

Creation and Use of the C2 Collaboration Testbed CollabSpace

***Nigel Tzeng
Jennifer Ockerman, Ph.D.***

The logo for Applied Physics Laboratory (APL) at Johns Hopkins University, consisting of the letters 'APL' in a large, bold, sans-serif font.

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APPLIED PHYSICS LABORATORY

Overview

Control Systems Integration Group (GVI)

- /// **Purpose**
- /// **CollabSpace Testbed – Nigel Tzeng**
 - /// **Testbed Foundation - NASA World Wind**
 - /// **CollabSpace Plug-In**
 - ◆ Situational Awareness Display
 - ◆ Geospatial Whiteboarding
 - ◆ C2 Enhanced Chat
 - ◆ NCES/SOA Based Design
- /// **FY 06 Experiment – Jennifer Ockerman, Ph.D.**
 - /// **Overview**
 - /// **Design**
 - /// **Environment**
 - /// **Task and Procedures**
 - /// **Results**
 - /// **Conclusion**
- /// **Questions**

Purpose

Control Systems Integration Group (GVI)

- /// **“C2-E-N-08-01 - Improve the capability for real-time collaboration among C2 entities supporting mission execution.”**
 - Air Force Capability-Based Planning
FY08 Command and Control Functional Needs Analysis Report, pg C-42
- /// **Explore advanced collaboration techniques with application to C2 and time sensitive mission execution in mobile and dispersed environments.**
 - /// **Three Primary Areas of Study**
 - ◆ Geospatial Collaboration
 - ◆ Temporal Collaboration
 - ◆ Process Collaboration
 - /// **Requires an instrumented collaboration testbed.**

Foundation - NASA World Wind

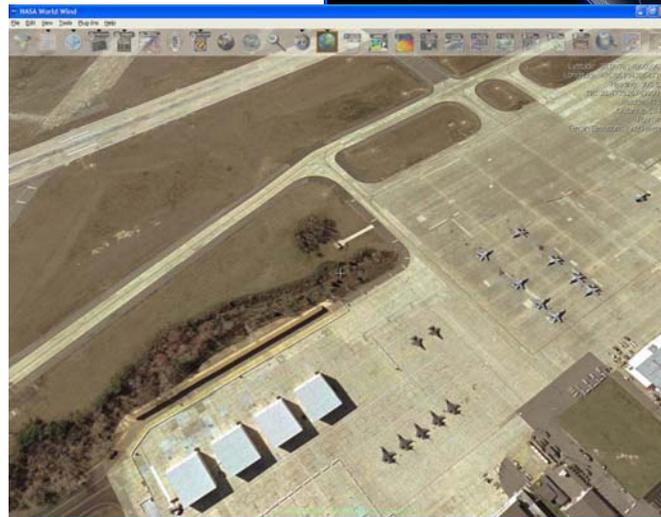
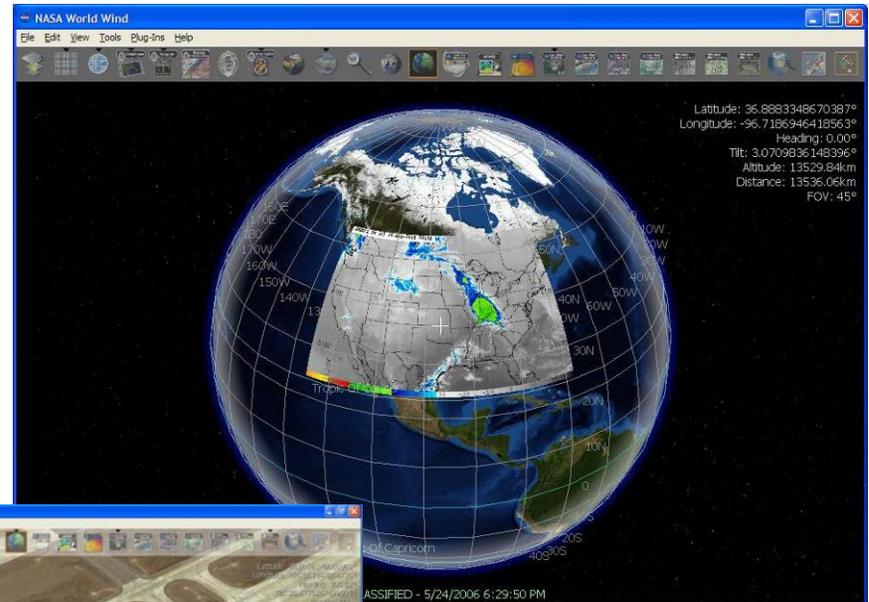
Control Systems Integration Group (GVI)

/// Interactive 3D geospatial visualization platform

- /// 24/7 access to NASA, USGS, NRL, NOAA and other data
- /// Seamless integration of multiple data sources

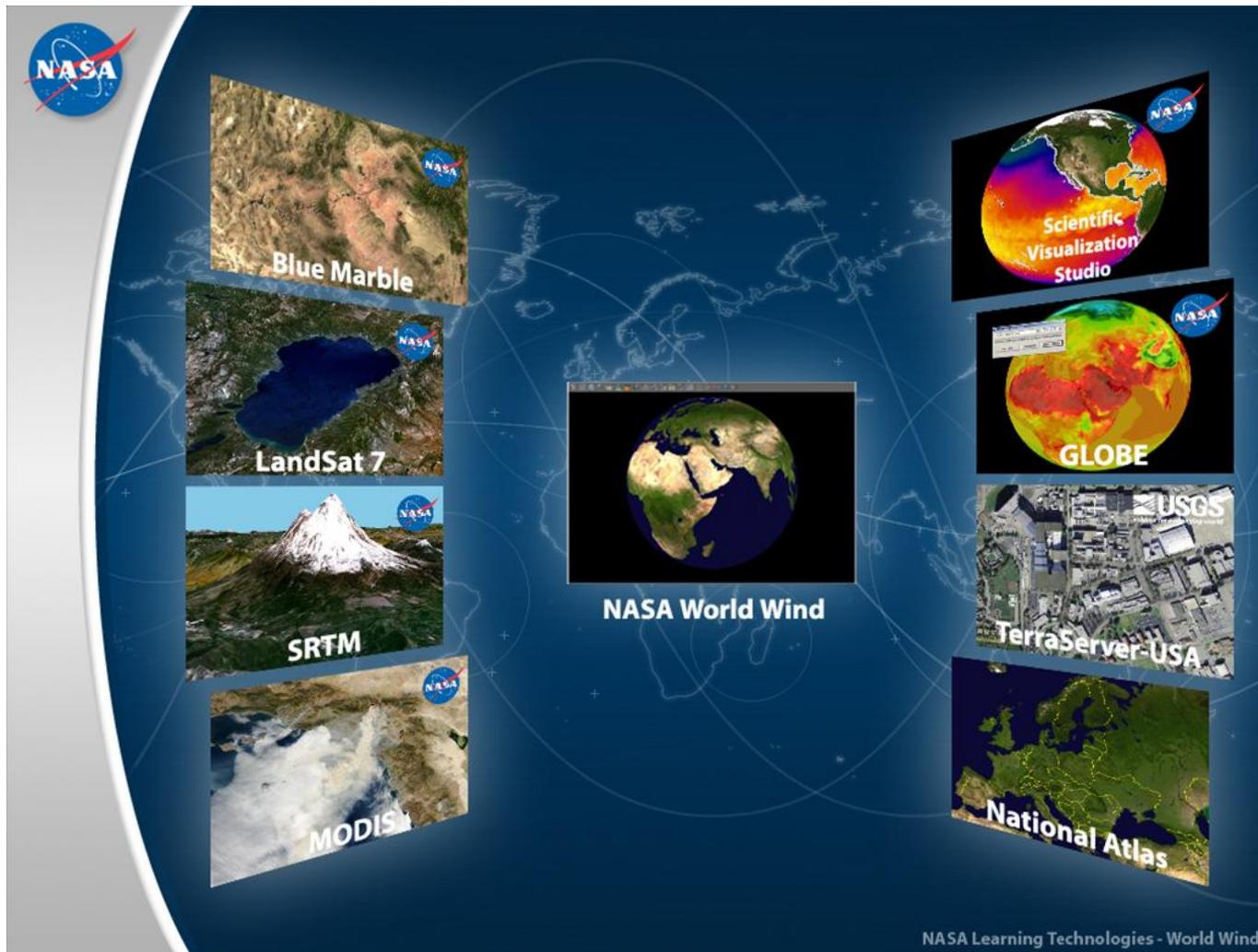
/// Open Source

/// SIPR Approved



NASA World Wind Data Sources

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NASA Learning Technologies - World Wind

NASA World Wind - DoD Users

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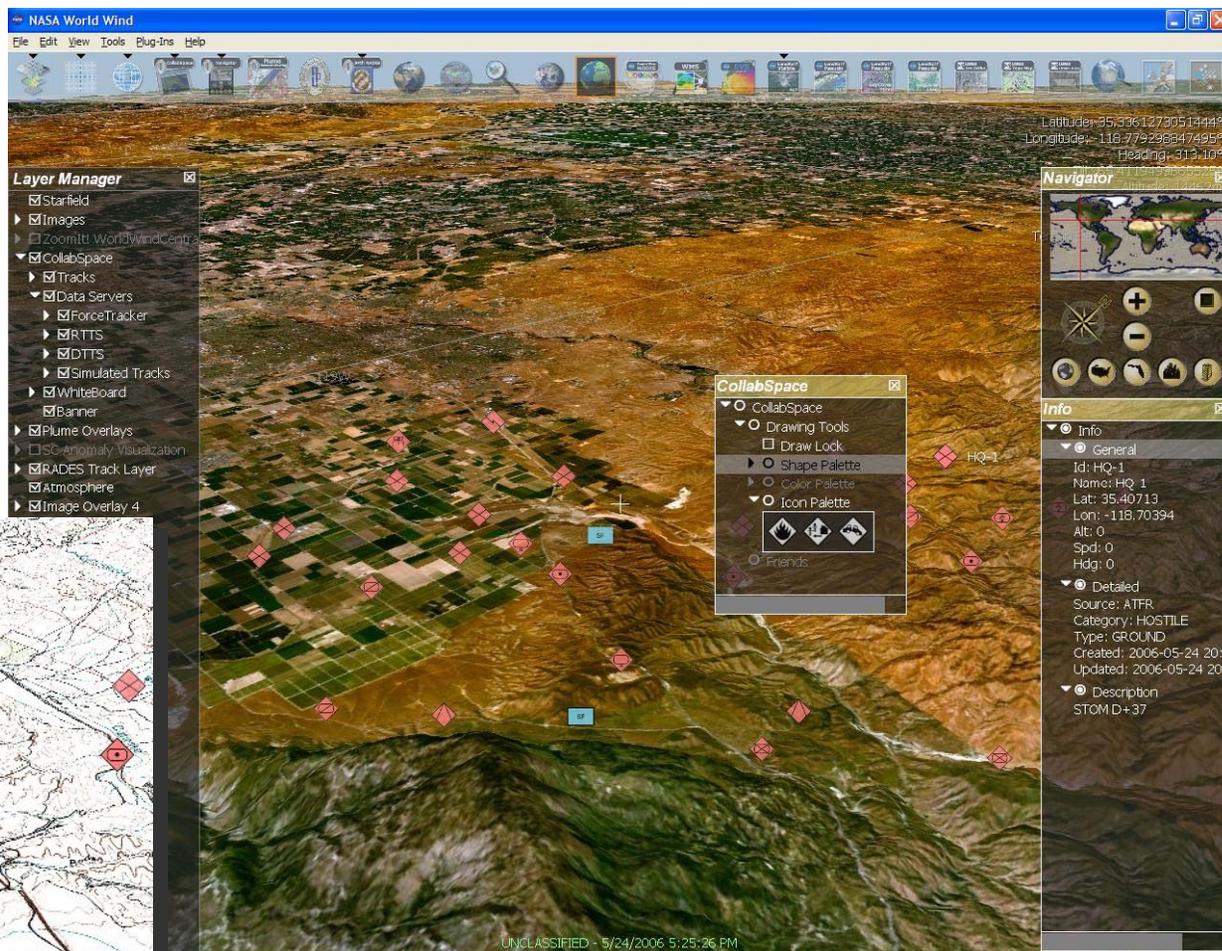
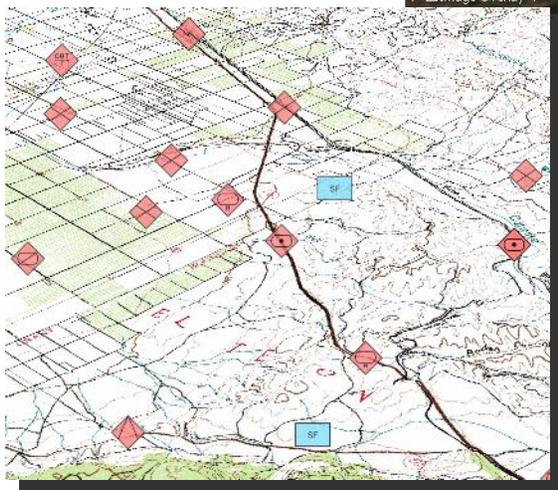
NASA Learning Technologies - World Wind

Situational Awareness - MIL-STD 2525B

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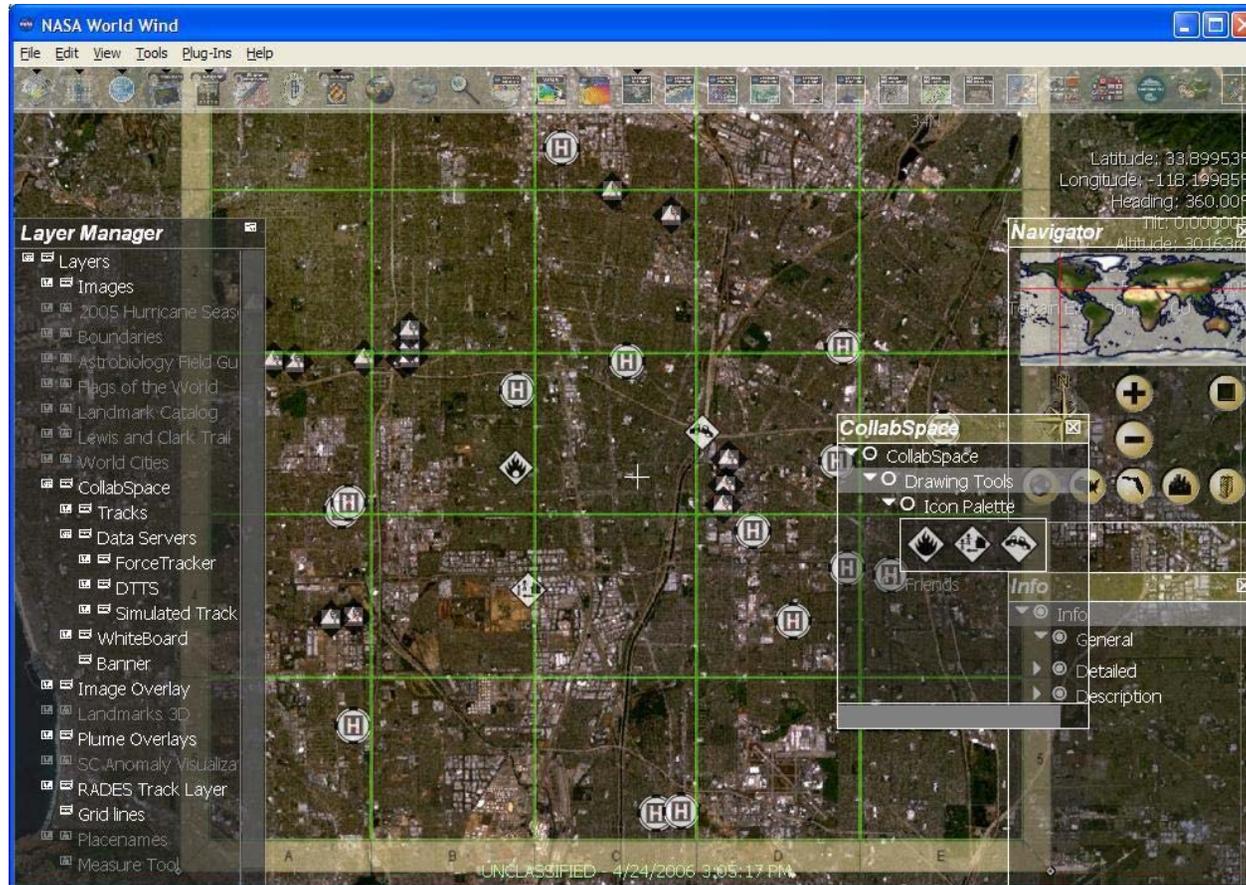
Tracks

- /// NCES/GIG
- /// Web services
- /// JSAF
- /// FAA
- /// CEC



Situational Awareness – DHS ERS

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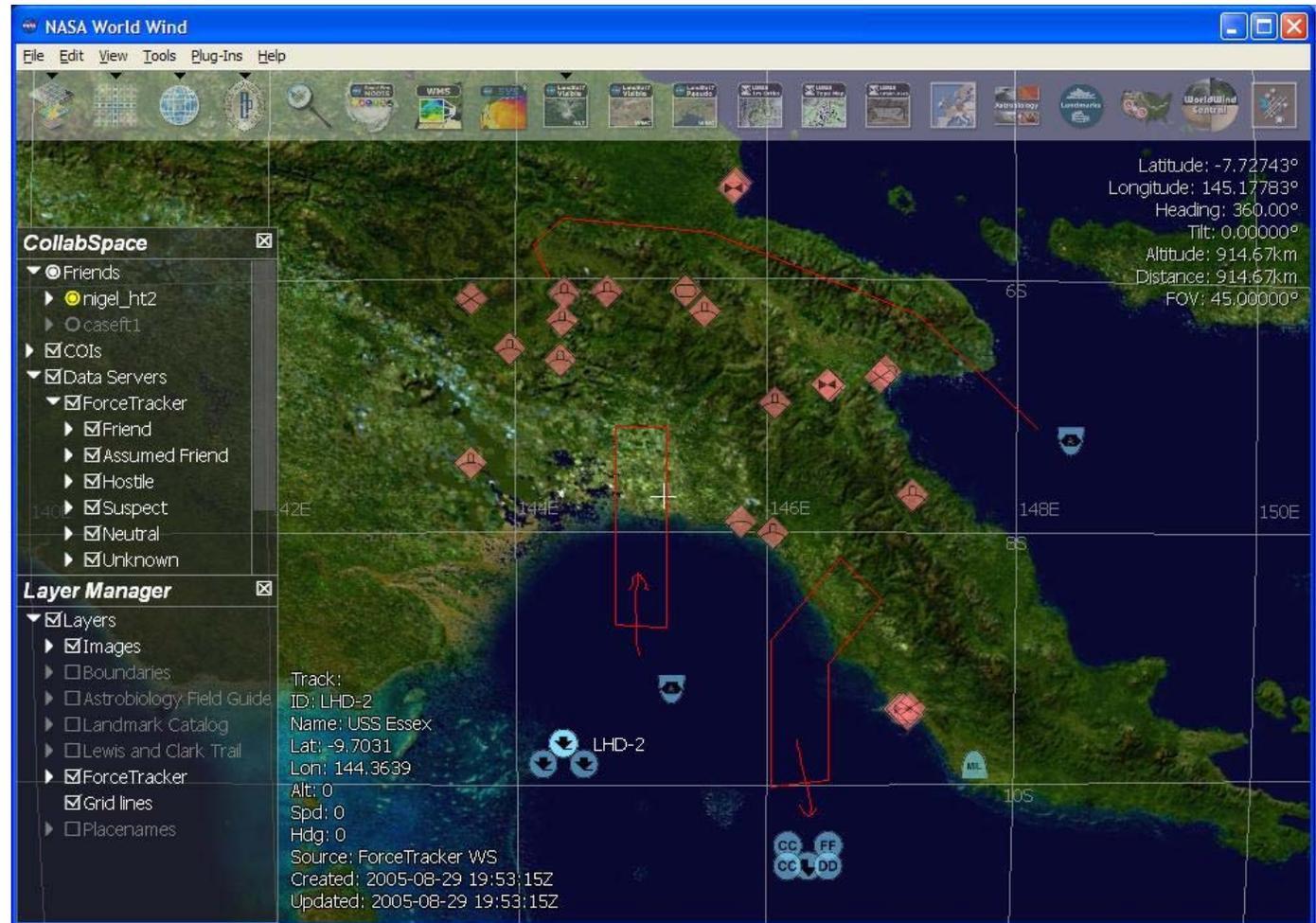
/// **NCES/GIG
Web Services**

/// **Disaster Management Interoperability
Services/Common Alerting Protocol**

Geospatial Whiteboarding

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- /// Polygons
- /// Polylines
- /// Freehand
- /// Points
- /// Overlays
 - /// Shapefile
 - /// XML
- /// Images
- /// Icons
 - /// MIL-STD 2525B
 - /// DHS ERS



C2 Enhanced Text Chat

Control Systems Integration Group (GVI)

police - fire - eoc - medical

File Rooms Options

police - fire - eoc - medical

Chat

13:21 **Fire-3(eoc)**: EOC-1 hook fire [FIRE-1](#)

13:21 **Police-2(police)**: EOC-2 are there reports of looting in [C3](#)

13:21 **Med-1(medical)**: EOC-3 where is injured person [VICTIM-2](#)

13:21 **FEMA-2(eoc)**: EOC-2 is there an active helicopter in [D1](#)

13:21 **Police-2(police)**: EOC-1 are there reports of looting in [D1](#)

13:21 **Fire-1(fire)**: EOC-2 add new fire to grid [E5](#)

13:21 **Police-3(eoc)**: EOC-4 is there room in evacuation point [FEMA-4](#)

13:21 **FEMA-1(eoc)**: EOC-1 is there an active helicopter in [E5](#)

13:21 **Fire-3(fire)**: EOC-4 add new fire to grid [E1](#)

13:21 **Police-1(eoc)**: EOC-4 is there room in evacuation point [FEMA-2](#)

13:21 **Fire-1(medical)**: EOC-2 are there any hospitals with beds?

13:21 **Police-3(eoc)**: EOC-1 is there room in evacuation point [FEMA-3](#)

13:21 **Police-3(eoc)**: EOC-3 is there room in evacuation point [FEMA-3](#)

13:21 **Fire-1(eoc)**: **EOC-0 hook fire FIRE-2**

13:21 **Police-3(police)**: EOC-4 are there reports of looting in [B2](#)

13:21 **Fire-2(fire)**: EOC-3 add new fire to grid [D2](#)

13:21 **Police-2(eoc)**: EOC-3 is there room in evacuation point [FEMA-2](#)

13:21 **Fire-0(medical)**: EOC-4 are there any hospitals with beds?

13:21 **Fire-4(eoc)**: EOC-2 hook fire [FIRE-1](#)

13:21 **Police-0(police)**: EOC-4 are there reports of looting in [D2](#)

13:21 **Fire-3(fire)**: EOC-2 add new fire to grid [A5](#)

13:21 **FEMA-2(eoc)**: EOC-1 is there an active helicopter in [C2](#)

13:21 **FEMA-4(eoc)**: EOC-2 is there an active helicopter in [C3](#)

13:21 **Police-3(eoc)**: EOC-2 is there room in evacuation point [FEMA-0](#)

13:21 **FEMA-4(eoc)**: EOC-1 is there an active helicopter in [D4](#)

13:21 **FEMA-3(eoc)**: EOC-3 is there an active helicopter in [E1](#)

13:21 **Fire-3(fire)**: EOC-4 add new fire to grid [C5](#)

13:21 **Fire-3(medical)**: EOC-1 are there any hospitals with beds?

13:21 **Police-2(medical)**: Casualties at C1. ID: [VICTIM-3](#)

13:21 **Police-1(police)**: EOC-4 are there reports of looting in [E3](#)

13:21 **Fire-4(medical)**: EOC-3 are there any hospitals with beds?

13:21 **FEMA-4(eoc)**: EOC-1 is there an active helicopter in [B5](#)

13:21 **Fire-3(medical)**: EOC-2 are there any hospitals with beds?

Tasks Req(1) ToDo(5)

ToDo Tasks

- 1321-(Q5): hook fire FIRE-2
- 1320-(Q4): are there any hospitals with be
- 1319-(Q3): add new fire to grid A2
- 1319-(Q2): is there an active helicopter in
- 1318-(Q1): Please do something

Requested Tasks

- 1318-(Q1): fire (Q1) what is your status

Color indicates which room a msgis from.

Chat messages to user are bolded.

Hyperlinks to objects in World Wind

Tabs contain multiple rooms

List of questions to you.
Typing a name as first string indicates a request. In this example Fire-1 is asking EOC-0 (the user) to hook FIRE-2.
Click on list item to respond.

List of questions you've asked of others.

Geospatial Display (Wireless form factor)

Control Systems Integration Group (GVI)



/// Form-Factors

- /// Tablet PC (Wireless)
- /// Workstation PC

/// Operating System

- /// Windows XP
- /// Windows 2000

FY 06 Experiment

Dr. Jennifer Ockerman

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Experiment Overview

Information Technologies Group (STI)

/// Focus – Text Chat

/// Purpose – Explore enhanced integrated text chat

/// Comparison of performance between current chat clients and chat clients augmented for the C2 environment.

- ◆ Collapsing multiple room chat into a single display and discriminating based on color coding and labels.
- ◆ Automatic task tracking so that requests for information are not lost.
- ◆ Automatic hyperlinking of known objects in chat to the geospatial representation or other data.

/// Reason – Observations of Red Flag at the CAOC-N

- ◆ Warfighters observed monitoring multiple chat rooms (typically 4-5 but with reported instances of up to 16 rooms)

FY06 Experiment Design (1 of 2)

Information Technologies Group (STI)

///Independent Variables:

- /// Volume of chat messages – low and high**
- /// Presence or absence of automated task list**
- /// Presence or absence of automated object links**
- /// Number of windows – single or many**

///Dependent Variables:

- /// Response time to directed requests**
- /// Response time to geospatial display changes**
- /// Accuracy in response**

FY06 Experiment Design (2 of 2)

Information Technologies Group (STI)

2⁴ Factorial Design blocked on participants

- /// Confounding one first-order interaction and two second-order interactions
- /// 22 participants – Johns Hopkins University students
- /// Participants separated into four groups: A, B, C, D
- /// Order of sessions was random

		Task List				
		No	Yes	No	Yes	
Windows	Single	A	C	D	B	No
	Many	D	B	A	C	
	Single	B	D	C	A	Yes
	Many	C	A	B	D	
		Low	High			
		Volume				

Experimental Environment

Information Technologies Group (STI)

- /// **Severe earthquake has just occurred in undefined city**
- /// **Participant plays part of emergency controller**
- /// **Four chat rooms**
 - /// **Police**
 - /// **Fire**
 - /// **Medical**
 - /// **FEMA**
- /// **Icons on geospatial display**
 - /// **Incidents – fires, looting, gas line ruptures, etc.**
 - /// **Police**
 - /// **Fire equipment**
 - /// **Hospitals/Medical equipment**
 - /// **Shelters**

Experimental Tasks

Information Technologies Group (STI)

/// Follow instructions provided in chat

- /// Hook (locate and click on) icon in geospatial display**
- /// Answer simple questions with yes/no or grid location**
- /// Place icon at supplied grid location**

/// Click on changes in icons on geospatial display

- /// Acknowledge appearances of new icons**
- /// 100+/- icons depicted on geospatial display simultaneously**

Experiment Screenshots

Information Technologies Group (STI)

The screenshot displays the NASA World Wind application window. The main view is a satellite map of a city area overlaid with a green grid. The grid is labeled with letters A through E across the top and numbers 1 through 5 down the left side. Various icons are placed on the grid, including cars, ambulances, and fire trucks. A red fire icon is visible in grid cell C3. A chat window titled "police - fire - eoc - medical" is open in the top right, showing a log of messages with timestamps and grid coordinates. A "Tasks Req(1) ToDo(5)" window is also open, listing tasks with checkboxes and grid coordinates. An "Info" window is visible at the bottom right of the map area.

Chat Log:

- 13:21 **Fire-3(eoc):** EOC-1 hook fire [FIRE-1](#)
- 13:21 **Police-2(police):** EOC-2 are there reports of looting in [C3](#)
- 13:21 **Med-1(medical):** EOC-3 where is injured person [VICTIM-2](#)
- 13:21 **FEMA-2(eoc):** EOC-2 is there an active helicopter in [D1](#)
- 13:21 **Police-2(police):** EOC-1 are there reports of looting in [D1](#)
- 13:21 **Fire-1(fire):** EOC-2 add new fire to grid [E5](#)
- 13:21 **Police-3(eoc):** EOC-4 is there room in evacuation point [FEMA-4](#)
- 13:21 **FEMA-1(eoc):** EOC-1 is there an active helicopter in [E5](#)
- 13:21 **Fire-3(fire):** EOC-4 add new fire to grid [E1](#)
- 13:21 **Police-1(eoc):** EOC-4 is there room in evacuation point [FEMA-2](#)
- 13:21 **Fire-1(medical):** EOC-2 are there any hospitals with beds?
- 13:21 **Police-3(eoc):** EOC-1 is there room in evacuation point [FEMA-3](#)
- 13:21 **Police-3(eoc):** EOC-3 is there room in evacuation point [FEMA-3](#)
- 13:21 **Fire-1(eoc):** **EOC-0 hook fire FIRE-2**
- 13:21 **Police-3(police):** EOC-4 are there reports of looting in [B2](#)
- 13:21 **Fire-2(fire):** EOC-3 add new fire to grid [D2](#)
- 13:21 **Police-2(eoc):** EOC-3 is there room in evacuation point [FEMA-2](#)
- 13:21 **Fire-0(medical):** EOC-4 are there any hospitals with beds?
- 13:21 **Fire-4(eoc):** EOC-2 hook fire [FIRE-1](#)
- 13:21 **Police-0(police):** EOC-4 are there reports of looting in [D2](#)
- 13:21 **Fire-3(fire):** EOC-2 add new fire to grid [A5](#)
- 13:21 **FEMA-2(eoc):** EOC-1 is there an active helicopter in [C2](#)
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Tasks Req(1) ToDo(5):

- 1321-(Q5) hook fire FIRE-2
- 1320-(Q4) are there any hospitals with beds?
- 1319-(Q3) add new fire to grid A2
- 1319-(Q2) is there an active helicopter in [E5](#)?
- 1318-(Q1) Please do something

Requested Tasks:

- 1318-(Q1): fire (Q1) what is your status

Experiment Procedure

Information Technologies Group (STI)

- /// Participant consent**
- /// Participant training on configurations to be used**
- /// Four task sessions with short opinion questionnaires in between**
- /// Final opinion questionnaire**

- /// Two hours total for each participant**

Expected Results

Information Technologies Group (STI)

/// Performance

- /// Negatively impacted by higher volume of chat**
- /// Positively impacted by the presence of the ask/request list**
- /// Positively impacted by the presence of the object links**
- /// Negatively impacted by multiple windows or “rooms”**

/// Volume will interact with the other main effects

Results - Objective

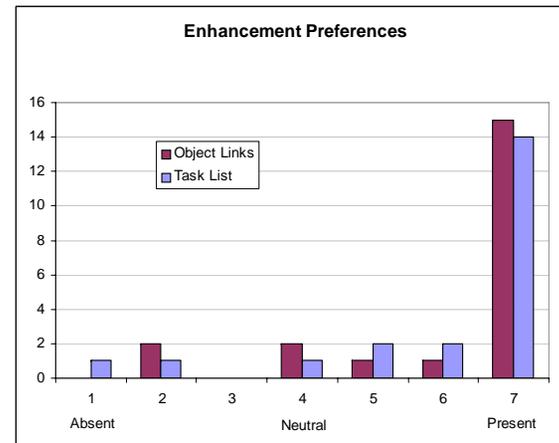
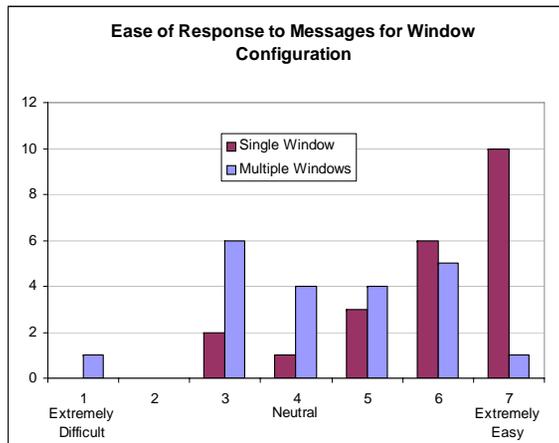
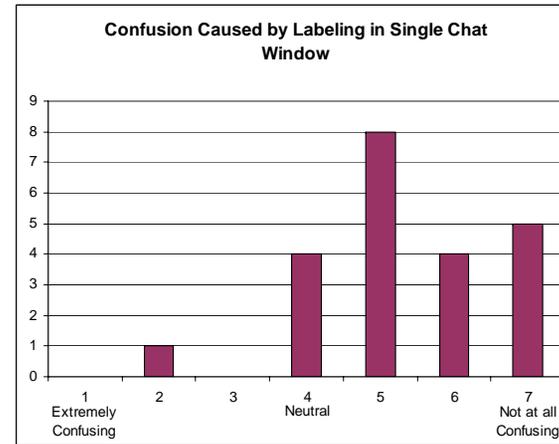
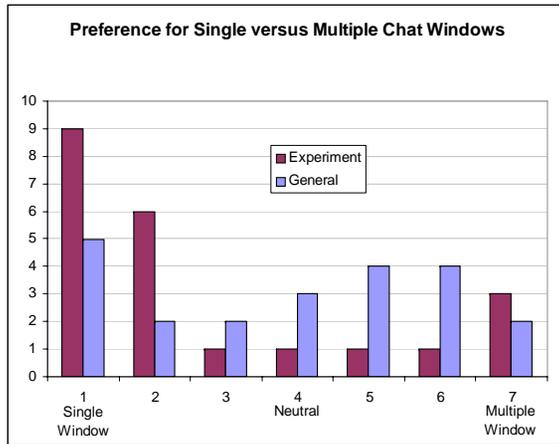
Information Technologies Group (STI)

General Linear Model Analysis of Variances (significant p-values)

		Acknowledge		Hook		Correct Place		Correct Response	
		%	time	%	time	%	time	%	time
Main Effects	Volume				0.075	0.065			0.009
	Task List				0.090			0.099	
	Object Links		0.010	0.101	0.072				
	Windows	0.037	0.010						
Interactions	Volume x Task List					0.084			
	Volume x Object Links		0.057					0.054	0.060
	Volume x Windows		0.060						
	Windows x Task List	0.077			0.041			0.013	0.082
	Windows x Object Links		0.061						

Results - Subjective

Information Technologies Group (STI)



Experiment Conclusions

Information Technologies Group (STI)

/// Performance

- /// Higher volume had negative impact on three of the four tasks but particularly on the chat responses
- /// Task list had marginal effect on performance but was well liked
- /// Object links also well liked and had a positive impact on hooking
- /// Single window positively impacted acknowledgements and was preferred for this type of environment
 - ◆ Task lists mitigate some of the attention problems when there are multiple windows but a single task list would be preferred
- /// **When volume was high, object links positively impacted % of and time to provide accurate responses**

Final Thoughts

Information Technologies Group (STI)

- /// Single window may show more positive impact when there is more common context between the windows**
- /// Object Links may be more helpful if also available within the task list**
- /// Hyperlink from task list message to message in window may show promise in more context rich environments**
- /// Intend to re-test with warfighters if the opportunity arises.**

Questions?

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Features

Control Systems Integration Group (GVI)

/// CollabSpace

- /// **3-D Geospatial Visualization (NASA WorldWind)**
- /// **Situational Awareness (APL)**
 - ◆ MIL-STD 2525B Symbology
 - ◆ DHS Emergency Response Symbology
- /// **Geospatial Collaboration (APL)**
 - ◆ Geospatial Whiteboard, Post-It Nodes, Annotations, Overlays
- /// **Text Chat Collaboration (APL – Jabber/XMPP Protocol)**
 - ◆ Presence Information
 - ◆ C2 Enhanced Chat – Single and Multi-user
- /// **C2 Web Service Integration (APL)**
- /// **Metrics Collection Support & Logging**

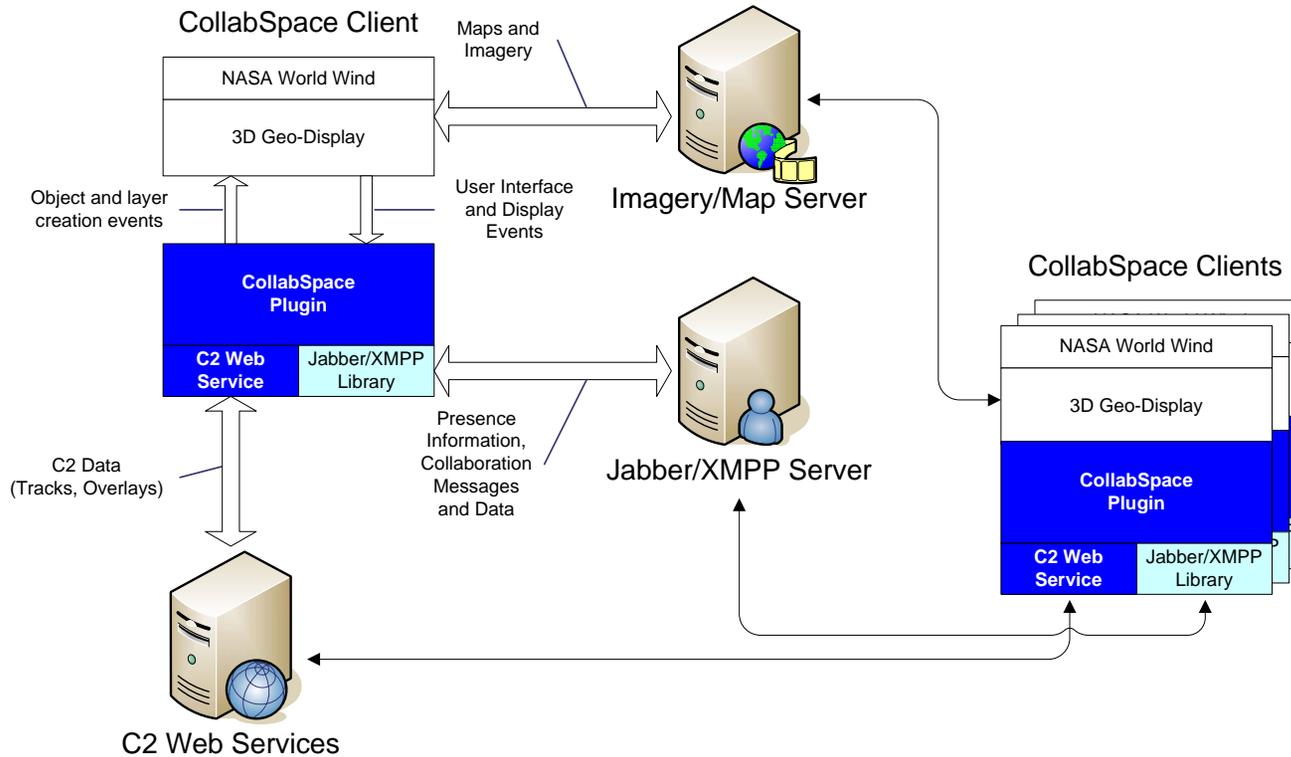
CollabSpace Requirements

/// The Collaboration Testbed (CollabSpace) will:

- /// R1: The testbed must instrument each collaboration feature so that metrics can be collected and post experiment reconstruction can occur.**
- /// R2: The testbed must provide basic geospatial situational awareness display**
- /// R3: The testbed must provide basic presence capability.**
- /// R4: The testbed must provide basic single and multi-user chat capability**
- /// R5: The testbed must provide basic “whiteboarding” capability on the geodisplay.**
- /// R6: The testbed must provide data import and export capability from other C2 systems.**
- /// R7: The testbed must be extensible.**
- /// R8: Investigate secure wireless technology and alternative form factors.**

NCES/SOA Based Architecture

Control Systems Integration Group (GVI)



- APL Developed Software
- 3rd Party Libraries
- NASA World Wind