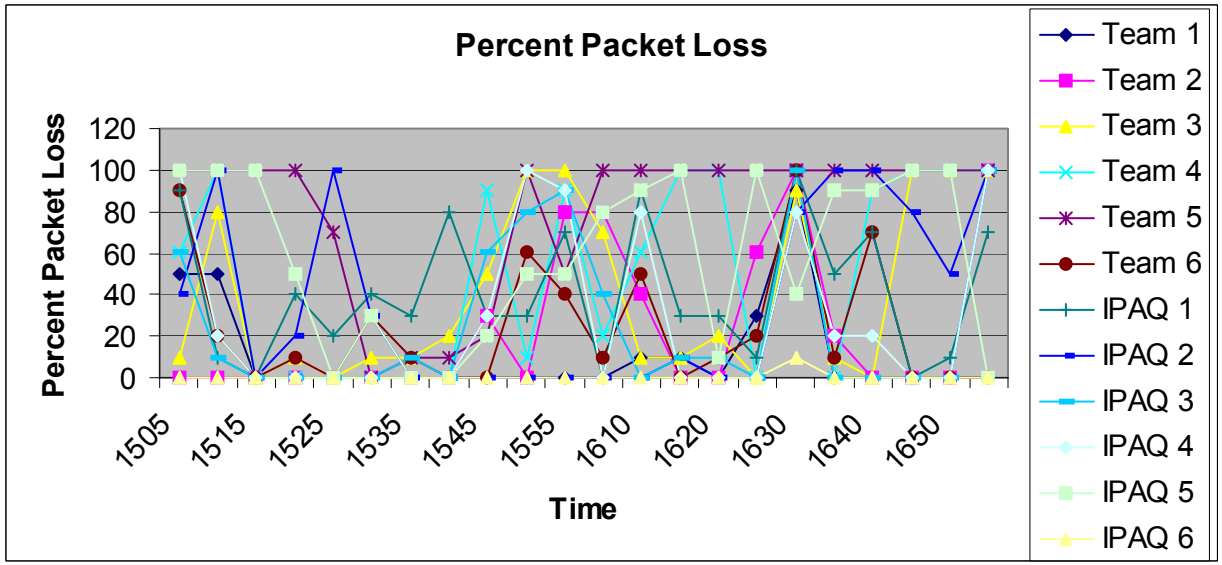
P2P Throughput Analysis



Monitoring bandwidth and packet loss: performance awareness feedback







First findings: challenges of sharing network performance awareness, making collaborating users aware of network behavior

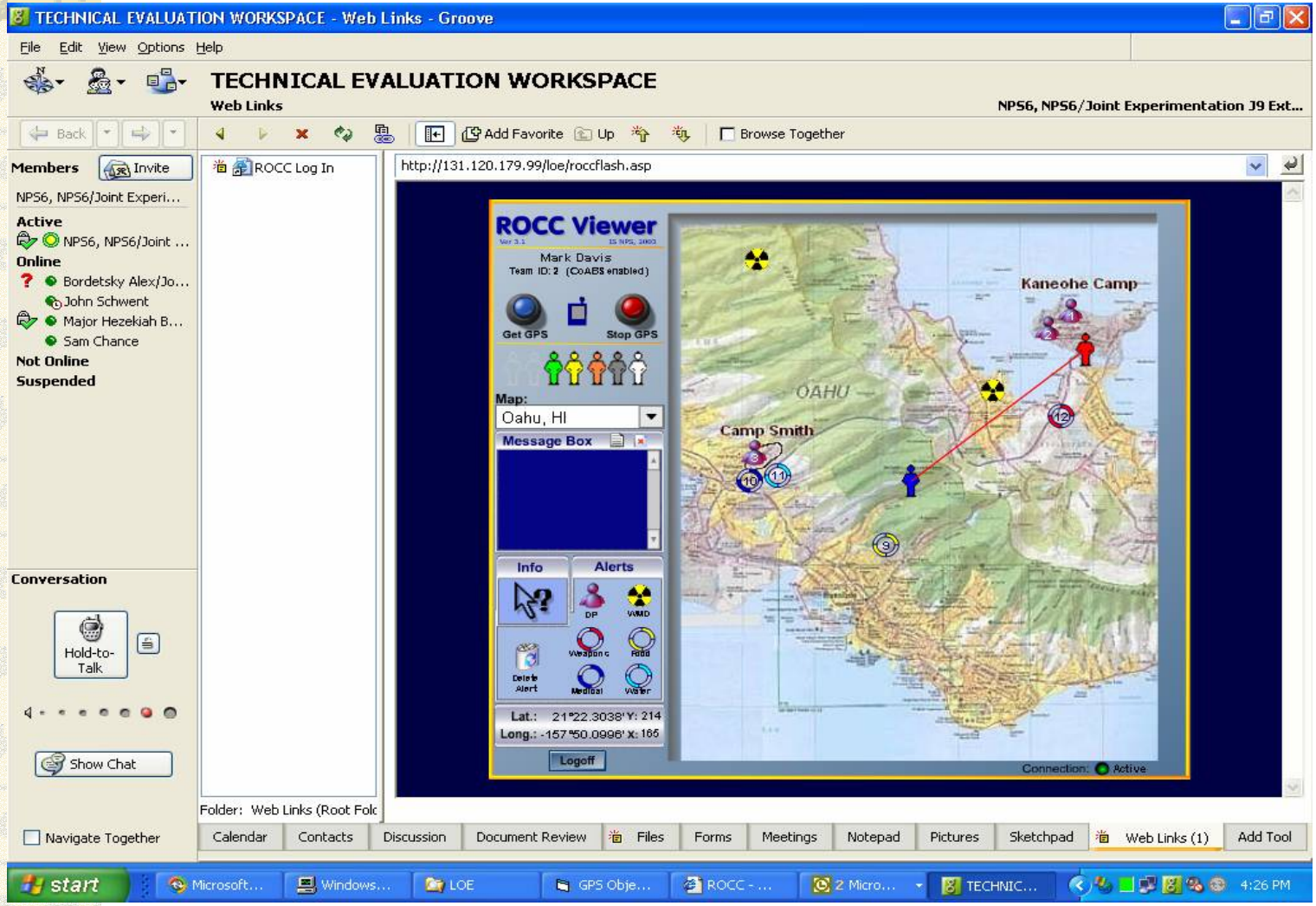
- Overwhelming multiple views on performance and configuration constraints
- Lack of time, bandwidth, and qualification to interpret network awareness data by mobile collaborating users
- Help in filtering and interpretation of network management data is needed

Establishing P2P Networking Facilitator

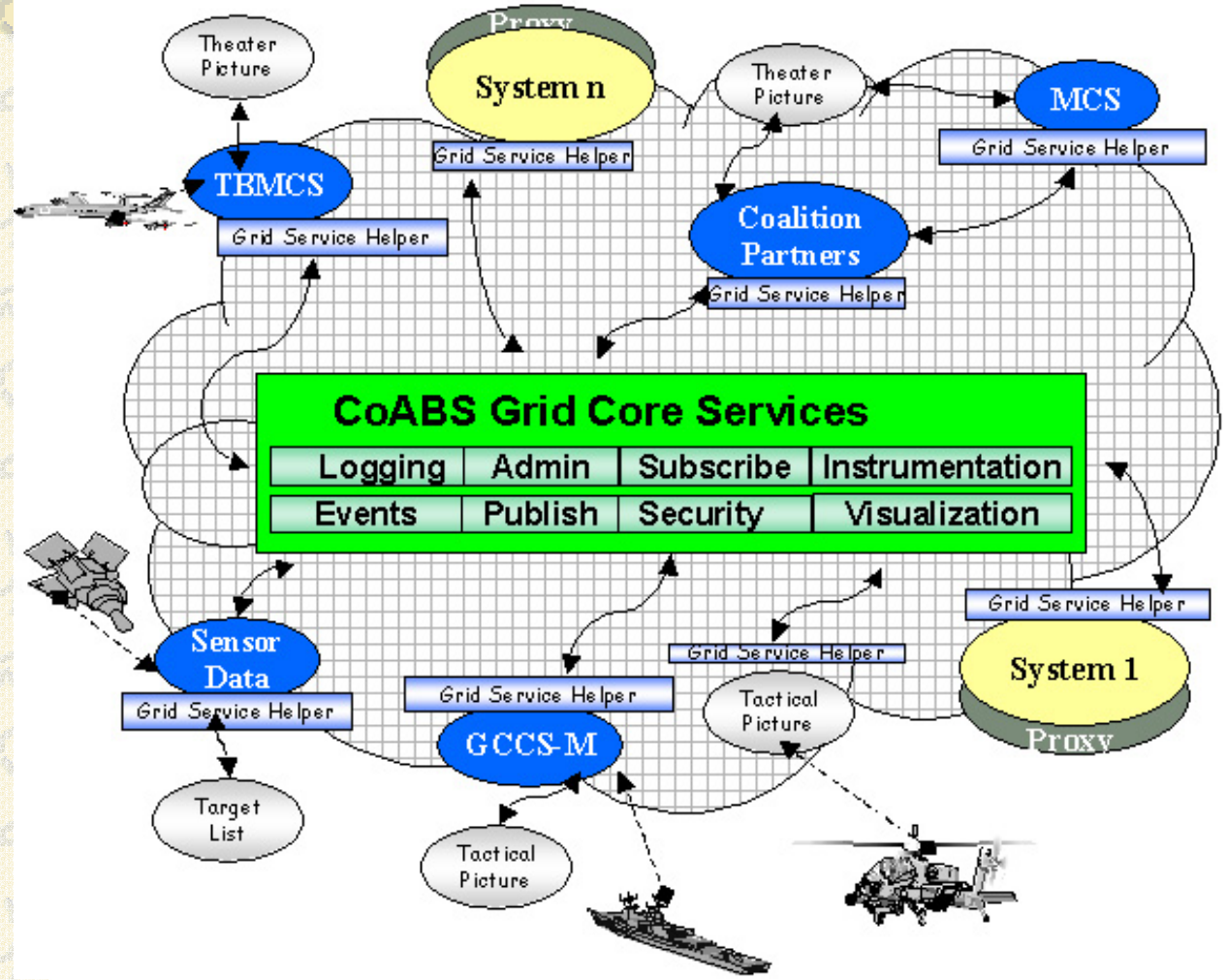
- ***We observed self-organizing behavior of R&S team members in switching the modes of communication***
- ***The strongest and unexpected effect of self – organizing behavior emerged on the Tactical Operation Center site: the P2P team created system Facilitator***
- ***Facilitator interpreted and shared in fly selected network performance data in order to synchronize the voice and data sharing calls between the team members***

PACOM Experiment: Humanitarian Operations

Tactical Grid Nodes: MEU Members Augmented by Situational Awareness Agents



Improving the P2P Collaborative Node Status Awareness via the Agent Representatives: DARPA CoABS Grid Model



Different Agent Service Models

- **DARPA CoABS Grid:** CoABS Grid Scalability
- Experiments (Kahn and Cicalese)
- **NASA KAoS:** Human-Agent Teamwork and Adjustable Autonomy in Practice (Sierhuis, et. al.)
- **NOMADS:** Toward an environment for strong and safe agent mobility (Suri, et.al.)
- **DARPA Cougaar** framework (http://www.cougaar.net),
- **CORBA** (http://www.omg.org), and
- **Voyager** (http://www.recursionsw. c o m / o s i . a s p)

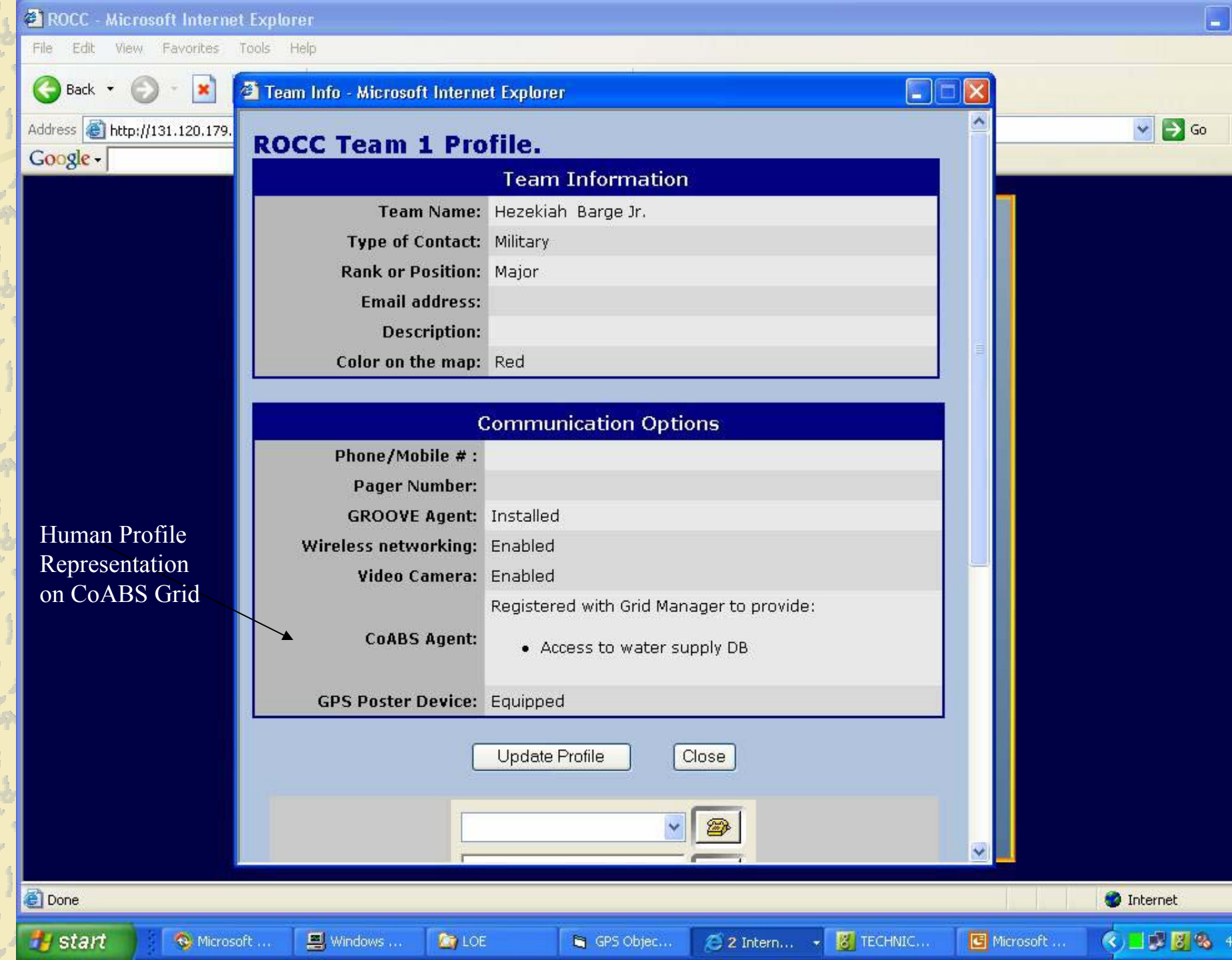
Application Awareness Solution Based on the CoABS Grid Model

Agent Representatives on the CoABS Grid

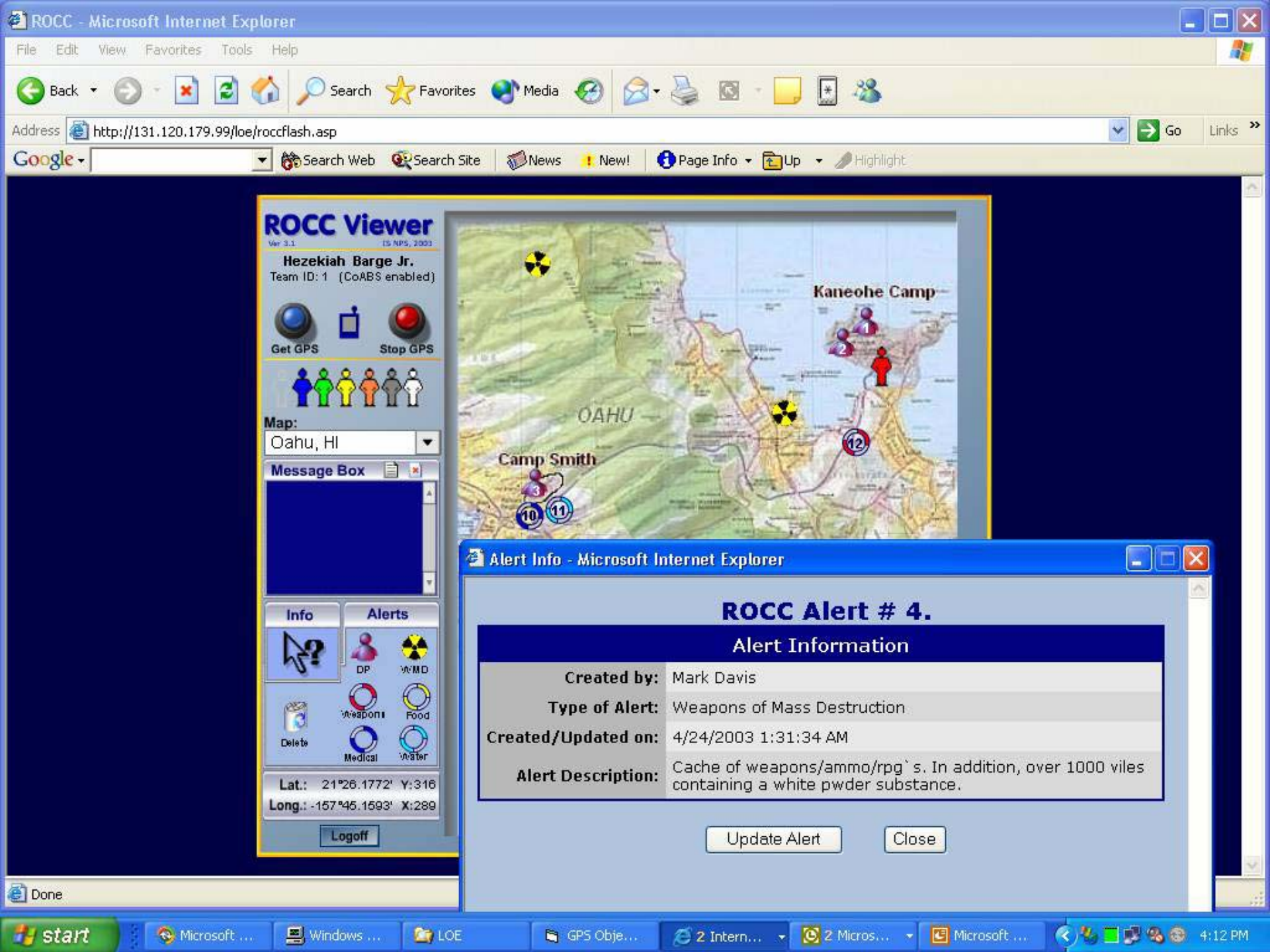
- CoABS Grid Representative for Human Operator Profile
- CoABS Grid Representative for GPS Tracking Agent
- CoABS Grid Representative for ISR Events
- CoABS Grid Representative for Text Messaging

Agent Wrappers Representing Remote Data Base and Expert Sources

- CoABS Wrapper for the remote Application Database
- CoABS Representative for the Expert Profile Management Agent



Human Profile Representation on CoABS Grid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Created/Updated on: 4/24/2003 1:31:34 AM
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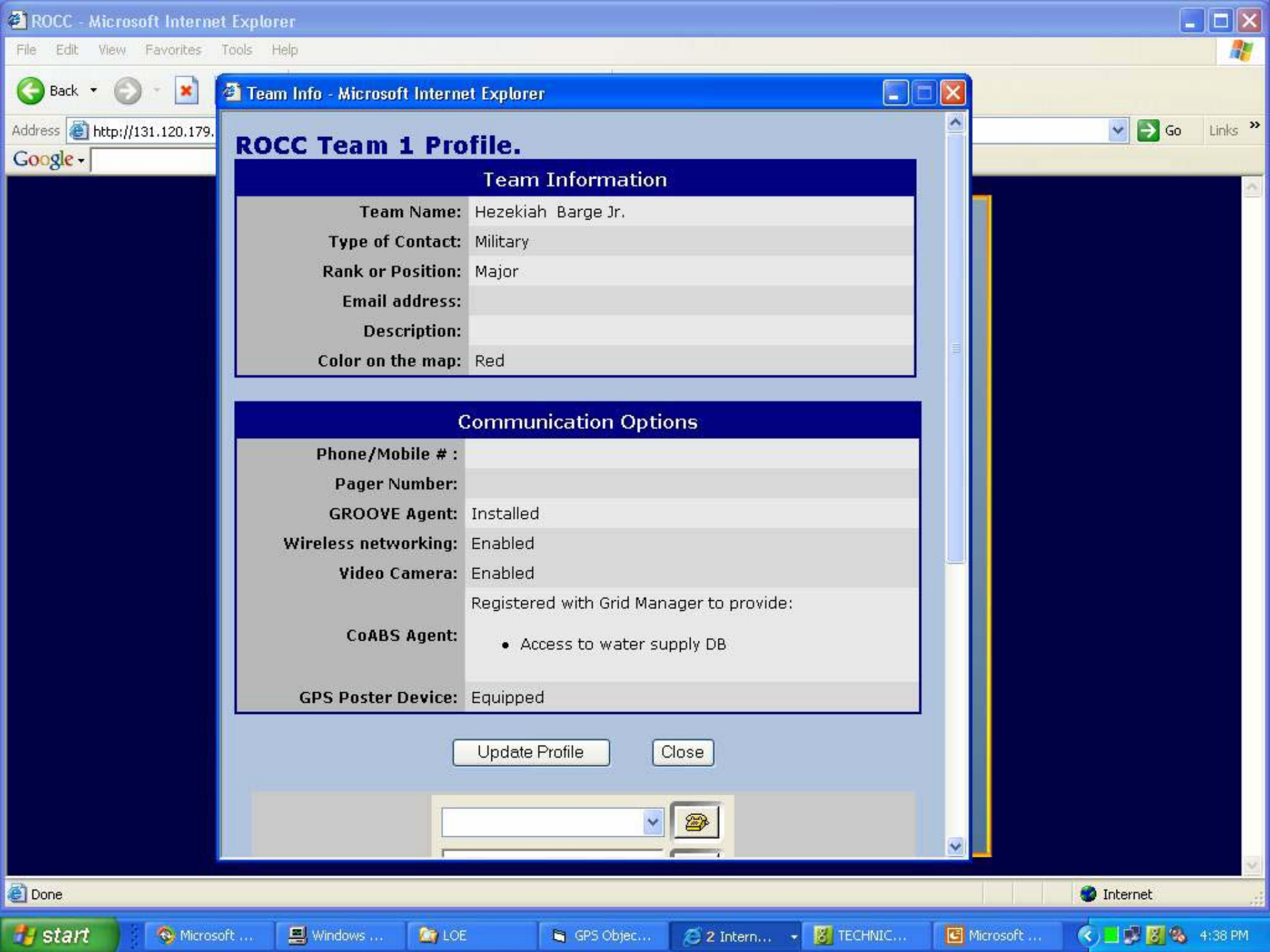
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Team Information
Team Name: Hezekiah Barge Jr.
Type of Contact: Military
Rank or Position: Major
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Description:
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Phone/Mobile # :
Pager Number:
GROOVE Agent: Installed
Wireless networking: Enabled
Video Camera: Enabled
CoABS Agent: Registered with Grid Manager to provide:
• Access to water supply DB
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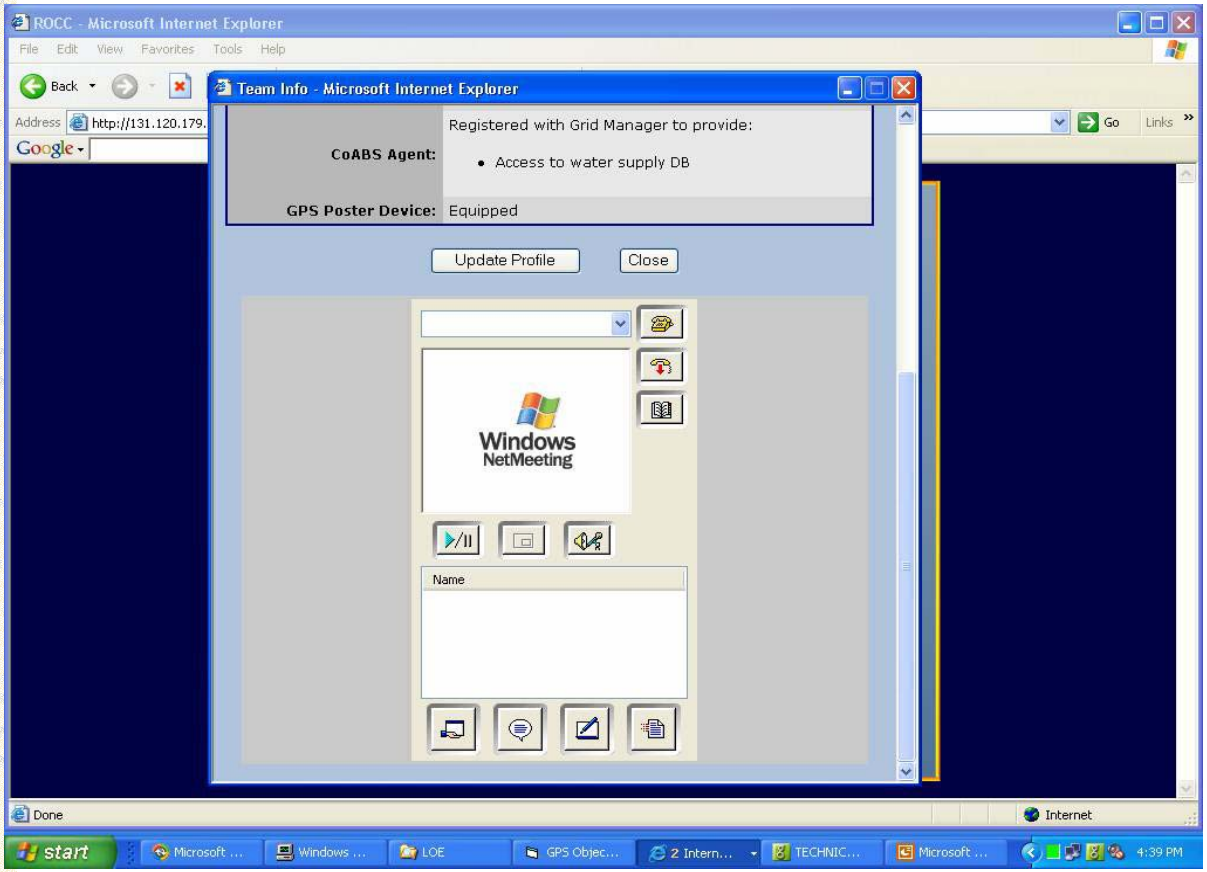
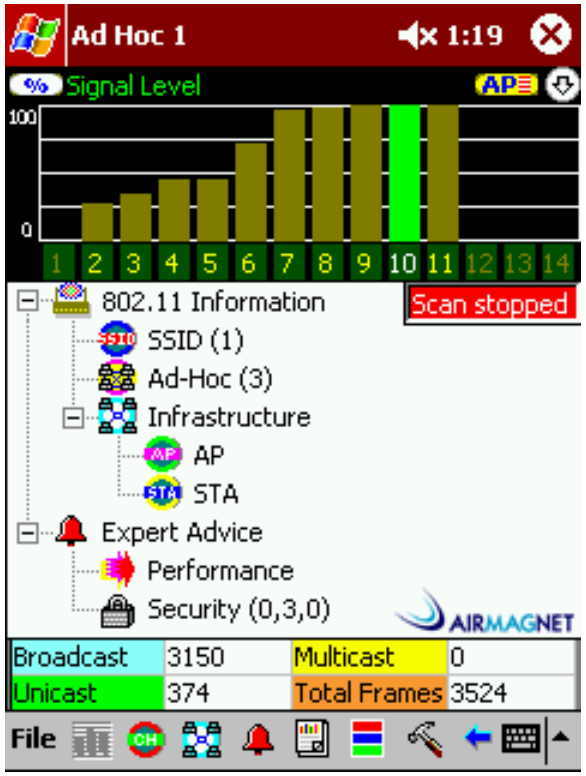
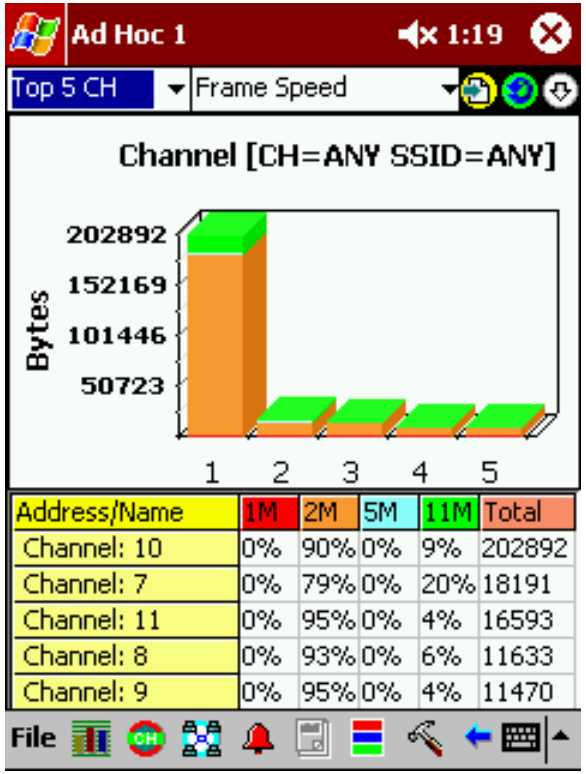
MEU member profile with embedded video access



Displaced Person Alert

Network Awareness Feedback: PDA View of Network Performance ("Micro NOC")





Findings: CoABS Model Success and NA Feedback Problems

- **Bandwidth management for P2P Groove clients**

  This issue appeared to be critical form of operational feedback to the team members. They frequently used "Micro NOC" feedback to identify the coverage and adjust their operations to the failing coverage.

- **Scalability through CoABS**

  The experiments proved scalability of CoABS multiagent platform for maintaining P2P collaborative awareness. The MEU members were able to seed and respond to multiple surveillance events using the grid agents

- **Problems with rapid understanding of network behavior**

  Interpretation of technical detail contained in the "Micro NOC" views appeared to be extremely inefficient, slowing down surveillance data sharing process. The network performance data should be filtered and delivered directly to the main Situational Awareness interface

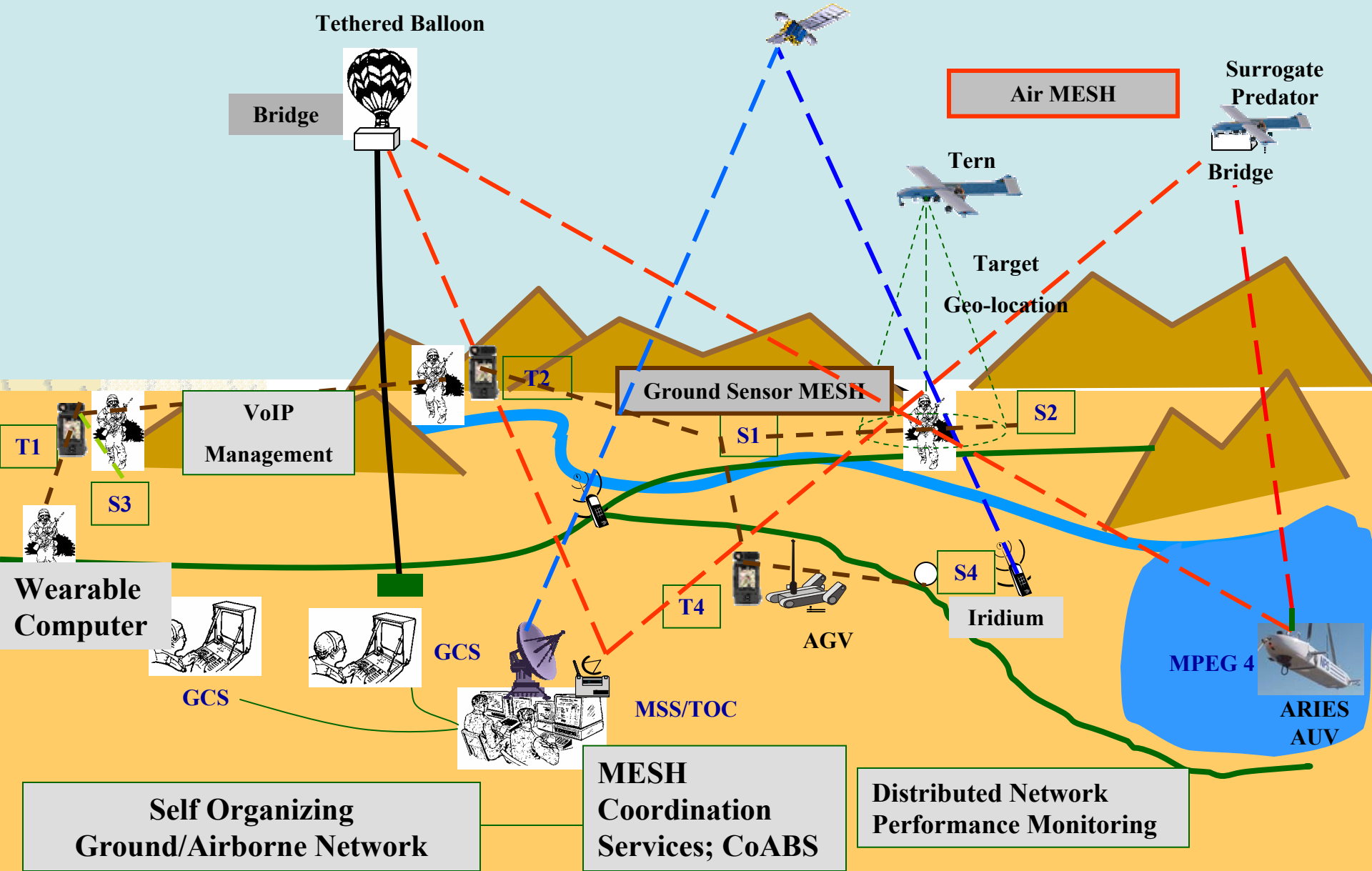
SOCOM Experiment: Sensor-UAV-Decision Maker Collaborative Grid

STAN: Surveillance and Target Acquisition Network

- Tactical Grid Collaborating Nodes: SOF unit operators, unattended ground sensors, UAVs, OFDM Towers, and TOC
- Long-haul terrestrial wireless (802.16) and airborne 802.11 data communications
- Multipath networking capabilities augmented by the Iridium satellite links
- Long-haul (30-100 mi) sensor/operator P2P mesh
- Ubiquitous video surveillance and shared SA

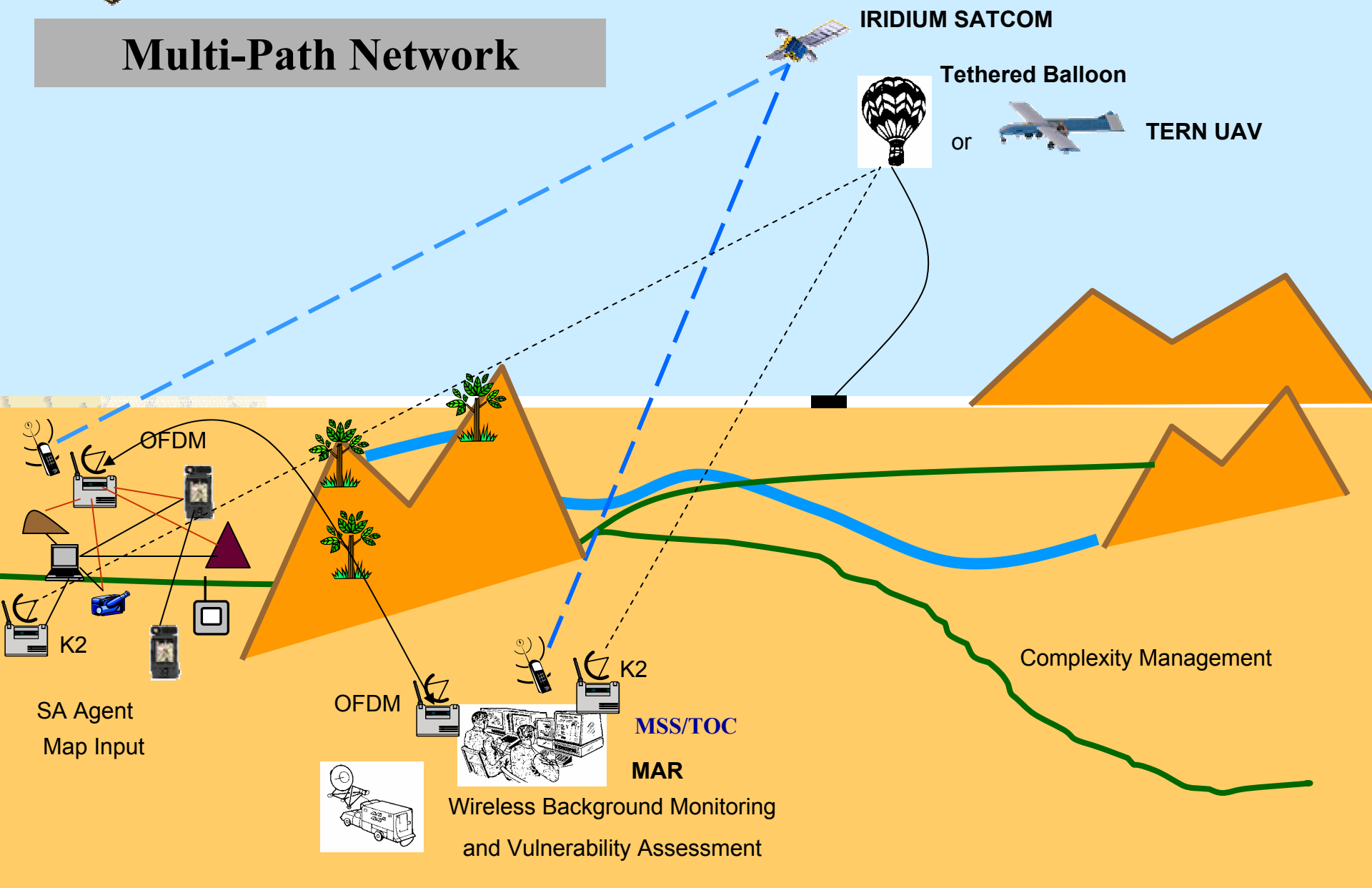
STAN 5 Feb. 04 Camp Roberts, CA

NPS with Contractor Team Support

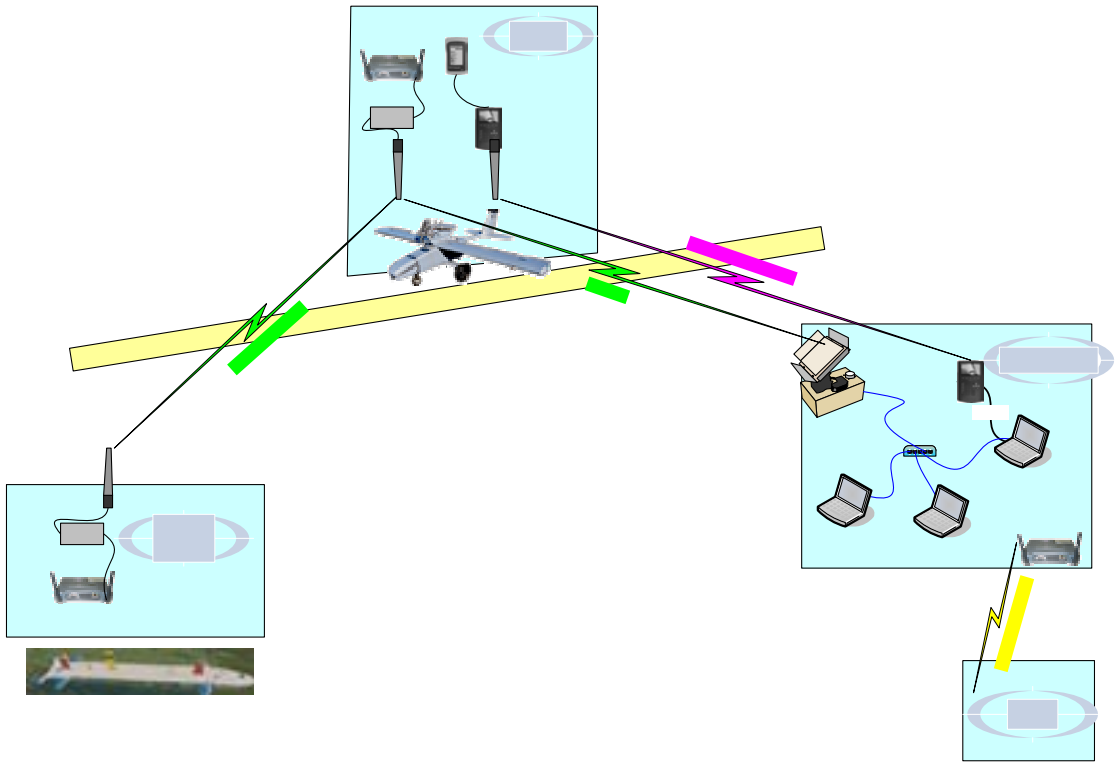


STAN 6 May 04 Camp Roberts, CA

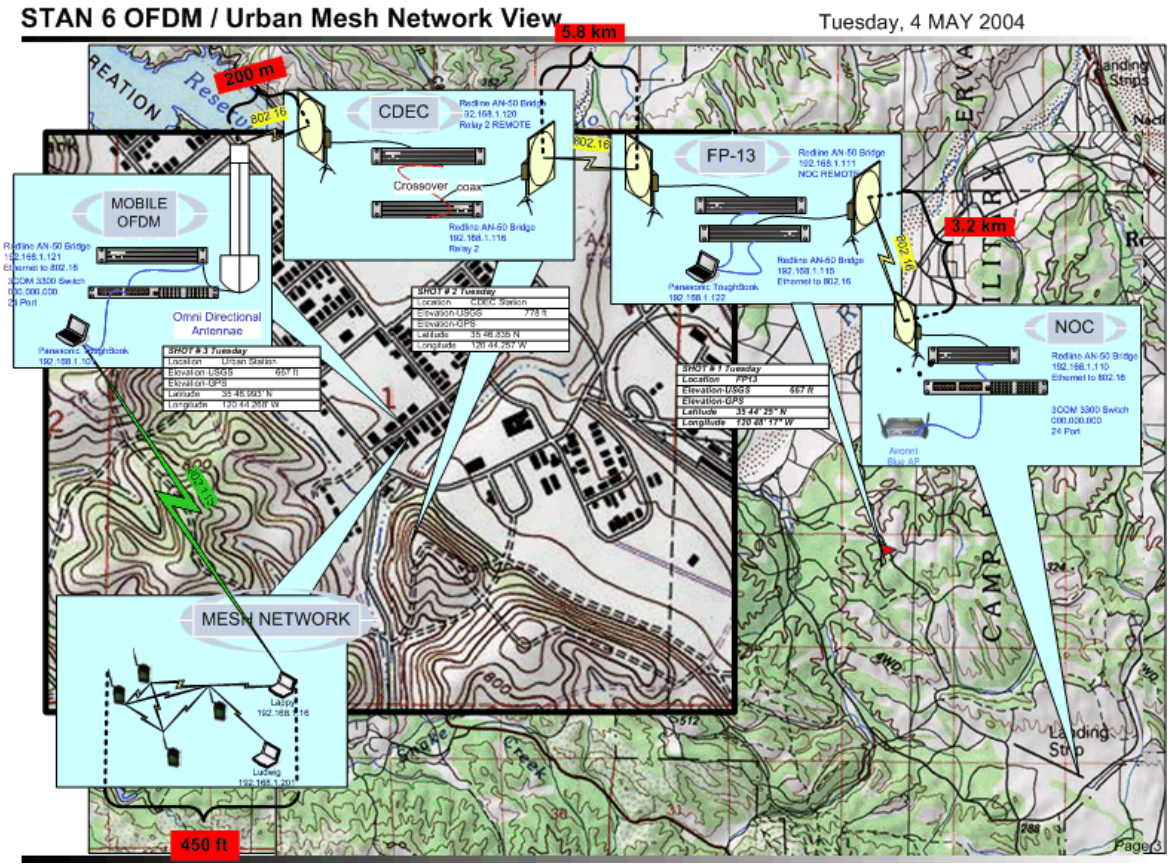
Multi-Path Network



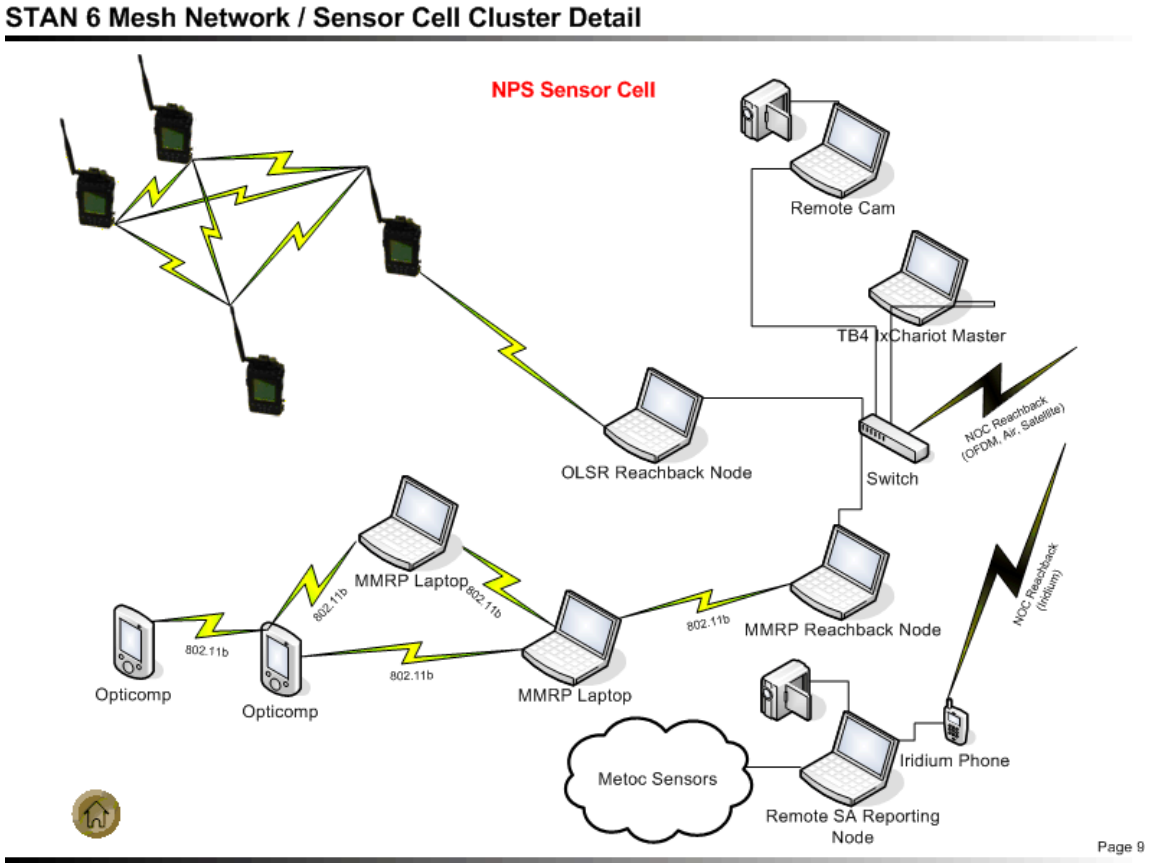
Networking with Unmanned Vehicles (designed by LCDR Axel Schumann, German Navy)



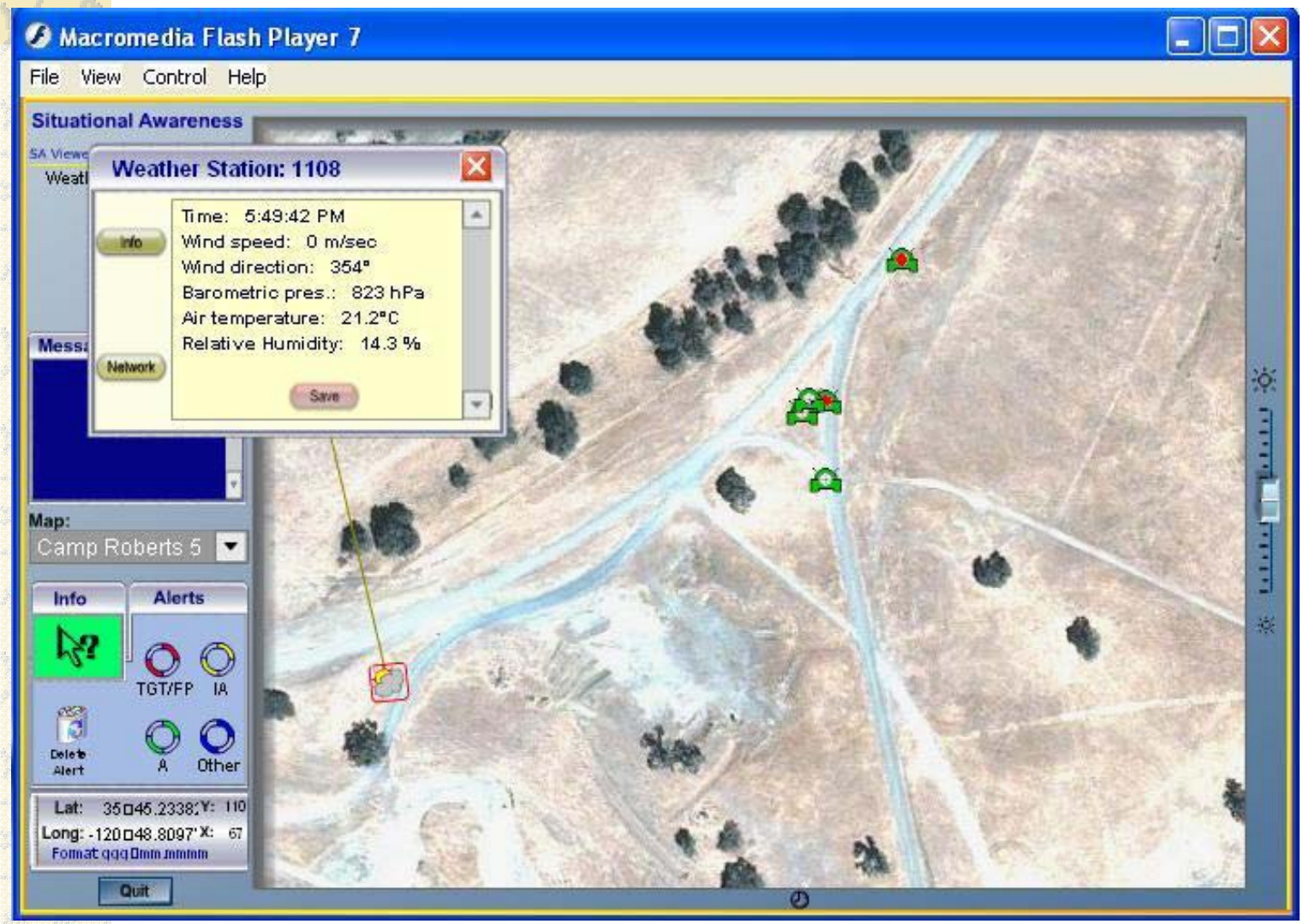
OFDM Components of Grid (designed by LT Ryan Blazevich)



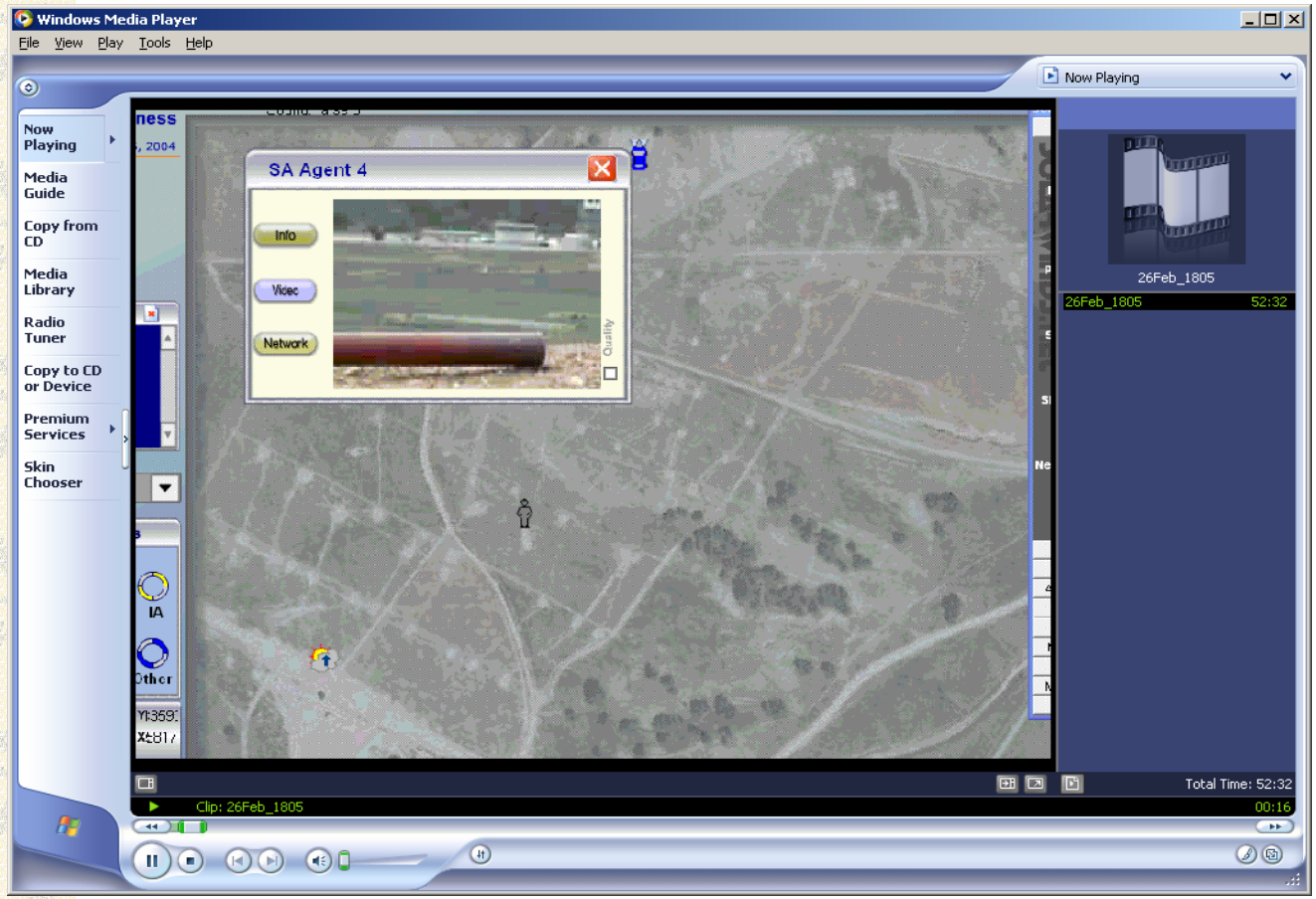
Sensor Cluster Mesh
(designed by LCDR Eric Bach)



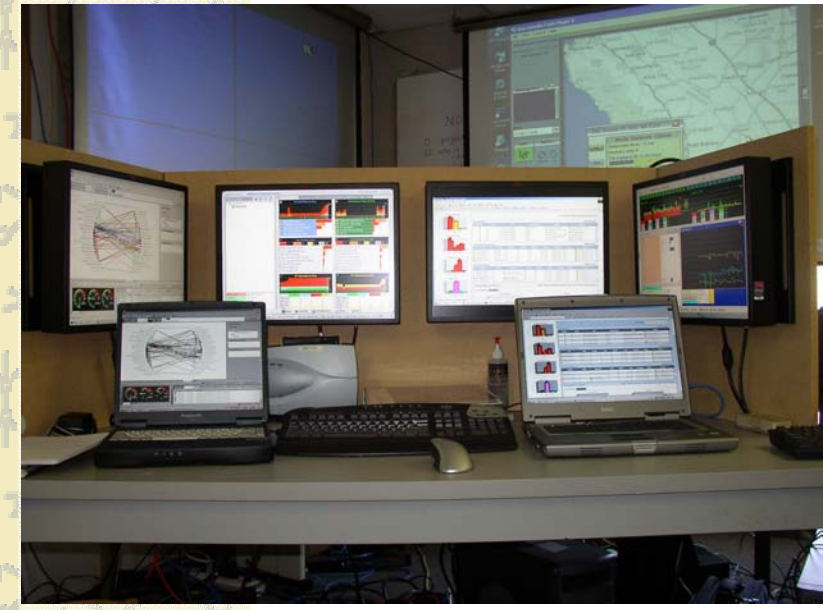
Shared SA screen with Weather Station agent reporting to the Grid



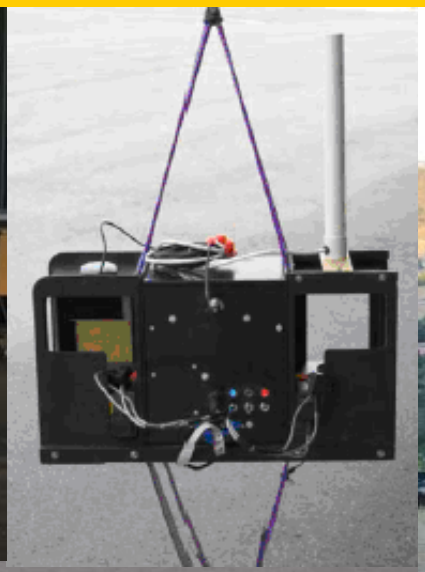
Situational Awareness with Video Sensor Agent reporting to the Grid



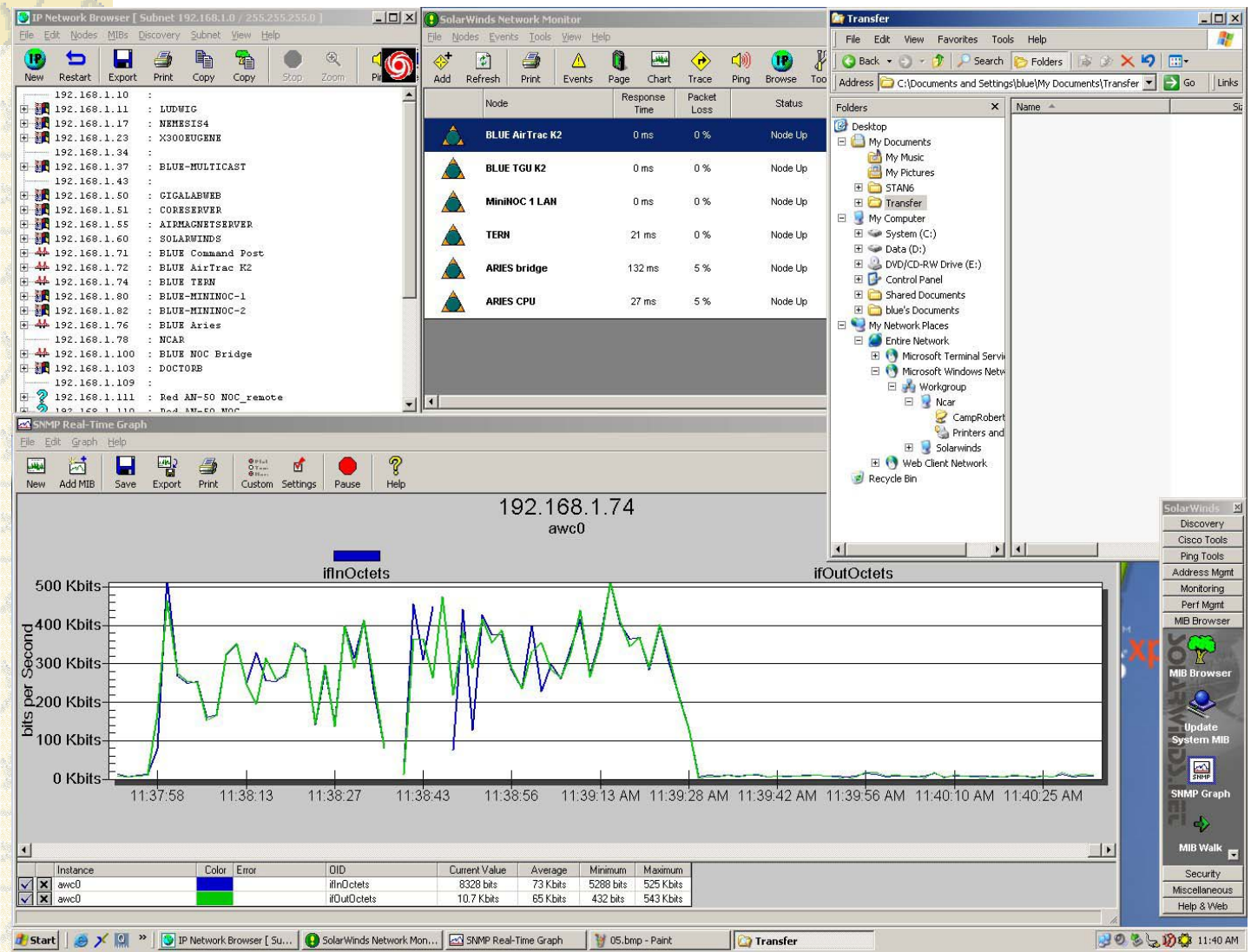
Grid NOC



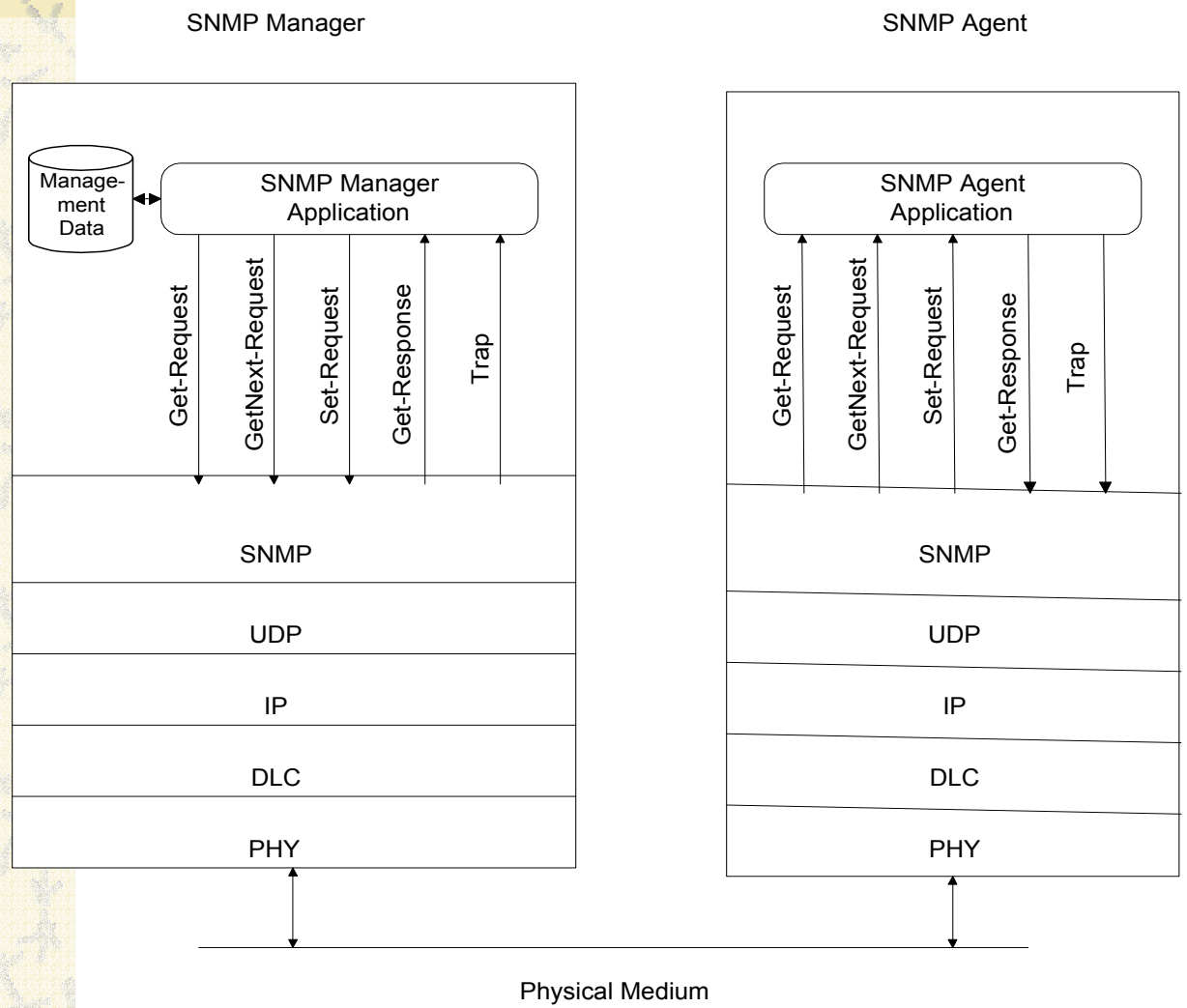
UAV Link Portable NOC



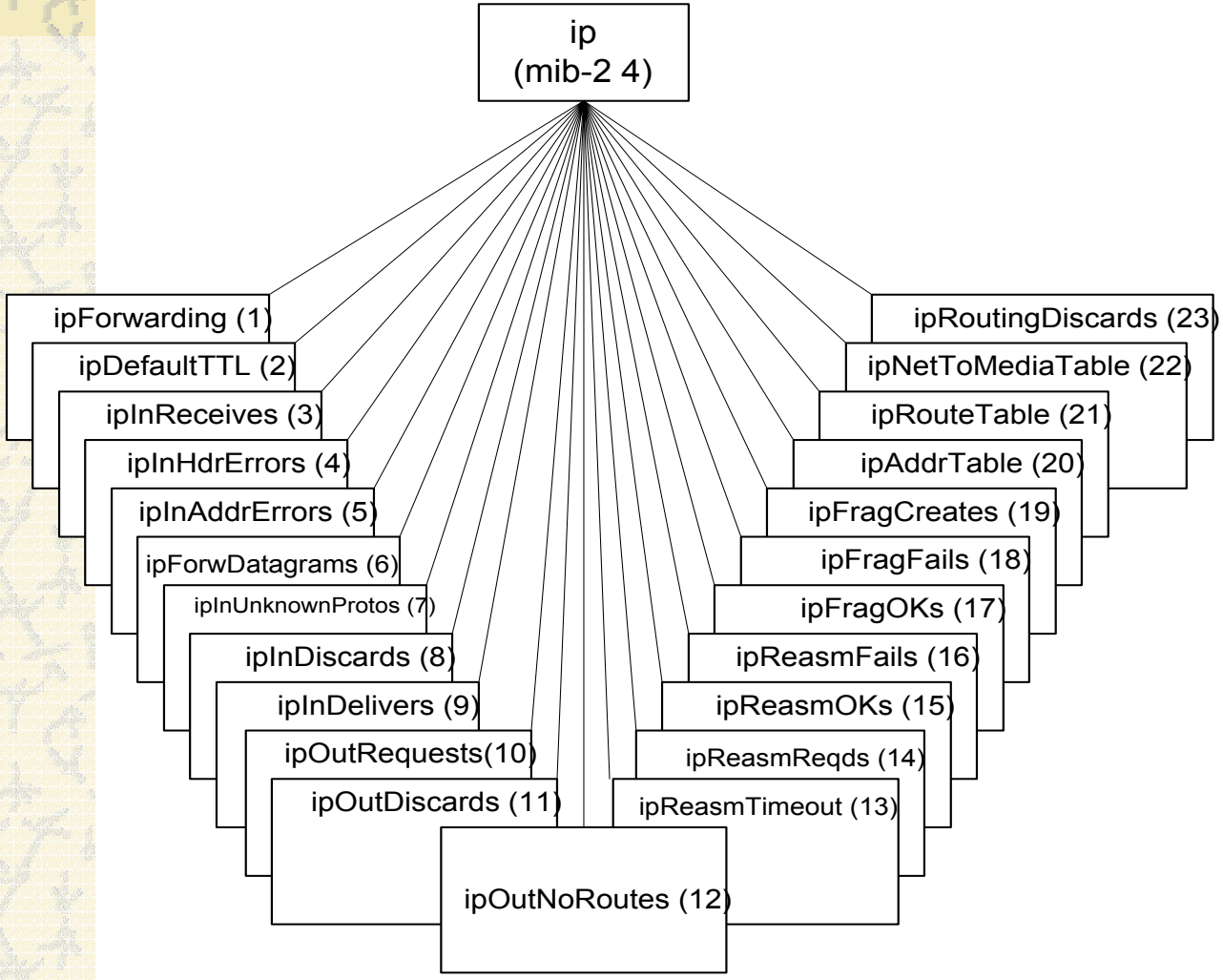
UAV Behavior as a Networking Node



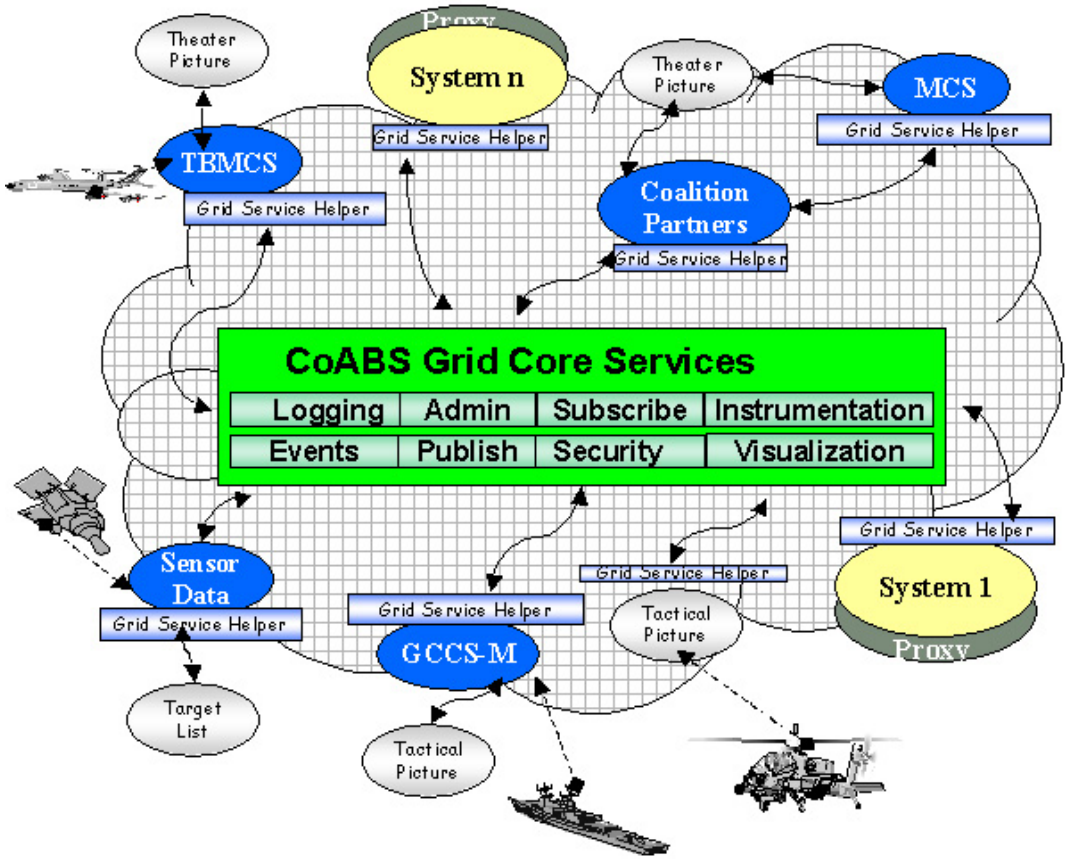
SNMP Agents for Network Mangement



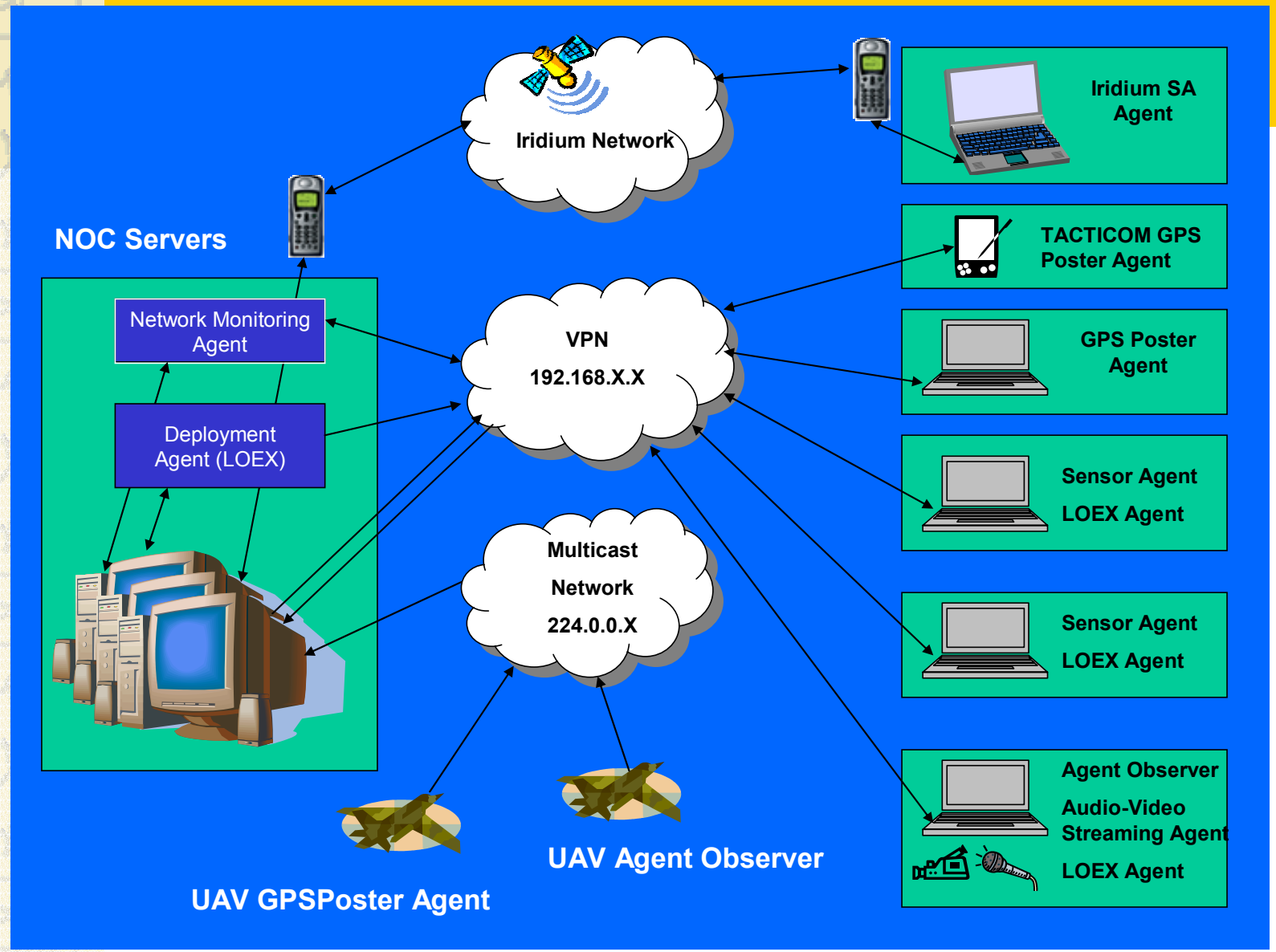
MIBs that SNMP agents manage:



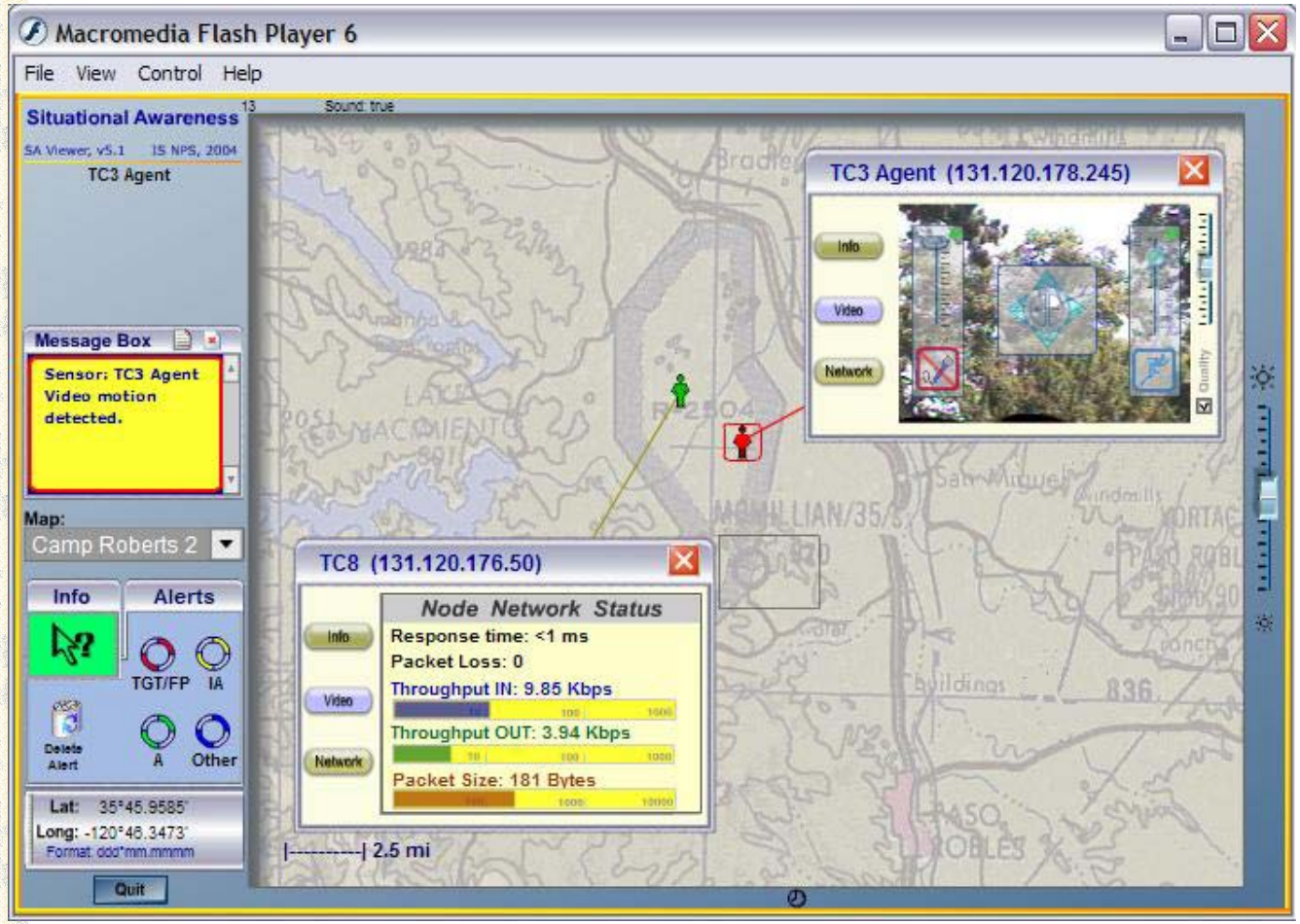
Network Awareness Solution: Extending SNMP communications to SA CoABS Services



STAN SNMP Agents Join the CoABS Services Environment



Combining Situational and Network Awareness in Grid Operation



Sensor SNMP Agents Reporting to SA Grid

Summary

- It is feasible to design network aware collaborative P2P nodes based on the SNMP agents integration with SA CoABS middleware
- The current model is limited by human-in-the-loop solution
- To further automate self-organizing behavior of ISR sensor-DM grid QoS multiple criteria policies for agents are needed
- New level of awareness could be achieved by adding the human-centric solution: collaboration of TOC, vehicle NOC, UAV link NOC, man-portable NOC, etc

Questions?