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WHITE PAPER

April 4, 2024

TO: FIRESCOPE Board of Directors
23300 Castle Street
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FROM: FIRESCOPE Ops Team, Task Force, Emerging Information Technologies Subcommittee

SUBJECT: WILDLAND DISMOUNTED RESOURCE TRACKING

APPROVAL: This White Paper was approved by the Board of Directors on April 4, 2024

Summary: The ability to remotely view the location of dismounted firefighters would enhance the safety of all who operate in the wildland environment. Rapidly advancing technology and connectivity improve the outlook for tracking dismounted resources in all terrains. The ideal solution will be quickly deployed, easily connected, able to be viewed on a Common Operating Picture (COP), and able to be shared with other agencies.

Knowing where resources are located is an age-old fire service problem. For the wildland fire service, describing and sharing location becomes even more problematic when working away from roads and known landmarks. Advances in location-based technology over the last 20 years have brought the fire service to a point where automatically sharing the exact location of resources in real-time can be achieved in all but a few circumstances.

During routine fire operations, knowing the locations of resources lends to increased efficiency and effectiveness. A certain level of safety can be achieved by understanding where resources are located when completing hazardous activities like firing operations and in the event of an incident within an incident.

The purpose of this paper is to provide a list of considerations for evaluating “resource tracking” solutions, information on current commercially available solutions, and the intrinsic limitations associated with the various communication pathways used to share resource locations.

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Findings: The desire to know the location of resources on a wildland fire is transitioning from a "nice to have" to a "must-have" for a variety of factors. High-profile tragic incidents like the fatal burn over of the Granite Mountain Hotshots and the uncertainty of their location thrust location-sharing technology from the military to the wildland fire service 10 years ago. In 2019, the John D. Dingell Jr. Conservation, Management, and Recreation Act (Dingell Act) directed the federal wildland agencies to "*develop and operate a tracking system to remotely locate the positions of fire resources for use by wildland firefighters, including, at a minimum, any fire resources assigned to Federal type 1 wildland fire incident management teams*."

In response to the mandates in the Dingell Act, the Interagency Fire Management Board (FMB) chartered the interagency Dingell Act Resource Tracking (DART) group to conduct and review the required pilot projects. The Dingell Act also directed the federal wildland fire agencies to develop the tracking solution as a joint effort with state-level firefighting agencies. The research done for this paper indicates the federal government is focusing on integrating their solution with the solutions that state and local governments develop to meet their requirements. It is the opinion of the FIRESCOPE Emerging Information Technology (EIT) group that this decision reflects the reality of the monumental task of ensuring all agencies are using a solution that meets their technical and fiscal requirements.

It should be noted that there are no existing labor laws or statutes requiring state and local government fire agencies that respond to federal wildfires to meet the Dingell Act requirements. The DART team indicated that if a resource lacks an existing solution or integration, a tracking device will be issued to a resource by the Type 1 Incident Management Team (IMT). Furthermore, the Dingell Act only requires resource tracking on a Type 1 incident being managed by an IMT. Tracking during the initial attack period, while beneficial, is not a requirement per the language in the Dingell Act.

It is the opinion of the EIT group that tracking resources from the initial attack period is beneficial and that any pre-existing agency-to-agency integration would naturally offer resource tracking during this period. Furthermore, this highlights the need for multi-agency technical collaboration before the incident to ensure disparate systems are connected and sharing resource locations. Many local government agencies already share resource locations through a variety of technical sharing agreements and software applications. However, these are generally limited to vehicle tracking and are not focused on dismounted personnel tracking.

In preparation for this report, a questionnaire was submitted to California fire service professionals to gauge their interest and knowledge of shared resource tracking. Nineteen responses were received and evaluated. Although there were various opinions on what defined a resource and when resources should be tracked, the responses showed an overwhelming need for accountability in terms of safety during an incident.

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At the inception of the Dingell Act, which required the tracking of ‘resources,’ came the question of what defines a ‘resource’. The DART team has requested clarification and is awaiting a response for the definition of a ‘resource’ from FMB. The DART pilot projects focus on both vehicle and dismounted firefighter locations. The DART focus is not on tracking each individual, but rather on those with the potential to work alone. The result would be a mix of agency-owned vehicles pre-equipped with a vehicle tracker and a dismounted tracking device for single resources or teams dismounted far from the vehicle.

The communication pathways for location sharing are of paramount importance. The P.A.C.E. acronym for Primary, Alternate, Contingency, and Emergency is applicable to describe these communication pathways. Most career all-hazard fire departments in California are sharing vehicle locations with some form of computer-aided dispatch (CAD), common operating picture (COP), and/or mapping system. The primary means of transmitting location data are through land-based cellular connectivity over the major commercial carriers of ATT/FirstNet, Verizon, and T-Mobile. Wildland incidents with dismounted firefighters may not be in areas with reliable cellular connectivity. Most agencies do not have an alternate communication pathway to continue sharing their location when disconnected from their cellular provider. Additionally, these agencies may not have hardware/software applications to track the dismounted individuals and/or teams.

It should be noted that not all connectivity solutions offer the same capabilities. As to not add significant weight and restriction to arduous work activities, dismounted solutions need to be small and light. With the smaller size comes a tradeoff in bandwidth and battery life. Dismounted tracking devices are typically limited to sending and receiving location, point of interest, small polygons/shapes, and messages. Battery life must also be considered, as devices used to track dismounted firefighters will need to support common operational periods used on Federal, State, and Local Incidents.

The most common alternative pathway for sending data is through satellite communications from commercial providers. Satellite communications are more expensive when compared to land-based cellular providers. For an agency that has traditionally reliable cellular service as its primary communications pathway, transmitting over cellular and satellite simultaneously becomes cost-prohibitive. However, some solutions will set a priority for cellular and only switch to satellite when needed. This type of solution allows an agency to only use one pathway at a time which is more cost effective.

It is worth noting that some satellite communications are one-way only; they send the location of the device over the satellite pathway but do not use the satellite communications to bring other user locations back into a common operating picture/mapping application. This method is used to save on costs associated with data and is not a limit to the capability of the system. Each agency should evaluate the cost benefits of a tiered approach to connectivity.

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Satellite services do have limitations in a few scenarios. For the device to work, it requires a clear view of the sky. Topography, location, and weather conditions can affect the device's ability to connect to the satellite. Agencies that have robust wide-area radio systems, like CAL-FIRE, leverage their statewide radio network to transmit vehicle location data. In this approach, cellular is primary, radio is alternate, and satellite is contingency. The majority of public safety agencies are not leveraging radio networks as an alternative communications pathway due to their limited footprints.

Personnel tracking with satellite communication devices has existed in the outdoor recreation community since 2010. These devices are targeted at outdoor enthusiasts who recreate in areas that are not covered by land-based cellular networks. These same cellular denied areas are also frequently visited by first responders on wildfires and search and rescue missions. These devices allow the user to have their location tracked remotely, and/or sent on demand, as well as send an SOS message to a call center, which in turn summons help. The latest versions allow text messaging and mapping through the device or a Bluetooth-enabled smartphone companion application. Many of these solutions have open application programmable interfaces (APIs) which allow the location to be shared with third-party applications and could be integrated into a wildfire tracking solution today. The DART pilot project included some of these existing commercial solutions.

Creating mobile ad-hoc networks (MANET) is another means of linking together locations of resources. In this model, MANET radios create a mesh network where applications that can communicate peer-to-peer can share location on a local network. MANET solutions allow the users to fill in coverage gaps by adding radio nodes to connect radios that are not in the line of sight of one another. The closest comparison is VHF voice radio repeaters deployed during a wildfire. Additionally, some high bandwidth MANET systems can bridge to the public internet. In this configuration, if one MANET radio node is connected to the internet, all connected nodes share this internet connection. The most common configuration is a vehicle-mounted MANET radio that is connected to the internet via cellular or satellite communications. Much like satellite communication devices, there is a tradeoff between performance and cost.

An emerging technology that is on the immediate horizon in the connectivity realm is cellular service from space. In this configuration, the providers are using cellular frequencies with satellites. There are a handful of commercial companies that have successfully tested transmitting data over these networks. What is novel about this deployment is that a cellular device will be able to access this network as is without the need for additional hardware. Once a device is no longer connected to a terrestrial antenna it would connect to this network. This technology is still a few years from becoming available.

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The remainder of this document lists considerations when evaluating a solution for resource tracking. The primary focus is on dismounted solutions because they can double as a vehicle tracker. The consideration categories are broken down into software, hardware, and deployment options. It is essential for any solution to have the capability to share location data with other systems. Open APIs are crucial to ensure location exchange in all solutions can be populated across the multitude of common operating systems. Data that remains in a silo has limited value.

Recommendations: Standard Equipment for dismounted resource tracking should consist of the following capabilities and features:

1) Software
    i) Ability to share data across other systems agnostically so no one solution is a silo. This is likely achieved by open APIs on the server(s)/back end to share locations to other programs/COPs. Common interface languages should be used (i.e. JSON)

    ii) Ability to choose update intervals. The research among fire service leaders determined that different resource types or incidents may require different data intervals.
        (a) Distance
        (b) Time

    iii) Configuration should be easy and via web portal or mobile OS application.
        (a) Contact Info
        (b) Personal Accountability Report (including but not limited to Callsign, Name, ID, Apparatus #, etc.)

2) Dismounted Hardware - the device(s) each firefighter would wear.
    i) SWaP
        (a) Size - should not impede the user's ability to perform arduous work activities.
        (b) Weight - should not weigh enough to encumber the wearer.
        (c) Power - should last for an operational period and not have proprietary or unusual charger characteristics.
            (i) Internal battery supply to last a minimum of 12 hours, ideally 24+ hours.
            (ii) Ability to charge in the field with commercially available equipment.

    ii) Weather Resistance
        (a) Intrusion Protection of at least IP68 or greater.
        (b) Shock/Drop/Vibrations Resistance.
        (c) Temperature (0-140 F).

iii) GPS Receiver
- (a) Internal Global Positioning System (GPS) receiver.
- (b) Dual frequency Global Navigation Satellite System (GNSS).
- (c) 3-meter or better accuracy.

3) Deployment

i) Standalone
- (a) ability to be used as a stand-alone tracking device without user interaction beyond turning on and charging.
- (b) Ability to send a canned message.
- (c) Ability to trigger an SOS.

ii. Optional Mobile Operating System (OS) Companion Application.
- (a) Ability to integrate with a mobile OS companion application.
- (b) Ability to show the user location on the mobile map.
- (c) Ability to see the other users' locations on the mobile map.
- (d) Ability to send/receive chat messages.
- (e) Ability to send SOS message.
  - (i) Include location
- (f) Ability to send point and polygon.

iii. Location Sharing
- (a) Networks
  - (i) Satellite
    1. Bands
    2. Commercial off-the-shelf (COTS) providers
    3. Transmit Power
  - (ii) Cellular
    1. Bands
  - (iii) Mesh/MANET
    1. Bands
    2. Transmit Power
- (b) Ability to leverage multiple communications pathways to choose the most cost-effective network.
  - (i) Solutions that have built-in cellular or are paired with cellular phones may have the ability to leverage the cellular phone data connections and then fail over to satellite when a cellular connection cannot be made. This can help control the fees associated with satellite providers.
- (c) Mesh or peer-to-peer solutions can have local area tracking, and depending on software capability, can forward these locations over satellite or cellular networks. In this configuration, only certain communication nodes in the network are connected to the wider network.

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Appendix

DART Pilot Project:

https://storymaps.arcgis.com/collections/c193360ddf124e5e9ad70b344d40eb14

Dingell Act Provision for Resource Tracking

Section 1114. Wildfire Technology Modernization

(3d) LOCATION SYSTEMS FOR WILDLAND FIREFIGHTERS. —
IN GENERAL. —
(1) Not later than 2 years after the date of enactment of this Act, subject to the availability of appropriations, the Secretaries, in coordination with State wildland firefighting agencies, shall jointly develop and operate a tracking system (referred to in this subsection as the ‘‘system’’) to remotely locate the positions of fire resources for use by wildland firefighters, including, at a minimum, any fire resources assigned to Federal type 1 wildland fire incident management teams.

(2) REQUIREMENTS. —The system shall—
(A) use the most practical and effective technology available to the Secretaries to remotely track the location of an active resource, such as a Global Positioning System; (B) depict the location of each fire resource on the applicable maps developed under subsection (c)(3).
(C) operate continuously during the period for which any firefighting personnel are assigned to the applicable Federal wildland fire; and (D) be subject to such terms and conditions as the Secretary concerned determines necessary for the effective implementation of the system.

(3) OPERATION. —The Secretary concerned shall—
(A) before commencing operation of the system—
(i) conduct not fewer than 2 pilot projects relating to the operation, management, and effectiveness of the system; and
(ii) review the results of those pilot projects.
(B) conduct training, and maintain a culture, such that an employee, officer, or contractor shall not rely on the system for safety; and
(C) establish procedures for the collection, storage, and transfer of data collected under this subsection to ensure—
(i) data security; and
(ii) the privacy of wildland fire personnel.

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