

NPS GIGA Lab Testbed for CKM Projects

Alex Bordetsky

Associate Professor

Department of Information Sciences

Naval Postgraduate School

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE JAN 2004		2. REPORT TYPE		3. DATES COVERED 00-00-2004 to 00-00-2004	
4. TITLE AND SUBTITLE NPS GIGA Lab Testbed for CKM Projects				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School, Information Sciences Department, Monterey, CA, 93943				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Collaboration and Knowledge Management (CKM) Workshop, 13-15 Jan 2004, San Diego, CA					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

What is the GIGA CODE Lab?

- ✦ Name: **Global Information Grid, Agents, and COllaborative Decision Environments**
- ✦ Mission: *Experimental studies of Global Information Grid Operation and Applications*
- ✦ Products:
 - *Testbed facilities for GIG NOCs, collaborative decision environments, agent grid, and network-centric human-agent habitats,*
 - *Experiments,*
 - *Thesis Projects,*
 - *Class Projects,*
 - *Research proposals, papers, conference presentations.*

What is the GIGA CODE Lab?

- ✦ Name: **Global Information Grid, Agents, and COllaborative Decision Environments**
- ✦ Mission: *Experimental studies of Global Information Grid Operation and Applications*
- ✦ Products:
 - *Testbed facilities for GIG NOCs, collaborative decision environments, agent grid, and network-centric human-agent habitats,*
 - *Experiments,*
 - *Thesis Projects,*
 - *Class Projects,*
 - *Research proposals, papers, conference presentations.*

Research Focus on Sensor-Decision Maker Networking and Collaborative Technologies

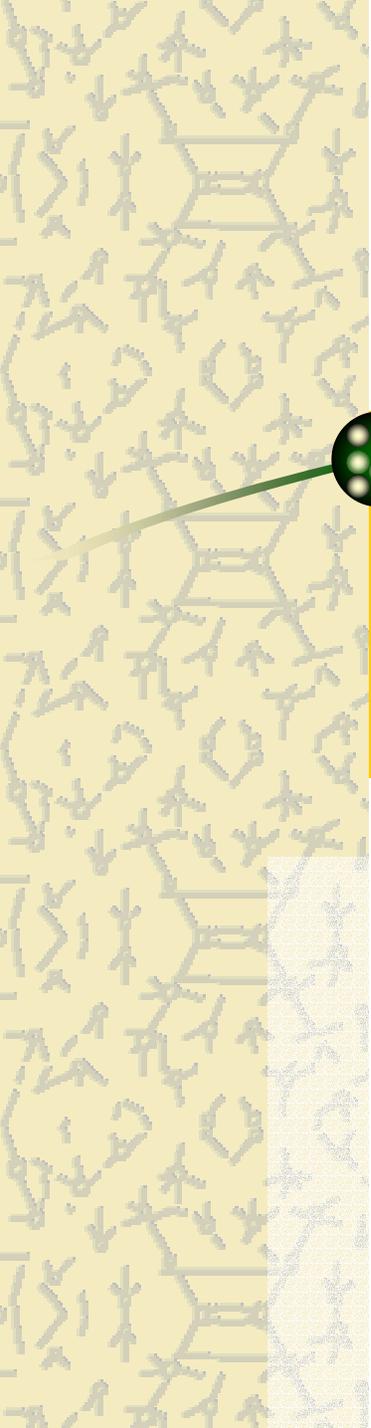
Hez Barge Mark Davis John Shwent	Wireless Collaborative Network for Relief Operations Coordination and Control	Dynamic Multipath Networks, Adaptable to C2/Adaptive Management Distributed Collaborative C2/Shared SA IST, HLS, integration with PACOM Virtual Civil-Military Coordination Center.
Leroy Dennis Michael Ford	Ubiquitous Surveillance Network Testbed	Dynamic Multipath Networks Adaptable to C2 IST, HLS, NPS Code 05.
Steve Brzostowski Larry Smith	Collaborative Technology and Situational Awareness Systems for Airborne Mission Planning	Distributed Collaborative C2/P2P C2 IST, C4I, CIRPAS

Situational Awareness and Collaborative Networking

Sam Chance Marty Hagenston Clyde Richards	Using a Semantic Web Application Employing Mobile Software Agents To Improve Military Operations	Distributed Collaborative C2/Agent Grid IST, CS, SE-Wayne Meyer Institute of Systems Engineering
Jack Fay	Transforming Fleet Network Operations with Decision Support and Augmented Reality Technologies	Distributed Collaborative C2/ NOCs Collaboration/Adaptive Network Management IS, CS, Center for Wireless Mobile Devices at Cebrowski Institute, NPS Fleet Transit Experiment
James Nasman	Fusion of Augmented Reality and Collaborative Technologies to Support Fleet Aviation Maintenance	Distributed Collaborative C2/Shared SA IS, CS, Center for Wireless Mobile Devices at Cebrowski Institute, NPS Fleet Transit Experiment
Chris Manuel	UAV Networking for Special Operations Reconnaissance Missions	Dynamic Multipath Networks Adaptable to C2/Adaptive Network Management IST, Special Operations, EE NPS UAV Networking Experiment

GIGA Lab Testbed Infrastructure

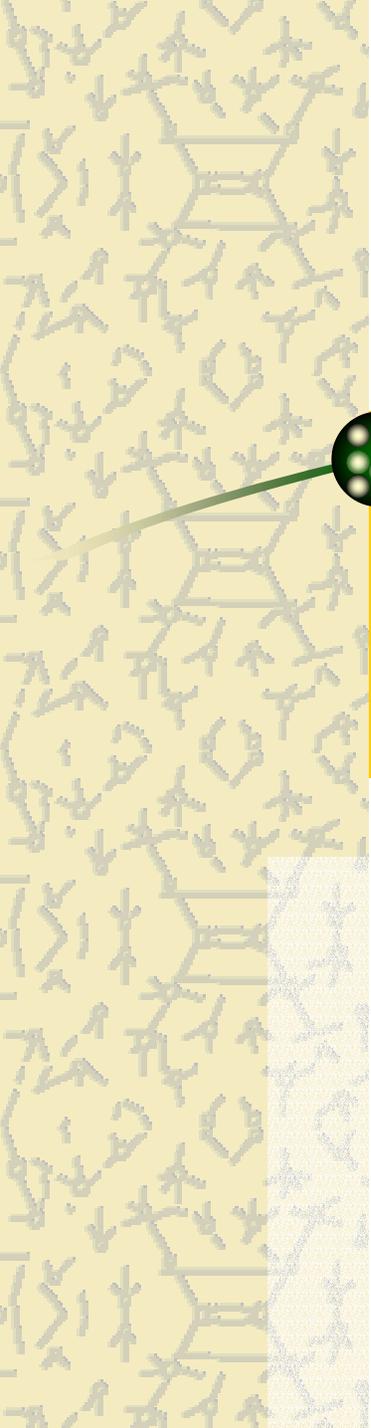
- ✿ **Network-Physical layer segments:** wireless LAN, NASA ACTS Ground Station, Internet 2 Node (Server Iron, IronView), GPS enabled PDAs/handhelds, federated student satellite network ground station, UAV links, deck operation sensors, surveillance sensors
- ✿ **Application layer, collaborative C2 and situational awareness environment:** mobile Peer-to-Peer and Client-Server collaborative testbed (Groove system and NPS agent facilitators), agent grid (DARPA CoABS platform), GPS based situational awareness and monitoring agents.
- ✿ **Adaptive Network Management Environment:**
 - Management Nodes (NOC segments): Spectrum, and Solar Wind systems, End-to-End VoIP system, terrestrial NOC for the Nemesis Project, ACTS Ground Station. Management Nodes (NOC segments): Spectrum, and Solar Wind systems
 - Multiagent CoABS middleware (DARPA) integrated with SNMP MIB agents
- ✿ **Network Simulation Modeling** segments: OPNET-STK based models of UAV LANs, UAV-LEO satellite networking, sFlow and SNMP MIB management agents.
- ✿ **Integrated Management Environment** : network-centric human-agent habitats



Background Studies: Peer-to-Peer Self-Aware Collaborative C2 Environments

Adaptive Wireless Networking for Support of P2P Collaborative C2





Shared Situational Awareness for Small Expeditionary Units

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

The screenshot displays a Groove workspace titled "P2P LOE 13Mar02 - Links - Groove". The main content area shows a web browser window with the URL `http://localhost/loe/loemaps.asp`. The browser displays a page titled "Peer-to-Peer Limited Objective Experiment".

Key elements on the page include:

- Identity:** Local_CP
- Target type:** Radio buttons for "Terrorist" (selected), "Bomb", and a dropdown menu set to "type to be defined".
- Location:** "Your last known Longitude: -121.530760°, Latitude: 36.357560°".
- Warning:** "GPS is down" in red text.
- Map:** A floor plan map with a green highlighted area. Labels "HAL" and "ROOT" are visible on the map.

On the left side of the Groove interface, there is a sidebar with the following sections:

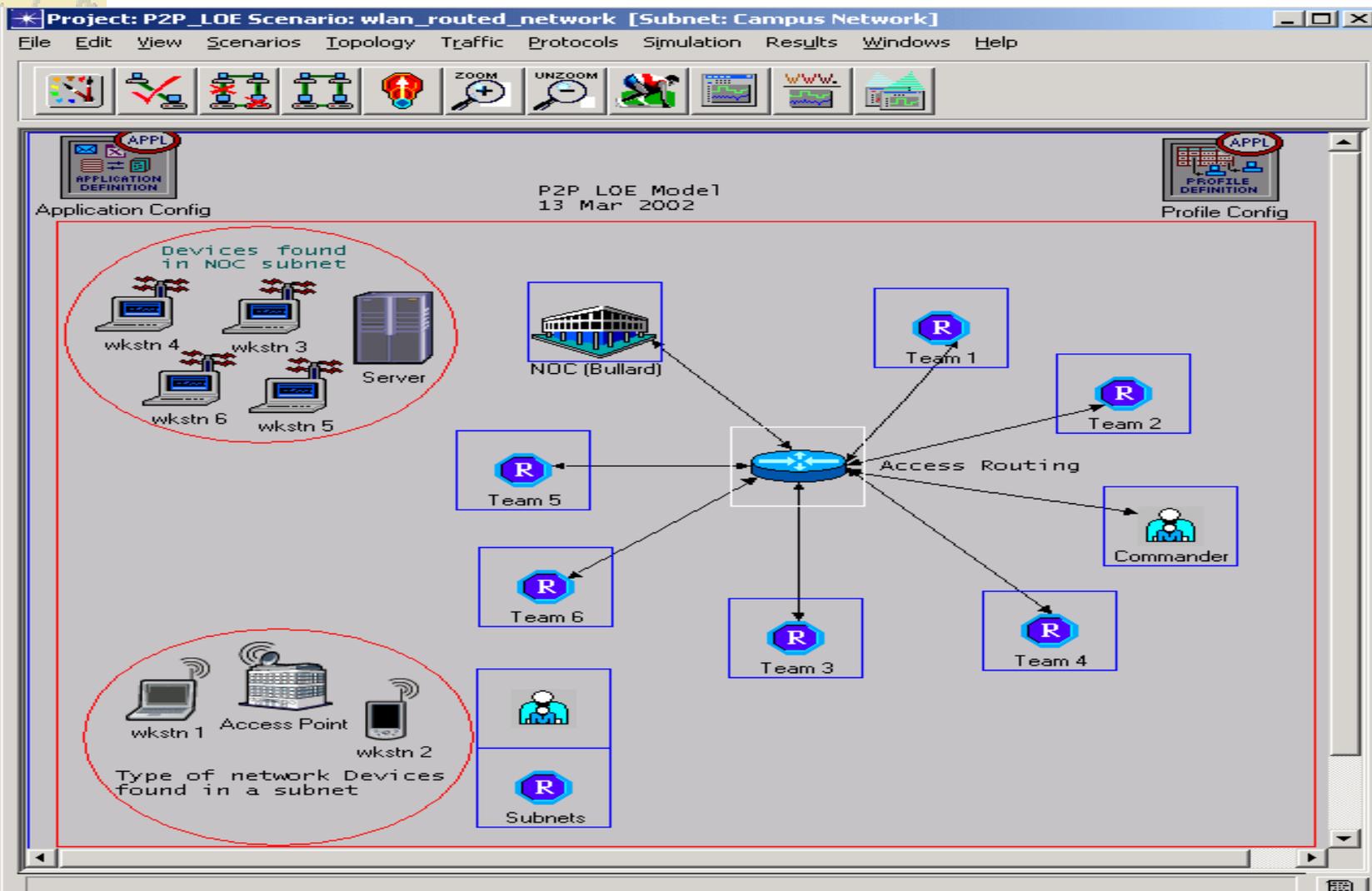
- Invite:** An "Invite" button.
- Active:** A list of active users, including "TM5".
- Online:** A list of online users, including "Bordetsky, Alex".
- Not Online:** A list of users who are not online, including "Adam Michels (...)", "Crowson, Jeff", "Heather Penta", "Kemple, Bill", "Kline, Jeff", "Pilnick, Steve", "Rulof, Rob F.", "Sawyer, Lee", "TeamSpare", "Thate, Tim", "TM1", "TM2", "TM3", and "TM4".
- Conversation:** A chat window with a "Hold-to-Talk" button and a "Hide Chat (1)" button.
- Navigate Together:** A checkbox labeled "Navigate Together".

At the bottom of the workspace, there is a "Conversation" window with the following text:

tm6 proceeding to vic of sp401 to get more info
TM1: 3/13/02 4:59 PM
rgr
TM6: 3/13/02 4:54 PM
roger on our way home
Uhrig, Bill: 3/13/02 4:59 PM
RTB, fill out final SA Sheets

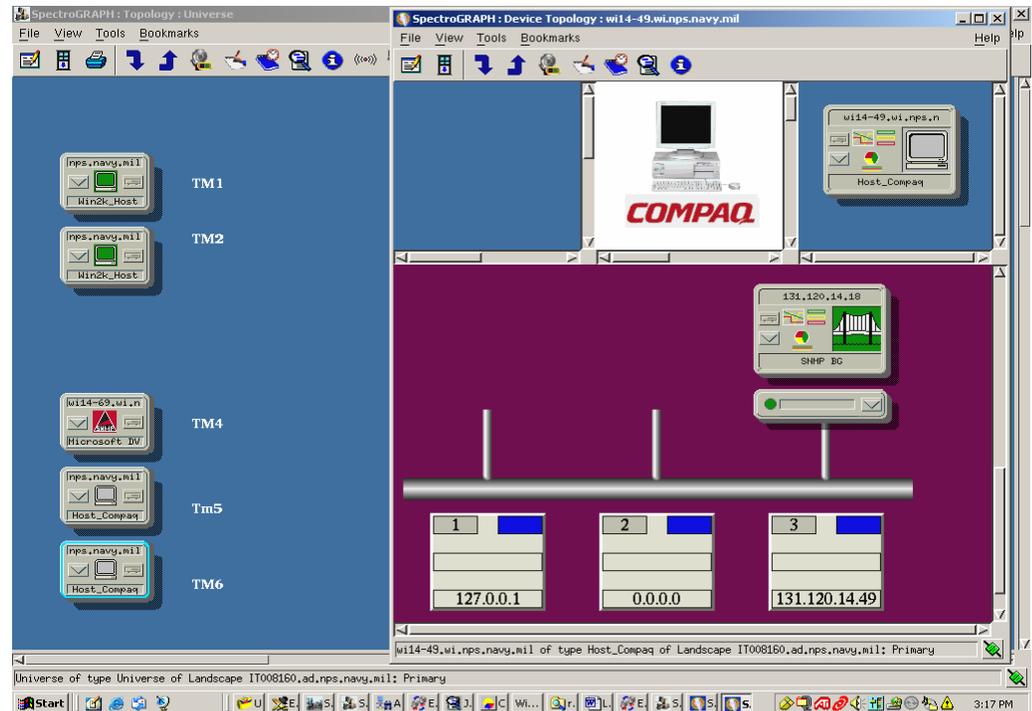
Below the chat window, there is a prompt: "- Click here and type to chat with other members of the space -".

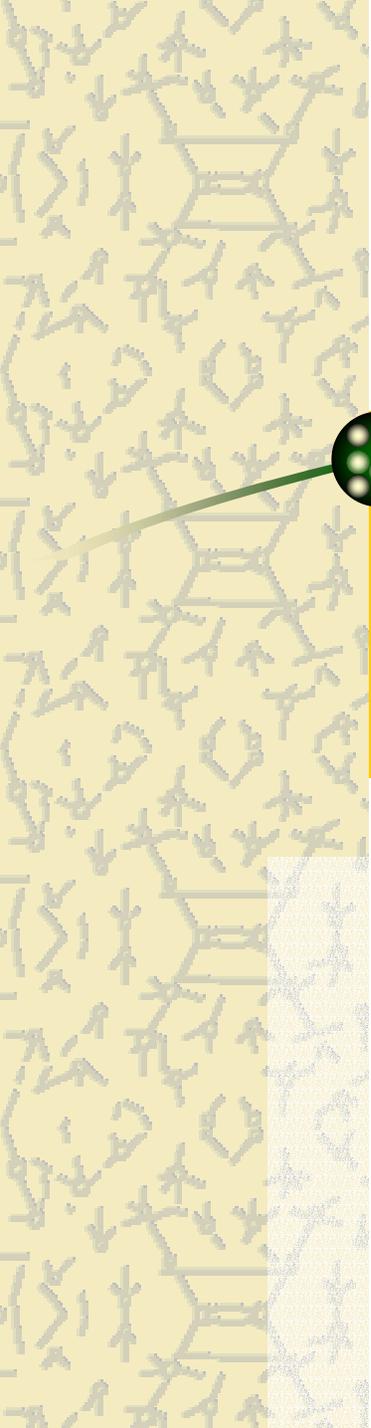
P2P Tactical Collaborative Environment Topology



Tactical Operations Center View of P2P Collaborative Network

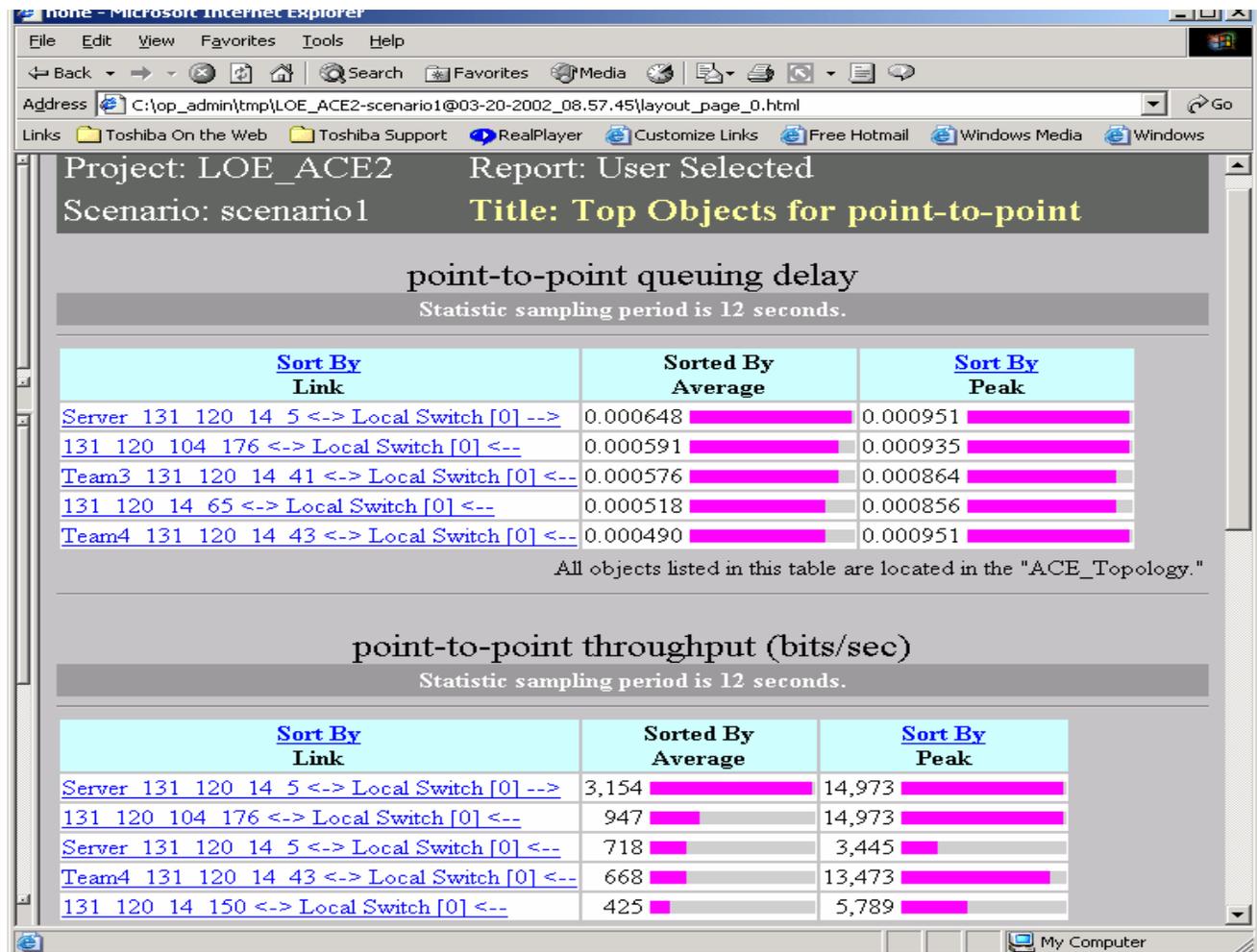
- Network Management System Snapshot of P2P Topology during the experiment
- TM1-TM5 are S&R team members mobile units



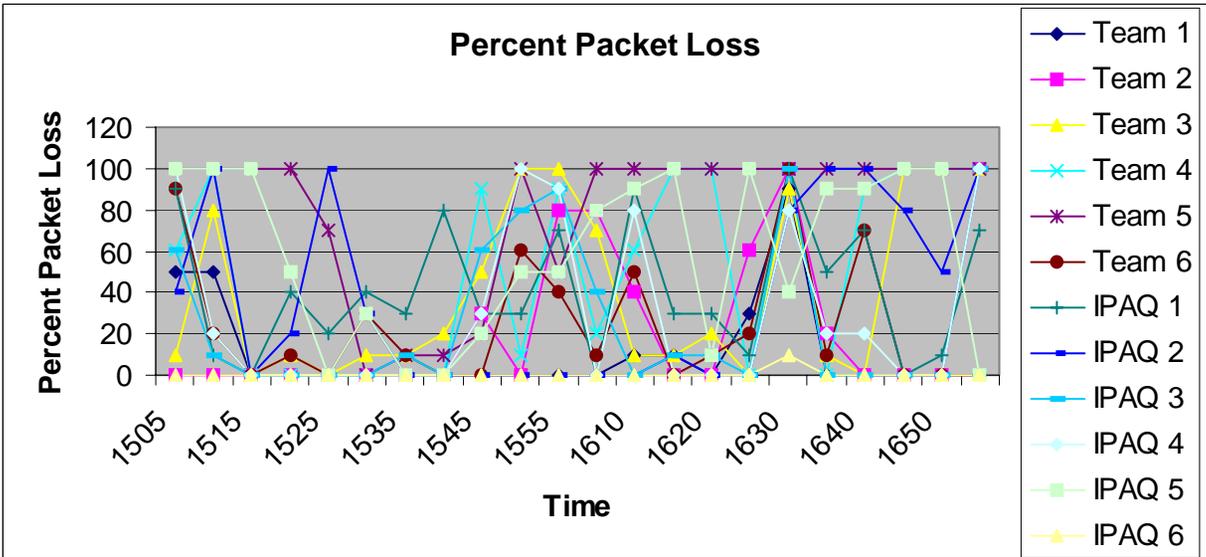
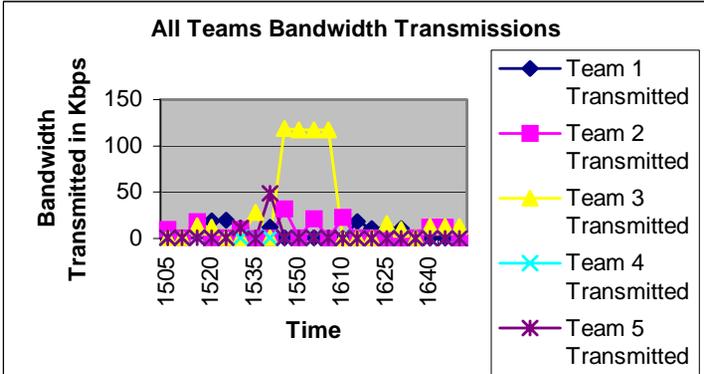
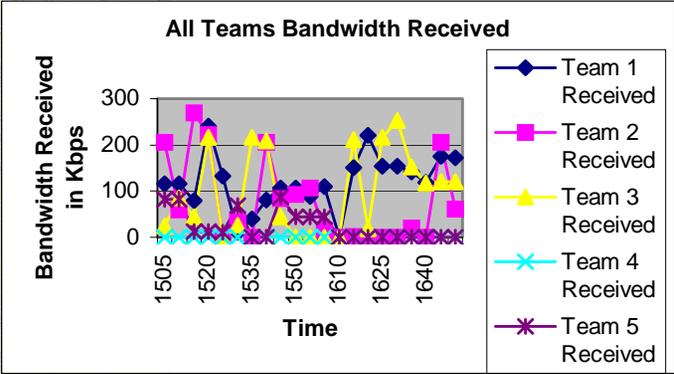


New level of feedback: network performance awareness

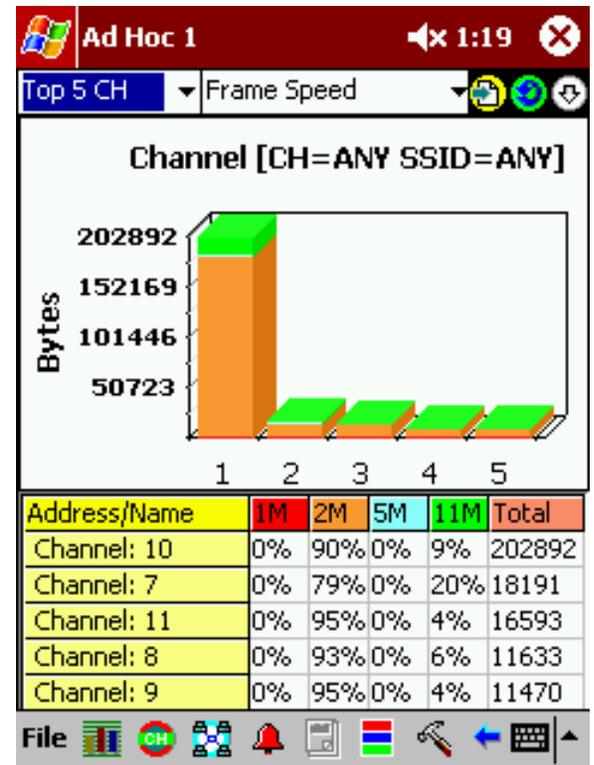
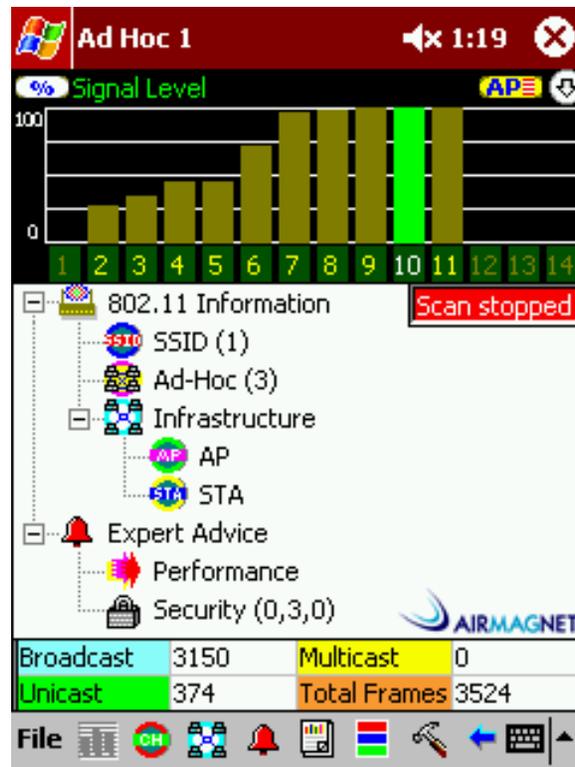
P2P Throughput Analysis

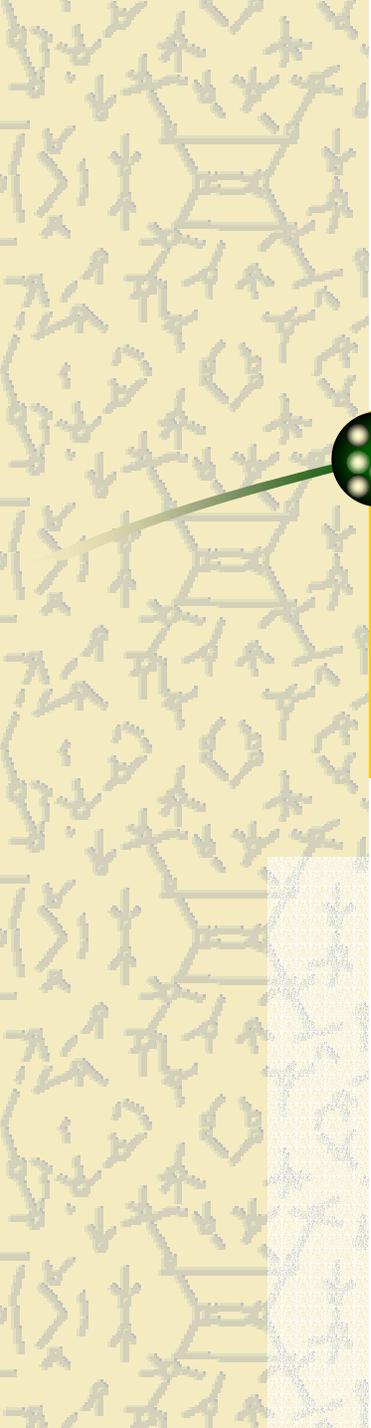


Monitoring bandwidth and packet loss



PDA View of Network Performance Feedback





Self-Aware P2P Environment: Facilitator Model

Establishing P2P 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 command center site: the P2P team created 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*

Additional Facilitator Functions

- ✦ Bandwidth management for P2P Groove clients

This issue appeared to be critical form of operational feedback to the team members. They frequently used Orinoco client to identify the coverage and adjust their operations to the failing coverage. Groove client lacks such mechanism

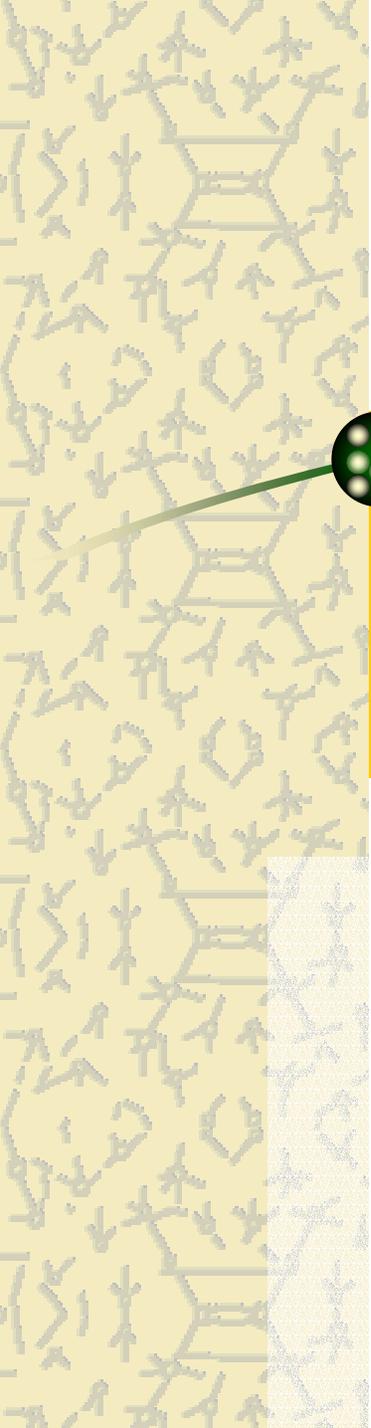
- ✦ Scalability and mobility

The experiments proved scalability of wireless P2P collaborative networking. The main problems emerged in synchronizing voice communication that created a lot of interference. By some reason the members ignored using the voice messaging. Common opinion: wrong interface. The data sharing features scaled up easily.

Support for Access to C-S Sources

- ✦ Combining P2P with Client-Server communications

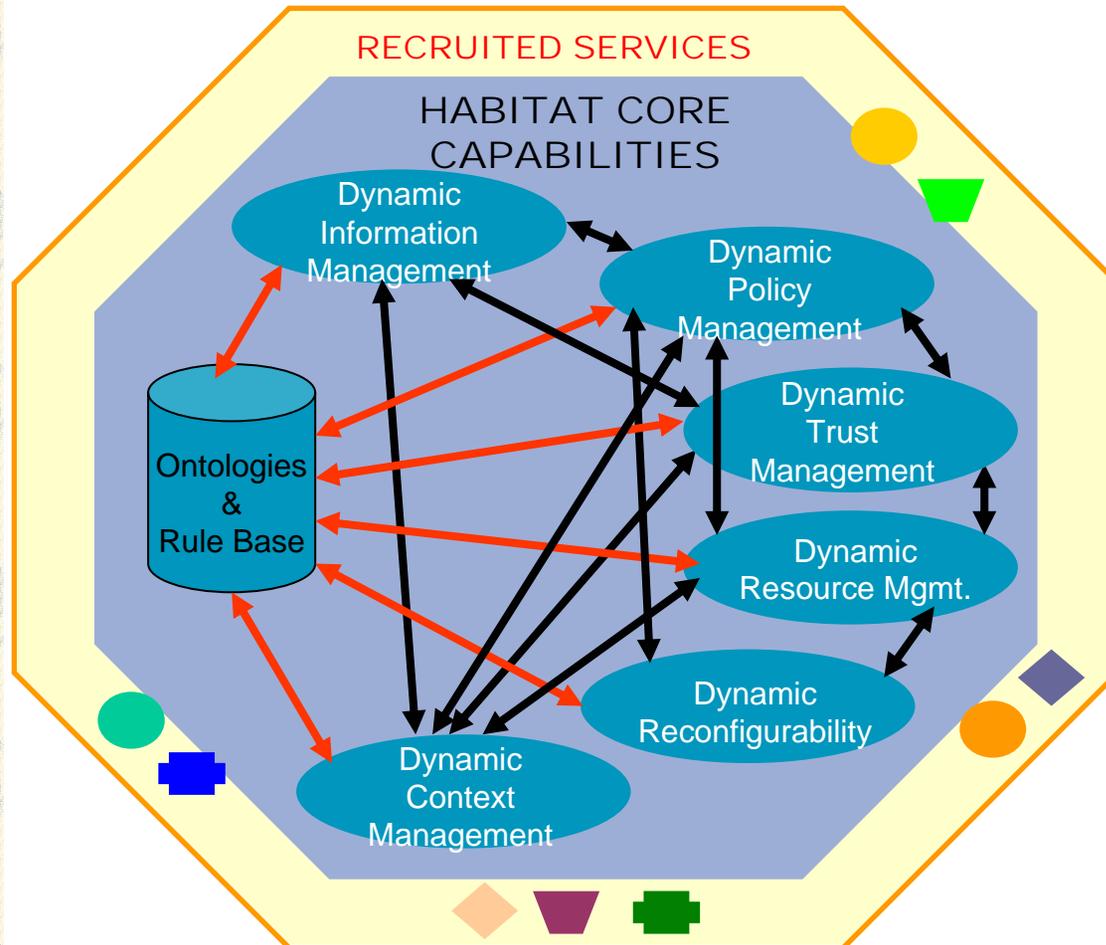
Experiment proved P2P and C-S integration feasible, but sensitive to the roaming between the access points coverage areas. The P2P application sharing features yet underdeveloped in Groove appeared to be especially sensitive to roaming. They drop applications processing by crossing the boundaries with substantial packet loss. Restoration features are necessary



Human Agent Habitats

DARPA NICCI Habitat Approach

(NICCI stands for Network-Centric Infrastructure for Command, Control and Intelligence)





Human-Agent Tactical Habitats

- ✦ Relief Operations Habitat
- ✦ Aircraft Carrier Deck Operation Habitat
- ✦ Network Operations Fusion Habitat
- ✦ Expeditionary Force UAV Networking Habitat
- ✦ SOF UAV Networking Habitat
- ✦ Ubiquitous Surveillance Habitat
- ✦ Search and Rescue Habitat
- ✦ SEALs Small Boats METOC Data Collection Network

Humanitarian Operations Habitat

TECHNICAL EVALUATION WORKSPACE - Web Links - Groove

File Edit View Options Help

TECHNICAL EVALUATION WORKSPACE
Web Links

NP56, NP56/Joint Experimentation J9 Ext...

Back Forward Stop Refresh Home Add Favorite Up Browse Together

Members **Invite**

NP56, NP56/Joint Experi...

Active

NP56, NP56/Joint ...

Online

Bordetsky Alex(Jo...
John Schwent
Major Hezekiah B...
Sam Chance

Not Online

Suspended

ROCC Log In

http://131.120.179.99/loe/roccflash.asp

ROCC Viewer
Ver 3.1
15 NPS, 2003

Mark Davis
Team ID: 2 (COAES enabled)

Get GPS Stop GPS

Map: Oahu, HI

Message Box

Info **Alerts**

DP WMID
Delete Alert Weapon c Road
Medical VESR

Lat.: 21°22.3038' N; 157°50.0996' W
Long.: -157°50.0996' W; 21°

Logoff

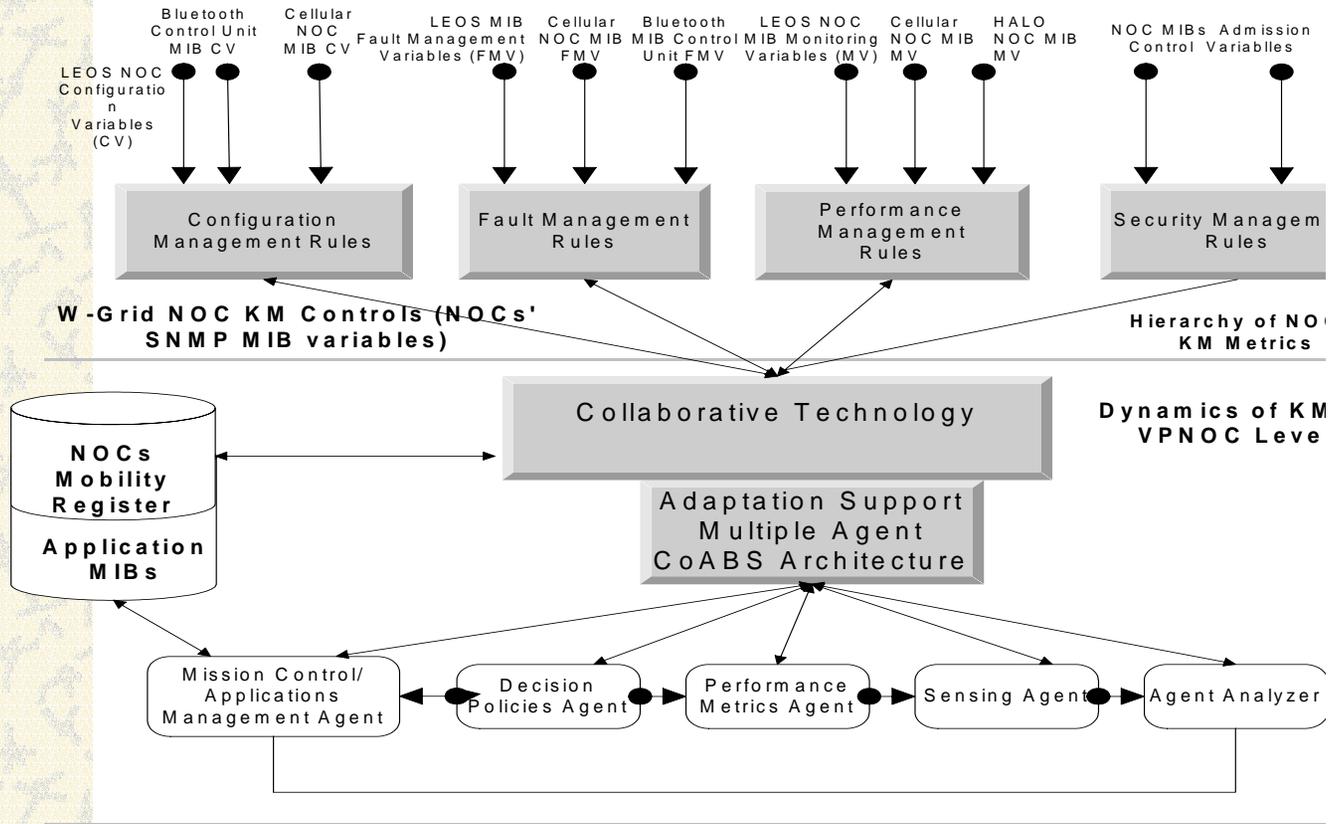
Connection: Active

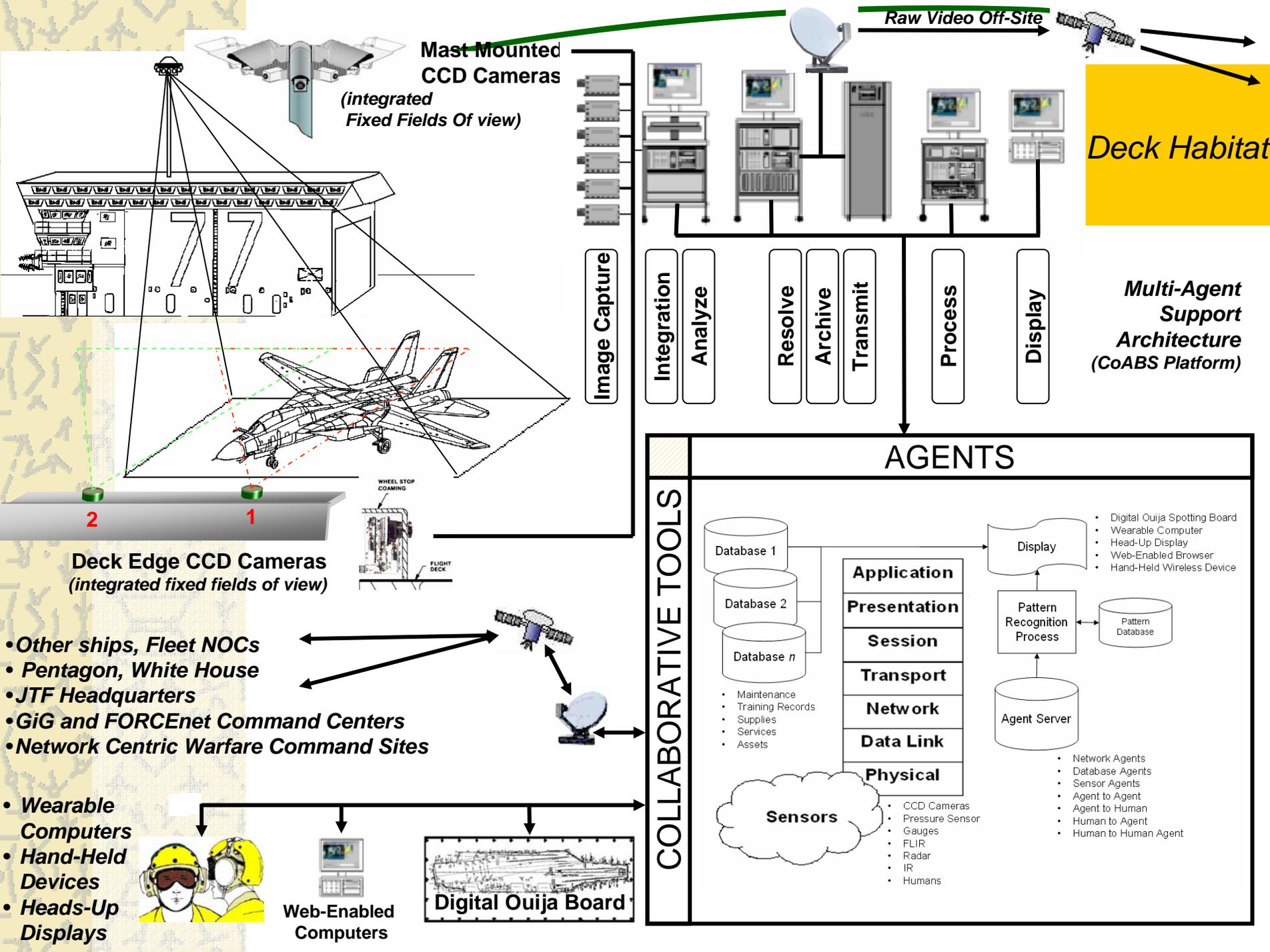
Folder: Web Links (Root Fol...

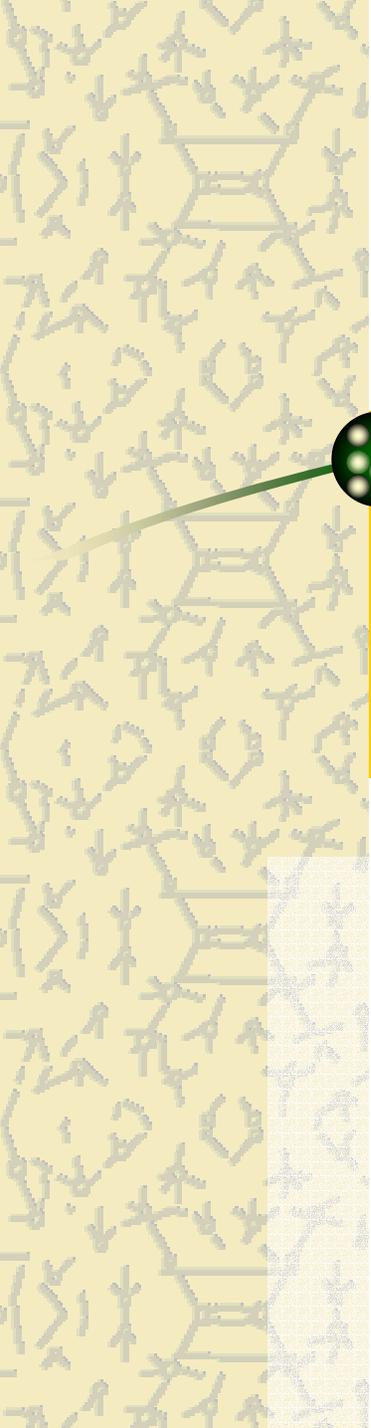
Calendar Contacts Discussion Document Review Files Forms Meetings Notepad Pictures Sketchpad Web Links (1) Add Tool

start Microsoft... Windows... LOE GPS Obj... ROCC - ... Z Micro... TECHNIC... 4:26 PM

Network Operations Habitat







CKM Testbed: P2P Situational Awareness Integration with EWALL

Objectives

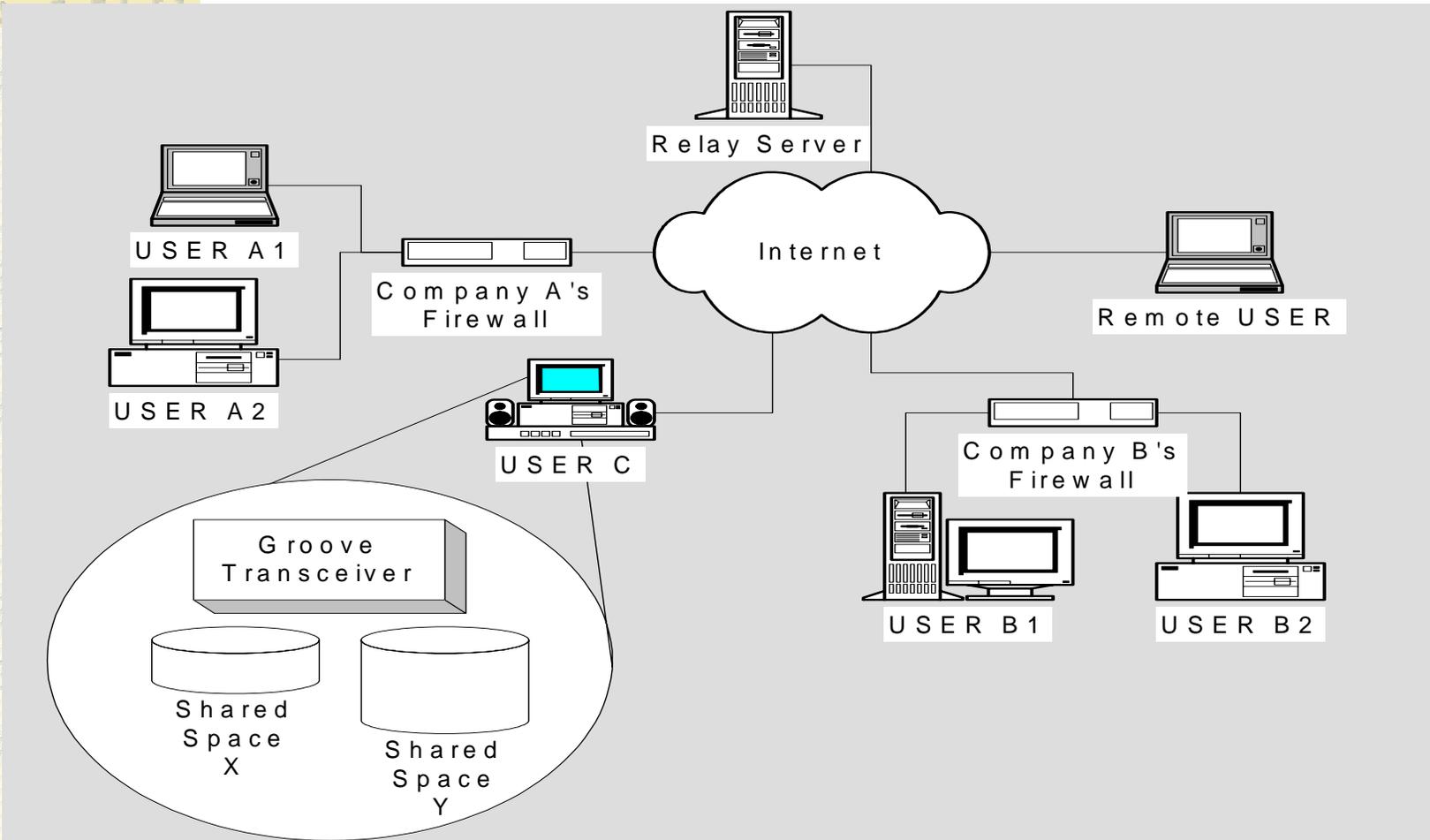
- ✦ Providing testbed for exploring situational awareness, knowledge visualization, knowledge base construction, knowledge sharing, and consensus development aspects of applying collaborative technology to tactical level network-centric operations
- ✦ Providing set of proof-of-concept limited objective experiments addressing the challenges of tactical level team collaboration on planning and conducting the NEO missions.
- ✦ Providing flexible interface for plugging in the CKM collaboration products.
- ✦ Bringing location awareness to EWALL, advance EWALL philosophy in data relationship analysis via location based information
- ✦ Bringing EWALL data fusion and association mechanisms to tactical peer-to-peer collaborative environments



Testbed Platforms

- ✿ MIT EWALL Client-Server Web-based Teamwork Environment
- ✿ Groove P2P Collaborative Shared Workspaces Network
- ✿ NAVAIR Groove-EWALL Modules
- ✿ NPS Self-Aware Human-Agent Habitat
- ✿ NPS Tactical Networks for NEO Experimentation

Groove network peer-to-peer work space sharing architecture



Groove Transceiver: Extended Presence Detection

The screenshot displays the Groove Transceiver interface for a document review session. The window title is "NPS - Battle Rhythm Project - Document Review - Groove". The interface includes a menu bar (File, Edit, View, Options, Help) and a toolbar with navigation and document management icons. The main content area is titled "NPS - Battle Rhythm Project Document Review" and shows "Revision 12" with the author "Eric Bach/Naval Postgraduate School". The status is "In Progress".

On the left, there is a sidebar with an "Invite" button and a list of users under "Active" (Cantemir, Charlie Ahcariu/N...) and "Not Online" (Axel, Bordetsky, Alex, borgqueen, Dennis Magsombol, Dieter Oros/Naval..., Eric Bach/Naval P..., Ron Montehermos..., Ryan Blazeovich/N..., Todd Pugh/Naval ...). A "Suspended" section is also present.

The main area is divided into "Documents" and "Comments". The "Documents" section shows a folder structure: "Eric Bach/Naval Postgraduate School" > "BattleRhythm_Project_Mair". The "Comments" section has a table with columns "Document", "Comment", "Author", and "Created". Below the table, it says "Select a comment above to view detailed information." There are "Add Comment" and "Respond" buttons.

At the bottom, there is a "Conversation" section with "Hold-to-Talk" and "Hide Chat (2)" buttons. A chat window shows a message from "Eric Bach/Naval Postgraduate School: 3/29/03 10:54 AM" with the text "Latest rev 12". A "Send" button and an "Options" dropdown are also visible.

Document	Comment	Author	Created
Select a comment above to view detailed information.			

Groove-based shared situational awareness: adding location and content awareness via agents

The screenshot displays a Groove workspace titled "TECHNICAL EVALUATION WORKSPACE - Web Links - Groove". The interface includes a menu bar (File, Edit, View, Options, Help) and a toolbar with icons for navigation and actions. The main content area is divided into several sections:

- Members:** Lists participants in the workspace, including "NP56, NP56/Joint Experi..." and "Active" members like "NP56, NP56/Joint ...".
- Conversation:** Features a "Hold-to-Talk" button and a "Show Chat" button.
- ROCC Viewer:** A central application window showing a map of Oahu, HI. The map displays various locations, including "Camp Smith" and "Kaneohe Camp", with markers and lines indicating connections. The viewer includes controls for "Get GPS" and "Stop GPS", a "Message Box", and a "Logoff" button. It also displays coordinates: "Lat.: 21°22.3038' N; 157°50.0996' W; 165".
- Info and Alerts:** Sections for "Info" (with a question mark icon) and "Alerts" (with icons for DP, WMD, Weapon c, Medical, and VESR).

The workspace is running on a Windows operating system, as indicated by the taskbar at the bottom, which shows the Start button and several open applications including "Microsoft...", "Windows...", "LOE", "GPS Obj...", "ROCC - ...", "2 Micro...", and "TECHNIC...". The system clock shows the time as 4:26 PM.



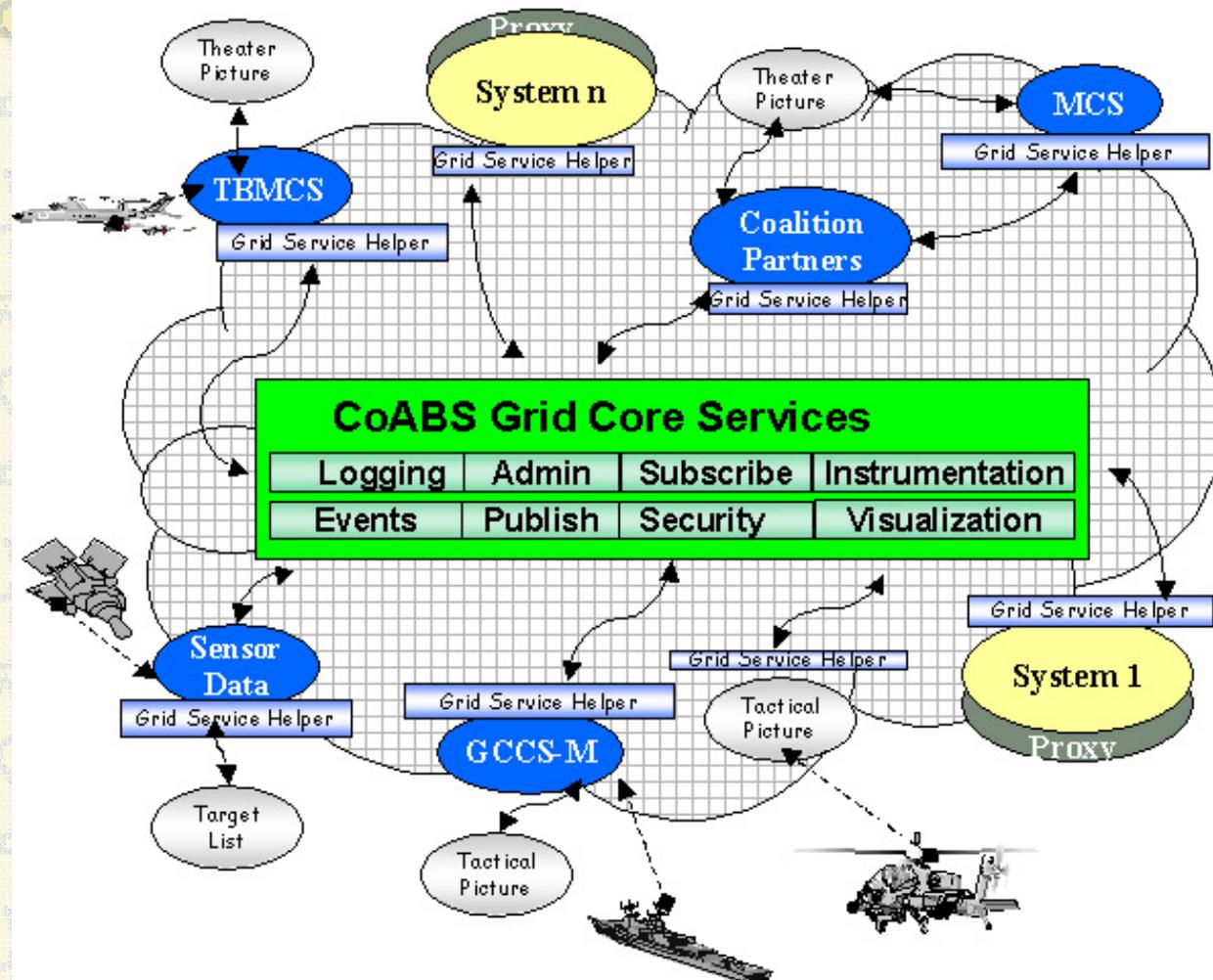
EWALL Integration

- ✦ Major challenge for present tactical P2P collaborative environments: lack of fusion and shared reasoning features
- ✦ One good answer: integration with EWALL
- ✦ First step- C2 GUI interface level
- ✦ Next step-multiagent grid: EWALL modules as grid services

ROCC Human-Agent Habitat

- ✦ ROCC: Relief Operations Coordination Center
- ✦ Using the principles revealed by the DARPA CoABS program, which deals with the techniques used to safely control, coordinate, and manage large systems of autonomous software agents, the NPS has developed an agent-based ROCC system for tactical level of Complex Humanitarian Emergency situational awareness. Its main mission is to give the users self-aware capability to maintain situational awareness on each other's location and have a common knowledge of events in their area of operations.
- ✦ The tool manages to integrate a series of in-house developed agents with the ROCC web-based application and with the Groove client. A short description of the functions covered by the two most important agents is:

CoABS Grid: Multiagent Middleware



ROCC Multiagent Architecture

- ✦ **The SA Management Agent** provides the visual interface display for all participants through their web browser and is intended to support the shared situational awareness for all the tool's users. It provides display capability for a great amount of information which allows a user to make informed decisions on how to assist in a particular event and also provides the necessary information to coordinate assistance.
- ✦ **The Tracking Agent** provides position-location information to the SA Management Agent for display in the browser. Data collected by the Tracking Agent comes from one of two input sources. One source uses manual inputs from the user who clicks and drags a user icon to a location on the display. The icon is then dynamically displayed to everyone accessing the ROCC. A second input source is from a GPS receiver. This is accomplished by enabling a software agent that takes the GPS receiver input and transmits it to the SA Management Agent in the ROCC, which subsequently moves the user icon to the correct location on the display. This method is much more accurate and requires no user input to adjust position information. This method of input is obviously hindered when a participant is obstructed from GPS detection (e.g. inside a building) or does not have a GPS receiver. In this situation, the user can easily switch to manual inputs by clicking the appropriate button on the ROCC display.
- ✦ Finally, the Complex Humanitarian Emergency Situational Awareness Tool may exist in two different spaces at the same time:
 - on the web server** – that means it is accessible to all the users that can access the server where it resides;
 - on the CoABS Grid** – which can be understood as the infrastructure layer that has all the of the agents and services running on it.

ROCC Situational Awareness Multiagent Systems

Agents

- Tracking Agent
 - GPS or Manual
- SA Management Agent
- CoABS Grid Agent
- Text Messaging Agent
- Database Agent



ROCC Agent-Based Architecture for Situational Awareness Sharing

- ✦ Concept: 100% SA view sharing
- ✦ Client-Server Elements (C-S)
- ✦ Peer-to-Peer Elements (P2P)
- ✦ Flash based integration of C-S and P2P components
- ✦ Bandwidth Friendly
- ✦ CoABS integrated: immediate access to expert sources via the CoABS Grid



Using ROCC Agents in CKM NEO Scenario

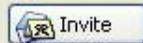


TECHNICAL EVALUATION WORKSPACE

Web Links

NPS6, NPS6/Joint Experimentation J9 Ext...

Members



ROCC Log In

http://131.120.179.99/loe/roccflash.asp

NPS6, NPS6/Joint Experi...

Active

NPS6, NPS6/Joint ...

Online

Bordetsky Alex/Jo...

John Schwent

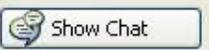
Major Hezekiah B...

Sam Chance

Not Online

Suspended

Conversation



Folder: Web Links (Root Fol...

ROCC Viewer
Ver 3.1 15 NPS, 2003

Mark Davis
Team ID: 2 (CoABS enabled)

Get GPS

Stop GPS

Map: Oahu, HI

Message Box

Info

Alerts

Lat.: 21°22.3038' N; 214
Long.: -157°50.0996' W; 165

Connection: ● Active

Navigate Together

- Calendar
- Contacts
- Discussion
- Document Review
- Files
- Forms
- Meetings
- Notepad
- Pictures
- Sketchpad
- Web Links (1)
- Add Tool

ROCC Viewer
Ver 3.1 15 Npr, 2003

Hezekiah Barge Jr.
Team ID: 1 (CoABS enabled)

Get GPS Stop GPS

Map: Oahu, HI

Message Box

Info Alerts

DP WMD Weapons Food Medical Water

Lat.: 21°28.1772' Y:316
Long.: -157°45.1593' X:289

Logoff



Alert Info - Microsoft Internet Explorer

ROCC Alert # 4.

Alert Information

Created by:	Mark Davis
Type of Alert:	Weapons of Mass Destruction
Created/Updated on:	4/24/2003 1:31:34 AM
Alert Description:	Cache of weapons/ammo/rpg`s. In addition, over 1000 viles containing a white pwder substance.

Update Alert Close

ROCC Team 1 Profile.

Team Information

Team Name: Hezekiah Barge Jr.
Type of Contact: Military
Rank or Position: Major
Email address:
Description:
Color on the map: Red

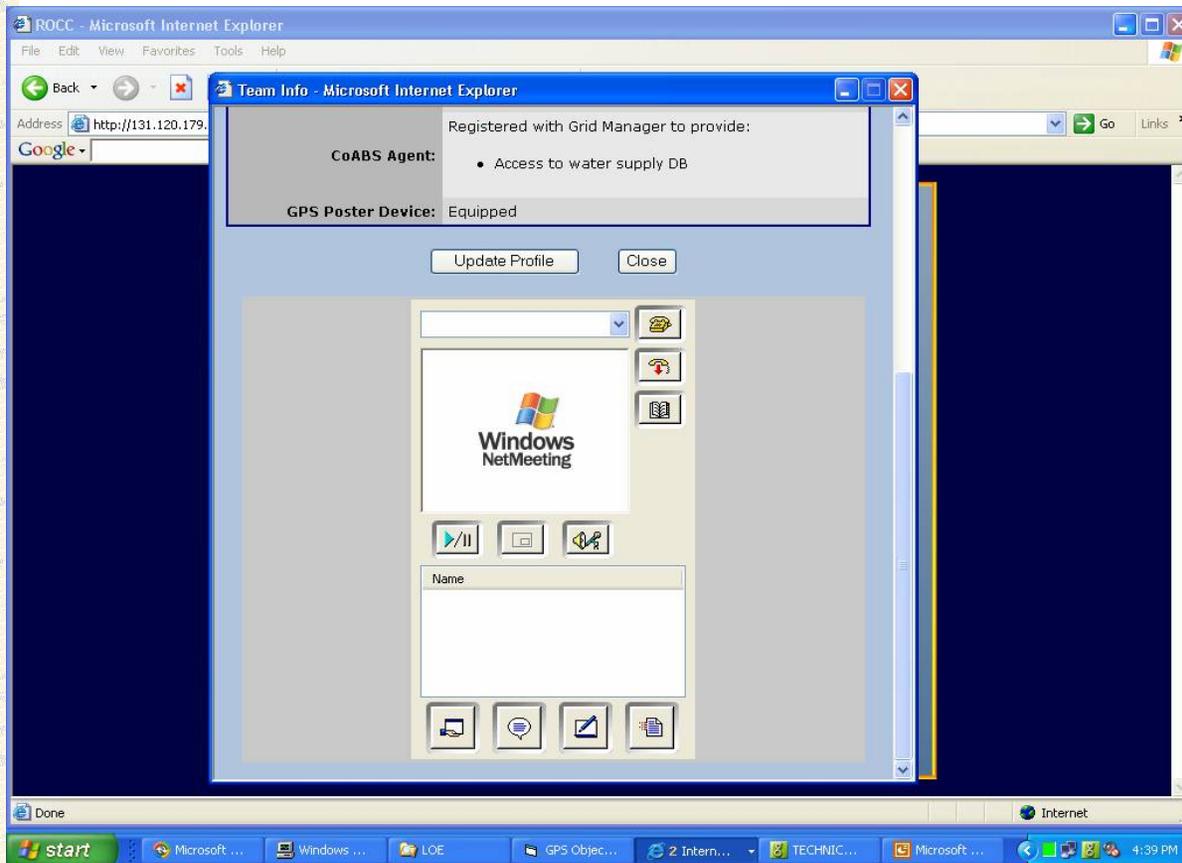
Communication Options

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

GPS Poster Device: Equipped

Habitat member profile with embedded video access



Displaced Person Alert

ROCC Viewer
Ver 3.1
Hezekiah Barge Jr.
Team ID: 1 (CoABS enabled)

Get GPS Stop GPS

Map: Oahu, HI

Message Box

Info Alerts

Lat.: 21°23.329'1" Y:241
Long.: -157°45.4382' X:282

Logoff

Alert Info - Microsoft Internet Explorer

ROCC Alert # 3.
Displaced Person Information

Created by: Tommy Testman Camp: Camp Smith

Displaced Person:



Fatima Tirkiti

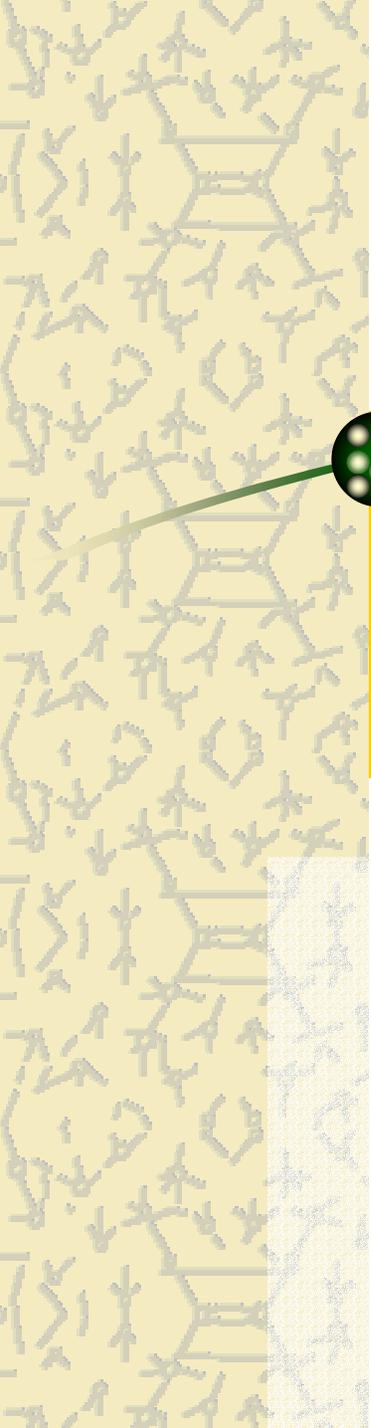
Age: 25
Sex: Female
Marital Status: Married
Status: Missing Adult , need clothing , need medical assistance
Spouse Name: Muhammad Tirkiti
Home Origin: Tirkit
Comments: Not cooperating
Marked as: Not marked.

Created/Updated on: 4/22/2003 2:01:47 PM

Approach to EWALL Integration



Acrobat Document



Questions?