APPLICATION OF REMOTE SURVEILLANCE TECHNOLOGIES TO ENHANCE PUBLIC INFORMATION AND OUTREACH RELATED TO FIRE MANAGEMENT OBJECTIVES

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ABSTRACT

Since 2004, the National Center for Landscape Fire Analysis (NCLFA) has deployed broadband radio equipment coupled with strategic monitoring technologies to support management of wildland fires in remote areas of the western United States. Wireless broadband radios and surveillance-grade camera equipment have provided cost-effective monitoring of fire behavior, smoke, and weather for extended events in inaccessible terrain. The use of surveillance equipment in fire is expanding, and the direct benefits include enhanced capabilities for communications, data acquisition, and data transfer. A 2007 deployment in the North Cascades of Washington State emphasized additional, unexpected utility of this equipment in support of public outreach and education by providing public Web access to daily archived video and near-real-time digital images of fire activity. It is likely that access to this archived video enhanced communications between fire managers and members of the public because of the increased transparency in management actions and fire activity, and the common language provided by the video for each side to communicate their message with context. This experience suggests that public access to these types of near-real-time media is an important tool to help build and maintain public support for long-term fire management objectives. The high bandwidth provided by broadband radio networks allows multiple data transfer objectives to be met using the same network; therefore, providing data for public consumption does not have to come at the cost of other network-related management goals. We conclude that in addition to the direct benefits of remote surveillance to fire managers, this secondary benefit related to public outreach may actually provide the most value, from a fire management perspective, because of its potential utility as a tool to effectively communicate fire management goals to the public.

Keywords: communication, fire management, public outreach and education, remote cameras, surveillance, wireless technologies.

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INTRODUCTION

Effectively communicating complex management ideas to the public in a dynamic fire environment is challenging. Fire managers must build and maintain public support for their operations, yet they often lack a common language and the supporting context to deliver their message. This is particularly applicable in modern multiple-objective fire management where, when appropriate, fire officials must often defend their rationale for using fire as a resource management tool. Even for incidents where the sole management objective is fire suppression, these same challenges exist. Current interagency fire policy dictates that for fires occurring on public lands fire managers are required to carefully balance firefighter safety, public safety, structure protection, costs, personnel and resource demands, resource management objectives, environmental factors, and the long-term social impacts of the suppression actions or perceived inactions they may take (NIFC 2008). In addition, policy changes implemented in 2009 may further complicate the public's understanding of fire management. This new policy states that any wildland fire can be "concurrently managed for one or more objectives and objectives can change as the fire spreads across the landscape" (NIFC 2009). The complex decision-making process surrounding wildland fire is difficult to communicate clearly to those outside of the process itself, let alone to parties outside of the fire community.

Communication difficulties abound in fire management. Operationally, terrain and distance compound these problems. Fires that are physically isolated due to limited road access or topography, and those that are burning in remote locations far from the Incident Command Post (ICP), pose additional communications challenges in terms of efficiently transferring data and corresponding between field and management personnel at multiple locations. Valuable fire behavior and weather data collected in the field that would aid managers in their decision-making processes often lose much of their value by the time these data make it back to the hands of fire managers at ICP. Conversely, these same challenges make it difficult to deliver safety and intelligence materials meant for personnel on the ground before these documents also become outdated and lose relevance.

Here we present a cost-effective method for addressing these communications difficulties using commercial off-the-shelf (COTS) long-range broadband radios to establish a high-bandwidth data connection to strategic line-of-sight locations on active fires. The Internet connection provided by these networks enables efficient data transfer between field personnel and incident command, thereby improving their operational communications capabilities. This will in turn increase efficiency, safety, and lead to more informed

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decision making related to fire management strategies and tactics. Additionally, the networks can support installation of surveillance cameras to address long-term fire monitoring needs. Where appropriate, the video provided by these cameras can be made available for public consumption and used as a tool to enhance communication of fire management objectives and the potential impacts of these actions on the public. Because of the design, multiple objectives are met using the same network, costs are minimized due to a decreased need for long-term monitoring by field personnel or air operations, and real-time fire intelligence is available to all affected and interested parties.

FIRE INTELLIGENCE MODULE

The National Center for Landscape Fire Analysis (NCLFA) at the University of Montana relies on collaborative relationships with local, state, and federal partners to incorporate developments in science and technology into various areas of fire management. In line with these goals, NCLFA developed the Fire Intelligence Module (FIM) to assess and improve the utility of a variety of geospatial tools deployed on fire management incidents with the hope of improving overall efficiencies in management decision making, while simultaneously helping to contain costs. Specifically, this involves two key objectives: to deploy and test new technologies for fire management and to train fire personnel in the use and applications of these technologies to complete the cycle of technology transfer.

The FIM is staffed by NCLFA employees who carry full interagency fire qualifications and who hold years of collective fire experience in a variety of work settings. FIM crewmembers also have extensive technological expertise in the fields of GPS, GIS, remote sensing, network administration, and information technology. It is through this combination of scientific skills and fire experience, coupled with our affiliation with an academic institute, which enables us to pursue novel deployments of technology on fire. In this way, the FIM aims to supplement the management capabilities of fire managers by providing access to technologies that they would not otherwise have the time or resources to pursue and implement.

Wireless Broadband Networks

In 2004, in response to requests from the fire use community to help improve their operational efficiency in monitoring long-term inaccessible fires, the FIM developed a system using COTS technologies to provide cost-effective, temporary means to remotely monitor fire behavior. This system uses long-range broadband radios to provide a high-bandwidth Internet connection at strategic line-of-sight locations. Internet Protocol (IP)–enabled surveillance-grade pan-tilt-zoom (PTZ) cameras provide real-time streaming video and Web-based motion control that allow fire managers to remotely monitor nearly 360 horizontal degrees with 21× optical zoom near the fire perimeter, from any place in the world with an Internet connection. Additional specifics describing the equipment used and the technologies involved are provided in Hartung et al. (2006) and Riddering (2006).

Beyond video surveillance, there are numerous management and research opportunities that capitalize on these high-bandwidth networks as a communications backbone. Simple Web access enables field personnel with a laptop and a password to exploit the resources of the Internet while in a remote location, including maintaining email correspondence, sharing documents via FTP (File Transfer Protocol), submitting and obtaining spot weather forecasts firsthand, and using Internet-based resources, such as Google Earth (Google, Mountain View, CA), for mapping and orientation purposes. Also, because of the ability to share large data files, more advanced real-time geospatial analysis, including fire perimeter and progression mapping, can take place interactively between GIS-knowledgeable field and incident command personnel. This can lead to more accurate and updated maps, which in turn leads to more informed decision making. These networks also provide great utility for enhanced real-time communications using technologies such as Web-based video conferencing and Skype (Skype Technologies, Luxembourg City, Luxembourg; www.skype.com). In terms of research opportunities, any IP-enabled measurement device can be attached to the network, including instruments to record air quality, weather, and fire behavior data. The network reliability and bandwidth provided by the wireless broadband technologies ensures a robust connection for multiple management and resource objectives via the same network, thus minimizing overall cost to the fire, as well as the technological footprint on the landscape.

CASE STUDY: 2007 TOLO AND DOMKE LAKE FIRES

In August 2007, NCLFA staff deployed equipment, including two cameras, to the Tolo and Domke Lake fires in north-central Washington State to support remote surveillance objectives. Each fire was burning in inaccessible wilderness areas, and fire-use objectives dictated that minimum suppression actions be taken for each incident. It was anticipated that these fires would burn well into the fall, which meant that each incident would have to retain significant field personnel and air support to effectively monitor any fire growth for several weeks, at minimum. Fire managers of the Tolo Fire were interested in implementing specific contain and monitor strategies, while the Domke Lake Fire was managed as a suppression incident. Fire managers for both incidents needed to manage for these objectives while simultaneously minimizing both risk to firefighters in the extremely rugged landscape and costs for managing the long-term incidents. The network we installed addressed these issues by wirelessly spanning nearly 100 km of terrain to provide remote video-monitoring capabilities for each incident, accessed via a secure Web site.

To support each incident, we created a public Web site that provided near-real-time still images and daily archived streaming video of fire behavior captured from each camera. This enabled public access to the same fire behavior imagery that Forest Service and National Park Service officials were viewing, but provided an additional level of security because the public did not have any power to control the PTZ capabilities of the camera. For security reasons, the locations of the cameras and network relay sites were not disclosed. Links to this ad hoc site were made available online through

a variety of sources, including on the Web page for each incident at InciWeb.org, on an email discussion list created by evacuated residents of a wilderness inholding called Holden (Holden Village Exiles Forum 2007), at GoLake-Chelan.com, a general news and tourism Web site for the Lake Chelan area (Isenhart 2007), and on the NCLFA homepage (NCLFA 2009). This information was also published in the *Wenatchee World* newspaper (McNiel 2007) and provided directly by fire personnel. Over the course of 1 month, this Web page received nearly 8,000 visits, representing 17 different countries and 48 U.S. states. Sixty percent of these visitors were returning to the site from a previous visit (J.P. Riddering, NCLFA, unpublished data).

Our interpretation of this technology's positive impact on public perception of fire management actions is based on observed Web traffic as well as supporting evidence from agency personnel. Forest Service and National Park Service personnel witnessed real changes in the overall nature and frequency of interactions with the public following the availability of this imagery via the public Web site. When people were able to access real-time images of fire behavior via the Web site, management personnel fielded fewer phone calls from concerned citizens (T. Johnson, National Park Service, personal communication; B. Sheehan, USDA Forest Service, personal communication). Evacuated residents and individuals concerned about smoke from inversions or plumes could access the Web page and get unfiltered fire behavior information. It is likely that access to this archived video gave the public a sense of ownership in the decision-making process related to the management of these fires because they could view firsthand the same images that fire officials were using to make their informed management decisions. This site enhanced overall communications between fire managers and the public because the imagery provided a common language and a communications medium for each side to deliver their message with context.

This network also resulted in real long-term cost savings for each incident. Anecdotal evidence supports this assertion. For example, upon making this network available, a Type III helicopter that was previously supporting monitoring operations for the Tolo Fire was able to be released for other use. Daily flights over the fire were no longer needed, and occasional monitoring flights were accomplished using the North Cascades National Park's seasonally contracted helicopter in conjunction with other park management operations. The Domke Lake Fire experienced similar cost savings simply through the need for fewer monitoring flights over the lifespan of the incident. Decreasing the number of flights taken in hazardous conditions also reduces exposure for firefighting personnel, providing an unquantifiable safety benefit.

The network provided additional economic benefits to each fire through generally enhanced communications with the public. The agencies were able to more effectively and efficiently deliver their message when needed, and fire staff were freed up to focus on other fire-related duties. Based on this experience, we conclude that the real utility of wireless networks and surveillance equipment in fire management extends beyond the realms of incident management and scientific monitoring into the areas of public outreach and education.

IMPLICATIONS FOR FUTURE WORK

The level of public response to the information on these Web sites was unanticipated, as was the reported general shift in public sentiment about the wildland fire operations. This deployment revealed the potential of these systems as a tool for public outreach and education in support of fire management objectives, specifically as a means to get the public exposure to the complex decision-making process of fire management.

The external and internal education potential associated with these networks has yet to be explored. Fire behavior video captured remotely and safely could be used for a variety of informal science education purposes, including public service announcements, outreach videos, and interpretive kiosks in ranger stations and science museums. These same videos could also be used extensively within the fire community to supplement training materials for new and established fire courses. The near-real-time nature of the images could provide additional educational value through enhanced Web site content such as daily messages describing the effects of the previous day's weather on fire behavior, utilizing the archived video to elucidate the message. Finally, these networks have yet to be applied to the prescribed fire domain, where the same opportunities for public outreach and education exist.

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