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MSSMP: No Place to Hide

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ABSTRACT

The Multipurpose Security and Surveillance Mission Platform (MSSMP) system is a distributed network of remote sensors mounted on vertical-takeoff-and-landing (VTOL) mobility platforms plus portable control stations. The system is designed to provide a rapidly deployable, extended-range surveillance capability for a wide variety of security operations and other tactical missions.

While MSSMP sensor packages can be deployed on many types of mobility platforms, initial system demonstrations have used a Sikorsky Cypher VTOL unmanned aircraft as well as a portable sensor unit. In January 1997, the MSSMP system was demonstrated at the Military Operations in Urban Terrain facility at Ft. Benning, GA, flying down city streets, looking through lower- and upper-story windows ahead of advancing troops, and performing observations after landing on the roof of a two story building.

The MSSMP system makes maximum use of commercial off-the-shelf (COTS) subsystem-level components for sensing, processing, and communications, and of both established and emerging standard communications networking protocols and system integration techniques. This paper will (1) discuss the technical issues involved in focusing these elements to produce a system architecture that can flexibly support the range of configurations needed to address a wide variety of applications while facilitating the ongoing integration of new technology COTS components, and (2) present the results of recent user evaluations.

1. INTRODUCTION

Battlefield commanders require reliable and timely information about enemy activities and other situations occurring in their area of operations. Currently, a situational awareness void exists between the capabilities of the unmanned aerial vehicle (UAV) sensor system and the tactical unmanned (ground) vehicle (TUV) sensor system. The energy required by the UAV to stay aloft limits the amount of time it can remain on station and does not allow for continual surveillance. The TUV can remain on station for a much longer period of time, but is limited in speed and movement over rough terrain. In order to provide adequate protection and situational awareness, a system must not be hampered by rough terrain or limited length of time on station. An unmanned, autonomous air-mobile surveillance system with vertical take-off and landing (VTOL) characteristics could provide both quick deployment of remote sensors to nearly inaccessible ground locations and a much longer time on station. This would be especially useful in areas having limited road networks or in a Military Operations in Urban Terrain (MOUT) environment.

The intent of such a system is not necessarily to provide sensing while in flight but to provide the commander with a rapidly deployable/recoverable, air-mobile, day/night, all-weather, real-time, unmanned system which will provide autonomous surveillance, detection, and assessment capabilities. These capabilities will provide timely mission-essential information on enemy activity and terrain. It will also provide commanders with an early warning device to aid them with force protection planning.

To meet this need, the Multipurpose Security and Surveillance Mission Platform (MSSMP) program, formerly known as the Air Mobile Ground Security and Surveillance System (AMGSSS) [1- 3], has been initiated. The program has the objective of developing a system to rapidly position remote sensors and other payloads at locations out to 10 km in range. Payload mobility is provided by small, unmanned, VTOL, shrouded rotor aircraft. The system utilizes a distributed network control-communication architecture which allows for flexible integration and operation of multiple remote sensor systems and control stations. This architecture also provides flexibility in future integration with evolving military digital radio networks such as the Army's Tactical Internet and DARPA's Warfighter Internet.

The vertical mobility capability of the MSSMP greatly reduces control complexity and communication requirements for system operation relative to teleoperated or semiautonomous ground mobile systems. Operator involvement is at the supervisory level, eliminating the need for full time attention to platform operation.

MSSMP supports the Reconnaissance, Surveillance and Target Acquisition (RSTA) mission requirements of tactical security forces and front line ground forces. The conceptual system (Figure 1) consists of three air-mobile, remote ground sensor units, a High Mobility Multi-Wheeled Vehicle (HMMWV)-mounted base station and a trailer for ground transport of the air mobile platforms. The air mobile platforms are small (less than 300 lb. and 6 ft. diameter) units that transport the sensor payload to the operational sites. MSSMP will allow the field commander to quickly extend his information gathering perimeter out to 10 kilometers. The platforms can be deployed together as a barrier or independently to monitor assets, critical routes, or choke points. The ground based sensors provide long-term surveillance without putting personnel at undue risk. The unit's rapid mobility and insensitivity to intervening terrain allow it to be quickly relocated to operationally relevant locations. Recent operations have investigated extending the concept to supporting law enforcement operations and Military Operations in Urban Terrain (MOUT). The US Army Military Police (MP) School is also interested in the system's potential as a multipurpose platform for positioning communication relays and deploying non-lethal agents.

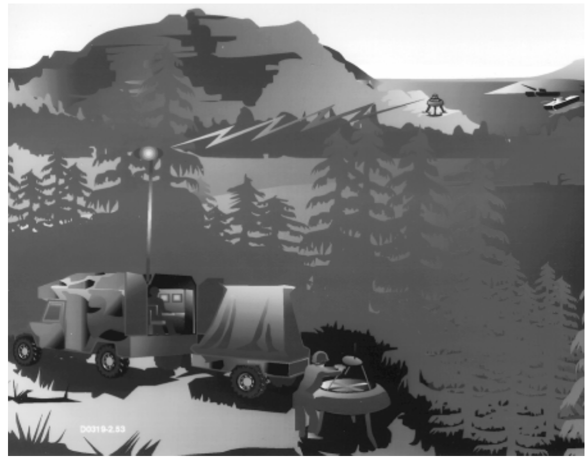

Figure 1. MSSMP concept.

Early in the project a Broad Agency Announcement (BAA) solicitation was advertised to ascertain the state of the art in small, VTOL, ducted fan, unmanned aircraft. Based upon the responses to this BAA, it was determined that the Sikorsky Cypher was the only platform mature enough to support concept feasibility experiments. NRaD's role has been to provide technical direction and to develop the sensor subsystem, including the command/control architecture, communications, and operator interface. Sikorsky has provided the Cypher aircraft and supported all operations with hardware integration and operation. This paper reviews the distributed network-based sensor subsystem and operator control station developed at NRaD and the user evaluations conducted for the US Army MP School.

2. NRaD SUBSYSTEMS DESCRIPTION

NRaD was responsible for developing the control/display interface, the sensor package, the software structure for command/control of the sensors, and the communications link between the control/display and sensor package.

The payload weight and power supply capacity of the air vehicle and the bandwidth of the radio-frequency (RF) communications link imposed several constraints on the system design:

• The sensor package must be small and low in weight and power consumption.

• The majority of sensory data processing must be performed at the remote end. This reduces both the bandwidth and the power consumption required to transmit the information. Decisions will be made by the remote computers, so that only useful data is transmitted.

• The system architecture should be flexible enough to allow easy integration of future sensors and the replacement of current sensors with more advanced models.

To accommodate these goals, where possible we used low-power, low-weight components developed for laptop computers, and employed the Transmission Control Protocol/Internet Protocol (TCP/IP) as the basis for our intercommunications scheme.

For prototyping purposes, we developed a Windows-based graphical program running on a laptop computer as the Control/Display unit (Figure 2), and assembled a portable Mission Payload Prototype (MPP) consisting of the sensors and remote processors (Figure 3) [2]. This allowed development of the system to proceed independently of the Cypher's progress. Demonstrations of the MSSMP remote sensing subsystem were conducted with the MPP acting as a surrogate MSSMP vehicle, providing the security and surveillance functionality without the mobility. The sensors and processors were later duplicated and packaged into a Cypher-mounted pod (Figure 4). However, the MPP proved so valuable during the numerous field tests we conducted that it has continued to play an integral part in further system demonstrations, operating concurrently with the air-mobile MSSMP unit and playing the role of a second air-mobile unit, a ground vehicle-mounted unit, or a man-portable sensor package. The TCP/IP based communications architecture allows numerous sensor packages and control stations to operate together in an Internet-like network or on the Internet itself.

The following sections describe the sensors selected to perform the security and surveillance objectives, the processing architecture supporting these remote sensors, the control/display station developed to direct MSSMP operation and integrate and display the returned data, and the network architecture designed to provide maximum flexibility in payload integration.

Figure 2. The MSSMP Control/Display unit

Figure 3. The MSSMP Mission Payload Prototype

2.1 Sensors

The MSSMP sensor suite includes:

- Visible light video camera
- Infrared video camera (FLIR)
- Laser rangefinder
- Interface for an acoustic sensor

Sensor selections were guided by the criteria of minimum power, size and weight, as well as adequacy of performance, low cost and off-the-shelf availability at integration time.

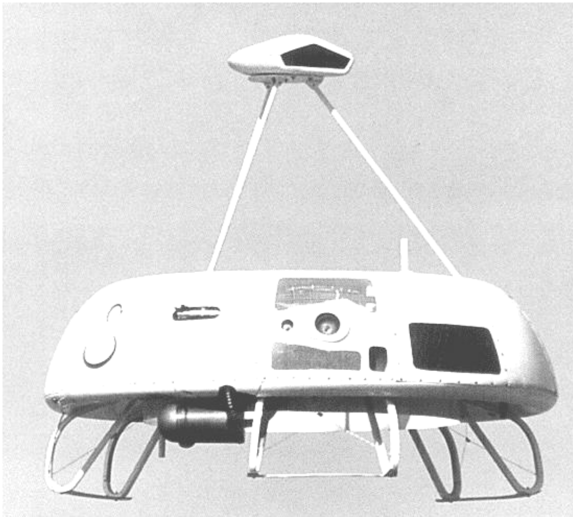

Figure 4. The MSSMP air-mobile unit.

Visible-Light Video Camera:

A Cohu camera with a Canon 10:1 zoom lens and a 2X range extender was selected. Design specifications called for monochrome images with sufficient resolution to allow classification of vehicles at 2.5 km and personnel at 1 km. This setup allows us to meet the Johnson Criteria [4] for resolution, as well as the sensitivity, dynamic range and signal-to-noise ratio necessary for reliable target detection and classification at those distances.

Infrared Video Camera:

The thermal imager is required to meet the same requirements as the visible-light imaging system but in total darkness. An Inframetrics InfraCam was selected, with a 100mm lens. This imager uses a platinum silicide focal plane array for high pixel uniformity and a proprietary Stirling-cycle dewar cooler to combine light weight with low power and reasonably high image quality.

Laser Rangefinder:

To determine target range, a laser rangefinder was included in the sensor suite. Minimum MSSMP requirement for a laser rangefinder is the ability to reliably determine the range of typical military targets at up to 2,500 meters with 10 meters accuracy. The unit must also be class 1 eyesafe and remotely controllable.

Nine laser rangefinders were found which met the requirements to varying degrees. The Melios, in wide use in the US Army, would probably be the best choice for a fieldable system. However, to save money and weight, we compromised and used a Reigl Lasertape for the prototype system. The Lasertape works well to about 800 meters, sufficient for many applications.

Acoustic Detector:

Because of the immaturity and rapid evolution of product development of acoustic detectors, we decided to provide an external data connection for an optional acoustic sensor instead of physically integrating one into the sensor package. A prototype acoustic sensor made by Northrop-Grumman was connected to the MSSMP Mission Payload Prototype and tested in the field in late 1995. The acoustic package is a small ring of three microphones with custom processing hardware and a serial interface. Output indicates target azimuth angle, type (ground vehicle, jet, helicopter, etc.), and detection/ classification confidence. MSSMP software provides programmable filters that allow the user to discard specified types of sound from specified azimuthal areas, and uses the information returned to aim the cameras for video confirmation and target identification.

A more detailed description of MSSMP sensors can be found in [3].

2.2 Sensor Processing Architecture

Three microcomputers reside in the remote sensor package, processing and reducing the raw data collected before transmitting them back to the Control/Display unit. These take the form of low-power PC-104 form-factor processor boards, running the MS-DOS and MS-Windows 95 operating systems.

The Payload Processor handles the communication with the Control/Display unit, interpreting and executing high level Control/Display commands by generating and sending sequences of simple low level commands to the various sensor subsystems via RS-232 and other interfaces. It also coordinates the flow of information between all payload computers; monitors, filters, and consolidates alerts received from the Image Processor and Acoustic Detector; and periodically sends status updates for all sensors to the Control/Display unit.

The Image Processor compresses images before sending them back to the Control/Display unit, using the JPEG compression technique. It also performs the motion detection function when commanded by the Payload Processor.

The Video Processor is dedicated to real-time video compressing and transmission. Currently, a commercial Windows-95 CU SeeMe software package is used to perform this function.

All three payload computers and the Control/Display computer are interconnected in an Ethernet TCP/IP network, resulting in a very flexible distributed processing architecture that has proved invaluable in many aspects. Each computer has its own Internet address, and theoretically can be thousands of miles apart, connected only by the Internet. This architecture allows parallel development of the subsystems at different sites and easy debugging by substitution of any processor by an equivalent desktop computer, and produces a flexible system that can be readily expanded or modified [2].

2.3 Control/Display

Figure 5 shows an example of one of the three selectable Control/Display screens—the Geographic View, with an aerial photo providing orientation for various sensory data (details of the Control/Display features were presented in [2]). The software is a Microsoft Windows-based program with standard Windows menus, buttons, and dialog boxes. Using a keyboard and mouse, the operator can command the remote sensors to perform elementary functions such as taking snapshots using the daylight or infrared camera (at specified zoom, focus, gain, polarity, azimuth and elevation, etc.), measuring range using the laser rangefinder, turning the FLIR on or off, or program complex sequences of commands such as complete panoramas, acoustic filters, and motion detection at various critical points. An in-depth discussion of how these commands are executed can be found in [3].

While the Control/Display program was first developed for laptop computers, we have also successfully demonstrated it both on the Litton Handheld Terminal Unit (HTU), one of the prototype Force XXI Dismounted Soldier System Units, and on a Xybernaut soldier-wearable computer. The 16-pseudo-color sunlight-readable display on the current generation of HTUs made the maps in the Geographic View somewhat hard to see. However, a 256-color version is currently under development at Litton and will allow more effective use of the Control/Display graphics. The wearable computer tested with the MSSMP system includes a small computer (with integrated trackball) and battery pack that can be worn around the waist, a small head-mounted display (over one eye) with integrated camera, microphone and earphone. This configuration added several demonstrated capabilities to the system, including:

- Voice control and feedback of system functions.
- Heads-up display, enabling the soldier/operator free movement while controlling and monitoring the system.
- Video from the soldier/operator's head-mounted camera, enabling the soldier to function as a sensor within the network.
- Integrated soldier voice communications within the communications network architecture.

Figure 5. View of Control/Display screen with Ft. Benning panorama and corresponding aerial photo.

2.4 Communications Architecture

The MSSMP communications architecture consists of an all digital fully connected network providing integrated video, voice, and data services. The fundamental component of this architecture is its basis on the TCP/IP protocol set. This enables plug and play compatibility with existing wired and wireless commercial/government off-the-shelf (COTS/GOTS) communications hardware including evolving military tactical digital communications data links.

The DoD concept for joint services interoperability in the 21st Century, *C4I For the Warrior,* envisions a widely distributed user-driven infrastructure in which the warrior "plugs in" to obtain information from secure and seamlessly integrated Command, Control, Computer, Communications and Intelligence systems. Each service has its own strategy for meeting this vision: the Navy's *Copernicus*, the Air Force's *Horizon*, the Marine Corps' *Marine Air Ground Task Forces C4I*, and the Army's *Enterprise*. TCP/IP compliance has been designated as the glue between all of these strategies to obtain and maintain interoperability between the services, and provide the "plug in" capability to the warrior.

The Army's roadmap for fulfilling the *Enterprise* strategy is the *Army Digitization Master Plan*, which outlines the Army's implementation strategy for digitization of the battlespace. There are four major thrusts in executing this plan [5]:

- Develop command and control software and hardware initially focused at brigade-and-below levels.
- Establish a seamless communication infrastructure called the "Tactical Internet."
- Integrate future digitally embedded weapons systems and non-embedded legacy systems into the Tactical Internet by means of standardized protocols, data standards, and message exchange formats.
- Develop a Battlefield Information Transmission System that will augment the Tactical Internet with commercially-based technologies that in the far term will allow for the increased information flow necessary to support a fully digitized force.

The MSSMP communications architecture is following the roadmap laid out by the Army Digitization Master Plan. It is plug and play compatible with the Tactical Internet and will be plug-and-play compatible when the evolving higher throughput Battlefield Information Transmission System communications hardware (Near Term Digital Radio, Future Digital Radio, and the Joint Services/ARPA SPEAKEASY radio) becomes available.

The architecture was initially developed using SINCGARS and PRC-139 tactical radios. The SINCGARS radio is the Army's projected least common denominator Combat Net Radio. Magnovox/SAIC PCMCIA Tactical Communication Interface Modules (TCIMs) with NRaD modified software provided the physical layer for the IP-based network connectivity in accordance with MIL-188-220A over SINCGARS radios.

Operational tests of our data link were conducted in 1995, and beyond-line-of-sight (BLOS) network connectivity was established with this tactical IP data link. Although SINCGARS has a channel burst rate of 16 kbps, characteristics of the TCIMs and SINCGARS radios operating in data mode resulted in an effective data throughput rate of less than 4 kbps. In actual field tests, the overall effective data throughput was reduced further by excessive handshaking between the SINCGARS radios, resulting in something less than 500 bps.

Communications performance was improved significantly during later demonstrations by employing higher bandwidth communications links. We are now using Arlan wireless Ethernet bridges, COTS spread-spectrum IP radios operating at a data rate of up to 860 kbps.

The current MSSMP communications architecture provides the following features:

<u>IP-based fully connected network configuration</u>:

Automatic network configuration capability enables idiot-proof network connectivity even in a highly dynamic mobile environment. The wireless IP modems automatically configure themselves into a tree structured network using the Spanning Tree Protocol (IEEE 802.1d). Each radio maintains a dynamic configuration table of who is directly connected to whom within the wireless network. Radios (associated with sensors, soldiers, UAVs and control stations) are automatically added to or deleted from the network configuration table as they enter or leave the network. IP devices connected to each radio are also listed in the configuration table. This allows dynamic point-to-point paths between devices across the wireless network to be automatically established by the radios without the need of operator intervention. Beyond-line-of-sight endpoints can maintain connectivity across this dynamic network through data packet multihopping, autorouting, and autohandoff (roaming) features. If a radio node goes down, radio configuration tables will be updated and the data packets passing through the down radio node will be rerouted automatically.

<u>Integrated voice, video, and data services</u>:

Data packets containing video, voice, and sensor data are multiplexed onto the same RF channel. These packets can be transmitted point-to-point (unicast), point-to-multipoint (broadcast), or multipoint-to-multipoint (multicast). This multiplexing of services eliminates the requirement for separate communications systems that have traditionally been needed to provide for each of voice communications, video transmission, and sensor command and control.

Small, light weight and cost-effective hardware:

Interface hardware consists of PCMCIA cards developed for the laptop computer market and PC/104 cards developed for the industrial embedded computer market. Features of this hardware include high functional integration, very small form factor, low power dissipation, and light weight. These features are required for smart sensors deployed by soldiers [6] and payload restrictive UAVs.

Standard- and protocol-based architecture:

MSSMP communications software follows existing standards and protocols, including: TCP/IP, UDP, RTP, multicasting, RSVP, PPP, 802.3, 802.11, STP, CSMA/CA, SNMP.

Flexible mix of existing communications channels:

The architecture has been seamlessly demonstrated using a heterogeneous set of communications hardware including tactical radios, COTS wireless radios, the Internet, and Plain Old Telephone System (POTS) lines, all operating simultaneously. Cellular (AMPS and CDPD) connectivity has recently been added to the MSSMP communications architecture in the form of PCMCIA cellular telephone cards.

The previous section described the MSSMP system architecture. In the following section, we report results of recent MSSMP system tests.

3. USER ASSESSMENT TESTS

Two user assessment tests have recently demonstrated the capabilities of the MSSMP system in military environments. In May 1996, the system was demonstrated at the Military Police School at Ft. McClellan, Alabama, in a simulated counter-drug operation. The man-portable sensor package (the MPP) mounted on a ground vehicle-of-opportunity and the Cypher-mounted sensor package were operated simultaneously over the same radio link.

In January 1997, the MSSMP system's expanded role was demonstrated at the MOUT facility of the Dismounted Battlespace Battle Laboratory (DBBL), Ft. Benning, Georgia. The system demonstrated reconnaissance support with the vehicle flying down city streets, looking through lower- and upper-story windows, providing lookout support ahead of advancing troops, and performing observations after landing on the roof of a two story building. The vehicle also dropped a simulated radio relay on the top of a building, a miniature intrusion detector in an open field, and carried a standard Army laser rangefinder/designator as a payload.

3.1 Security/Counter-Drug User Assessment Test:

Purpose:

This exercise was planned as part of a Counter-Drug Symposium held at Reilly Airfield at the U. S. Army Military Police School, Ft. McClellan, Alabama. This was the first user evaluation of the complete MSSMP system with the NRaD-developed sensor package integrated onto the Sikorsky Cypher vehicle and the stand-alone portable sensor package.

Results:

After a few days of preliminary flight testing the final counter-drug demonstration was conducted. In this scenario the MSSMP system consisting of the Cypher and NRaD developed sensor package flew the length of Reilly Airfield (approximately 1.5 km) and autonomously landed in a position to observe a simulated drug pickup and arrest. The entire sequence was also observed and recorded by the MPP placed on top of a ground vehicle. Both the airborne sensor and the MPP were controlled and provided data over the same radio link. Figure 6 shows both sensor packages parked near the tent housing the control center.

3.2 MOUT-Environment User Assessment Test:

Purpose:

This exercise was designed to test the expanded capabilities of the MSSMP and to assess the operational impact of employing a mix of state-of-the-art sensors attached to an unmanned, autonomous air-mobile platform having VTOL capability. An aerial vehicle of this nature equipped with specially configured, interchangeable mission payload packages or sensor suites could support numerous operations and missions. These missions could include: support to counter-drug and border patrol operations, signal/communications relays, detection

Figure 6. MSSMP system with Cypher-mounted sensor suite in foreground and MPP on top of HMMWV in background.

and assessment of barriers (i.e., mine fields, tank traps), remote assessment of suspected contaminated areas (i.e., chemical, biological, and nuclear), fire control, and even resupply of small quantities of critical items (dependent on vehicle lift capability).

The US Army Military Police School (USAMPS) will use the results of this assessment to validate the operational concept for the utilization of MSSMP in a MOUT environment. The emphasis will be on MSSMP's ability to enhance the surveillance and intelligence gathering capabilities of the law enforcement community and others on the battlefield.

Results:

The exercise took place at the Dismounted Battlespace Battle Laboratory, Ft. Benning, Georgia, between 15 and 17, January, 1997, at a mockup facility simulating the MOUT environment. The exercise involved resources and personnel from NRaD, Sikorsky, USAMPS, DBBL, and Computer Sciences Corporation. Again, both the air-mobile MSSMP unit and the MPP were operated at the same time over the same communications channel.

Planned assessments of the system included: rapid deployment capability, payload flexibility, and remote sensing capabilities.

Rapid Deployment Capability:

The MSSMP air-mobile unit arrived at the designated location in a truck. It was lifted out of the truck and placed on the ground by three to five persons in an average of five minutes. It was found that although three people could lift the vehicle, the job was much easier for four or more.

While Sikorsky has designed a remote starting mechanism for the Cypher, this development has not been completed and the vehicle had to be started by an external electric starter. The starter simply spun the Wankel engine fast enough to start the combustion cycle. Following engine startup, approximately one to three minutes is required for the engine to warm up before take off.

The average time for the vehicle to rise and begin forward movement was twenty seconds from the time a command was given. The test scenario located the observation points within one kilometer from the assembly area and it took the vehicle between one and three minutes to travel that distance. The reason for the spread in time was due to weather conditions, wind, and weight of payload.

The vehicle transits using the Global Positioning System (GPS), way points, and digital mapping. The way points are programmed into the computer from a digital map prior to the beginning of the mission and are used by the autopilot to navigate from take-off to landing. The system can also be controlled manually by an operator; however, this procedure is only used as a safety backup should the navigation system fail. Sikorsky successfully trained a previously untrained soldier to program and fly a mission with the platform in approximately one hour. This was accomplished through the use of a simulation program that allowed the soldier to plan and load way points into the platform, and simulate flying the mission.

The portable sensor package is normally carried in two separate briefcase-size containers (one contains the sensors, the other the processor base). It took an average of five minutes to unpack, connect the two halves and power up the system.

Payload Flexibility:

A total of eighteen flights were conducted, during which several mission payloads were used on the air-mobile unit and the MPP, including: visible light video cameras, infrared video camera (FLIR), laser rangefinder, smoke/gas dispersion system, a combination laser rangefinder/ target designator, and mechanisms used to carry and precision drop small equipment. (A radio relay device and tactical security sensors were dropped—see Figure 7.) It took an average of ten minutes to change the vehicle payload, using a standard socket set and wrenches. Due to the current payload weight limitation of the Cypher vehicle, the FLIR and laser rangefinder were not carried aboard (they were present only in the MPP). Sikorsky plans to upgrade the Cypher payload capability with an improved rotor system and higher engine speed.

Figure 7. The Cypher dropping a communications relay on the roof of a two-story building.

Security and Surveillance Capabilities:

Two operational scenarios were demonstrated. In the first, the air-mobile MSSMP unit flew just ahead of advancing troops, providing forward reconnaissance (Figure 8). Although it was not part of the original project goals, the MSSMP video camera was turned on and targeting hardware activated, providing live video feed while in flight (see movie clip at [7]). This capability would provide the advancing soldiers with real time, early warning sensing by remotely looking around corners from a safe distance, peeking into upper-story windows, etc. We also demonstrated that the MSSMP's Control/Display laptop computer can be replaced by a Litton Handheld Terminal Unit during these exercises.

In the second scenario, the MSSMP was commanded to land on the roof of a three-story building, and then to commence surveillance of the surrounding area. Figure 5 shows a part of the panoramic view of the area sent back by the MSSMP, displayed on the laptop Control/Display screen on top of an aerial photograph to provide orientation. Using the simple graphical interface, the operator proceeded to request larger, more detailed images of areas judged to be critical. Visual motion detection could then be commanded at critical entry and exit points to the area, as well as locations where hostile forces can suddenly appear (such as in open windows). The MPP complemented the air-mobile unit by demonstrating other features of the full sensor suite, including motion detecting and image capturing using the FLIR (Figure 9), as well as laser rangefinding of selected targets.

Figure 8. MSSMP flying just ahead of advancing troop, providing forward reconnaissance.

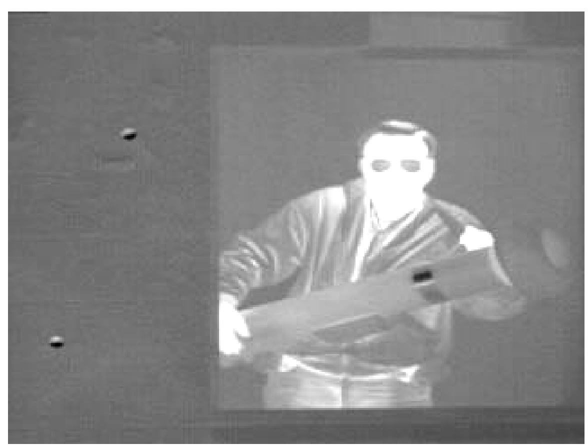

Figure 9. FLIR image sent back by the MPP showing a person with rocket launcher inside a dark upper-story window.

4. CURRENT STATUS:

These user assessment tests, conducted in military environments, have successfully demonstrated the potential of the MSSMP system concept. Feedback from these and other system demonstrations have been nearly unanimous in expressing a desire for this type of system. To deal with critical technology areas necessary to the future development of the MSSMP system, two Technology Base efforts, supported by the Defense Special Weapons Agency, are being pursued by NRaD in FY-97.

The first project is investigating more advanced human interface techniques for presenting tactical sensor information intuitively and intelligently to the soldier, preventing information overload during stressful conditions. Topics that are being studied include:

- Alternative input mechanisms (e.g., head tracking, eye tracking).
- Alternative displays and cueing mechanisms (e.g., see-through displays, audio cueing).
- More efficient, direct graphic presentation (not Windows-like).

The second project deals with issues relevant to tactical security sensor internetting and integration. One focus is on the identification or definition of IP-based protocols tuned to the requirement for message-based traffic over a heterogeneous RF network whose throughput and delay characteristics are likely to vary in both space and time. Such a protocol must, unlike TCP, provide real-time communications status information in order to allow both the operator and the remote sensor package to adapt their behavior to changing communications capacities in real time. A second focus is on identifying COTS distributed control techniques that can be used to expedite the effective integration of COTS sensor and other subsystems that provide only slow, asynchronous, character-based RS-232 control interfaces.

We are also actively seeking further support for the continued development of the MSSMP at a system level.

ACKNOWLEDGEMENTS

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http://www.nosc.mil/robots/air/amgsss/mssmp.html