



Office of the
Chief Scientist
& Engineer

NSW Bushfire Technology

The current state and challenges

This document aims to assist Bushfire Mission grant applicants, by providing a succinct summary of the current state and identified challenges in bushfire technology used by NSW Government agencies as well as common challenges faced by fire-response agencies

OVERVIEW

The 2019/2020 bushfires were bigger and more intense than any fires in recorded history. To better understand what happens during a bushfire and respond more quickly we need to accelerate the adoption of technology, especially in fire science, remote sensing, data science and artificial intelligence. We also need to improve government systems, training, and better manage critical infrastructure to minimise community and ecosystem damage.

Bushfire Response R&D Mission

The NSW Government's Bushfire Response R&D Mission ('Bushfire Mission') is providing \$28 million over four years to accelerate the development, commercialisation and adoption of bushfire technologies and services to improve our bushfire resilience, response, and recovery.

The Mission has four programs:

- 1) The Bushfire Commercialisation Fund providing financial support for early stage NSW companies (Technology Readiness Level (TRL) 3 – 7) to help them scale and attract private investment
- 2) The Bushfire Technology Pilots Program to support NSW companies pilot their technologies and services with NSW government end-user agencies, to test the technical merits and/or evaluate operational compatibility and providing commercial development to improve bushfire management and operations (TRL 7-9)
- 3) A STEM Outreach and Engagement Program to inspire and enable a new generation of technologists through education and skills training for school children focused on technologies of immediate relevance to bushfire response, and
- 4) Support the development of a Bushfire Technology Ecosystem to help coordinate and strengthen NSW's research and industry strengths in bushfire technology to drive adoption of bushfire technology, accelerate technology solutions, and deliver better environmental and economic benefits in NSW.

Current Challenges

A recent survey by the Office of the NSW Chief Scientist and Engineer of NSW government agencies identified the following areas where they would like to utilise technology and services to solve current challenges in:

- Asset-tracking and management
- People movement modelling
- Early fire detection
- Evacuation management Inter-agency communications
- Firefighting Firefighter training
- Field-level coordination
- Public communication and education
- Resource management and decision making about where to position resources and manage fire fighter availability, water, deployment, food etc.
- Situational awareness and monitoring, especially with dispersed information sources
- Wildlife monitoring and rescue
- Information sharing to improve whole of government engagement and adoption of innovative bushfire-related technology.

NSW agencies identified siloed information, lack of data intelligence, no access on mobile phones, and manual processes as key challenges

Priority areas for technology

Over the next decade, technology, machine learning and data services will change how fires – and other disasters – are managed. Intelligent tools and data-systems will inform risk assessment, preparation for fire seasons, early detection, firefighting response, and recovery.

| Priority | Objective | Examples of technology focus |
|---|--|---|
| Risk assessment, modelling, and prediction | Develop a better understanding and characterisation of bushfire risk to communities, ecosystems, industries, and regional economies. | <ul style="list-style-type: none"> • High-resolution data for mapping • Bushfire characteristics • Fire behaviour modelling • Data standardization and systems integration • Information, and communication technologies |
| Mitigation and risk reduction | Strengthen risk governance to mitigate and reduce the risk of bushfires to communities and ecosystems, industries, and regional economies. | <ul style="list-style-type: none"> • Utility and asset management • Land use planning and management • Managing risk in the built environment • Fuel management |
| Early detection and response | Effective bushfire risk management for community protection, ecosystems, industries, and regional economies. | <ul style="list-style-type: none"> • Fire and smoke detection • Early response and alerts Incident management • Notification and evacuation systems |
| Recovery and adaptation | Improve community preparedness for ecosystem resilience, recovery, and adaptation. | <ul style="list-style-type: none"> • Community resilience and wellbeing • Recovery and adaptation Bushfire loss and damage data • Public and ecosystem health |

Priority 1 – Risk assessment, modelling, and prediction

Predicting the fire spread

- Fire prediction systems calculate potential fire risks by predicting the direction, intensity, and rate of fire spread
- The ability to understand, predict, and monitor bushfire is fundamental to protect first responders, communities, and ecosystems through better planning, preparedness, risk management and response
- During bushfires, the Incident Management Teams (IMT) develops fire prediction models by combining map layers, fuel loads, weather information, known hazards, and fire data.



Challenges and priorities

- Using contemporary research, technology, and conditions to modernise fire prediction systems
- Providing accurate and credible fire spread information to the public in real time
- Generating real-time maps and models of fires to better plan and manage operations using on-the-ground intel
- Crews have limited access to technology and tend to use low-tech solutions
- Improved training on interpreting and applying intelligent data from fire planning tools such as fire modelling to better support decision making
- Australian fires can spread and start fires up to 30 km away by airborne burning vegetation or structures.

Priority 1 – Risk assessment, modelling, and prediction

Communication and information sharing

- Effective communication and information sharing is essential for successful ‘fireground’ (operational area at the scene of a fire) operations
- Every fire-management operation depends on the ability to reliably pass information across all emergency management agencies involved.

NSW Firefighters currently rely on the following systems:

Government Radio Networks (GRN, UHF, PSN, VHF simplex and duplex networks): Voice communications between the incident management team and division commanders, as well as between firefighters and incident management teams. **CB Radio:**

Used generally for local communications within teams – most firefighting crew carry a CB in addition to a GRN-capable radio.

4G Mobile Network: Poor coverage in rural areas and drops out rapidly away from urban centres.

Satellite Phones (Iridium): Worldwide coverage, but very expensive and so reserved for areas with no other communication options.

HF radios: Used in remote locations (Far-western NSW, northern SA, outback QLD etc)

Challenges and priorities

- Communication from the fireground usually relies on hand-held radios and voice reports, which are prone to distortion and miscommunication
- Poor network connectivity and communication blind-spots, particularly in remote areas impacts the ability to connect and communicate in a coordinated way, increasing the risk to fire fighters and reduces firefighting effectiveness
- Improving information flow from crew to crew, during shift changes can help information sharing
- Operating information technology in challenging environments due to damaged infrastructure, etc.
- Providing intelligence to the appropriate team, without causing cognitive overload, to better support all stages of fire response.



Priority 1 – Risk assessment, modelling, and prediction

Mapping and water supplies

- During bushfires, firefighters often have difficulty getting enough water. Up-to-date water supply maps provide essential information for fighting fires. Water supplies from sources such as swimming pools, tanks, and dams, may be vital for firefighters
- Having up-to-date, dynamic fireground maps of the surrounding terrain, hazards and risks is essential for firefighters and ground crew
- Intelligent, connected devices with mapping capabilities are already in use on the fireground, though enhancing the capabilities of integrating mapping systems with firefighter's personal handheld devices could result in better information flow.

Challenges and priorities

- Combining all government intel to develop a comprehensive whole of government fire methodology
- Improved mapping will assist firefighters to better predict likely bushfire changes
- Satellite data is not consistently factored into risk assessments, prediction, modelling, and mapping
- Enhancing mapping capabilities to be accessible via personal devices carried by individual firefighters could be game changing
- Improving fireground information and comprehensive map sharing technologies could dramatically improve coordinated response efforts
- Access to water for helicopters is assessed by ground crew and pilots together, including landing sites. While remote sensing from satellites and drones can help show where water lies, information can be up to a week old
- Currently not easy to assess routes to water sources, with this information needing to be communicated from the fireground at the time of need.

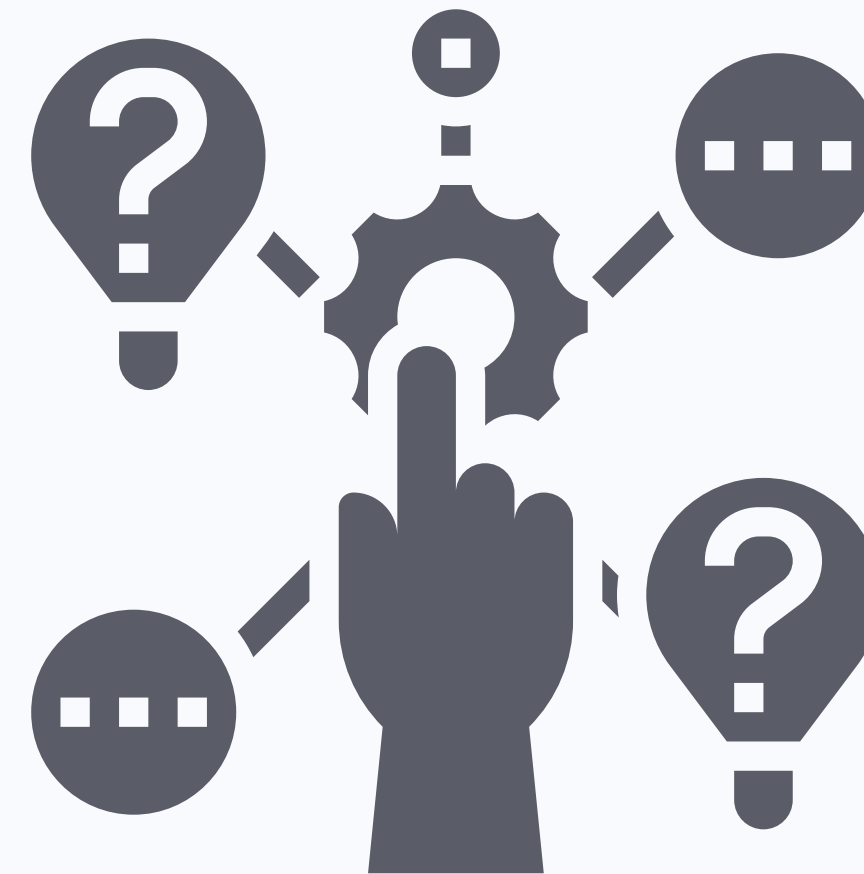
Priority 2 – Mitigation and risk reduction

Decision making and resource management

- Managing the resources required for fighting bushfires can be a huge operation, requiring the IMT to juggle competing priorities and make decisions based on the most current information they have access to
- IMT need integrated decision support tools that combine information from many areas:
 1. Availability of skilled personnel and their expertise
 2. Knowledge of deployment locations and access routes
 3. Real-time monitoring of fatigue levels, adjusted for difficulty
 4. Agile resource management tools that adjust for changing information.

Challenges and priorities

- Tracking vehicles and equipment is currently mostly done by manual checks and physical record taking
- Hand-written information is often incomplete or prone to errors – doubly so if communicated over radio link
- At times IMTs are required to make decisions based on imperfect knowledge and a limited view of the future.



Priority 2 – Mitigation and risk reduction

Fuel management

- Fuel management reduces the spread and intensity of bushfires which makes suppression more achievable and safer, reducing the impact on community and the environment
- The quantity of fuel (fuel load) at any place is determined by many factors including vegetation type, climate and productivity of the site, time and intensity of the last fire and recent weather events
- Effective planning and hazard reduction activities significantly reduce bushfire impacts. There are different types of hazard reduction including controlled burning, mechanical clearing like slashing undergrowth, or even reducing the ground fuel by hand
- Regular maintenance of internal roads and trails is important for firefighting access. Roads and trails also provide control lines to assist in fire containment
- Strategic fire trails are identified in bushfire management plans and strategies.

Challenges and priorities

- Improving knowledge of fuel dynamics across the different NSW vegetation types
- Uncertainty surrounding climate change impacts on fire management, including prescribed burning and the effects on biodiversity
- Better public communication. Public perception and misinformation can be problematic for agencies moving forward with fuel reduction measures
- More efficient methods of implementing prescribed fire (hazard-reduction burning) to reduce fuel loads
- Real time monitoring of fuel state (including type amount and moisture) at a local level to inform prescribed burning and bushfire risk
- Monitoring of air quality impacts surrounding prescribed fires to inform public messaging and planning of prescribed fire.



Priority 2 – Mitigation and risk reduction

Traditional Aboriginal land management practices

- First Nations Peoples connection to Country provides a rich source of knowledge for better land and water management, including fire management. For over 50,000 years, Australia's Indigenous people cared for country by using land management that worked with the environment
- Cultural burning is an ancient Indigenous burning practice used to heal the land, returning the Country back to health. It protects vegetation communities by suppressing weeds, encouraging native ground cover and tree regeneration. This in turn improves habitat for native animals and increases biodiversity
- Managing Country through cultural burning also results in bushfire hazard mitigation (reducing the fuel load) and supports bushfire risk mitigation for the broader community
- Cultural burning is spiritually and culturally important. Learning and sharing cultural burning knowledge is key to ensuring that these practices continue.



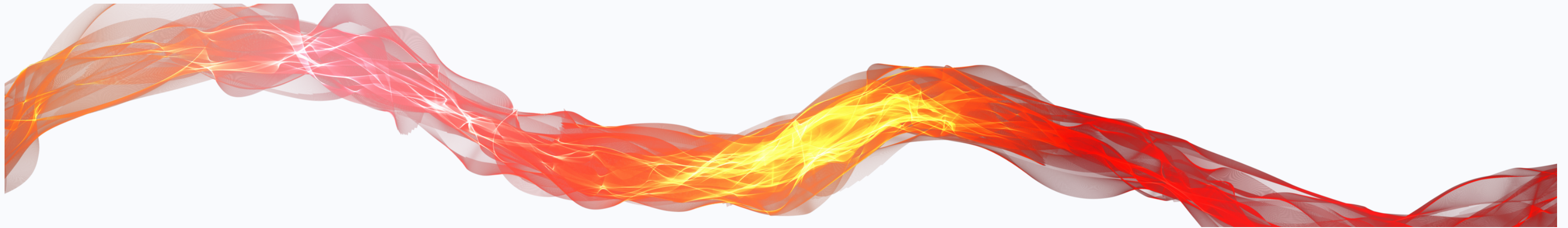
Challenges and priorities

- Indigenous land management contributes to the preventing catastrophic bushfires. Empower and support Aboriginal groups to develop their own cultural land management programs, including cultural burning
- Respectfully facilitating the sharing and building of knowledge and skills relating to ecosystem management and cultural burning amongst local Aboriginal communities and NSW Government requires significant stakeholder engagement and cultural learning.

Priority 3 – Early detection and response

Situational awareness

- Situational awareness in firefighting is the continual observation of the environment and how any change in that environment affects the mission and safety.



Challenges and priorities

- Monitoring of bushfire perimeter through smoke and cloud
- Fire fighters currently do not have a way to identify features in the fire location (e.g. hazards, assets, completed prevention activities that do not appear on standard maps) until they see them with their own eyes when responding to a fire
- Special conditions and terrain information must be shared by radio which is not ideal
- Difficulty of creating a visual image based on verbal descriptions, room for misinterpretation and overlooked details, etc.
- Gaining access to maps ahead of time can be difficult, responders currently may need to pre-load the files.

Priority 3 – Early detection and response

The Incident Management Team (IMT)

- The incident management team is responsible for planning the response to a fire that requires sustained action to fight (more than initial response)
- The incident management team will draw up a formal, static incident action plan in response to a significant event – a fire that will require more resources than the first responding team. Typically, this is put together within 12 hours of a fire starting



Challenges and priorities

- The use of multiple information systems which often contain conflicting information ensures that there is no single version of truth
- The delay in features annotated on paper or digital maps getting to the incident management team creates inconsistencies and knowledge gaps
- Electronic incident action plan can be difficult for fire fighters to get if mobile data coverage is poor
- Manual process (handwritten notes) for data and record capturing and reporting
- Coordinated incident response – currently equipment, technology, and data sources are managed by various government bodies, with minimal communication between coordinators
- Improved training programs for incident management team, on-the-ground fire planners, and operators in technology, services, systems, and process areas.

Priority 4 – Recovery and adaptation

Promote community awareness and resilience

- Local communities can contribute to fire management strategies, helping to raise awareness of the complexities of managing bushfire risk, while technology can help communities recover and reduce future fire risks. For example, Airborne Research Australia created free 3D high resolution maps of devastated areas in the Adelaide Hills and Kangaroo Island following the recent fires to assist communities, emergency services agencies and researchers plan the post-fire recovery, better understand fire behaviour, and develop future fire defence strategies

Challenges and priorities

- Support localised solutions and community resilience plans to build bushfire resilient and informed communities
- Innovative methods of quantifying and removing debris and dangerous materials are essential to community recovery and resilience
- Post-fire audits and investigation take a significant amount of time.

