

SITUATIONAL AWARENESS (SA) MULTI AGENT SYSTEM OVERVIEW

A. INTRODUCTION

SA Multi Agent System is a program that was developed for the purpose of increasing battlespace awareness of “war fighters” and combatant commanders during STAN (Surveillance and Target Acquisition Network) and TNT (Tactical Network Topology) experiments that are run each quarter at NPS. The common operating picture is based on maps or charts of the area of operations populated with agents that are represented by various icons like a person, truck, UAV, sensor etc. (Figure 1). The entities are located on the chart via latitude and longitude positions that can be entered manually, by clicking and dragging your symbol to your current position, or by a Global Positioning System (GPS) device. Since SA Multi Agent System did not have any user guide information available yet, this chapter is written to provide an overview of the program and to act as a user guide for those using this software program in the future.

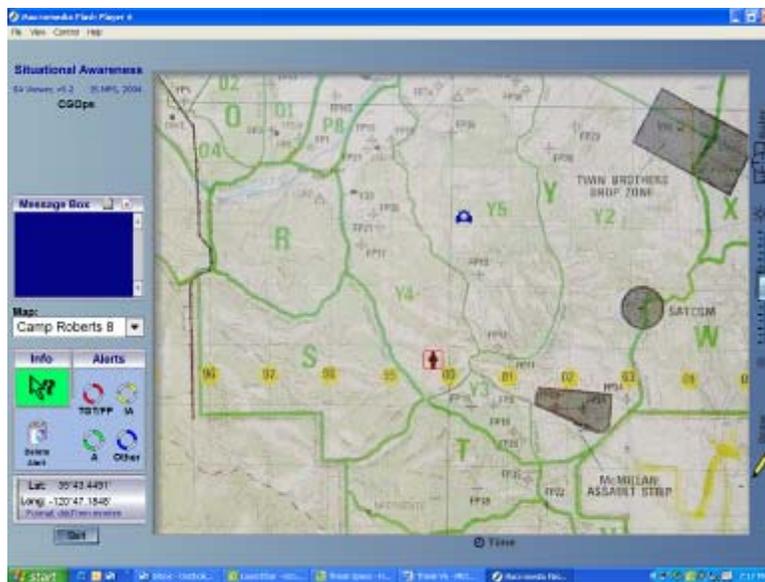


Figure 1. SA Agent GUI

SA Multi Agent System’s GUI provides the user with a shared view of the common operating picture of the battlespace. The basic functionality of any shared workspace is that it must show all the changes to any agent or system status within that workspace. SA Multi Agent System was designed to provide the war fighters, TOC, and NOC with these real time views of the relevant operational picture.

What makes SA Multi Agent System flexible and easy for the user to use is that it was built utilizing Macromedia movie techniques. Macromedia movie provides access to

“shared object” features that can be viewed on each users screen and can be continuously updated as the system’s status changes. Each shared object has a set of properties that allows for modification of its view and updated status. For example, when user moves an icon on the map, it immediately updates on all screens, if alerts are generated, voice notification or visual representations in the form of blinking symbols are shown. The operational maps that are available are customizable to any map that pertains to a specific operation. These maps act as the background that the agents are plotted upon.

SA Multi Agent System is a client-server application. The combination of this traditional client-server application and Macromedia’s shared object technique creates a new powerful approach to operational view sharing and provides the user with a rich and meaningful user interface. SA Multi Agent System is a database driven application which stores any changes in the operational picture in database tables so that it can provide updated operational pictures, calculate network performance variables, and allow future analysis. All events are relayed from the agent to the server where it is stored in these database tables and then the server synchronizes this data with all of the other agents. As a result, all of the agents have a real time view of the operational picture. The SA Multi Agent System also has a feature that can be made available by the administrator that allows a user to replay of any part of scenarios at any time.

B. BASIC COLLABORATIVE FEATURES

1. Instant messaging

Instant messaging allows send a text message to another agent in the field. In order to send a message, user needs to open the message window by clicking on the icon resembling a piece of paper on the top right hand side of the Message Box. This opens up a text window where the user can type a message. Once the message is composed, the “envelope” icon should be dragged and dropped on the agent’s icon you are contacting. If successful, there will be a voice notification and flashing line established between the user’s agent icon and the agent the message was sent to (Figure 2).

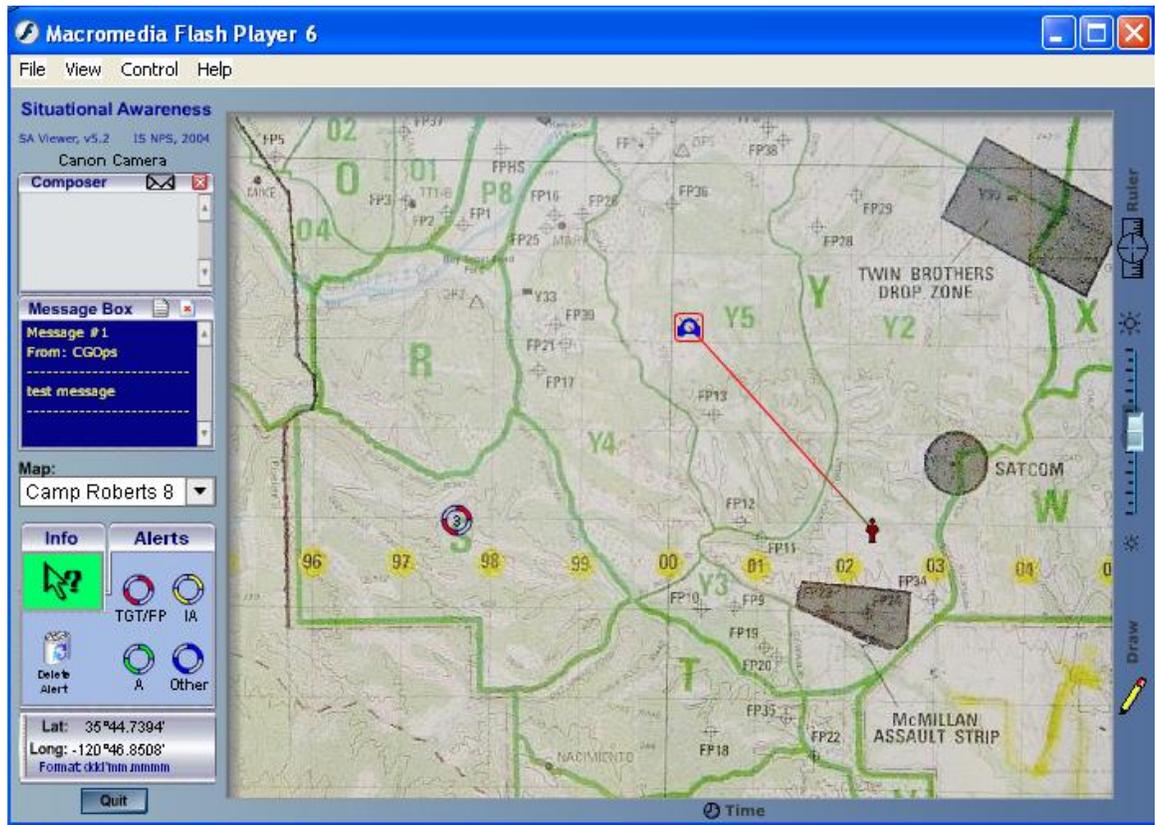


Figure 2. Instant Messaging

2. Agent information sharing

Information sharing is completed several different ways; by using the Info arrow button, instant messaging, through video motion and acoustic detection, using the agent's and an alert's information property screen etc. The Info arrow button can be clicked and dragged to the SA Agent you are interested in to attain general information about it. When the Info arrow button is dragged and dropped on the agent or alert icon, a property screen appears. The property screen contains three buttons which allow you to find out the status of the network connection, general information about the agent, and to hear and see video if the agent has that capability (Figure 3). The Info arrow button can also provide helpful tips about the basic elements of the SA screen when the user drags it over the screen element. The general information screen provides basic information about the agent and can only be modified by the system administrator or the agent itself. In regards to the network connection, there is a visual representation of the response time, throughput in and out, and the packet sizes being transmitted from the agent. The video screen allows you to hear and see anything that is being transmitted from or to the selected agent. Video motion and acoustic event detection can be toggled to an enabled or disabled mode by clicking on the appropriate slider box. When an agent's video sensor is triggered, all the agents receive an audible alert "video motion detected" followed by the transmission of video. Two sensitivity sliders allow you to adjust the

level of motion and acoustic detection to trigger an event (Figure 4). Adjustments to the quality of the audio and video can be made by adjusting the quality control button on the right hand side of agent's properties screen. The transmission rates range from 3Kbps up to 1Mbps. The quality of the video is controlled by the Macromedia application which is based on the current network connection quality. If you have a poor network connection video quality suffers and decreases the video frame rate down to 1 frame per second (fps). If you have a high quality network connection video quality increases up to a maximum rate of 15fps.

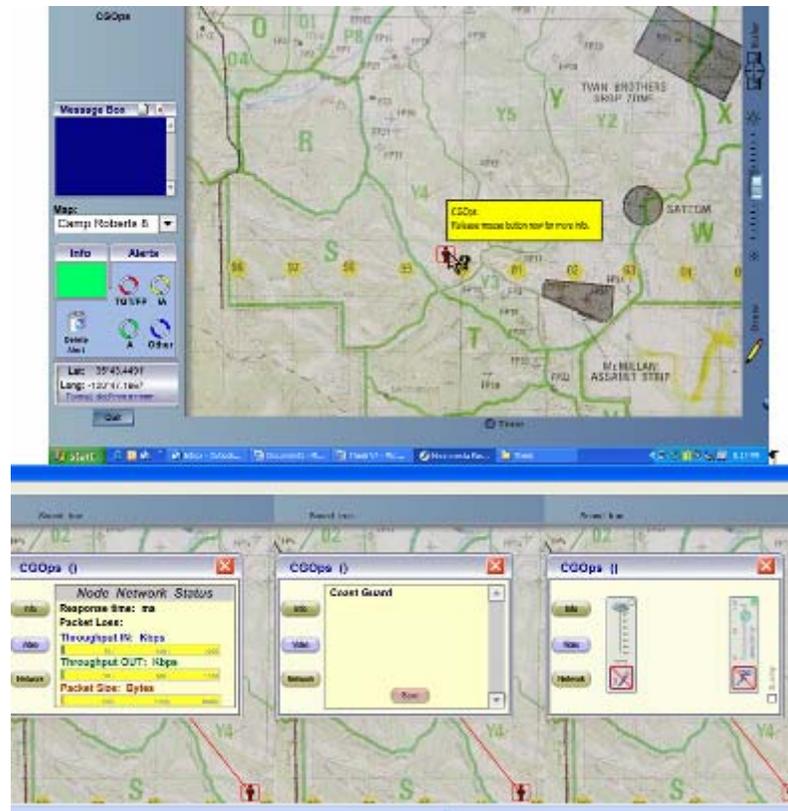


Figure 3. Information Sharing Views



Figure 4. Video Motion/Acoustic Detection Alert

3. Alert System

Alerts can be generated by any of the active agents. They are activated by clicking and dragging the appropriate alert to the relevant position. The originator of the alert will see a dynamic/spinning symbol that can be edit to include more information about what the agent is alerting others to. If you did not generate the alert, you will see a static symbol and can drag the Info button to the alert to receive amplifying information (Figure 5).

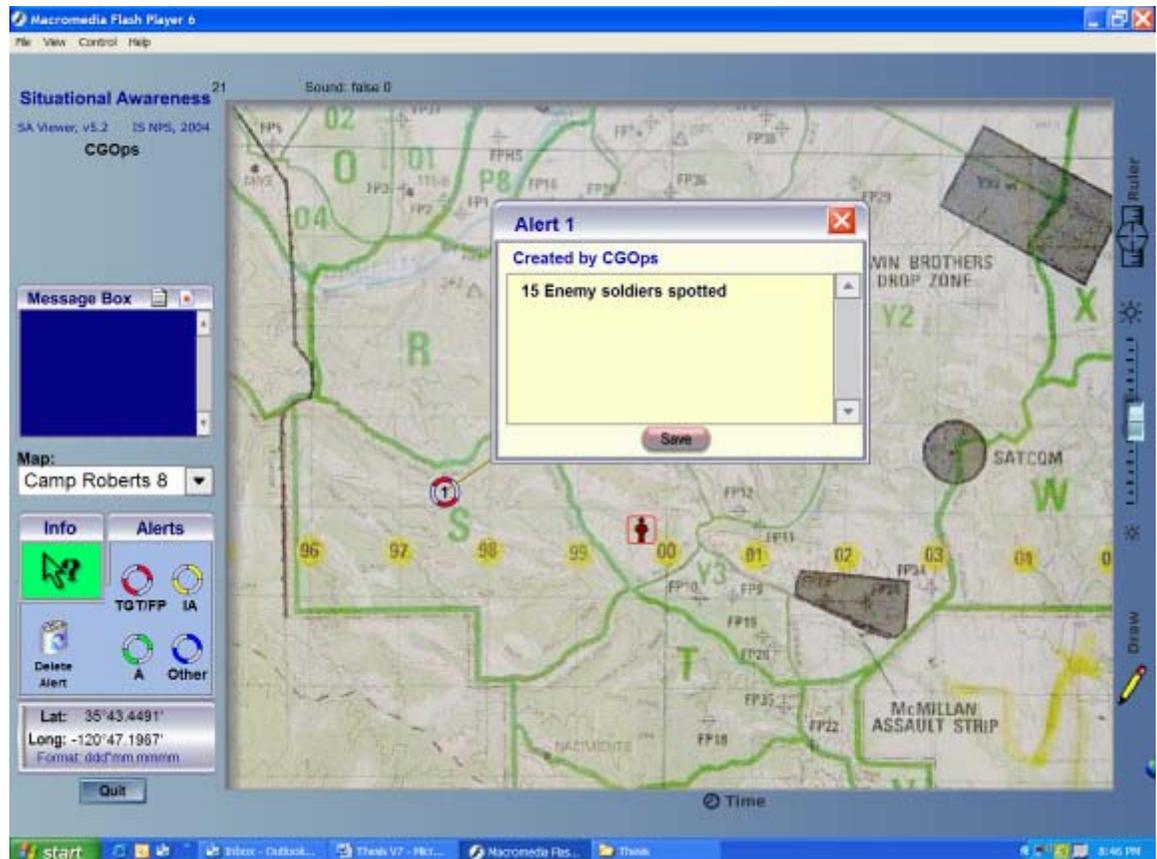


Figure 5. Alert Information

4. Ruler

The Ruler function allows the user to make a quick calculation of distance between agents, alerts or map points. To use this tool, click and drag the ruler from the right hand side of the GUI and place it on starting position of measurement. Extend the resulting line to the end position and the resulting distance will be shown (Figure 6). Distances are measured in kilometers and will be displayed in a yellow box. Click on the ruler symbol again to stop using the ruler.

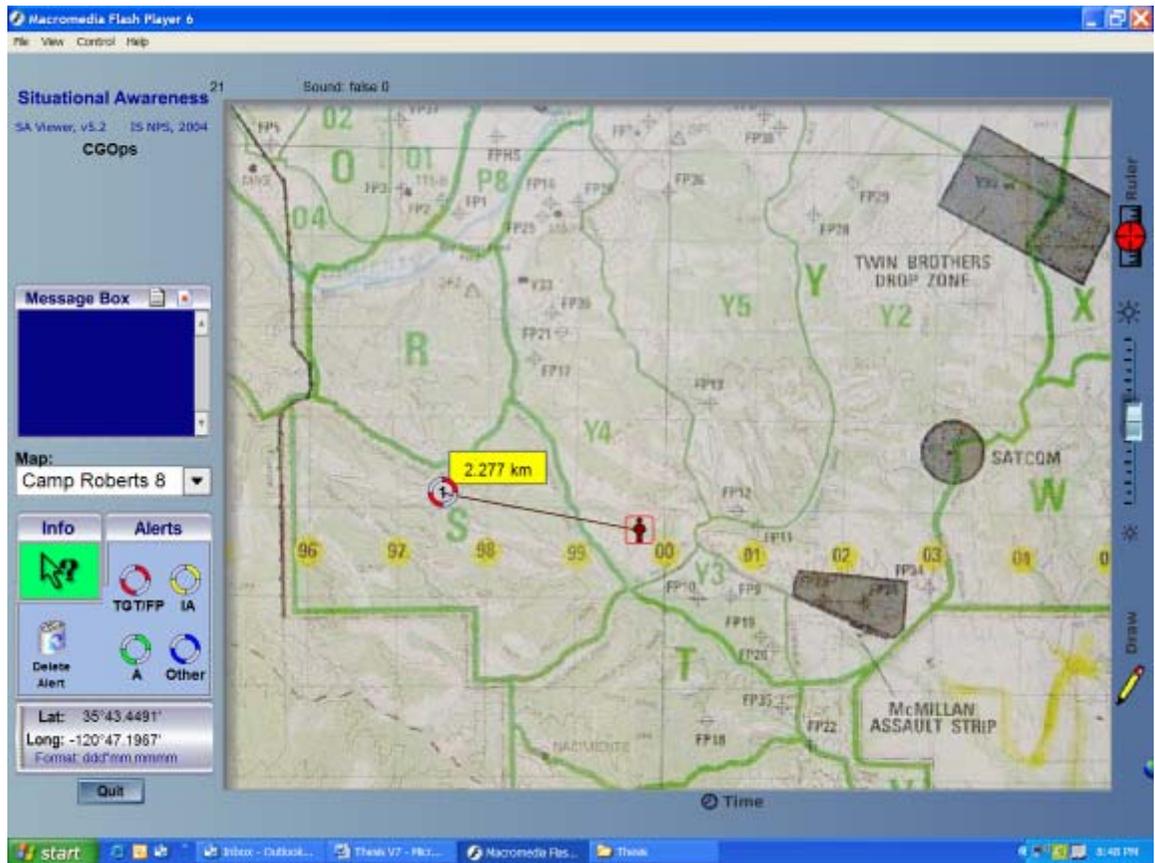


Figure 6. Ruler Representation

5. Contrast (for dark map background)

The contrast slider is located on the right hand side of the SA GUI. This function can be used when the map background you are using is really dark or cluttered. Adjust this button up or down to make the agents more defined on the screen (Figure 6).

6. Drawing

The drawing tool allows the user to place sketches on the maps similarly to sketchpad. To use this function, click on the pencil icon located on the right side of the GUI and then click on the area you would like to start drawing. Click and drag the icon to make continuous lines with you mouse (Figure 7). To remove the drawing, click on the X'd out pencil icon.

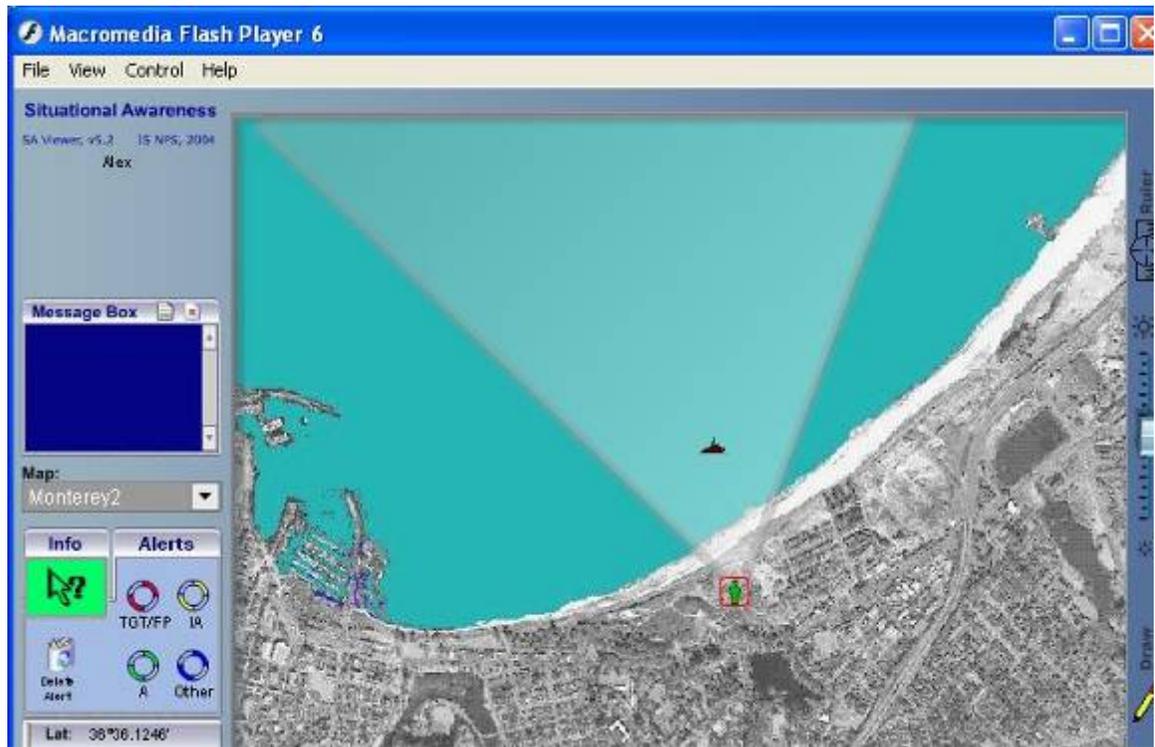


Figure 8. Show OFDM Sector Representation

C. COMMUNICATION MODE

1. Presence Awareness

Presence awareness is established once you establish a network connection to the SA server at NPS. The background color of Info arrow icon should change from red to green and confirms that your connection is established and active. If the background remains or turns red this means that a connection with the SA server has not been established or was lost. Depending on the map you are displaying and the location of other agents icon's will appear on your screen. Your agent will be differentiated from the others by being enclosed in a red square (Figure 8).

2. Network Awareness

Network awareness attained by the collaboration between Simple Network Management Protocol (SNMP) agents, which control each node's networking elements, and SA agents. The SNMP agent checks the network status of the node and collects the data. Instead of talking directly with the node's SA Agent, this information is collected by the SNMP management agent located on the SA server at NPS. This information is then redistributed back to the originating node and all the other active nodes in the SA Multi Agent System. This information can be displayed by dragging the green information button to any SA agent, dropping it on the agent, and clicking on the Network button (Figure 9).

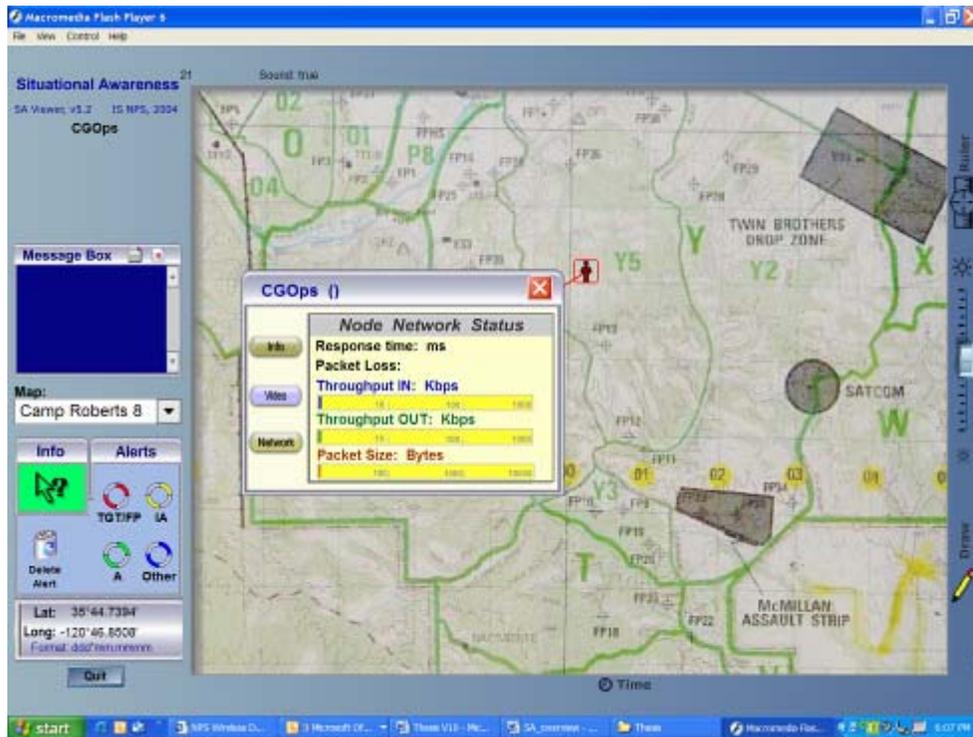


Figure 9. Network Awareness

D. NETWORKING CAPABILITIES

1. System Requirements

There are no network limitations to the way you can establish a network connection to the SA Server at NPS. Network connections can be established wirelessly over an 802.11 network using internal or external wireless cards, over an 802.16 network using a Redline AN-50 radio set, through a Local Area Network (LAN), over an Internet connection, and via a 900 MHz radio link. The SA server is also configured to use satellite communications via Iridium phones or modems. A general representation of the different types of connections is shown in Figure 10.

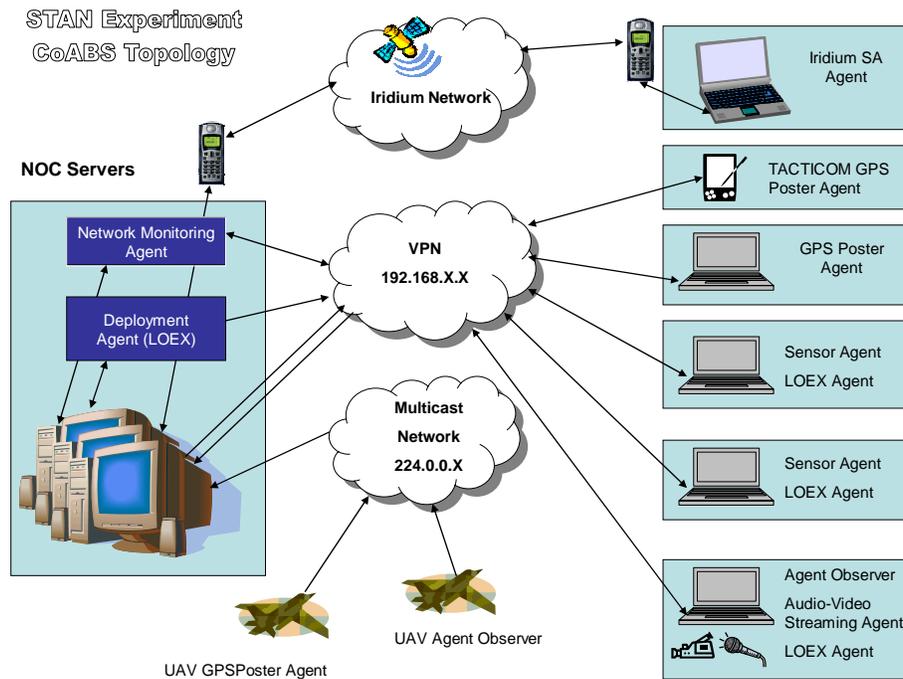


Figure 10. SA Agent Topology

2. Bandwidth requirements

There is no minimum bandwidth required to run SA Agent on a network. It is important to understand though that the slower network connection, the slower the synchronization of data.

E. INTERFACES AND TERMINALS

1. User interface customization

SA Agent is based on one basic visual representation. Customization is limited to choosing one of the available maps in the current version of SA Agent. The current version has 10 preloaded maps as the background of the GUI to cover Camp Roberts, Monterey Bay, and NPS' quadrangle. The available maps can be easily integrated to include any maps for any operational area.

2. User terminals

Operating system and Hardware requirements

The SA Multi Agent System was developed using several programming languages like Macromedia Flash MX on the client side and MS Visual Basic, MS C++, and Java on the server side. You can use SA Agent on a Microsoft Windows, Linux, Apple OS, or any other computer system as long as it has a version of Macromedia Flash Player created for that operating system and the machine has the ability to establish a network connection.

Software requirements

SA Agent requires Macromedia Flash Player to be installed. A configuration file (text file) will also need to be located in the same directory with SA Agent (Figure 11). This file requires a user ID, server IP address and Port number which will be assigned by the administrator. In case of using Multi-path network connection (wired, 802.XX, Iridium, etc.) the set of IP addresses, port numbers and interfaces will be assigned correspondingly to provide an uninterrupted network connection. This makes the connection more robust and secure.

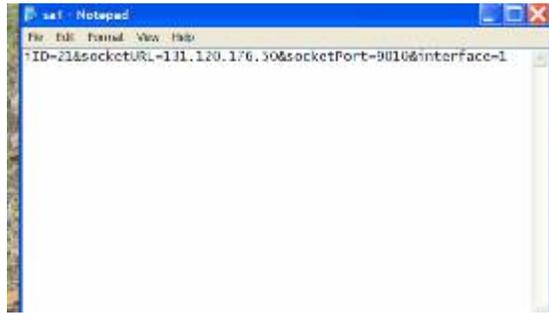


Figure 11. Configuration File

Internet connection

Any as long as it makes it back to the SA server at NPS.

F. SERVER SIDE APPLICATION

There are two administrative functions available to the SA administrator: SA Agent Tracer and Agent Administration Facility.

1. SA Agent Tracer

SA Agent Tracer is a software program that consists of socket connection port listeners and distributors. They listen to the available ports for TCP and/or UDP requests from all the SA agents. The Tracer processes the requests and then distributes all changes to other agents that are connected. Any event is then recorded and distributed i.e. position changes, alerts, motion detection, new drawings, acoustic interaction, etc depending on the sensor. The confirmation is displayed in the activity log and the corresponding update shows up on each agent's screen. The connection log records the status of each agent. Another feature that is useful to the administrator is the use of the commercial mobile phone Short Messaging System (SMS). If this box is checked, it will send the message to administrator's cellular phone to notify him that a change has occurred like an agent has logged in or logged off, video motion has been detected, or important system status changes have occurred. It also allows the administrator to make changes to SA server settings from his cellular phone. The last feature available on SA Agent Tracer is to enable the Snapshot on Motion function. This applies for smart or self

contained agents that have video or imaging capabilities. Snapshot on Motion allows for one of the agents (like a “smart rock”) to automatically capture images after motion is detected within its set of parameters (Figure 12).



Figure 12. SA Agent Tracer

2. Agent Administration Facility

Agent Administration Facility is the Web interface to the database that allows the administrator to manage all the SA Agents in the system (Figure 13). The basic functionality of the GUI is as follows:

- ID number: Needs to be unique and not duplicated on different units
- Icon Type: can be a person, car, UAV, weather station, observer, boat or a balloon. This is also customizable
- General Comments: Provides amplifying information about the agent
- Camera Ctrl: States that the agent is equipped with a pan-tilt-zoom (PTZ) video camera that is ready to be controlled remotely
- Enabled: Allows the administrator to enable or disable agents
- Ewall: Allows the administrator to include/exclude an agent from MIT’s Ewall agent list

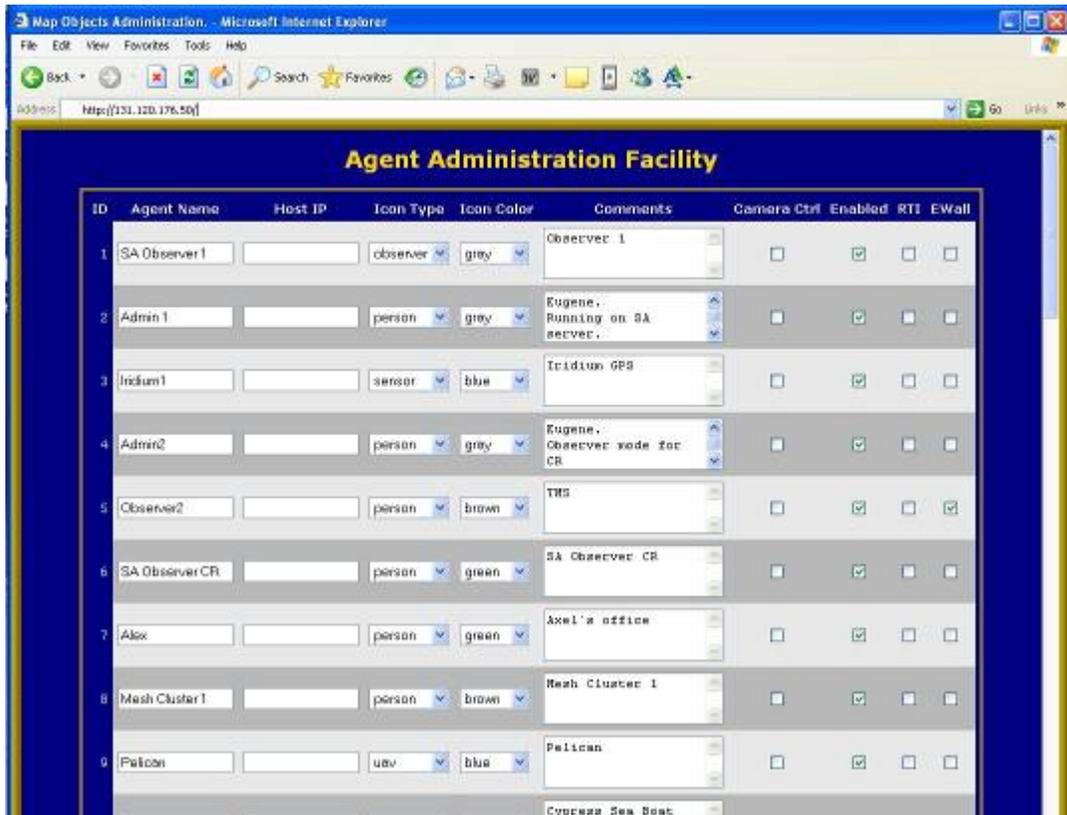


Figure 13. Agent Admin Facility