Sensor-Unmanned Vehicle Networks : Tactical Network Testbed (TNT) Approach

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Compiled of joint presentations with Dr. Dave Netzer, TNT Director

Background: NPS Field Experimentation Program, STAN, and TNT Experiments

OBJECTIVES:

- Provide opportunity for NPS students and faculty to demonstrate and evaluate their latest technologies in an operational environment and provide operational community the opportunity to utilize and experiment with these technologies.
- Take advantage of operational experience of NPS students.
- Provide Military and National Laboratories, DoD Contractors, and other universities opportunity to test and evaluate latest S&T in operational environment; small, focused field experiments with well-defined measures of performance.

HISTORY:

- Began in FY02 – use of UAVs for improved capability of downed pilot rescue
- Jan. 03 - combined field experimentation program with CW2 Chris Manuel's Surveillance and Target Acquisition Network Project (STAN) – quarterly field experiments began July 03
- FY05 STAN transitioned to USSOCOM programs MAI and JTCITS and NPS TNT (Tactical Network Topology)

PRIMARY SUPPORT:

- CDTEMS (Congressional Funding): FY03 = $1M, FY04=$2M, FY05=$1.75M
- USSOCOM: FY05 = $1. 96M (Light Reconnaissance Vehicle), FY06 (JMUST)

Availability Facilities

NPS/

CIRPAS

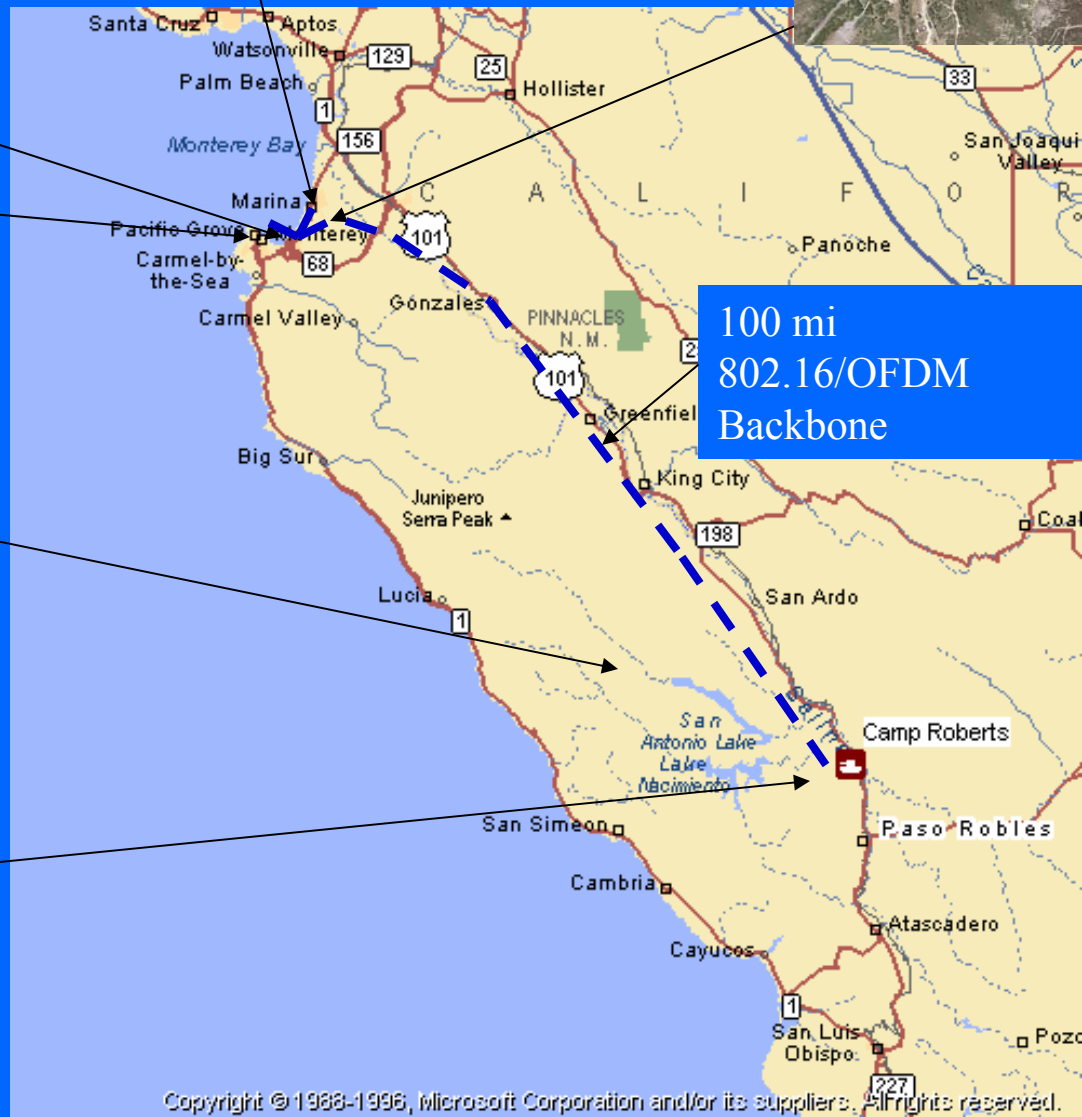
MOUT,
Old Ft. Ord

NPS Campus

Beach Laboratory
and Monterey Bay

Ft. Hunter Liggett
165,500 Acres

Camp Roberts
42,784 Acres



100 mi
802.16/OFDM
Backbone

NPS Air Assets

CIRPAS

GCS (2)

Predator (2)

GNAT 750 (2)

Altus ST

Pelican Surrogate UAV (2)

AN/MPQ-64 Sentinel Air Surveillance and Target Acquisition/Tracking Radar

UV 18-A Twin Otter

TERN and FROG (3)

(Plus multiple TERNS provided by SOCOM – flown by VC-6)

Tethered Balloons

Small and Micro UAVs

FY05 TNT Team

NPS:	- FY 04: 23 Thesis Students, 22 Faculty
	- FY05: 22 Thesis Students, 31 Faculty
	(to date) Course Projects: IS, OR, CS
Students	- Joint (SOF, Army, Navy, AF,
	MC) with OP Experience
CIRPAS	- UAV Field, Flt. Support
IS Dept.	- Networks: Performance, Architecture,
(GIGA Lab)	Vulnerability Assessment, DoS
	Collaboration; 3D Terrain, Targeting
OR Dept.	- M&S, MOPs, Human Systems
	Integration, Insurgency Analysis
CS Dept.	- Networks, Encryption, DoS
DA Dept.	- CONOPS, Mission Analysis
MAE Dept.	- Avionics and Controls, UAVs
	- AUVs, Undersea Sensor Grids & Coms
ECE Dept.	- Covert Networks, IED Detection and
	Jamming, Smart Antennas, LPI/LPD
Met Dept.	- Local Meteorology, Radar Threat, EO
	Performance
Meyer Instit.	- Systems Engineering, MMALV
Instit. for M&S	- Red Team Intent
CDTEMS	- Funding

AF Force Protection Battlelab: Sensor Cluster

ONR/NRL 113: Experiment Support

MIT/ ONR : EWall Collaboration and Data Fusion Testbed

Virginia Tech: Antennas

USSOCOM :
- Funding, UAVs, UGVs,
- Requirements
- Contractor Team Mgmt.

USASOC: SOF Personnel

A.F. Big Safari: Funding

Office of Force Transformation: Funding, Wolf PAC, TACSAT

VC-6: TERN UAV Flight Support

SPAWAR: GIG-EF

NSA NTIO: SIGINT

LLNL:- Cooperative Research
UWB: Coms, Radar, Sensors
IED and Tracking
Radiation Detection
Voice Recognition

AFSOC: UAV Operations

Camp Roberts ANG : Vehicles, Small Arms

NAVSOC: NAVBOARD

DLI: Language, Team Support

Inter-4 :
- Tacticomp, NAVBOARD, UWB

Redline Communications: OFDM/ 802.16

Mesh Dynamics – Multi-Radio Mesh

ITT: Mesh

SAVY: RFID

CenGen: SecNet-11 for MANET

GENEX Technologies: Sensors & UAV Payloads

Fortress Technologies: Encryption

PowerWAN: Power Grid WAN

Rajant: BreadCrumb

Flarion: 802.20/OFDM Mobile Coms

Media Group: NOC Architecture

Evidenced Based Research: C2

MCTSSA: Ruggedizxed PDA, Radio Coms

NPS TNT FY05

Assets and Network Building Blocks

- **Light Reconnaissance Vehicle** - Local and Global C3I, UAV Control
- **Persistent Surveillance Mesh Networking Solutions**
  - Air Nodes: Multiple tethered balloons and airships with cameras and sensors
  - Mesh Networking Protocols: 802.11b with OLSR, ITT with AODV,
  - Ground Sensor Nodes: Smart Rocks, UWB sensors (LLNL), Motion Detectors
  - Self-forming / self-healing solutions
- **Multi-path Networks** (802.11b, 802.16/OFDM, 802.20, Mesh, UWB (LLNL), Iridium, Globalstar) with complexity management
- **802.16/OFDM and 802.20**
  - 100 mi 802.16/OFDM backbone utilization with reach-back using Army SATCOMSTA, SPAWAR GIG-EF, DREN
  - Airborne, ship, and mobile ground (LRV)

TNT Testbed Sensor-UV Networking Capabilities

Unmanned Vehicles

- **UAVs**
  - Coupled video turret, small UAV flight control, and PVNT 3D terrain capability for target lock-on and 1-2 m location accuracy on moving and stationary targets
  - Morphing Micro Air-Land Vehicle
  - Cooperative behavior of multiple UAVs (autonomous landing)
  - Control of multiple UAVs over network

- **AUVs**
  - FL Sonar
  - Autonomous operation with vehicle tracking
  - Mine locating in littoral
  - SA in TNT

Smart Antennas – ship, UAV, ground vehicle; non-rotating tracker

RFID- active, passive, and UWB

TNT Testbed Sensor-UV Networking Capabilities (continued)

Network Operation

- **TOC/NOC Architectures**: fixed, deployable, mobile, man-pack

Global Connectivity

- TACSAT
- GIG, DREN

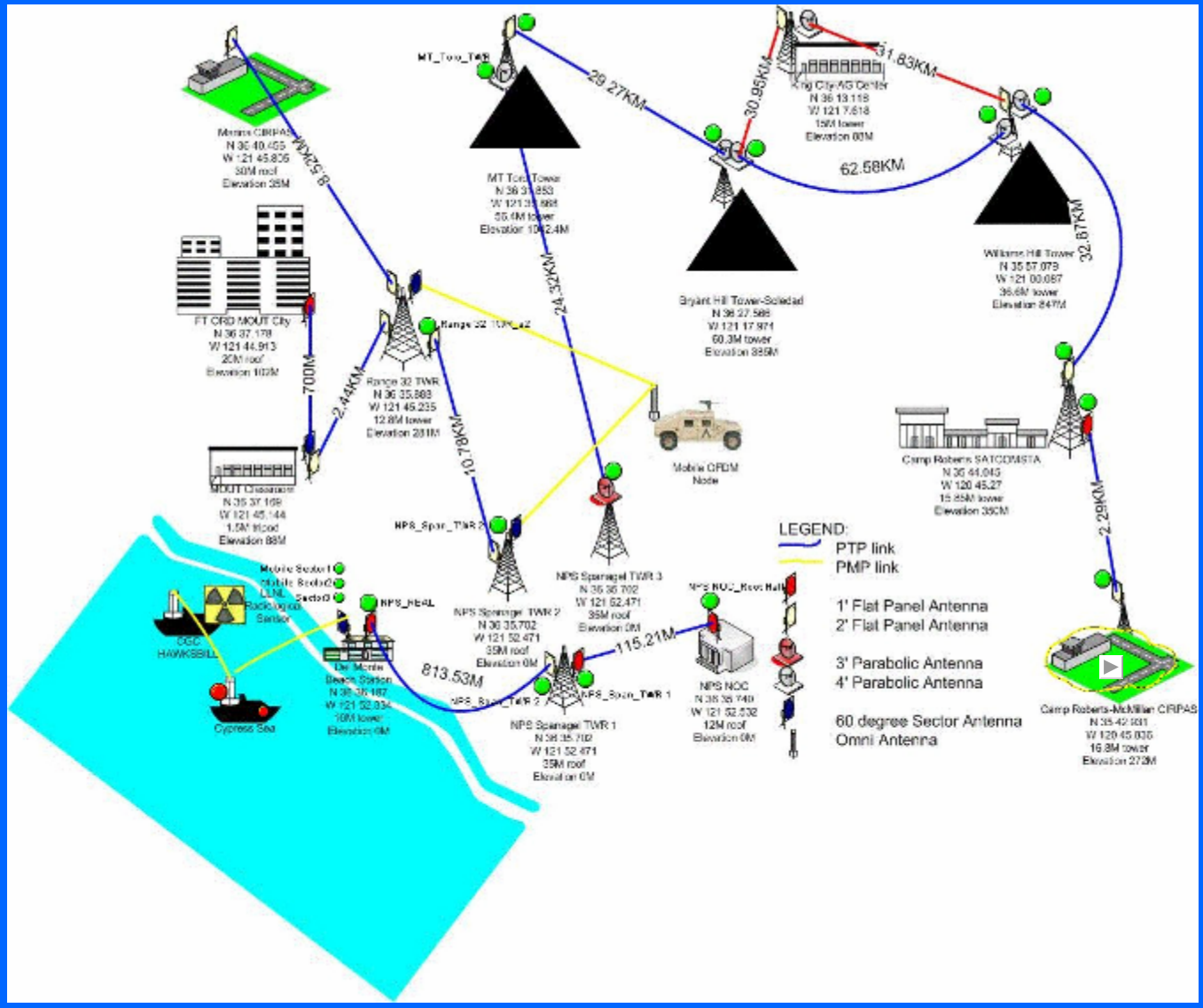
Applications: Collaborative Technologies

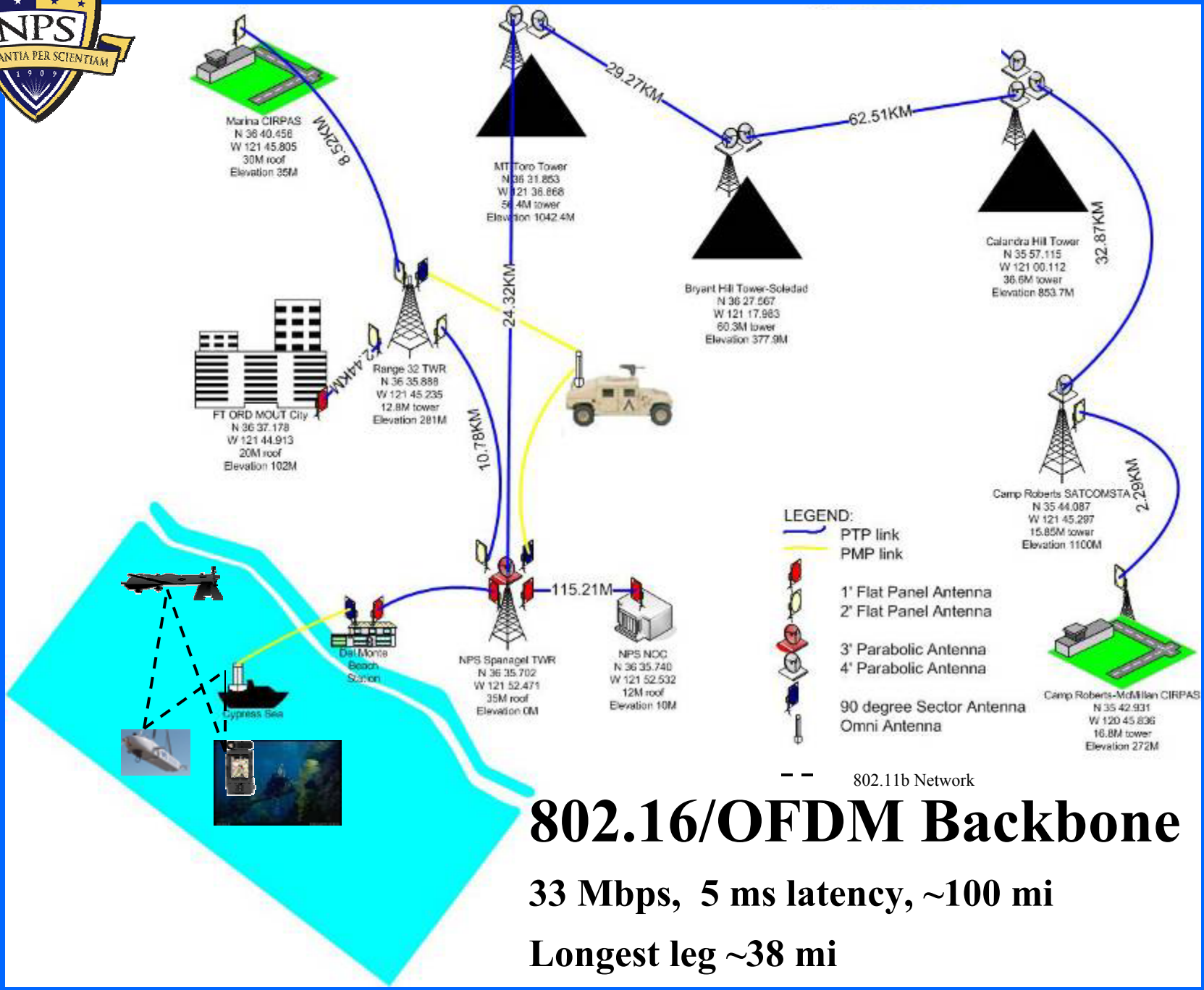
- Groove
- SA Agents
- EWall

TNT Testbed Humanitarian Operations Support Capabilities

- Rapid integration of long-haul (OFDM 802.16, Satellite, EPLRS) and short-haul (ITT, 802.11, 802.20, UWB) wireless networking segments into the seamless ad hoc mobile communications service
- Rapid integration of manned-unmanned vehicles and geographically distributed sensors
- Multipath (multiplatform) self-organizing mesh
- Global connectivity to the Humanitarian Operations Area
- Perimeter surveillance and IED identification
- Tagging and personnel tracking
- Sharing logistics medical supplies tracking with NGOs
- Global and local collaboration with NGOs for action planning and emergency response
- Collaborative real-time identification, biometrics, radiation, and other sensor data analysis

TNT Wireless Plug-and-Play Testbed: Delivering Tactical and Global Reach to Experimentation and Training Sites





802.16/OFDM Backbone

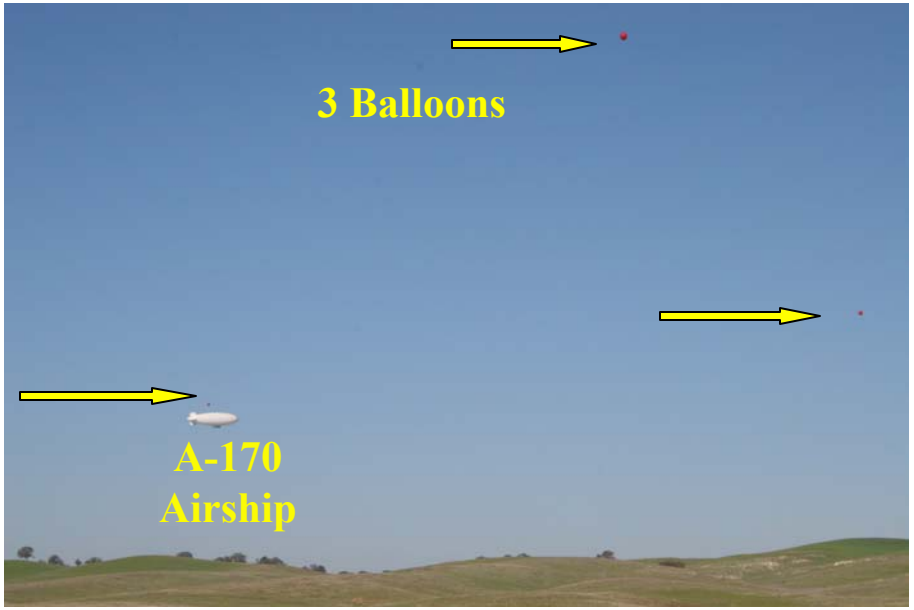
33 Mbps, 5 ms latency, ~100 mi

Longest leg ~38 mi

Stretching the Sensor-UV Mesh into the Air

(TNT 05-1, Nov 2004)

MESH Topology



HHMWV Cameral Control

Network camera, ITT and 802.11b

A-170 Airship

Reach-back

Video

Camera GPS Tracker SA

Internet

NOC NPS

Self forming/ healing

7 Videos + SA

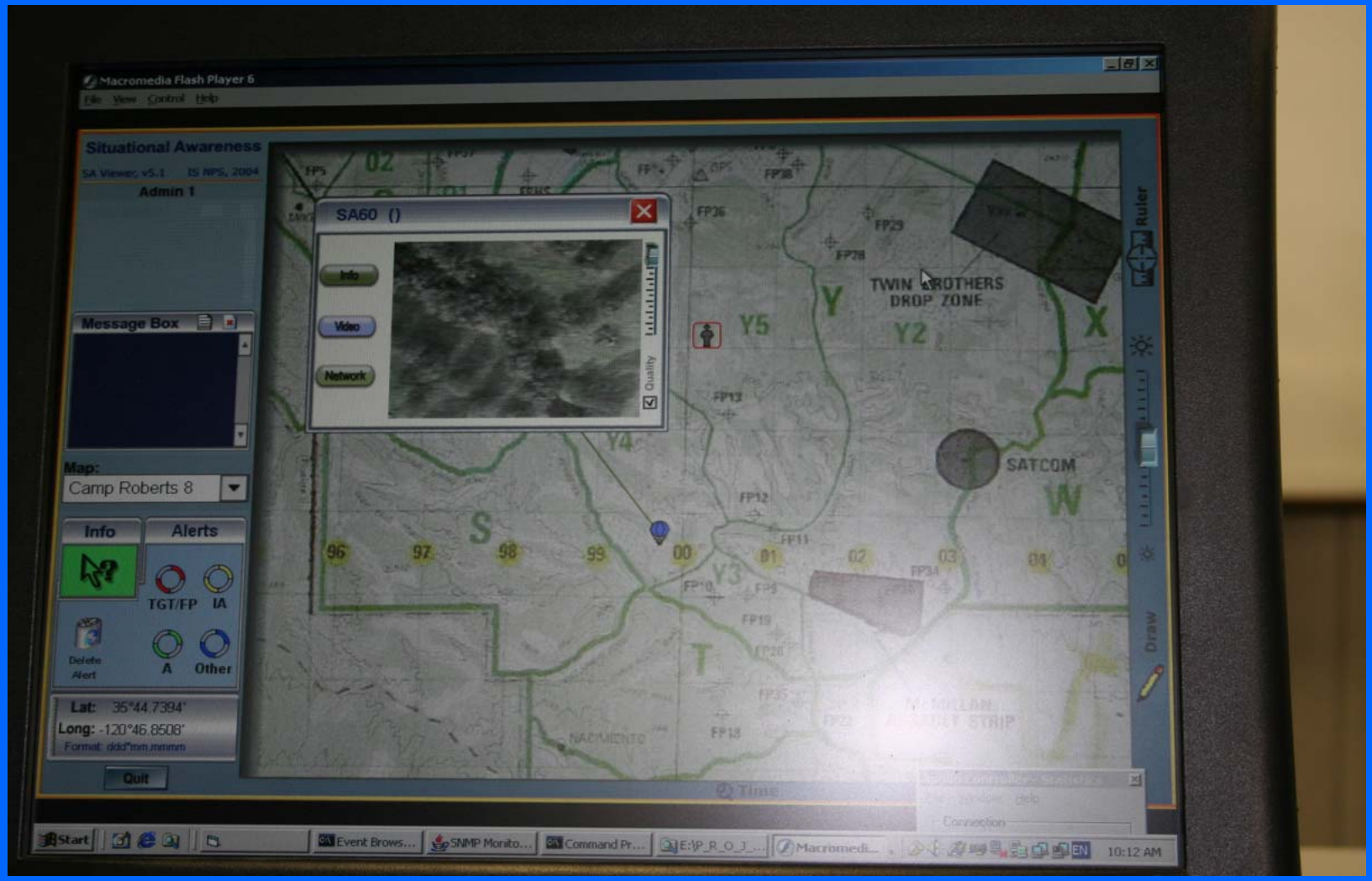
TOC CR

802.11b MESH

Tethered Balloons: Network camera,Pelco, small laptop, Freewave, GPS, 6 hr batteries

TNT 05-1, Nov 2004

Video from SA-170 Airship via 802.16/OFDM and Situational Awareness View at TOC



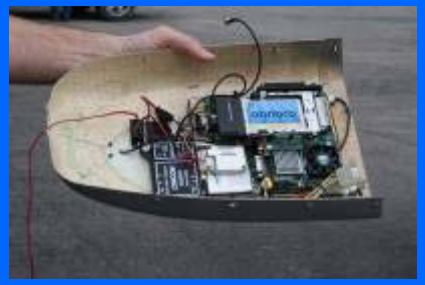
Integrating Air Mesh with NGO/Military Vehicles and Vessels

Improved Camp Roberts TOC

Cypress Sea Approaching USCGC HAWKSBILL – Radiation Detection

Surrogate Light Reconnaissance Vehicle

VC-6 with TERN UAVs



TERN Network Payload

Balloon Payload

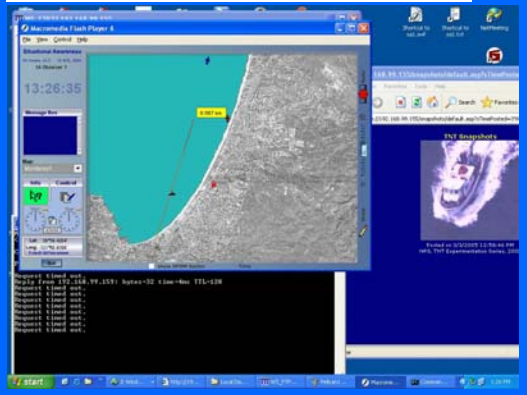
Stretching the Wireless Mesh to Sea

Cypress Sea Support Boat

Cypress Sea NOC

Pelican 802.16/ OFDM Payload

SA for Cypress Sea, Pelican, Pelican Video



ARIES AUV

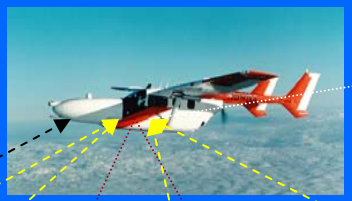
Resolution Target for EO Performance Prediction

NAVBOARD

Multipath Networking: Adaptation to SOF Units Ad-Hoc Capabilities

TNT 05-2 Feb 05

Above and Below Water Situational Awareness for Combat Diver



Surrogate UAV

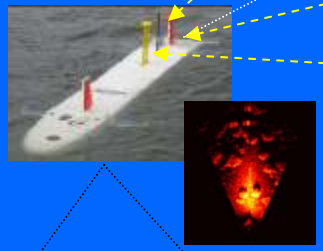
NPS NOC

802.16/OFDM

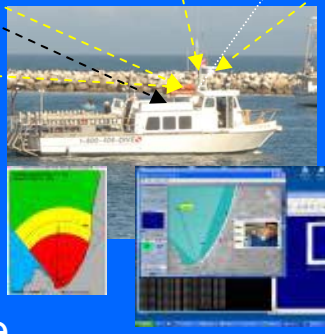
VoIP

GPS

Shore Image



802.11b
or Mesh



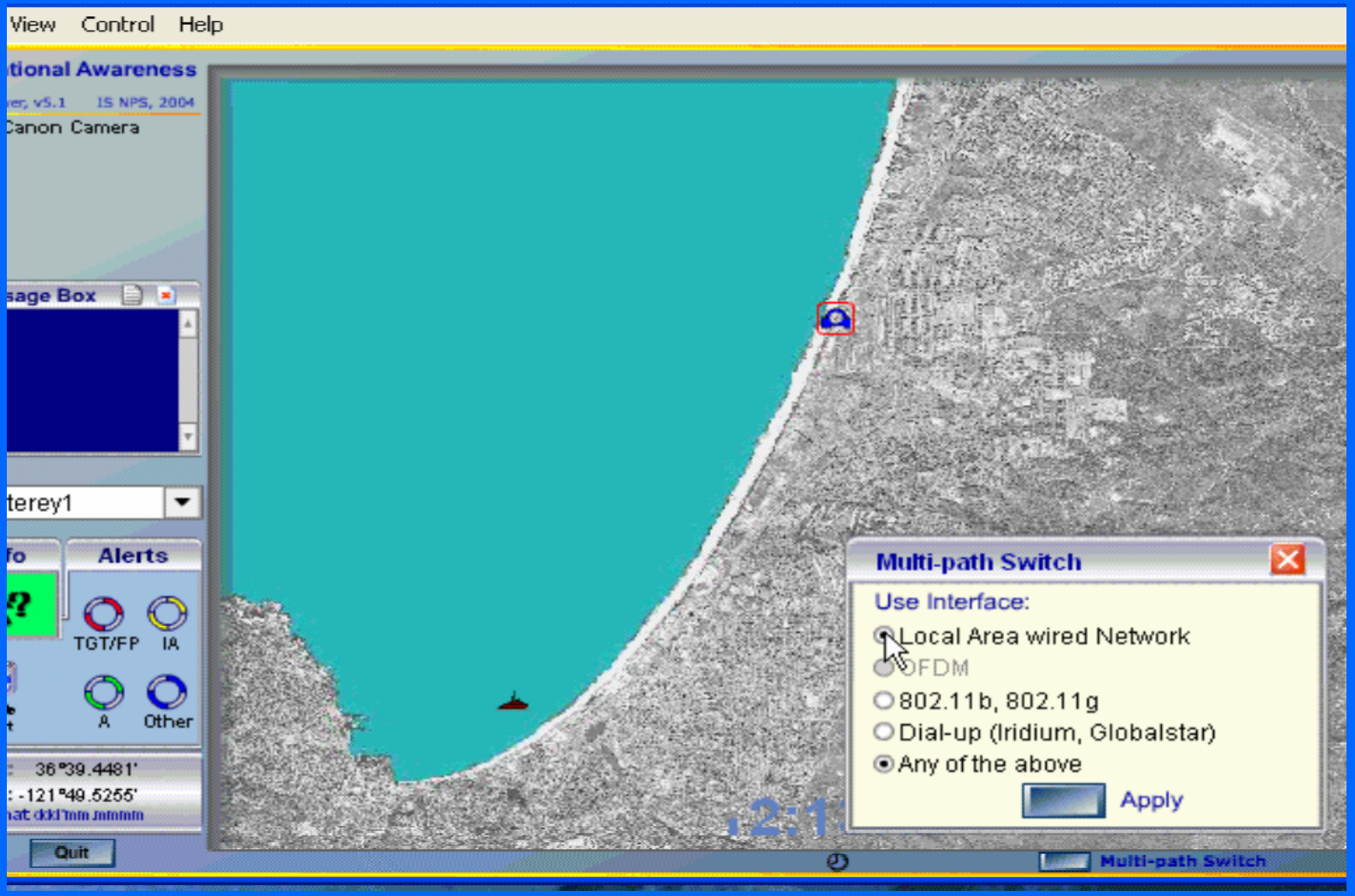
ARIES
AUV

Cypress
Sea with
SA

NAVBOARD

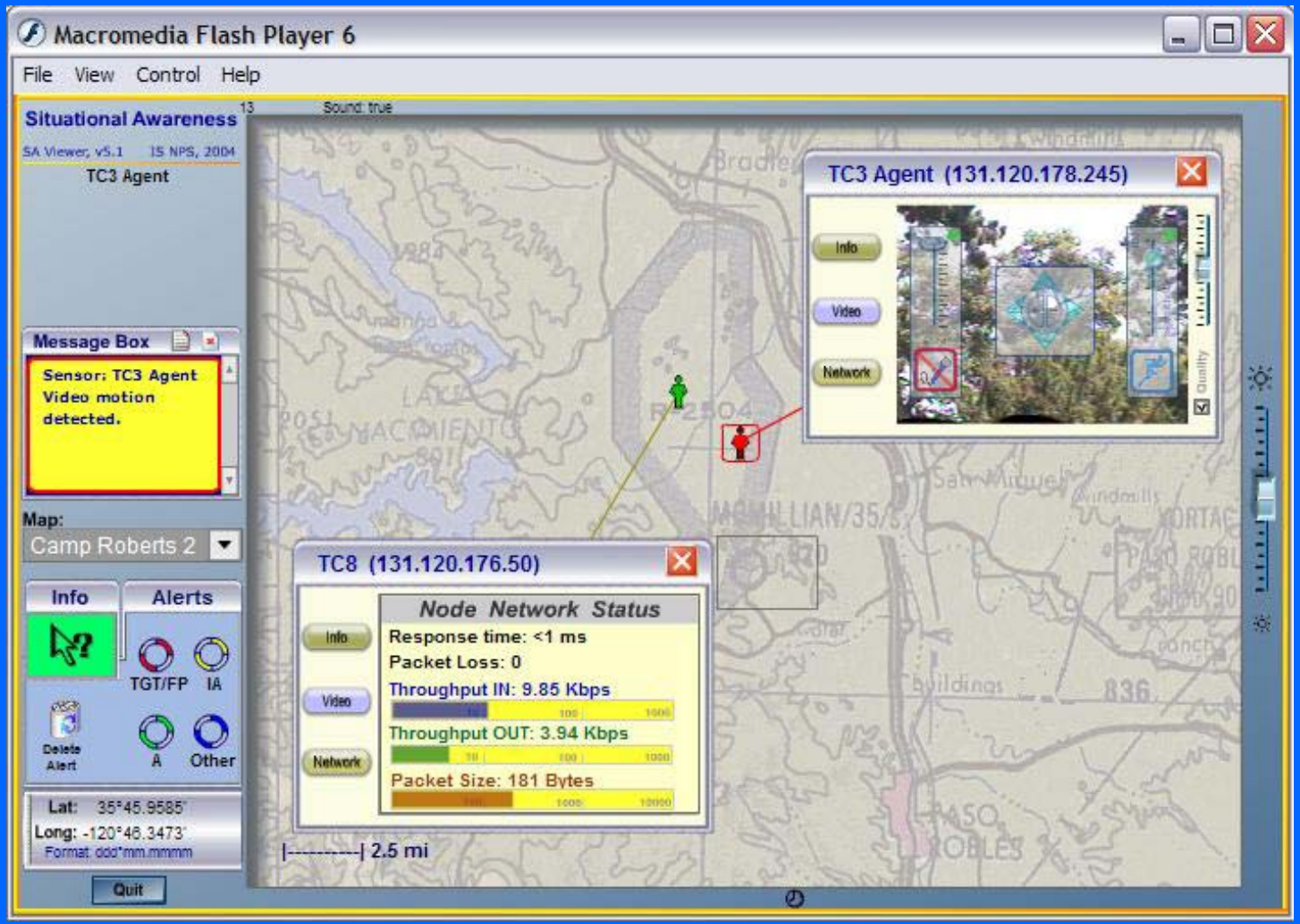
Mine Location and Image

SA Switch for Multipath Human-in-the-Loop Adaptation: SOF crews can switch the network to the mode, which is only available at the moment

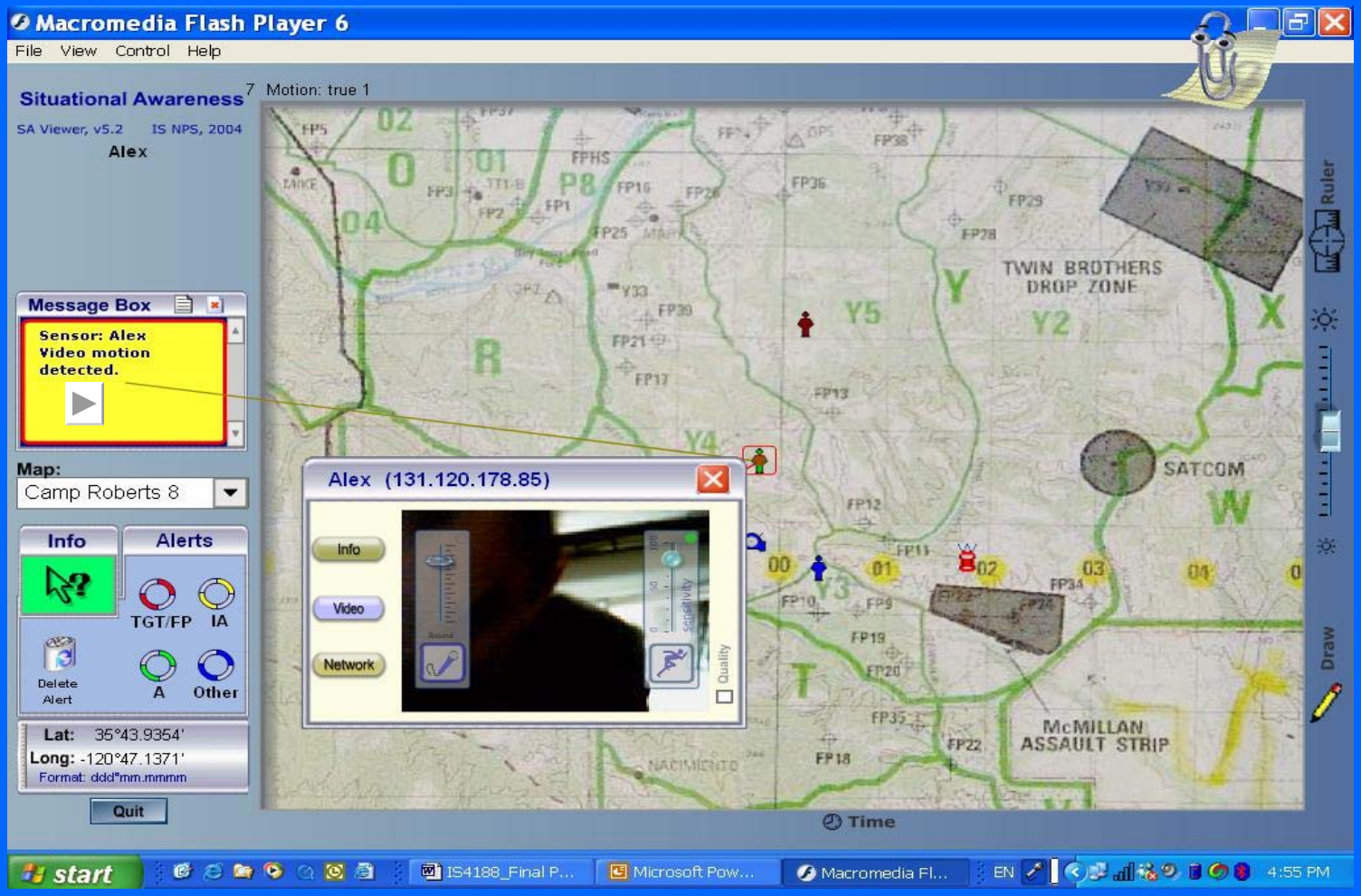


TNT 05-2, Feb 2005

Network Aware Sensor-UV Grid

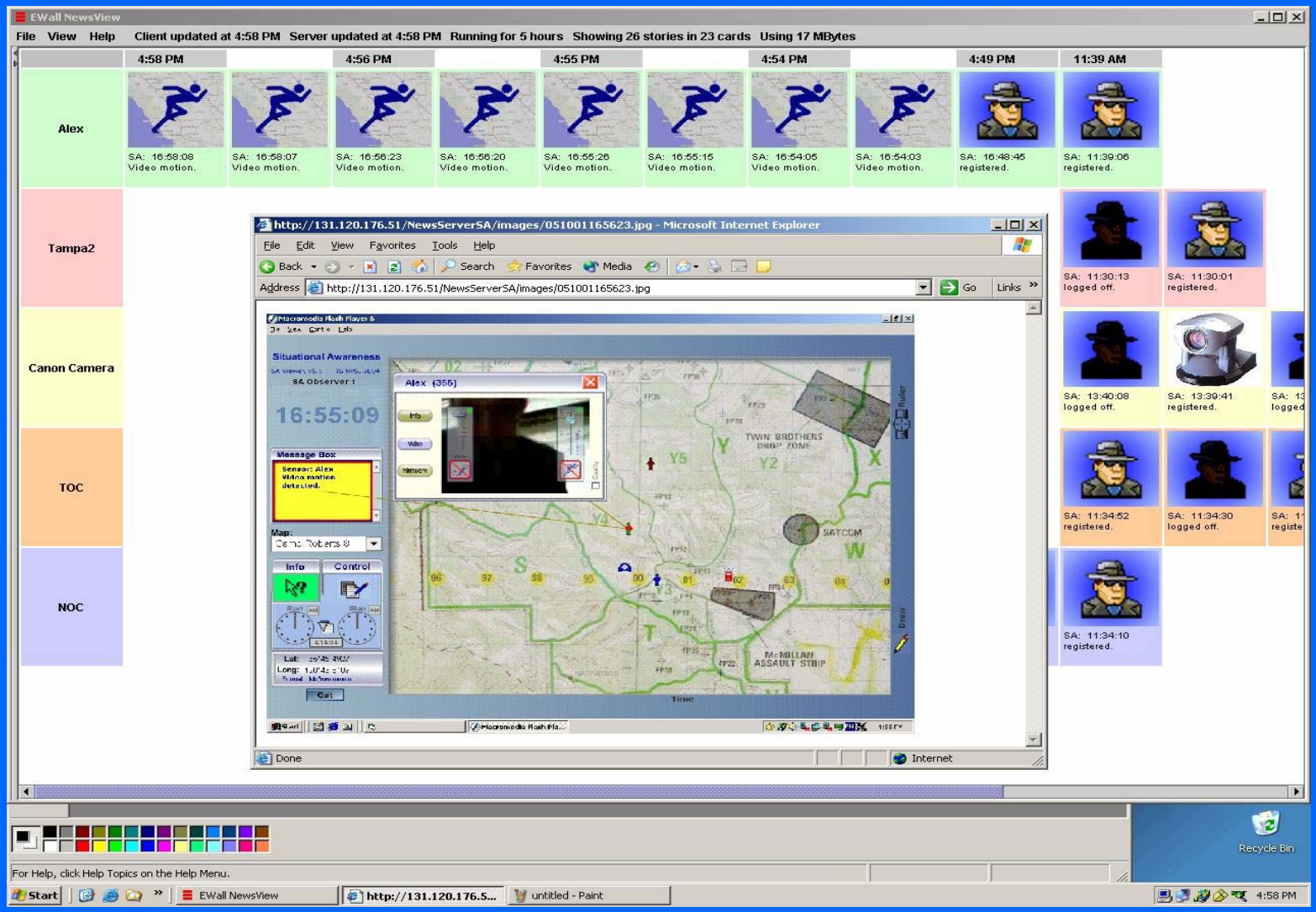


Peer-to-Peer Data Sharing with NGOs via the SA Agents Representing Sensors and Decision Makers



Data Fusion with Civil-military Operations Community: SA Agents output is captured by the NPS interface to the EWall News Server

Agent-EWall integration creates network-centric memory mechanism for developing shared understanding of SA events

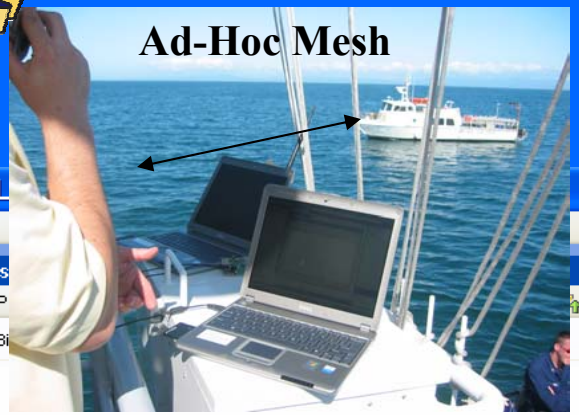


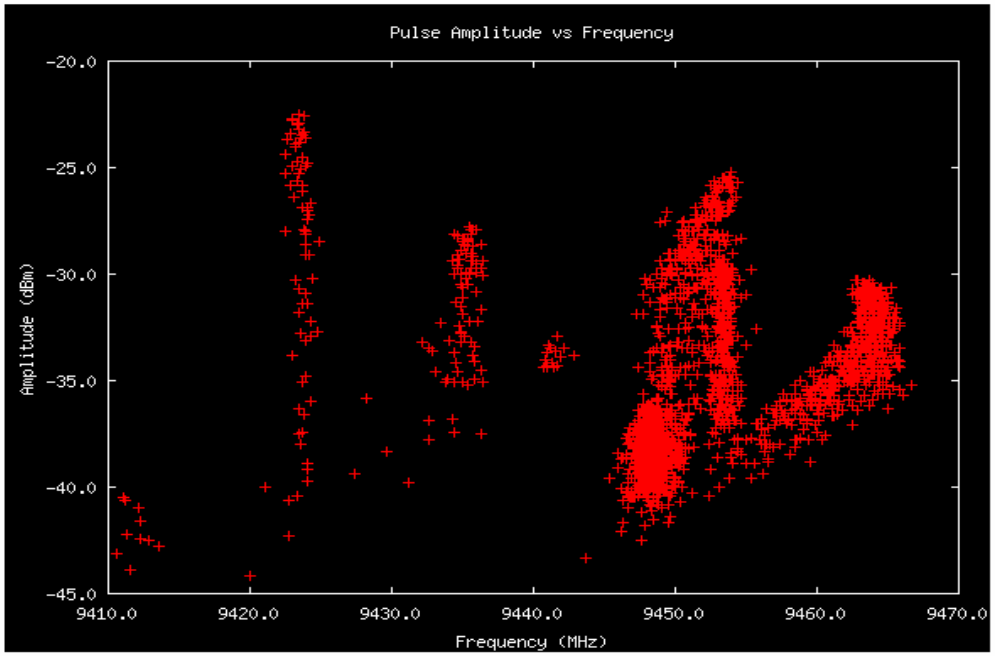
Stretching the Wireless Mesh and Collaborative Technology to Sea: Radiation Detection and Boarding Party Support (NPS-LLNL)

Global Civil-Military Collaboration via the TNT testbed

Target Ship Enters Monterey Bay; Collaboration with TACSAT for Ship ID

Ship-to-Ship





LLNL

File Edit

groove

Pictures

Add P

HawksBi

Picture 3 of 3

Workspace Members

In Workspace

Alex Bordetsky/Naval Postgra...

Online

Offline

Boarding Officer

Jadon Klopson/Naval Postgraduate ...

Joseph Herzig/Naval Postgraduate ...

Les Nakae

Omar Medina

Omar Medina

Stephen Burdian/Naval Postgraduat...

Invite to Workspace: More

-Enter name or email- Go

Chat

2/28/05 11:49 AM

Just to pass along...Cypress Sea made positive ID on TOI based on TACSAT info and have sent over a boarding team...

Vonda Olsavsky/Naval Postgraduate School:

2/28/05 11:55 AM

to further inform...we cannot get mesh connectivity between Cypress Sea and Hawksbill and will be putting them both on the

-Type here- Go

Common Tasks

Add Tools

Set Alerts

View Workspace Properties

Send Message to Members

Files | Discussion | Notepad | Calendar | Pictures | Sketchpad

8.57 KB

start

4 M.. | 2 W.. | Inbo... | 2 M.. | 2 G... | 4:00 PM

Radiation Awareness: Collaboration with LLNL for Radiation Analysis via the TNT

LLNL Experiment - Pictures - Groove

File Edit View Options Help | Workspaces | groove

how Picture List | Picture 2 of 3

Workspace Members

- In Workspace
  - Alex Bordetsky/Naval Postgra...
- Online
- Offline
  - Boarding Officer
  - Jadon Klopson/Naval Postgraduate ...
  - Joseph Herzig/Naval Postgraduate ...
  - Les Nakae
  - Omar Medina
  - Omar Medina
  - Stephen Burdian/Naval Postgraduat...

Invite to Workspace: More

-Enter name or email- Go

Chat 1

2/28/05 12:46 PM
Note the new files just posted...total of 6 neutron pod files as of now...

Les Nakae: 2/28/05 12:57 PM
First Neutron file looks poisson, 2nd shows some multiplication. Now checking Gamma files.

Les Nakae: 2/28/05 12:59 PM
Sorry, I meant correlation, not multiplication. Darrell

-Type here- Go

Common Tasks

- Add Tools
- Set Alerts
- View Workspace Properties
- Send Message to Members

Files | Discussion | Notepad | Calendar | Pictures 1 | Sketchpad

(2) Microsoft PowerPoint

8.57 KB

start | 4 M.. | 2 W.. | Inbo... | 2 M.. | 2 G... | 4:02 PM

UWB sensor link joins the Mesh

Extending the Mesh by the UWB links enabling IED Tracking and Motion Detection Through Walls and Metal Structures

LLNL UWB

LLNL UWB Thru-Wall Motion Detection

Motion detection by camera with UWB link thru 3 walls into TNT mesh

Breathing Detection: LLNL UWB Radar thru wall

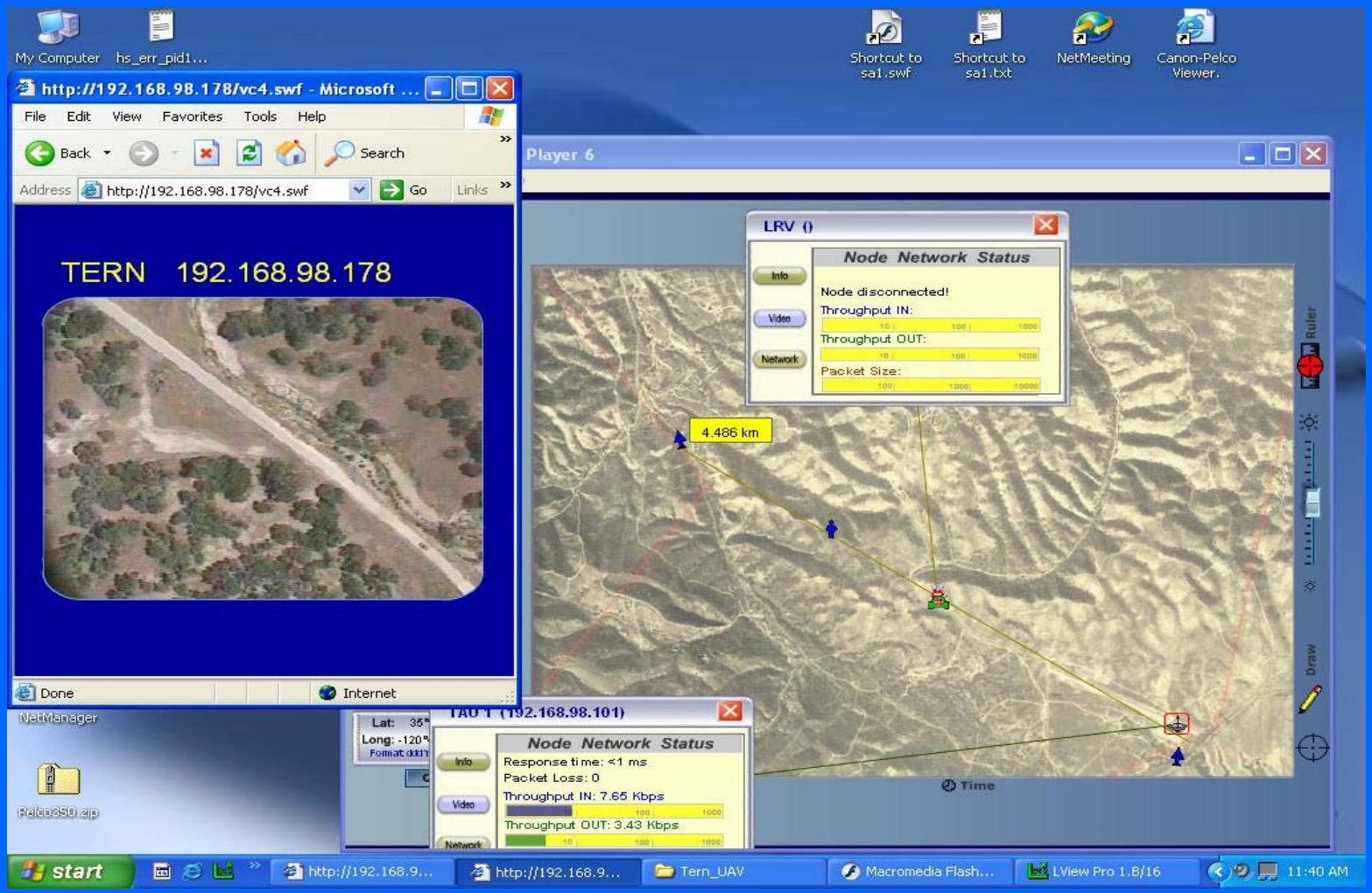
What's next:

-Learning the network integration constraints

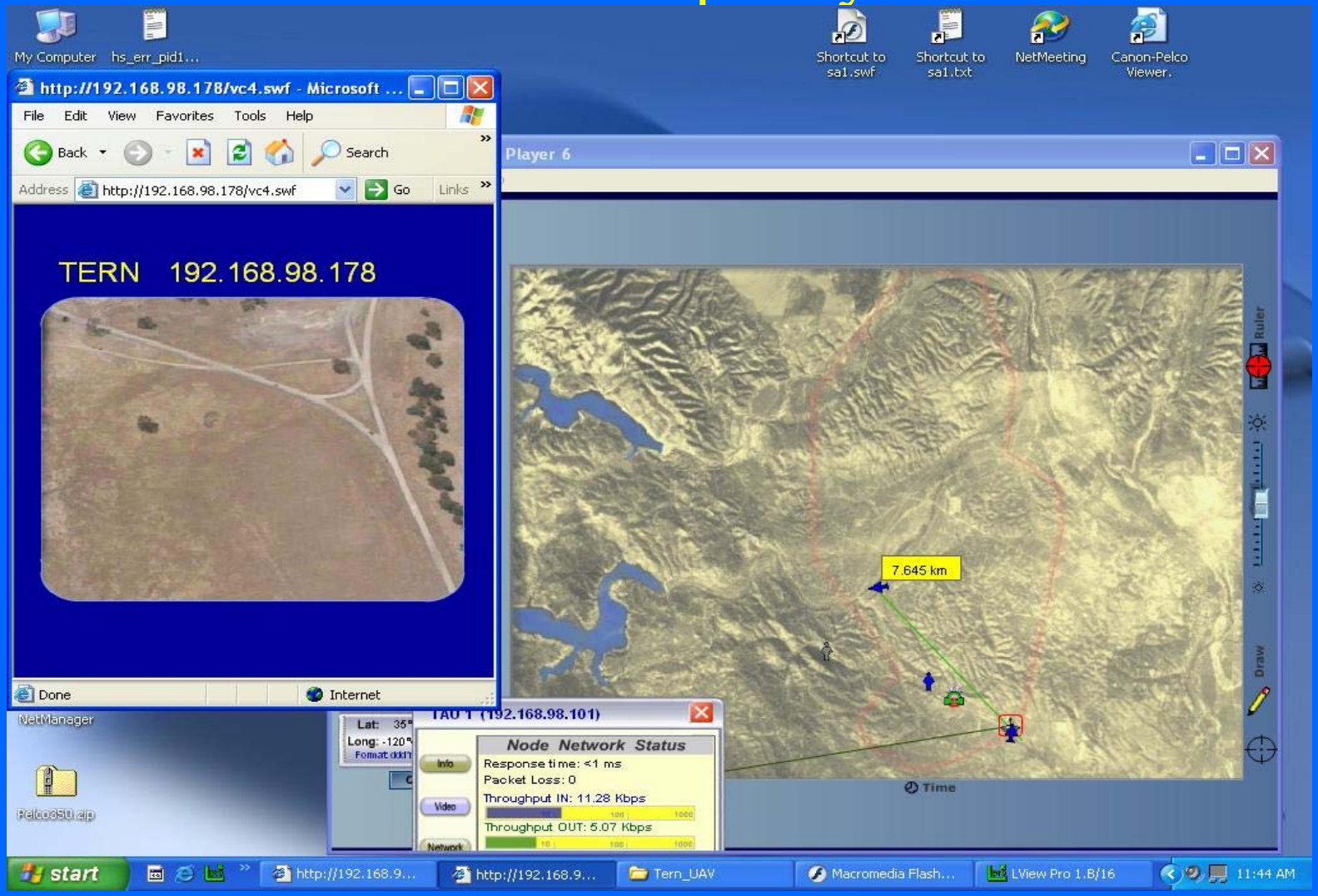
-Deriving policies for on-demand civil-military sensor-unmanned vehicle networking

-Exploring collaboration and data sharing models for Humanitarian, Tactical, and Network Operation Centers

Learning constraints: UAV surveillance perimeter for the SOF-Humanitarian Operations Area



Larger (still feasible) perimeter but lower video quality



Looking inside the building via the UAV: UWB solution

Questions?

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