



OFFICE OF WILDFIRE TECHNOLOGY RESEARCH AND DEVELOPMENT

2024 Annual Report



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Executive Summary

The Office of Wildfire Technology Research and Development (OWTRD) was established to serve as the central organizing hub for the State government's identification of emerging wildfire technologies. The escalating frequency and devastation caused by wildfires in California requires a variety of approaches to address the intensifying threat. Emerging technologies have the potential to bring efficiencies to the various efforts utilized in the prevention and mitigation of wildfires. As wildfire is a matter of Statewide concern, the Legislature has enacted several legislative proposals over the last few years to address this threat, including California Senate Bill (SB) 109 (Dodd, Ch. 239, Stats. 2021), which established the OWTRD and the Wildfire Technology Research and Development Review Advisory Board (Advisory Board) in the Government Code (GC).

In 2024, the OWTRD entered its second year of operation, continuing its focus on consulting with public, private, and non-profit entities working on emerging technologies for the wildfire community. As the OWTRD has continued to engage with various organizations throughout the wildfire community, it has also strengthened relationships and collaborative efforts with other public agencies that share a common interest in mitigating the damaging effects caused by wildfires.

The OWTRD's current focus areas include last-mile connectivity, dismounted firefighter location, enhanced situational awareness, firefighter health and safety, and data availability and integration. A notable example of the Office's success is the ALERTCalifornia network of cameras and its addition of artificial intelligence (AI) to aid in detecting the presence of smoke columns. Due to this integration of AI capabilities, in October 2023, Time magazine recognized ALERTCalifornia and CAL FIRE as having one of "The Best Inventions of 2023."

In addition to the ongoing efforts of the OWTRD, 2024 marks the first full year of the Advisory Board being operational. The Advisory Board held its first meeting in December of 2023 and continues to meet at least four times per year. The Advisory Board reviews, analyzes, and assesses the activities and progress of the OWTRD and submits its findings to the Governor and Legislature by the first of January each year, pursuant to GC Section 8586.8.

The 2024 Annual Report presents the findings of the Advisory Board for the 2024 calendar year. The Annual Report includes a background section describing the functions of the OWTRD, areas of focus developed through extensive outreach across the fire industry, technology consideration criteria, and other technology efforts in the wildfire community. The Annual Report concludes with updated information relating to the entities the OWTRD has met with and activities and updates that have occurred since the previous Annual Report.



Legislative Mandate

The Office of Wildfire Technology Research and Development (OWTRD) was established within the California Department of Forestry and Fire Protection (CAL FIRE) by SB 109 (Dodd, Ch. 239, Stats. 2021) to serve as the central organizing hub for the State government's identification of emerging wildfire technologies. The Office is tasked with developing a balanced, multimodal research and development program designed to identify, research, test, and evaluate emerging technologies and tools designed to improve the State's preparation for, and response to, wildfires in the State. SB 109 also established the Wildfire Technology Research and Development Advisory Review Board (Advisory Board). The Advisory Board is required to submit its findings annually to the Governor and Legislature beginning in January 2024 and every year thereafter until the scheduled date of repeal, January 1, 2029.

Wildfire Technology Research and Development Review Advisory Board Members

- Secretary of the Natural Resources Agency, or their designee.
 - Designee: Lisa Lien-Mager, Deputy Secretary, Forest and Wildfire Resilience
- The Director of the Office of Emergency Services, or their designee.
 - Designee: Brian Marshall, Chief, Fire and Rescue
- The Director of the Department of Forestry and Fire Protection, or their designee.
 - Designee: Scott Gregory, Deputy Director, Technology
- One representative from academia involved in the field of wildfire research and technology development (Appointed by the Governor).
 - İlkey Altıntaş, University of California San Diego, Chief Data Science Officer
- One representative from the private wildfire response science, engineering, and technology industry (Appointed by the Governor).
 - Ronald Eguchi, ImageCat, President and CEO
- One representative from local government (Appointed by the Governor).
 - Ashish Kakkad, San Diego County Sheriff's Office, Chief Technology Officer,
- One member of the public employed as a first responder (Appointed by the Governor).
 - Andreas Johansson, Corona Fire Department, Fire Captain
- One member who is appointed by the Senate for a term of four years who is involved in victim services.
 - Kendall Jarvis, Legal Aid of Sonoma County, Lead Disaster Relief Attorney
- One member who is appointed by the Assembly for a term of four years who is involved in the protection of privacy and civil liberties.
 - Justin King, Law Offices of Justin H. King, Senior Trial Attorney



Introduction

Since 2003, 19 of the 20 largest wildfires in California's history have occurred, with 5 of the 8 largest taking place in 2020 alone. These wildfires have claimed hundreds of lives and caused billions of dollars in damage. It has reaffirmed that the prevention and mitigation of wildfire is a matter of Statewide concern that requires public service agencies and communities to work together to address the threat.

The OWTRD consults with public, private, and nonprofit entities to identify new technologies, tools, software, and other advances in wildfire preparedness and response. It is important to note that the OWTRD does not purchase emerging technology but rather functions as a resource for public, private, and non-profit entities innovating within the wildfire community. The OWTRD aims to remain apprised of new technologies and facilitate the gathering and dissemination of information to others in the wildfire community.

The OWTRD currently has five full-time equivalent positions allocated to the program. These positions are comprised of the following:

- (1) Deputy Chief
- (1) Research Data Manager
- (1) Research Specialist II
- (2) Associate Governmental Program Analysts

To fulfill its legislative mandate, the OWTRD engages in the following activities:

- Interaction with the Advisory Board to present findings and receive recommendations.
- Consultation with public, private, and nonprofit entities to identify new technologies.
- Coordination with subject matter experts to assist in providing input aimed at benefiting multi-agency wildfire-related initiatives.
- Evaluation of emerging wildfire technologies.
- Interaction and collaboration with various public service agencies.
- Participation in wildfire technology-focused conventions and gatherings related to technologies relevant to the wildfire community.

The activities of the OWTRD are subject to review by the Advisory Board, which serves in an advisory capacity and convenes at least four times per year. The OWTRD supports the Advisory Board with meeting logistics and planning, meeting content development, and facilitating robust discussions related to the various areas of expertise and priorities among Advisory Board Members.



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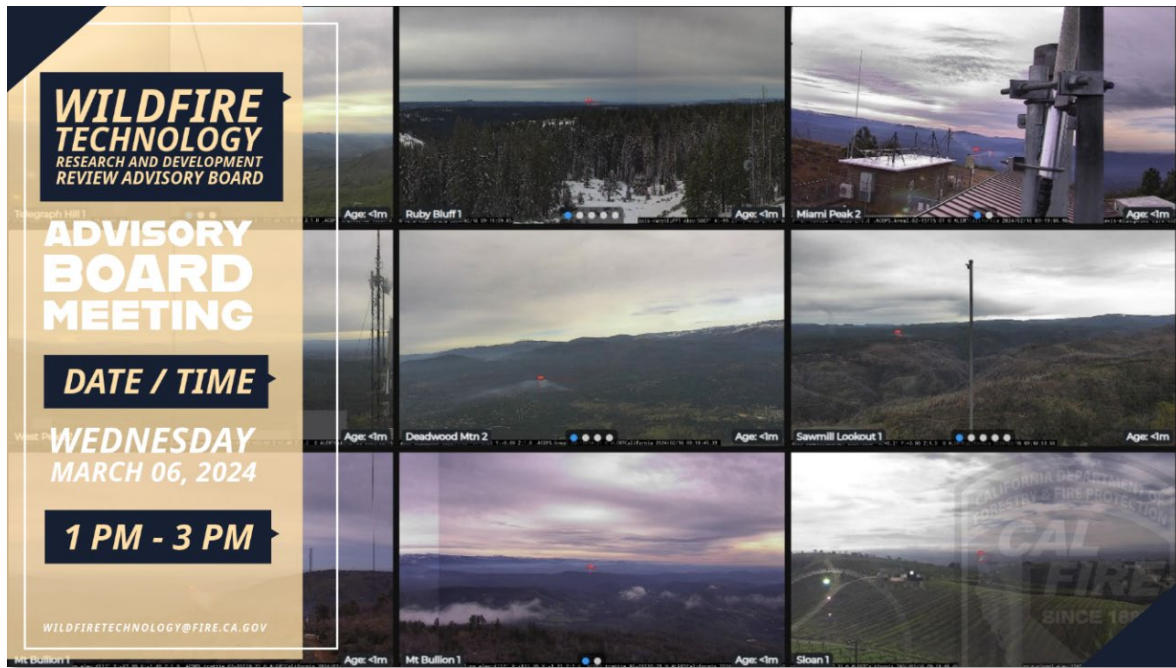


Figure 1. Welcome image from the March 06, 2024, Wildfire Technology Research and Development Review Advisory Board meeting that took place in Rancho Cordova, California.

The OWTRD also compiles their findings to be included in the Annual Report that is delivered to the Office of the Governor and the Legislature on an annual basis, no later than the first of January each year.

The OWTRD meets with many innovators in the wildfire community to maintain awareness of emerging technologies within the wildfire space and to either directly provide or facilitate the provision of subject matter expertise from a potential end user of the emerging technology. This also uniquely positions the OWTRD to connect various innovators and appropriate organizations for possible collaboration. However, the OWTRD does not provide internal contacts to public, private, and nonprofit entities for marketing or sales. Additionally, the OWTRD does not fund the development of external technologies. If an organization is looking to procure technology, the OWTRD is available to provide an overview of the solutions that are currently available for the organization to determine the resolution that works best for them.

As emerging technologies progress beyond conceptual or prototype phases, the OWTRD may participate in evaluating them to determine whether they have the potential to make a meaningful impact within the wildfire community. Just as large wildfires often require coordination among various agencies, technology innovators often need to engage with potential end users to ensure their solutions address real-world challenges. The OWTRD and the Advisory Board continue to interact with various organizations innovating within the wildfire community and aim to facilitate as much meaningful innovation as possible toward preventing and mitigating wildfires.



Current Areas of Focus

The wildfire community is engaged in multiple efforts to prevent and mitigate the damaging effects of wildfire. Many of these efforts involve technologies that have already proven their value. They are receiving ample usage and continued development by the programs and organizations actively utilizing them. The OWTRD attempts to focus on emerging technologies that would potentially serve a need within the wildfire community, but may not be currently receiving ample attention from other programs and organizations. The OWTRD's current areas of focus include last-mile connectivity, dismounted firefighter location, enhanced situational awareness, firefighter health and safety, and data availability and integration.

Last-Mile Connectivity

New technologies often require reliable connectivity, which remains a significant challenge for first responders in remote areas. If data is not quickly transmitted to the intended end-user, it can lose relevancy or effectiveness. This is why last-mile connectivity is an area of prime interest for first responders. Current technologies that extend beyond standard cellular networks are often expensive and lack the necessary coverage for large-scale emergency incidents. While additional local networks can help, they often fail to reliably cover the entire incident area.

One meaningful solution that has begun to see usage is data connectivity via low Earth orbit (LEO) satellites and compact antennas that can be quickly deployed in the field or mounted to vehicles and used while the vehicle is in motion. While the current antennas potentially remain a size and cost that may restrict wide-scale utilization, they have significantly increased the data connectivity capabilities for some first responders. An emerging technology on the horizon is LEOs that connect directly to mobile devices, also known as direct-to-cell.

Direct-to-cell technology is particularly promising because it can work with existing cellular hardware, eliminating the need for additional equipment or system upgrades. An important aspect of any new technology is its ability to work with tools and systems that are already in use without the need to purchase additional equipment or systems. Multiple efforts are underway within the telecommunications industry to eliminate gaps in cellular Long Term Evolution (LTE) coverage. If successful, it will significantly assist in solving the last-mile connectivity issue often needed for multiple emerging technologies. While bandwidth will be lower than what is currently provided via LEO satellite antenna and traditional data connectivity methods, this technology may eliminate dead zones and provide the reliable connectivity that first responders greatly need. Nevertheless, until this technology is available at scale, the OWTRD maintains awareness of alternative technologies that may provide useful improvements in the interim.



Figure 2. CAL FIRE and CalOES evaluating a last-mile connectivity solution in LaTour Demonstration State Forest east of Redding California in December 2023. Photography by OWTRD.

Dismounted Firefighter Location

Maintaining awareness of the location of firefighting resources is essential in efficiently dispatching first responders to emergency incidents. Utilizing Automated Vehicle Location (AVL) Systems, many California fire agencies have been able to monitor the near-real-time location of their motorized resources as they change locations throughout their response area or while on active incidents. This has dramatically enhanced their ability to dispatch the closest, most appropriate resource to emergency incidents and enhance situational awareness. However, quickly locating first responders via this method is only accurate if the firefighters are within their apparatus. Once the fire apparatus arrives at the scene of an emergency incident and receives an assignment that requires them to leave their apparatus, the most common way to obtain an updated location of the first responders is to communicate via radio traffic.

The next step in enhancing operational efficiencies and increasing safety is determining where the actual first responders are after they dismount their fire apparatus. This is what the dismounted firefighter location references. The ability to gain insight into the location of first responders during all phases of the emergency incident enhances both situational awareness and safety of the first responders and the communities they protect. Knowledge of firefighters' locations throughout all stages of an emergency incident can assist incident commanders in quickly assigning the most appropriate resource to a



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specific operation, maintain operational oversight of personnel locations, and quickly gain a geographical frame of reference for a developing situation, such as an incident within an incident.

Many organizations are making efforts within this space. Factors that may limit the adoption of or scaling of this capability are that it often requires the procurement of additional hardware, service fees, and a new software platform for firefighters to view the locations of other firefighters. Cell phones are often suggested as a primary location device; however, they are limited to locations where cellular coverage is available or a mesh network can be maintained.

The OWTRD began a proof of concept related to dismounted firefighter location, which aimed to maintain near-real-time location of personnel, operate independently of cellular networks, protect privacy, utilize commonly available consumer hardware, and does not require a new software platform.

Hand crews are firefighting resources that often begin work far from their crew transport vehicle. Therefore, it was apparent they were the most appropriate firefighting resource to test this proof of concept. This proof of concept utilized 11 CAL FIRE hand crews headquartered out of the CAL FIRE Santa Clara and Tulare Units. Readily available satellite communicators from multiple manufacturers were utilized as GPS location devices, as they operate independently of cellular networks and are capable of transmitting near-real-time locations from anywhere with an unobstructed view of the sky. The location of these satellite communicators was then displayed on the Common Operating Picture, Technosylva's Tactical Analyst.

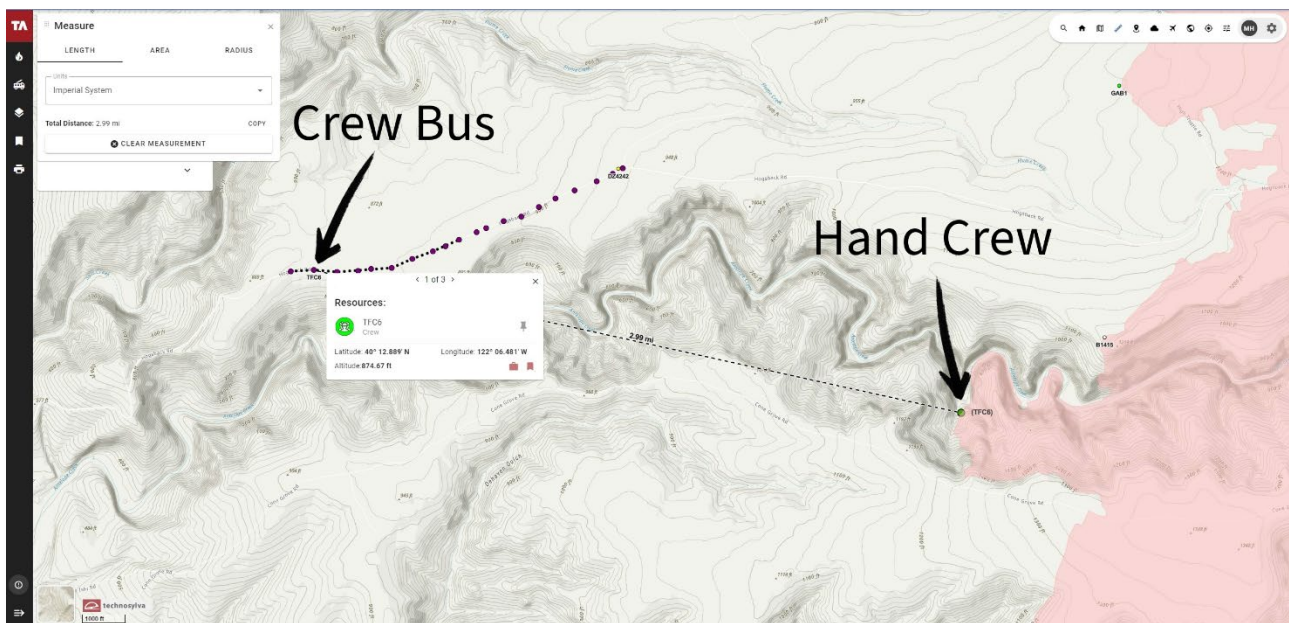


Figure 3. Image captured from Technosylva's Tactical Analyst displaying Tulare Fire Crew 6 satellite transponder location approximately three miles away from their vehicle's AVL location while assigned to the Park Incident.



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This proof of concept demonstrated that it is possible to work within platforms already utilized by first responders to add dismounted firefighter location capabilities. While many promising new software platforms add this capability, agencies may not want to switch platforms as there are associated expenses that include both the service cost and the training of personnel. This proof of concept intends to demonstrate that agencies can choose a solution that works best for their needs.

Enhanced Situational Awareness

Advancements in dismounted firefighter location and last-mile connectivity technologies support the greater effort of enhancing situational awareness, as do additional advances in imagery from ground-based camera networks, aircraft, and satellites. These tools enable fire agencies to access real-time or near-real-time data, providing decision-support tools that assist first responders in assessing and responding to evolving situations.

An example of a decision support tool utilized by first responders that gained additional capabilities in 2023 was the ALERTCalifornia network of cameras and its addition of artificial intelligence (AI) to aid in detecting the presence of smoke columns. Due to this integration of AI capabilities, in October 2023, *Time* magazine recognized ALERTCalifornia and CAL FIRE as having one of “The Best Inventions of 2023.”¹

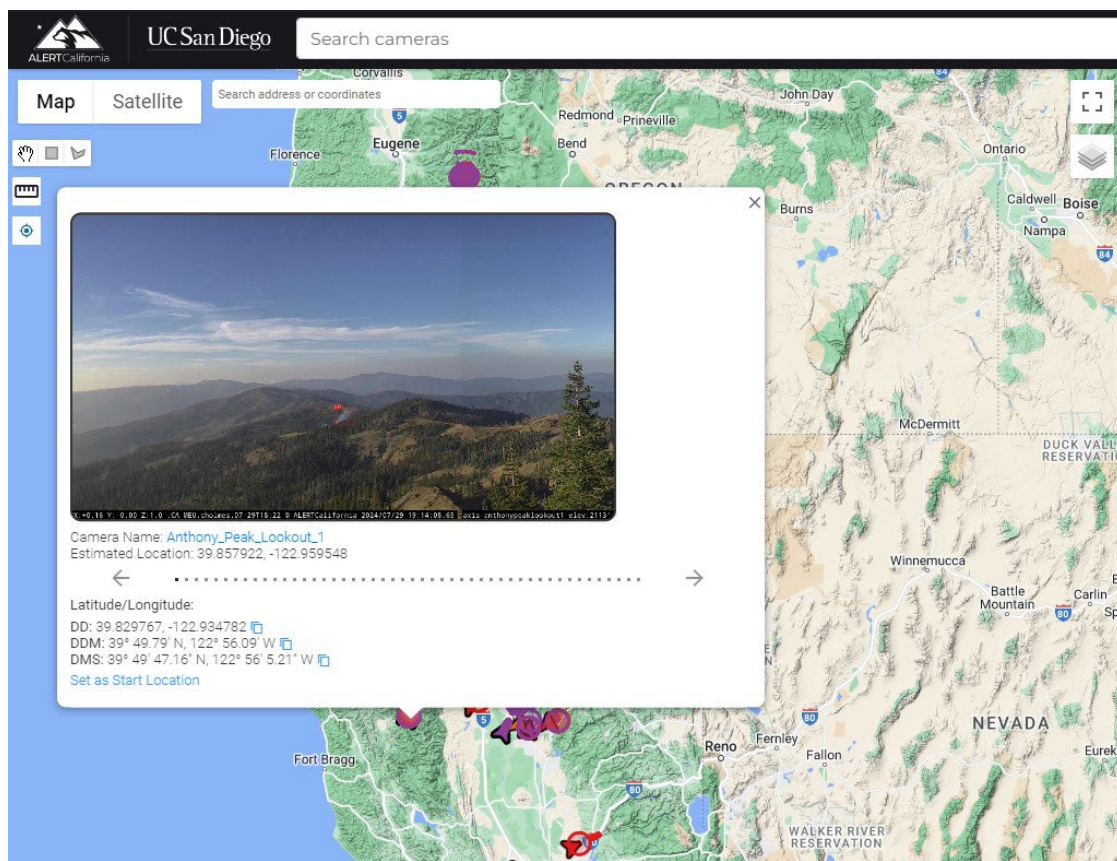


Figure 4. ALERTCalifornia network of cameras displaying a red bounding box where an AI detection of a smoke column can be seen. Images captured from alertcalifornia.org.



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This is another example of a tool already heavily utilized by first responders, adding a meaningful feature that significantly increased the capabilities of an already widely utilized system. While many “Artificial Intelligence” fire and smoke detection products are entering the market, one crucial feature the ALERTCalifornia Network incorporates is the ability to have a human-in-the-loop. Once the AI detects a smoke column, a human can view the detection and provide a secondary confirmation as to whether the detection is valid or a false positive. This minimizes the chances of unnecessarily dispatching resources to a location and potentially placing them out of position when an actual emergency takes place.

On the other hand, not all technologies meet expectations. The OWTRD evaluated two smoke sensing systems within a forested environment in Mendocino County, California, from July 2023 through July 2024. Like many on the market, these systems claim to utilize artificial intelligence to detect a variety of gases and particulates; in addition, one of the systems also utilizes infrared sensors to alert for the possibility of wildfire. Both systems evaluated by the OWTRD had significant challenges, including maintaining power and connectivity within the forested environment. Another important aspect that these systems made apparent was the value of having a human-in-the-loop, such as camera-based systems with AI smoke detection. Aside from the performance issues both systems exhibited during the year-long evaluation, what also became apparent was the feasibility of an end-user procuring, installing, and maintaining sensor networks that require multiple devices every square acre or square mile for contiguous coverage. Efficiencies can be gained in systems that require fewer devices to cover large geographical areas.

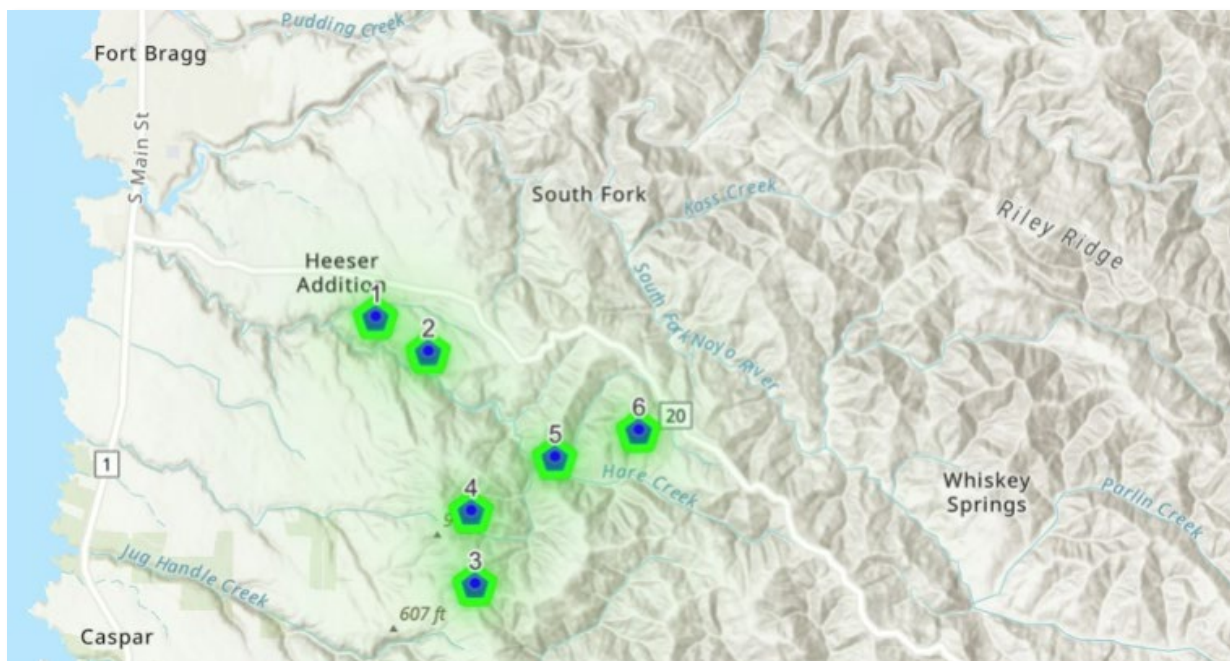


Figure 5. Geographic overview of one of the two remote smoke sensing systems placed in Mendocino County, California. Image by OWTRD.



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A promising initiative currently in the early stages is FireSat, which the Earth Fire Alliance is leading.² For many years, satellites have enhanced situational awareness for public service agencies and the public. For example, two National Aeronautics Space Administration (NASA) satellites, Aqua and Terra, house a specific type of sensor technology known as MODIS (Moderate Resolution Imaging Spectroradiometer) that can detect the thermal signatures of fires and hotspots.³ MODIS has been in use for several years and can visualize every point on Earth every one to two days.⁴ The Earth Fire Alliance aims to create a fire-first satellite constellation focusing on wildfires and their ecological effects. FireSat aims to launch approximately 50 low Earth orbit satellites, allowing an approximate 20-minute revisit rate to provide greater fidelity imagery than previously available via satellites. If FireSat is successful, it has the potential to greatly enhance situational awareness relative to multiple aspects of wildfire mitigation.

Firefighter Health and Safety

While the three areas of focus mentioned above contribute significantly to first responders' well-being, the OWTRD has an additional interest in increasing firefighter health and safety, such as the potential use of wearable devices to provide live health data and personnel location. Advancements in, and implementation of, wearable technologies may present some challenges due to the capturing of personally identifiable information; however, there is interest in efficiencies related to safety that these technologies could bring about.



Figure 6. Incident briefing before an event on June 29, 2024, in which the OWTRD facilitated the integration of multiple Internet of Things (IoT) technologies into a single common operating picture for use by multiple agencies. Photography by OWTRD.



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In 2024, the OWTRD worked on a proof of concept with multiple organizations and public agencies to utilize wearables for personnel location and live health monitoring to be displayed within the Android Team Awareness Kit (ATAK). However, the organization providing the technology to transmit live health data via a wearable device to ATAK was unsuccessful in gaining approval from the wearable device manufacturer to transmit live health data to an external platform because it involved personally identifiable information. However, the overall proof of concept was a success as multiple Internet of Things (IoT) devices and capabilities were integrated into a single common operating picture that was utilized by multiple public service agencies, introducing them to new technologies and capabilities. The OWTRD maintains a high interest in emerging technologies that may promote health and safety for first responders.

Data Availability and Integration

Many variations of wildfire-related data are collected from different sources and organizations, and various methods are used to collect the data. However, the data and technologies employed to collect, store, and utilize the data may be siloed, sensitive, or proprietary based on specific users or types of software. In a world of ever-increasing data and technological complexity, the ability for data to be made available to end users for various needs and used on the software platforms of their choice is essential. In addition to making data available and usable, data quality, quantity, management practices, and standards are critical considerations to facilitate access to and efficient use of wildfire-related data.

Technologies utilized by first responders can be mission-critical, and the protection of internal systems and operations is paramount. When new technologies and platforms are developed, first responders need and desire the use of data and technical standards to ensure technologies work together and the data generated is available and useable. Data standards ensure effective aggregation, sharing, and reuse of data assets.⁵ Technical standards ensure compatibility among different devices, product quality, and safety. Data and technology standards work together and play an important role in understanding and utilizing data and developing new technologies in the wildfire industry. Technologies developed for first responders often fail to conform to commonly used data and technology standards. These standards are crucial to ensure data interoperability and accuracy and reduce system redundancy.

Examples of areas where data and technical standards exist include identity, Application Programming Interface (API), and security:

- Open identity standards can streamline user experience and may also enhance security posture. Common identity standards include FIDO (Fast Identity Online) and OIDF (OpenID Foundation).
- An API is a set of protocols or rules allowing software applications to communicate with one another. APIs are essential for the interoperability of different technologies. The key may not be specific data exchange standards but a well-documented and standards-based API. An example of a data standard related to API is OpenAPI (OpenAPI Specification).



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- Security standards aim to prevent unauthorized access, use, disruption, destruction, and modification of data. Examples of security standards include NIST SP800-53, which provides a catalog of security and privacy controls for information systems and organizations. Open Standards for security not only streamline user experience but may also align with enhanced security posture. Common security standards include Fast Identity Online (FIDO Alliance) and ODIF (OpenID Foundation).

One way to achieve the goal of making high-quality data available and usable is for organizations to adopt a data strategy. A well-executed data strategy aligns industry priorities to the data and tools that support the priorities and provides direction on planning, accessing, and synchronizing data processes and operations across the industry. Data strategy also includes adopting policies and processes that support data management, governance, and quality, as well as adopting data and technical standards. A well-formulated data strategy helps drive technology development by clearly defining industry priorities and needs that technology solution developers can then use to develop solutions that incorporate established technical standards. This facilitates the integration and interoperability of different hardware and software tools and greater access to, and use of, industry data acquired from various sources. This dramatically improves the achievement of operational priorities, including resource allocation efficiencies that lead to cost savings, reduced personnel fatigue, and the potential for automation.



Considerations

The OWTRD collaborates with external organizations and internal teams to obtain industry input and evaluate solutions in a systematic way that facilitates innovation within the industry. The Areas of Focus were developed and continue to evolve through a series of engagements with the wildfire community, including forums with fire service professionals and meetings with additional public, private, and non-profit entities.

The OWTRD evaluates emerging technologies to ensure they have evolved past the conceptual or prototype phase and are potentially ready for evaluation in real or near-real-world environments. The OWTRD accomplishes this through an assessment process that determines if the emerging technology would present utility and have the potential to generate interest from early adopters. Additionally, the OWTRD provides an awareness of the capabilities and needs of the fire community, as well as information related to various resources available that may assist in developing new wildfire technologies to potentially add efficiencies toward meaningful innovation.

In the fast-changing world of emerging technology, there can be instances where some promising solutions may not deliver as expected. When a new solution presents itself, it is essential to pay attention to the details, not only what the claims are that the solution will provide, but also the important factors that may not be mentioned. New technologies can have impacts that are both operational and financial; it is crucial that early adopters thoroughly research and vet the solutions that are presented to them before full implementation.

The OWTRD focuses on evaluating the merits of the technology category, not individual products within the category. Below are some of the aspects the OWTRD brings into consideration when evaluating emerging wildfire technologies:

- Industry Gap – The need is clearly defined and not appropriately addressed.
- Scalable – From a technological and financial standpoint, the technology has the potential to be implemented at a large scale.
- Benefits – Benefits of the technology solution are clearly identifiable.
- Equitable – The technology solution has the potential to be implemented within all communities, including those that are under-resourced, underserved, and overburdened.
- Emerging – New/novel technology or use of a pre-existing technology, not a mature commercial product.
- Existence – The technology is beyond the concept or prototype phase.
- Integration and Interoperability – The solution currently works with or has the potential to work with established solutions and systems.
- Cost – The solution has the potential to be financially attainable by prospective end-users.
- Regulatory Considerations – The solution considers legal and regulatory constraints and recognized standards.



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- Feasibility – The solution has the potential to be effectively carried out considering factors like resources, time, technology, legal and regulatory constraints, and financial costs.

If the emerging technology solution addresses a need and shows potential to be implemented, the OWTRD may consider an evaluation of the solution. The OWTRD facilitates the evaluation of emerging technologies for the wildfire industry. However, the OWTRD does not determine which technologies should be implemented, nor does it procure the technologies to integrate into CAL FIRE's operations. The OWTRD's role is to address industry gaps and facilitate product development related to emerging technologies that are not of focus by other programs within CAL FIRE or other fire agencies to benefit all within the fire industry and the communities we serve.



Other Technology Efforts within the Wildfire Community

National Aeronautics and Space Administration (NASA)

The National Aeronautics and Space Administration (NASA) is working on several multi-year initiatives focused on wildfires, including FireSense and ACERO.

NASA FireSense is a five-year effort focused on improving US wildland fire management.⁶ NASA is working with operational agencies responsible for wildland fire management to mature and deliver NASA's unique earth science and technological capabilities. NASA expects to fund select research projects to investigate four phases of wildland fire: pre-fire fuel conditions, active fire dynamics, post-fire impacts, and air quality forecasting. The project began in 2023 and is expected to conclude in 2027 or 2028.

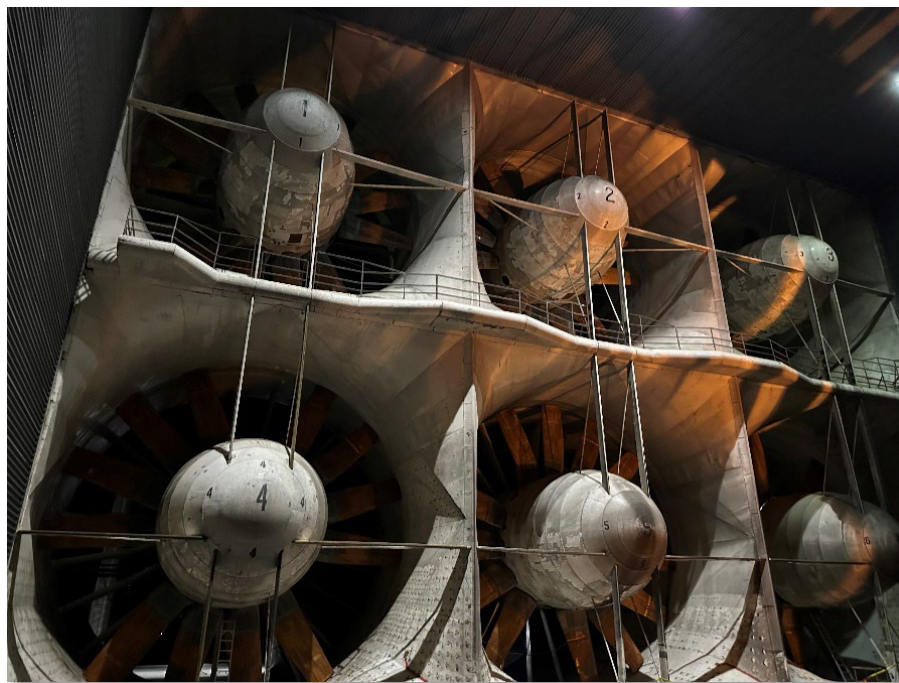


Figure 7. Photograph of the NASA AMES Unitary Plan Wind Tunnel taken during the NASA ACERO Workshop in April 2024. The wind tunnel was built at NASA Moffet Field in the 1950s. Photography by OWTRD.

NASA's Advanced Capabilities for Emergency Response Operations (ACERO) project aims to advance technologies for first responders to keep pace with the growing threat of wildland fires.⁷ This effort seeks to create interagency collaboration related to operational priorities, technology adoption, and programmatic alignment. In addition, the initiative aims to develop new approaches for data gathering, information sharing, aircraft safety, and extended aerial operations necessary to keep pace with the increasing rate and



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severity of the fire environment. For example, ACERO is working to potentially enable uncrewed aircraft systems (UAS) to provide communications, monitoring, logistics, and suppression for wildland fires, as well as efforts to safely integrate UAS into the airspace. This initiative explores airspace management technologies to increase airspace awareness and communication capabilities between crewed and uncrewed aircraft and ground crews during wildfire incidents, enhancing situational awareness and reducing airborne hazards.

United States Forest Service (USFS)

As previously mentioned, situational awareness is critical before, during, and after emergency incidents. The United States Forest Service (USFS) is also making advancements in this field. It is currently working on a new Common Operating Picture, the Wildland Fire Team Awareness Kit (WFTAK), which is an example of enhancing the capabilities of a technology already developed and used by first responders who utilize the Team Awareness Kit (TAK). TAK is a geospatial mapping engine, initially developed for the Android operating system, that facilitates tactical situational awareness, navigation, and data sharing.⁸ TAK employs an open source “government off-the-shelf” model that ensures all government TAK users have free access to the software. The Android version of TAK, known as ATAK, is the most mature. However, applications also exist for viewing the TAK Common Operating Picture using Windows (WinTAK), iOS (iTAK), virtual reality (VTAK), and the web (webTAK).

TAK programs generally allow developers to add additional features and capabilities. Several capabilities are relevant to first responders, such as features that integrate radio systems, allowing the application to function in areas that lack cellular service, and features that synchronize official geospatial data related to incidents across all TAK devices, which is a free-to-use government off-the-shelf (GOTS) application that the Department of Defense developed to facilitate communication across multiple users to achieve shared tactical awareness. The 2019 Dingell Act requires the USFS to create a tracking system to locate USFS wildland firefighters' positions remotely. The USFS considered industry feedback to begin the development of Dynamic Automated Resource Tracking (DART) to meet the requirements of the Act and selected TAK as the platform. The result is the Wildland Fire Team Awareness Kit (WFTAK).⁹ An intergovernmental group known as the TAK Product Center develops and maintains the core TAK applications and allows community members to develop on TAK through plugins and integrations.

The USFS is also partnering with NASA on multi-year efforts to evaluate two high-altitude platforms intended to improve wildland firefighters' situational awareness. These efforts are STRATO (Strategic Radio and Tactical Overwatch) and HALE (High Altitude Long Endurance Aircraft).

The STRATO project is evaluating the endurance and communications capabilities of a high-altitude balloon.¹⁰ The large helium balloon hovers over an incident at about 60,000 feet in the stratosphere, taking pictures, delivering data to incident managers, and providing real-time mapping and communications options to incident commanders and



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crews. The evaluation aims to understand the capabilities to collect infrared and visual data, broadcast a cellular signal, transmit a high-band radio that can enable push-to-talk communications, and operate a WiFi network. This technology is in the research and development phase, with a test flight completed in early August 2024.

The USFS has been working on demonstration testing of HALE since 2020.¹¹ These aircraft operate at elevations above commercial airspace and are intended to remain in a specific geographic area for extended periods, which can be weeks or months. They are planned to be outfitted with imaging sensors and communication systems that provide incident awareness on the ground. Like STRATO, the evaluation aims to assess their endurance and communication capabilities in a real-world environment.

FIRESCOPE

FIRESCOPE is a Statewide program established in Health and Safety Code Section 13070, in which the California Governor's Office of Emergency Services (Cal OES) and CAL FIRE jointly administer the FIRESCOPE Program.¹² The program provides recommendations and technical assistance to Cal OES to continue the operation, development, and maintenance of the FIRESCOPE Incident Command System (ICS) and the Multi-Agency Coordination System (MACS) and to provide professional recommendations and technical assistance to the Director of Cal OES and the Cal OES Fire and Rescue Branch regarding program elements.

Within FIRESCOPE, multiple subcommittees are dedicated to specific subject matters to facilitate meeting the organization's overall goals. One of these subcommittees is the FIRESCOPE Emerging Information Technology Subcommittee (EIT), which researches and promotes effective information technologies for fire and rescue agencies.¹³ The EIT Subcommittee identifies opportunities to adopt standardizations while helping emergency services agencies prepare for expected future technologies. The Subcommittee strives to utilize a best practice model, free of political or geographic bias, drawing upon the experience and knowledge gained in delivering public service. An employee from the OWTRD is a member of the FIRESCOPE EIT and is actively engaged with the subcommittee.



Activities and Updates

In 2024, the following activities and updates occurred:

- Advisory Board fully seated
- Advisory Board engagement with public, private, and non-profit entities
- OWTRD organizational changes
- OWTRD continued engagement with the fire technology industry
- SB 74 (Dodd) proposed the removal of the OWTRD and Advisory Board sunset date.

The Advisory Board was formed and held its inaugural meeting on December 12, 2023, and continues to meet at least four times per year. During these meetings, the Advisory Board engages with and receives updates from OWTRD and other organizations working on emerging technologies within the wildfire community.

Due to the continued growth in the importance of technology related to the prevention and mitigation of wildfires, 2024 saw a reorganization of the OWTRD's reporting structure. The OWTRD now directly reports to the CAL FIRE Deputy Director of Technology.



Figure 8. Diagram of the OWTRD updated reporting structure.



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OWTRD staff attended and provided presentations at several meetings and conferences throughout California. In addition to interactions with the community and organizations at seminars and conferences, between January 2024 and July 2024, the OWTRD interacted with over 75 organizations and individuals through its standardized online technology intake process. Innovators continue to efficiently reach out to the OWTRD via CAL FIRE's public website.

Figure 9. Screenshot of OWTRD standardized intake form that is available on CAL FIRE's public website.

SB 74 (Dodd) would have removed the January 1, 2029 sunset date for the OWTRD and Advisory Board. The removal of the sunset date for the OWTRD and Advisory Board would have allowed both entities to focus on continued long-term strategies to improve wildfire technologies and engage in multi-year efforts with interagency partners. SB 74 was held on Suspense in the Assembly Appropriations Committee.



Conclusion

The increasing frequency and devastation caused by wildfires is ongoing. At the same time, technology continues to advance rapidly and plays an important role in how California approaches this issue. The OWTRD and the Advisory Board aim to continue contributing to efforts to address this challenge. In the years ahead, advances in connectivity, artificial intelligence, the Internet of Things, wearables, and a host of other hardware and software technologies may continue to offer increased capabilities. The OWTRD and Advisory Board will continue their work in serving as the central organizing hub for California's identification of emerging wildfire technologies.



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Appendix A: Acronyms and Definitions

ACERO	Advanced Capabilities for Emergency Response Operations. A project with NASA to advance technologies for first responders to keep pace with the growing threat of wildland fires.
ATAK	Android Team Awareness Kit
AVL	Automated Vehicle Location. The ability to monitor the near-real-time location of motorized resources.
DART	Dynamic Automated Resource Tracking. To remotely track the location of active resources and display the location of each on real-time maps.
FireSense	A project with NASA that is a five-year effort focused on improving American wildland fire management.
GOTS	Government Off-The-Shelf
HALE	High Altitude Long Endurance Aircraft. One of two projects to evaluate two high-altitude platforms intended to improve wildland firefighters' situational awareness.
iTAK	iOS Team Awareness Kit. Viewing the Team Awareness Kit using the iPhone operating system.
MACS	Multi-Agency Coordination System
MODIS	Moderate Resolution Imaging Spectroradiometer. A sensor that can detect the thermal signature of fires and hotspots.
STRATO	Strategic Radio and Tactical Overwatch. One of two projects to evaluate two high-altitude platforms intended to improve wildland firefighters' situational awareness.
TAK	Team Awareness Kit. A free application that assists wildland firefighters improve situational awareness, navigation, and data sharing. It may be used on cellphones, tablets, and computers, utilizing iOS, Android, Windows, virtual reality, and the web.
VTAK	Virtual Reality Team Awareness Kit
webTAK	Internet-based or web-based Team Awareness Kit
WFTAK	Wildland Fire Team Awareness Kit
winTAK	Windows Team Awareness Kit. Viewing the Team Awareness Kit using Windows.



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Appendix B: Senate Bill 109

Senate Bill 109, published September 24, 2021, is reproduced below in full, for reference:

LEGISLATIVE COUNSEL'S DIGEST

SB 109, Dodd. Department of Forestry and Fire Protection: Office of Wildfire Technology Research and Development.

Existing law, the California Emergency Services Act, establishes, within the office of the Governor, the Office of Emergency Services, under the direction of the Director of Emergency Services for the purpose of mitigating the effects of natural, manmade, or war-caused emergencies.

Existing law also establishes the Department of Forestry and Fire Protection and establishes various programs for the prevention and reduction of wildfires. Existing law requires the office and the department to jointly establish and lead the Wildfire Forecast and Threat Intelligence Integration Center, and sets forth the functions and duties of the center, including serving as the state's integrated central organizing hub for wildfire forecasting.

This bill would, until January 1, 2029, also establish the Office of Wildfire Technology Research and Development within the Department of Forestry and Fire Protection under the direct control of the Director of the department. The bill would make the office responsible for studying, testing, and advising regarding procurement of emerging technologies and tools in order to more effectively prevent and suppress wildfires throughout the state, through specified activities, as provided.

This bill would establish the Wildfire Technology Research and Development Review Advisory Board consisting of 9 specified members, including the Secretary of the Natural Resources Agency, or their designee, the Director of the Office of Emergency Services, or their designee, and the Director of the Department of Forestry and Fire Protection, or their designee, among others. The bill would make the Office of Wildfire Technology Research and Development subject to review by the board. The bill would require the board to meet at least 4 times per year, as specified. The bill would require the findings and recommendations of the board to be compiled and delivered to the office of the Governor and the Legislature no later than January 1, 2024, and annually thereafter, as provided. The bill would require members of the board to serve without compensation, but would allow members to be reimbursed for actual expenses incurred in connection with their duties.



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BILL TEXT

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. The Legislature finds and declares all of the following:

- (a) With approximately 40,000,000 residents, the State of California is the most populous state in the nation and has the third largest land area among the states (163,695 square miles).
- (b) California faces arguably the most complex and severe wildfire disaster conditions in the nation that pose threats to our people, property, economy, and environment. These challenges and complexities grow in magnitude each year.
- (c) Catastrophic wildfires pose an urgent threat to lives, property, and resources in California.
- (d) Seventeen of the 20 largest wildfires in California history have occurred since 2000, and 6 of the 7 largest wildfires occurred in 2020 alone.
- (e) The escalating frequency and devastation caused by wildfires demand ongoing research and development of emerging wildfire technologies and tools to prevent, monitor, identify, and suppress wildfires developed by public, private, and nonprofit entities in order to protect lives and property from the effects of wildfires.
- (f) It is in the best interest of the state that our wildfire preparedness and response infrastructure include and integrate the most effective and evidence-based scientific and technological perspectives and tools to address the wildfire threat facing California.

SEC. 2. Section 8586.8 is added to the Government Code, to read:

8586.8. (a) For purposes of this section, “office” means the Office of Wildfire Technology Research and Development.

(b) The Office of Wildfire Technology Research and Development is hereby established in state government within the Department of Forestry and Fire Protection to study, test, and advise regarding procurement of emerging technologies and tools in order to more effectively prevent and suppress wildfires within the state. The office shall serve as the central organizing hub for the state government’s identification of emerging wildfire technologies.

(c) The office shall be under the direct control of the Director of Forestry and Fire Protection.

(d) The office shall undertake, but is not limited to, the following activities:



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- (1) Develop a balanced, multimodal research and development program designed to identify, research, test, and evaluate emerging technologies and tools designed to improve the state's preparation for, and response to, wildfires in the state, including, but not limited to, fire retardants and ground, aerial, mobile, portable, communication, predictive modeling, software, or stationary equipment used for California's wildfire preparedness and by first responders.
 - (2) Consult with public, private, and nonprofit entities in identifying new technologies tools, software, and other advances in wildfire preparedness and response.
 - (3) Make recommendations to state and local agencies on the most effective and useful technologies and tools for procurement.
- (e) The office shall be subject to review by the Wildfire Technology Research and Development Review Advisory Board, which shall serve in an advisory capacity, and shall consist of the following nine members:
- (1) The Secretary of the Natural Resources Agency, or their designee.
 - (2) The Director of the Office of Emergency Services, or their designee.
 - (3) The Director of the Department of Forestry and Fire Protection, or their designee.
 - (4) Four members who are appointed by the Governor for a term of four years each, as follows:
 - (A) One representative from academia involved in the field of wildfire research and technology development.
 - (B) One representative from the private wildfire response science, engineering, and technology industry.
 - (C) One representative from local government.
 - (D) One member of the public employed as a first responder.
 - (5) One member who is appointed by the Senate for a term of four years who is involved in victim services.
 - (6) One member who is appointed by the Assembly for a term of four years who is involved in the protection of privacy and civil liberties.
- (f) The board shall meet at least four times per year to review, analyze, and assess the activities and progress of the Office of Wildfire Technology Research and Development,



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and to consult with public, private, and nonprofit entities regarding their interaction and responsiveness of the office.

(1) The findings and recommendations of the board shall be compiled and delivered to the office of the Governor and the Legislature as a report no later than January 1, 2024, and annually thereafter.

(2) The report developed by the board pursuant to this section shall be submitted in compliance with Section 9795.

(g) Members of the board shall serve without compensation, but they may be reimbursed for actual expenses incurred in connection with their duties.

(h) This section shall remain in effect only until January 1, 2029, and as of that date is repealed.



Endnotes

¹ Time Magazine, *Stopping Wildfires, The Best Inventions of 2023*. Pranav Dixit, October 24, 2023. [AlertCalifornia and Cal Fire AI Wildfire Detector: The 200 Best Inventions of 2023 | TIME/](#) Accessed on August 1, 2024.

² Firesat Constellation, Earth Fire Alliance Project. <https://www.earthfirealliance.org/#our-solution/> Accessed on August 5, 2024.

³ NASA Moderate Resolution Imaging Spectroradiometer Data Products. <https://modis.gsfc.nasa.gov/data/dataproduct/> Accessed on August 1, 2024.

⁴ NASA Terra flagship mission of the Earth Observing System. <https://terra.nasa.gov/about/terra-instruments/modis/> Accessed on August 8, 2024.

⁵ National Institutes of Health. National Library of Medicine, Data Glossary. <https://www.nlm.gov/guides/data-glossary/data-standards#:~:text=A%20data%20standard%20is%20a,of%20measurement%20is%20a%20standard/> Accessed on August 8, 2024.

⁶ NASA Firesense Program. <https://cce.nasa.gov/firesense/intro.html/> Accessed on July 12, 2024.

⁷ NASA ACERO Wildfire Program. <https://www.nasa.gov/directorates/armd/aosp/acero-wildfire/> Accessed on July 12, 2024.

⁸ Colorado Division of Fire Prevention and Control, Center of Excellence. <https://www.cofiretech.org/feature-projects/team-awareness-kit-tak/state-public-safety-tech-center-us-forest-service-partner-to-fight-fire-with-technology-advancements/> Accessed on July 12, 2024

⁹ Wildland Fire Team Awareness Kit. <https://wftak.wildfire.gov/guest/guest-home/> Accessed on July 12, 2024.

¹⁰ High altitude balloon technology being evaluated by the USFS. <https://www.swiftengineering.com/news/mapping-wildfires-from-70000-feet/> Accessed on August 1, 2024.

¹¹ High altitude long endurance aircraft being evaluated by the USFS. <https://www.fs.usda.gov/science-technology/fire/technology/HALE/> Accessed on July 12, 2024.

¹² FIREScope California. <https://firescope.caloes.ca.gov/> Accessed on July 12, 2024.

¹³ FIREScope California Emerging Information Technology Subcommittee. <https://firescope.caloes.ca.gov/Governance/Emerging-Information-Technology-Subcommittee/> Accessed on July 12, 2024.