USDA Forest Service Mobile Satellite Communications Applications

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ABSTRACT

The U. S. Department of Agriculture (USDA) Forest Service (FS) manages 191 million acres of public-owned land in the 156 National Forests of the USA. Much of this land is in remote locations with poor or no commercial communications services. Normal communications from Ranger stations and other offices are typically handled by the telephone companies. For internal working communications a Forest will use land mobile or handheld radios with appropriate base and repeater stations. Handheld radios are also used. There are usually some places within a Forest that does not have adequate coverage due to line-of-sight limits or other reasons.

When wildfire or other emergencies occur, independent radio communications systems are set up on separate frequencies so that the emergency communications will not interfere with daily operations in the area. Communications outside the immediate area of the emergency are not always adequate or available because of the remote locations where the command post may be set up.

The primary FS infrared (IR) line scanning systems presently rely on physical delivery of IR images on film for subsequent geo-location of the fire information onto maps. The FS is procuring two airborne IR line scanning systems (called Firefly) which will do digital signal processing on-board the aircraft to locate, by latitude and longitude, the fire and hot areas. This information may then be transmitted over a voice-grade radio-frequency (RF) link to the Incident Command Post (ICP). To avoid the need for the aircraft to establish line-of-sight with the ICP, and maintain it until completion of the transmission, the mobile communications satellite system will be used. This will permit the aircraft to transmit the pertinent location data while en-route to the next fire, saving valuable flight and pilot time.

Other potential uses for the mobile communications satellite may include search and rescue (SAR), automatic in-flight locating and reporting, dispatch orders, and en-route resource and situation status reporting.

INTRODUCTION

The USDA Forest Service (FS) and the Dept. of Interior spend an average of over $200,000,000 annually in the suppression of wildland fires. In extreme years the costs go up. In 1988, the suppression costs in the Greater Yellowstone Area alone was around $120,000,000. The number of personnel on large fires may vary from 300 to over 2000. Again, in the 1988 Yellowstone fires, more than 25,000 people worked there with a peak of 9500 and 117 aircraft. With the hazards and logistical complexities associated with

large wildland fires, the communications systems become very important. Fire Camps and ICP's are often located in remote areas. It is necessary to provide eating, sleeping, and sanitation arrangements, as well as transportation of people, equipment, and supplies often during rapidly changing situations.

Communications regarding the availability of resources (people, aircraft, ground vehicles, tools), and the situation status (fire location, behavior, predicted spread rate) are essential for effective and efficient suppression actions. The FS has used thermal infrared (3-5 and 8-12 micrometer bands) in airborne IR line scanning systems for about 25 years for fire management efforts. The primary problems related to this use are the availability, when needed, and the timeliness of interpreted, fire locations onto maps. Mobile satellite communications coupled with on-board digital signal processing, advanced navigation systems, and stored digital terrain elevation data are expected to improve the efficiency of the IR systems over the next 5 years.

INFRARED INTELLIGENCE

Areas with large fires often are completely "smoked in". That is, there is a smoke pall over a large area which reduces the visibility from aircraft to ground to near zero. Thermal infrared systems can detect hot areas like fire perimeters and fire spots through the smoke in most cases. The IR signals can be processed on board, resulting in a film display of terrain features and hot areas. The film must then be physically delivered, usually from the nearest landing strip, and a manual interpretation performed, to locate the fire on the maps of the area. The nature of the line scanners operating over uneven, rugged terrain results in a horizontal scale that is constantly changing from line to line or even within a single line scan.

The FS has successfully transmitted both IR video, and standard RS-170 video with IR and terrain features from the aircraft to the ground since 1974 (1). In 1983, the feasibility of further geo-referencing IR information on board, and transmitting same via satellites was studied (2). The methods established in the feasibility study are very similar to what is now being developed for the FS Firefly system, which is scheduled for operational use in 1993. The standard IR line scanner signals will be digitized and processed along with Global Positioning System (GPS) data, on-board gyro attitude sensors, and stored digital elevation data to provided a latitude-longitude location tag for all parts of an area exceeding a selected threshold value. This will permit the transmission of the fire location data over a voice grade link. Previous methods have successfully transmitted the IR video or images, but required wide RF bandwidths to reduce the transmission time down to a reasonable number. Also, the transmission and reception equipment were considerably more complex and expensive than what is required for voice-grade or lower data rate transmissions.

The new methods will permit the IR aircraft to "map" a fire and proceed on to the next fire area without the need for first flying to the landing strip nearest to the ICP, landing, delivering the film strips, and then taking off for the next fire. This will improve the amount of time spent collecting fire data to the amount of time spent delivering the data. In fact, there will be essentially no time lost in the delivery, because the aircraft will be on its way to the next destination while that is taking place via the mobile communications satellite.

Location accuracy and relative location of the fire perimeter or spots to firebreaks may not be as good as what can be found from the film. But

advances in forward looking infrared (FLIR), coupled with GPS or Loran C, can augment the large area, strategic information provided by the line scanners. The FLIR based units could also be equipped with mobile satellite communications capability which would also speed up their delivery of tactical IR information to the Fire Staff.

OTHER FIRE COMMUNICATIONS

There are other communications needs associated with the management of large fires or complexes of fires. The need for "routine" communications associated with the management of large numbers of people and suppression resources was mentioned. Fires are often in remote areas, and usually there is little or no time for a normal build-up of communications systems. Whatever is used must be highly portable and be able to talk to or network with commercial telephone systems at some place. Stringing telephone lines has been done many times in the past, but a totally mobile wireless method is much preferred. Besides some locations are too remote or inaccessible to consider the older common methods. Lines and in some cases even microwave or radio repeater tower sites may also be in jeopardy of the fire.

With numerous hand crews at diverse locations around the fire line, retardant aircraft, dozers, and engines deployed, it is likely that automatic location systems based on satellite communications may be used in the future. The locations of all units could be displayed on a color monitor and messages processed to show progress or emergencies. As wind or other conditions change, the changes and latest fire spread predictions would be available to all the crews and others out on the line in a matter of minutes. Satellite communications would let messages be sent to only the selected units or to all units simultaneously.

Another advantage to mobile satellite communications would be the "instant" set up time, compared to other methods, including other satellite systems. The fire staff could be on-line while in their vehicles en route to the fire scene.

FIRE OPERATIONS

Wildfire is quite unlike some other natural disasters such as earthquakes, tornadoes, hurricanes, or even floods. There is usually very little that can be done to control the other events. Steps can be taken to minimize the damage and loss of life that may be incurred with those, but once they start they are pretty much out of control. Wildfire is sometimes uncontrollable, too, when driven by high winds, but often it can be controlled or managed to a large extent. Such management necessarily requires a large amount of timely and pertinent data, as well as good judgment, and prediction models. Plans can be made, but are subject to the availability of the various types of resources that are available. The uses of mobile satellite communications systems offer ways to provide better data for better management resulting in lower suppression costs and natural resource losses.

CONCLUSION

The airborne IR signal processing system being developed will require the use of mobile satellite communications to achieve its full capability and improvement in delivery timeliness of processed IR data to the Fire Staff. There are numerous other beneficial uses, both during wildland fire management operations or in daily routine tasks, which will also benefit from the availability of reliable communications from remote areas.

REFERENCES

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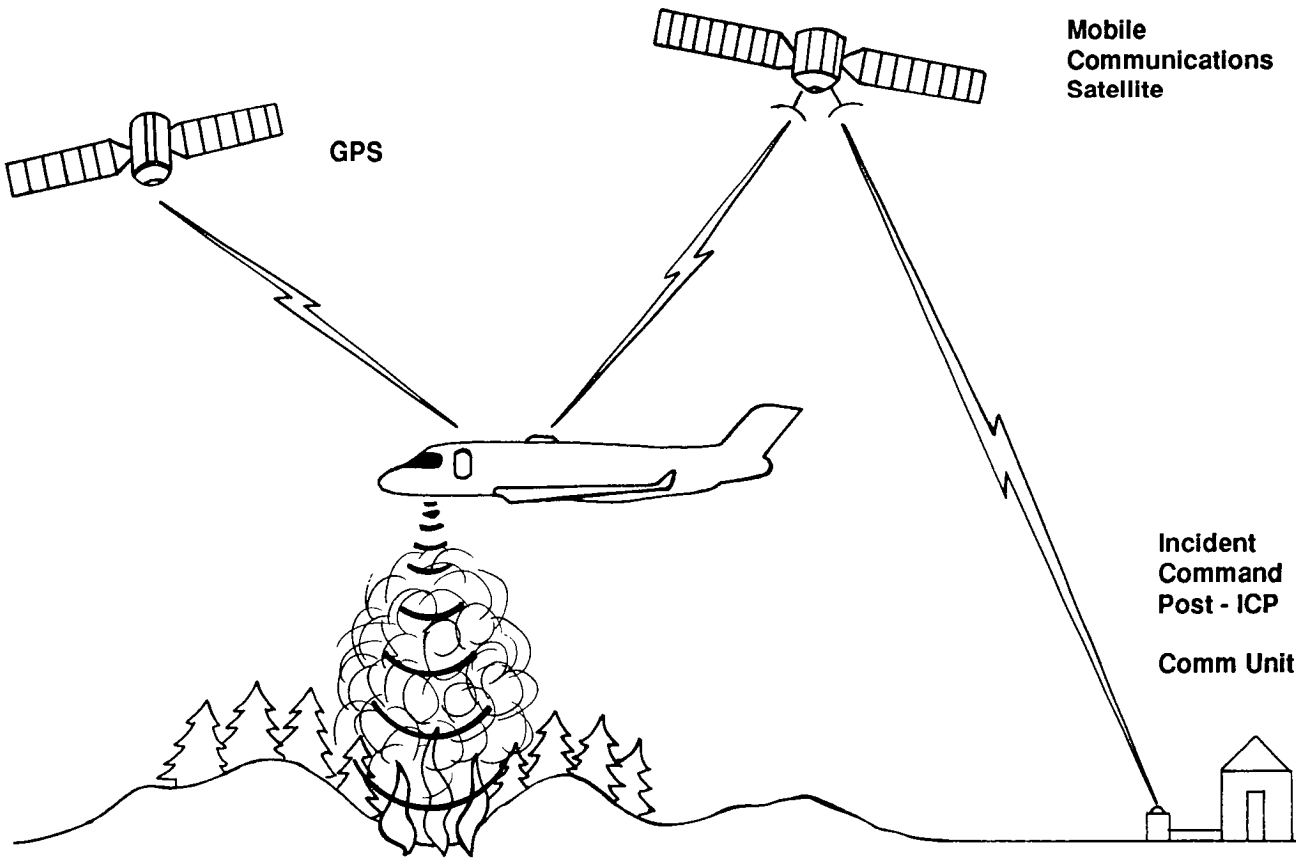

Fig 1 Firefly Concept