Applications of multi transmitter GPS-VHF in forest operations

Robert F. Keefe, Jan U.H. Eitel, Alistair M.S. Smith, Wade T. Tinkham

Dept. of Forest, Rangeland and Fire Sciences, University of Idaho, 875 Perimeter Drive, Moscow, ID 83844-1133

Abstract

GPS-VHF tracking systems can now integrate position tracking of multiple objects and personnel with onsite mapping on handheld devices and laptop computers. Combined GPS-VHF systems require neither internet access nor cellular signal reception for real-time, operational safety and supply chain mapping and monitoring on site. This independence of automated location mapping from both cellular signal and internet connection makes GPS-VHF powerful for several new applications in forest engineering, including logging safety and production logistics. These units also include methods for setting fixed radius and polygonal geofences that trigger positional alert signals when crossed by transmitters. The use of GPS-VHF in forest engineering can facilitate a number of improvements to conventional harvest unit planning and logging safety practices. We provide an overview of several applications of combined GPS-VHF in forest engineering currently being evaluated in a series of field experiments in the northern Rocky Mountain region of the United States. Combined GPS-VHF locator systems are useful for improving general communications among operators, and the efficiency and safety of harvest operations. However, safe use of this new technology depends upon the accuracy requirements for particular applications.

Introduction

Multi transmitter GPS-VHF systems currently being produced by Garmin and other manufacturers include one or more handheld receivers capable of mapping the locations of several positional transmitters in real time. Positional transmitters receive a conventional GPS signal and then transmit that location back to handheld or computer devices by VHF signal. GPS-VHF is now available in consumer-grade GPS units that include many features that can be easily adapted for use in forest operations, with relatively minor processing algorithms (Keefe et al., 2013; Keefe, 2014). GPS-VHF is able to function in remote locations where cellular reception and internet access are limited. This important characteristic of the technology is the feature that makes it most valuable for forest engineering, where inter-equipment communication about the relative positions of ground workers, equipment, and timber sale compliance features are critical for improving both safety and production. We describe several applications for GPS-VHF monitoring using fixed radius or polygonal geofences and transmitter position alerts to improve harvest unit planning and administration, define and monitor safe working areas, monitor equipment production logistics, and improve communications. Examples of the types of geofences used for these applications in digitally defined timber sales are shown in Figure 1.

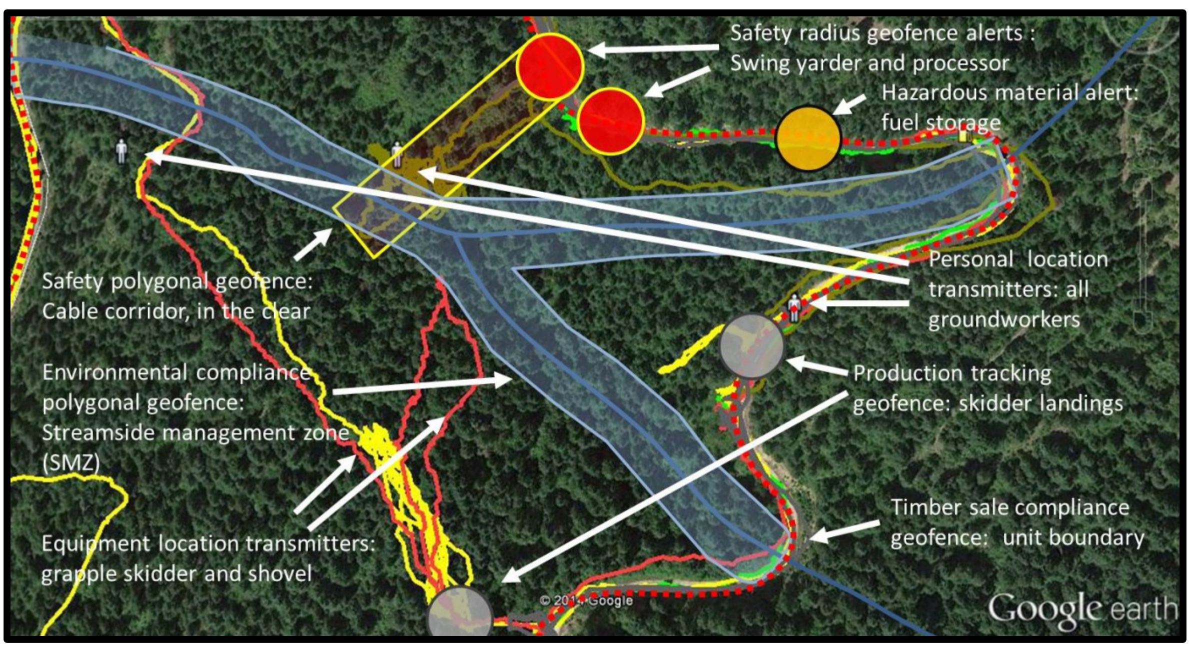
Harvest unit planning and administration

Conventional methods of marking harvest unit boundaries include use of tree marking paint and plastic flagging of various colors and text. GPS-VHF systems that accommodate fixed-radius or polygonal geofences may be used to define characteristics of the harvest unit that are conventionally marked with paint and flagging, and supplement these marking methods during active operations. Property boundaries, harvest unit boundaries, and Streamside Management Zones (SMZ) can all be marked digitally using geofences, and then used by operators for self-location and reference during harvesting. Because of the positional accuracy limitations of consumer-grade multi synchronous GPS-VHF transmitters, these applications should only be deployed to supplement, and not to replace, conventional marking methods until the suitability of GPS-VHF accuracy for various forest engineering applications is better quantified.

Silvicultural prescriptions and environmental compliance

Green-tree retention areas are a common requirement in sustainability certification programs such as the Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI). Group retention areas are most commonly irregular in shape. Using polygonal geofences, feller-buncher and skidder operators can mark group retention and group selection areas digitally. GPS-VHF transmitters placed on equipment then display the mapped location of equipment relative to these harvested (group selection) or unharvested (group retention) areas, and warn operators as they approach the geofence.

Figure 1: Example of a digitally defined harvest unit, coupling various geofence applications with real-time positional transmitters on all equipment and ground workers



Ground and cable productive cycles

By delineating fixed radius, linear, or polygonal geofence boundaries around the log landing or around a cable yarder, it is possible to use GPS-VHF to monitor and record each time an equipment of ground worker location transmitter crosses the geofence when entering or leaving the landing, or at some other location in the cycle. This makes real-time monitoring of cycle time progress available to other operators (e.g. processor, loader, multiple shovels or skidders).

Logging safety

Logging is typically among the most dangerous professions in the United States (Sygnatur, 1998). In ongoing studies in North Idaho, GPS-VHF transmitters have been sewn into safety vests and used to monitor the position of rigging crews during cable yarding, as well as the positions of manual fallers. Fixed radius geofence safety zones are also set around each piece of semi-stationary equipment, including the loader, processor, and swing yarder. Alert signals on handheld units in the cabs of equipment are used to indicate each time ground workers travel in or out of digitally defined safety zones. Similarly, polygonal, irregularly shaped geofences can be used to map fixed area safety zones around cable corridors, and around the log landing in ground-based or heli-logging systems. Hazardous material storage sites on active operations, including diesel fuel and herbicide, are also identified and mapped digitally with fixed-radius geofences. Any time equipment comes within the fixed-radius or polygonal safety area defined by the geofence around hazardous materials, an alert signal warns the operator.

Discussion

The successful layout and implementation of timber sales relies on clear communication between forest engineers and operators, spanning pre-sale unit planning and active logging. GPS-VHF systems make it possible to communicate the locations of unit boundaries, silvicultural treatments, and environmental compliance digitally, expanding operator awareness to real-time mapping of equipment locations and audible equipment position warnings. Using fixed or polygonal geofences with alerts, the same technology can be used to monitor key components of production, such as the partial or total completion of a grapple skidder or skyline carriage productive cycle. Fixed radius and polygonal geofence safety zones, coupled with GPS-VHF transmitters on ground workers and equipment, can help improve communication about safe working areas and hazardous material locations. However, safe and useful deployment of this new technology depends on careful characterization of appropriate applications based on accuracy requirements in forest environments.

References

Keefe, R.F. and J.U.H. Eitel (2013). Application of carriage-mounted agricultural cameras to improve safety in cable logging operations in Idaho. Proceedings, 2013 Annual Meeting of the Council on Forest Engineering, Missoula, MT, July 7-10, 2013

Keefe, R.F. (2014). Application of carriage-mounted agricultural cameras and multi transmitter GPS-VHF to improve safety in cable logging operations. Invited presentation, Oregon Logging

Conference, Eugene, OR, February, 2014

Sygnatur, E.F. 1998. Logging is perilous work. Compensation and Working Conditions Winter 3-9

Citation:

Keefe, R.F.; Eitel, J.U.H.; Smith, A.M.S.; Tinkham, W.T. 2014. Applications of multi transmitter GPS-VHF in forest operations. In Proceedings of the 47th International Symposium on Forestry Mechanization and 5th International Forest Engineering Conference, Gerardmer, France, 23–26 September 2014