# ANU-OPTUS BUSHFIRE RESEARCH CENTRE OF EXCELLENCE

## Building a national defence system against catastrophic bushfires

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Australia is experiencing unprecedented extreme fire conditions associated with prolonged drought, desiccating high temperatures and strong winds. This extreme weather creates catastrophic bushfire conditions that exceed known firefighting technologies – leading to significant ecological, economic, health and social costs.

We need a new approach that harnesses new technologies which is successful in eliminating the risk of rapid development of bushfires under extreme conditions. Combinations of technology developed for often different purposes, such as space, defence, communications and earth observation technologies, are key to improve tactics.

## Collaboration objective

**ANU and Optus have formed a partnership that seeks to develop a revolutionary national system to detect fires as soon as they start, and then put them out within minutes so they do not spread and grow out of control.**

This partnership forms the nucleus of an aspirational approach which is paramount to reducing the future likelihood of catastrophic bushfires. We are seeking additional partners to contribute to making this happen.

**Please contact us if you are interested in participating or contributing.**

## R&D Goal and Themes

The proposed goal is to detect a fire within one minute, and respond within five minutes.

| **DETECT** and locate a fire within 60 seconds of ignition | **COMMUNICATE** the location to extinguishing agent | **DEPLOY** accurately targeted aerial vehicle | **EXTINGUISH** fire within five minutes of ignition |
| --- | --- | --- | --- |

## Proof of concept – roadmap to a national system

The system will take a layered approach, optimising ground-based, aerial, and satellite systems to achieve our goals.

> **Short-term (2020-2021):** autonomous ground-based and aerial system for detection and suppression
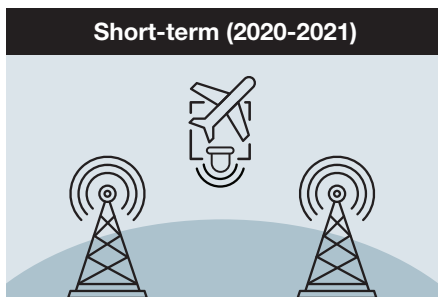
> **Mid-term (2021-2022):** constellations of cube-satellites set to launch in 2021 to complement the ground and aerial system, coupled with innovative extinguishing solutions
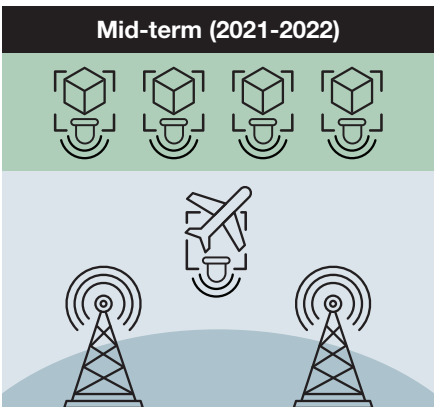
> **Long-term (2023-2024):** large geostationary satellite bearing a telescope to complement the ground and aerial system, coupled with novel extinguishing solutions


Short-term (2020-2021)


Mid-term (2021-2022)


Long-term (2023-2024)
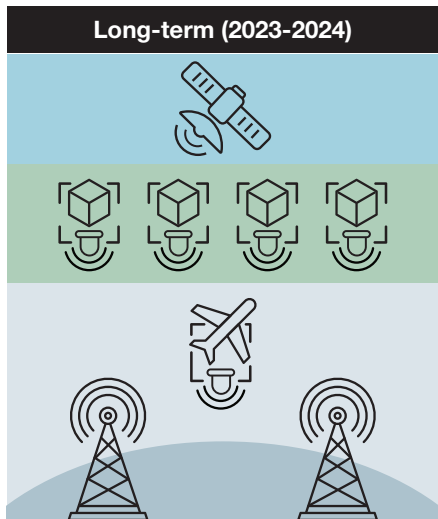
## ANU research capability

The Australian National University has a wide range of expertise across the full problem scope. This includes a team of twenty researchers working across fields such as:

> Ignition risk and fire growth

> Bushfire and environmental science

> Visual, infrared, Lidar, and other sensing technologies

> UAV/Drone technology

> Satellite Missions

> Weather, geospatial, and data analytics

> Compute infrastructure

> Advanced communications

> Extinguishing techniques

> Ground-based vision and Internet of Things sensors

> Remote sensing data analytics

> Autonomous systems

> Legal and economic analysis

## ANU Research Leaders

**Dr Marta Yebra** is a Senior Academic in Environment and Engineering. Her research focuses on using remote sensing data to monitor and forecast natural hazards. Marta led the development of the Australian Flammability Monitoring System and it is now designing Australia's first satellite mission to help forecast vulnerable areas where bushfires are at highest risk of starting or burning out of control.

**Professor Rob Mahony** is Professor in the Research School of Engineering. His research interests are in non-linear control theory with applications in robotics, geometric optimisation techniques and systems theory.



# Short-term (2020/2021) Project

In the short term, the ANU-Optus Bushfire Research Centre of Excellence plans to develop and demonstrate a collection of ground and aerial based systems for early fire detection and extinguishing.

These Proofs of Concept will draw upon ANU's research into ignition risk and Optus development and implementation of suitable communications systems.

In the first year, technology demonstrations will be conducted working closely with ACT and national organisations including: Australian Capital Territory Rural Fire Service, Australian Capital Territory Parks and Conservation Service, Australasian Fire and Emergency Service Authorities Council, and National Aerial Firefighting Centre.

Results from proof of concept trials in the ACT will guide future research programs and help to design an integrated defence system for implementation across Australia.

## Demonstration of early detection

Early detection of fires will be explored through the following approaches:

1. Long-range high-fidelity visual and infrared sensing in strategic locations by leveraging advanced machine learning algorithms

2. UAV systems for targeted high-fidelity detection of ignitions

3. Evaluation of ground-based low-power wide area network meshed sensors

4. Foundational communications and compute platforms to support integrated systems

5. Real-time data analytics.

## Strategically placed high-definition visual sensing and processing for long range early fire detection

24/7 long range and fully automatic early bushfire detection using advanced visual sensing and machine learning technology will be built. Currently cameras cannot provide super-early fire detection, and are used for monitoring purposes.

Maximising the dual use of Optus' & Government existing critical infrastructure (fixed and mobile towers, exchanges) to mount multi-modality visual sensors (visible range, infrared, and thermal).

## UAV technology for ignition detection and situational awareness

A fleet of UAV vehicles equipped with suitable sensors can provide targeted high resolution and regular surveillance of targeted high-risk areas. High confidence early detection allows for timely deployment of suitable suppression technology, extinguishing the fire at its source.

## Foundational comms platforms to support integrated systems

Optus will provide foundational comms platforms to support integrated systems. This project will investigate technologies such as mesh networking and satellites to overcome challenges to communications coverage in hilly and challenging terrain.

## Ground-based low-power wide area network meshed sensors

Low-cost, low-power multi-sensor nodes with long-range communication capability, deployed in high-risk areas can monitor multiple environmental parameters to enable early detection of wildfires and improve situational awareness.

## Real-time remote sensing data analytics using AI

The deployment of technology for early fire detection and response needs to be informed by an understanding of the risk of bushfire occurring, which in turns depend on fuel flammability.

Monitoring fuel flammability and fire detection in real time requires a constant stream of high-resolution imagery.

The required generated data exceeds the bandwidth, computational and storage capacity of our current systems

Efficient ways will be evaluated to store the large volume of data generated. Compute algorithms will be developed to convert that data into the required information on fuel flammability and active fire location in real-time.



## Demonstration of early extinguishing

A prototype water glider is under development in collaboration with Canberra UAV. It involves an innovative technique for water bombing from high altitudes (well above 5000 feet) which significantly mitigates the risks inherent in current approaches, providing very rapid response while obtaining high accuracy and good control over the spread of the water. It also allows the use of unmodified aircraft thus increasing the number of available aircraft and lowering costs. Proof of concept demonstration will be achieved in the short term.

## Legal and regulatory analysis

Relevant laws, regulation and social, economic and cultural issues will be identified and analysed associated with each solution.

# Medium to Long-term Approach

The ANU-Optus Bushfire Research Centre of Excellence aims to position itself as a key technology provider and research partner to fire services nationwide.

Medium-term goals include the enhancement of technologies demonstrated in trials and the formulation of an optimised national defence system for bushfire detection and response.

Early detection and suppression R&D will be complemented by ANU's OzFuel low Earth orbit satellite mission for near-real time fuel load and condition analysis.

In the longer term, the ANU-Optus bushfire response R&D program plans to develop a state-of-the-art fire detection instrument for geostationary orbit, providing greater sensitivity and ground resolution than existing geostationary Earth observation solutions. The instrument is planned to be launched in the next generation of Optus geostationary communications satellites.

A national detection and response capability will be developed through integration of:

1. Low Earth Orbit cube-sat constellation to support bushfire planning

2. Large geostationary satellite bearing a telescope capability

3. Scaled autonomous ground-based and aerial detection systems

4. Novel environmentally friendly technology to rapidly extinguish fires after ignition

### Low Earth Orbit (LEO) cube-sat constellation to support bushfire planning

ANU leads the development of 'OzFuel'. This aims to be the first Australian infrared satellite mission in Low Earth Orbit (LEO) to measure forest fuel load and vegetation moisture levels accurately across Australia.

Information on critical dryness levels will:

> help predict where bushfires are likely to start and those that will be difficult to contain;

> help emergency services allocate resources and design location of fire breaks in advance of or during a fire.

### Earth observation capability on geostationary satellite to support bushfire management

Established satellite-based active-fire detection and tracking is available (e.g., Australia-Sentinel, Landgate-Firewatch). The sensitivity of these contemporary systems limits the ability to detect small, low-intensity, fires before they may become a risk.

A dedicated detection system, tuned to the Australian environment, is required. A geostationary satellite can provide the sensitivity and ground resolution necessary for high-confidence, near real-time, detection and monitoring of small/cool fires.

A detection instrument is planned to launch on an available payload of a geostationary satellite in coming years.

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We are seeking contributors and partners to help us to achieve our aspirational goals.