SMARTSAT Cooperative Research Centre

Australian Government Department of Industry, Innovation and Science | Business Cooperative Research Centres Program

Earth Observation Program: Bushfire Applications

EMSINA

2021 Special Capability Information Day

Stuart Phinn

Program 3 – Earth Observation Research Director

The University Of Queensland AUSTRALIA

Remote Sensing RESEARCH CENTRE

Joint Remote Sensing RESEARCH PROGRAM

EOA Earth Observation Australia

Outline

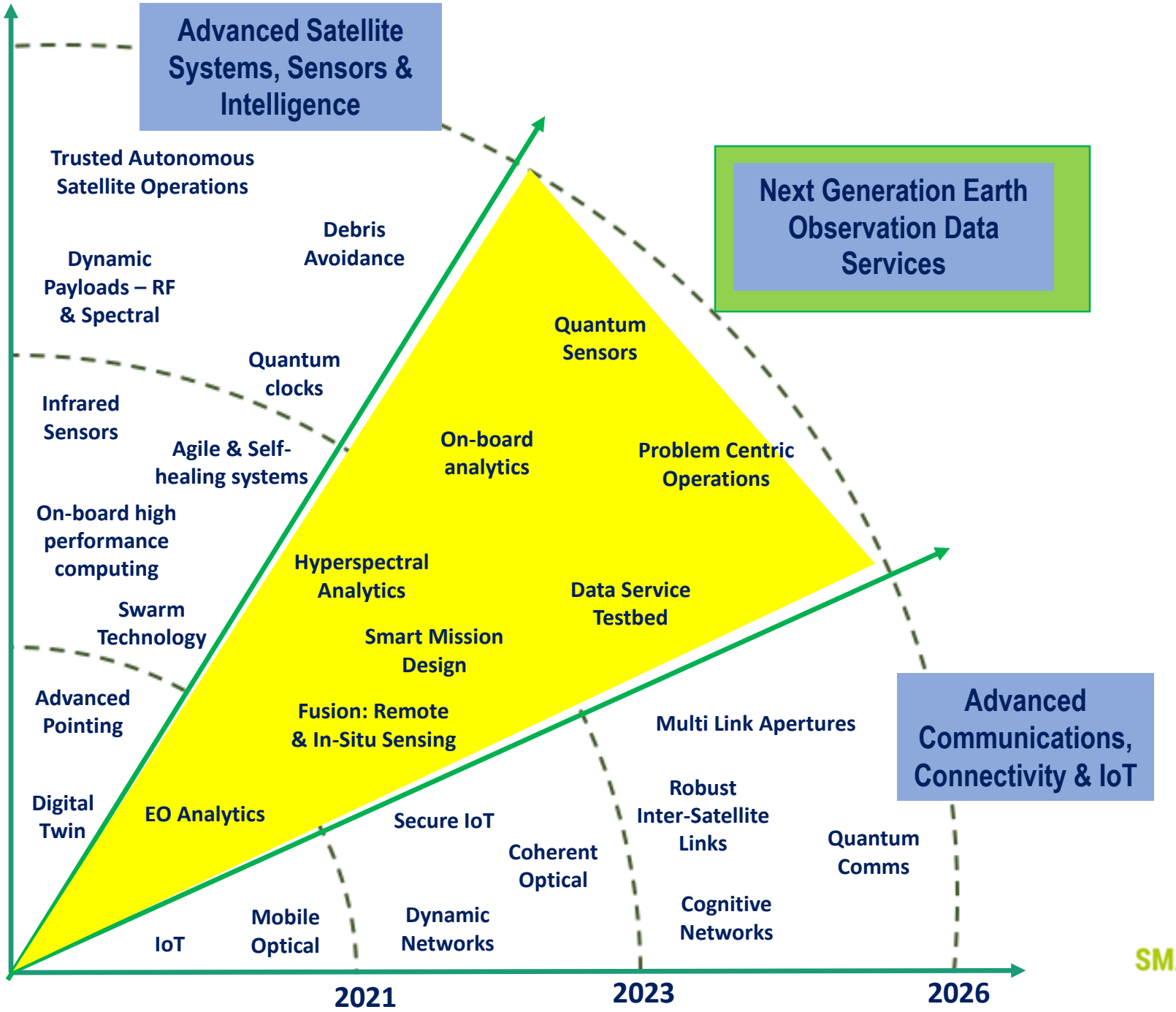
- SmartSAT Cooperative Research Centre Overview
- Research Program 3 Earth Observation
- Drivers for Fire Applications Development
- Current Fire Applications
- Planned Fire Applications 2021 –
- How to Engage with EO Applications Development

Building Australia's Space Industry

A leading space industry-research collaboration, building Australia's space capability, transforming our industrial sectors and improving the lives of every Australian to serve our nation.

- Advanced Communications, Connectivity & IoT
- Advanced Satellite Systems, Sensors & Intelligence
- Next Generation Earth Observation Data Services

Technology Roadmap



SMARTSATCRC

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Major Project Portfolio

Advanced Satellite Systems, Sensors & Intelligence

Next Generation Earth Observation Data Services

Advanced Communications, Connectivity & IoT

Dynamic Payloads – RF & Spectral

Infrared Sensors

On-board high performance computing

Advanced Pointing

EO Analytics

IoT

Quantum Sensors

On-board analytics

Hyperspectral Analytics

Fusion: Remote & In-Situ Sensing

Secure IoT

Problem Centric Operations

Data Service Testbed

Smart Mission Design

2021

2023

2026

SmartSat Capability Demonstrators

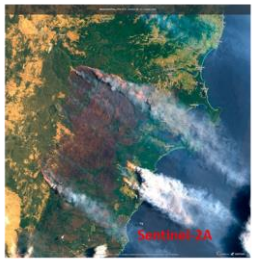
AquaWatch

Disaster Resilience

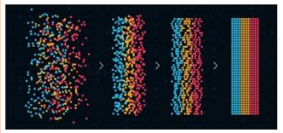
Indo-Pacific Inter-Connector

Super Res Mosaic Infrared Focal Sensor

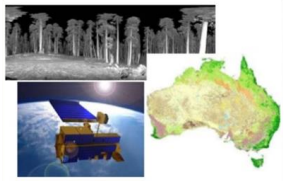
Bushfire Analytics



Trusted Pattern Detection



Know the Market



Groundwater IoT Monitoring

AquaWatch Phase 0

Oyster Water Quality

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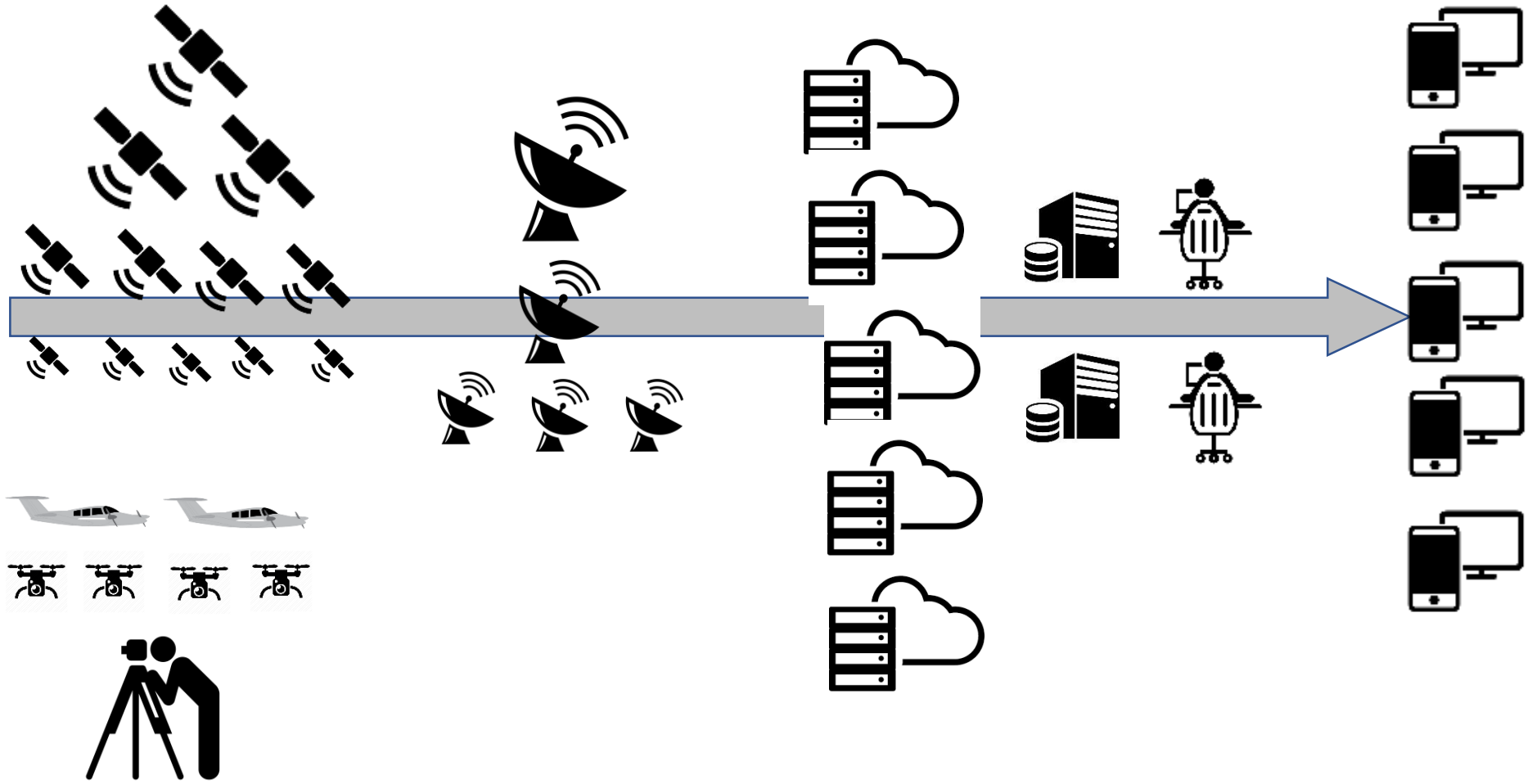
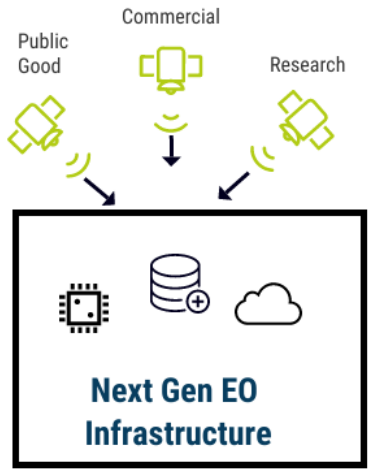
Earth Observation Workflows 2020 and beyond ? : Images to Information?



SMARTSAT CRC RP3: Next Generation Earth Observation Data Services

Milestone 3.1

Processes to seamlessly access national and international EO data storage, processing and delivery infrastructure

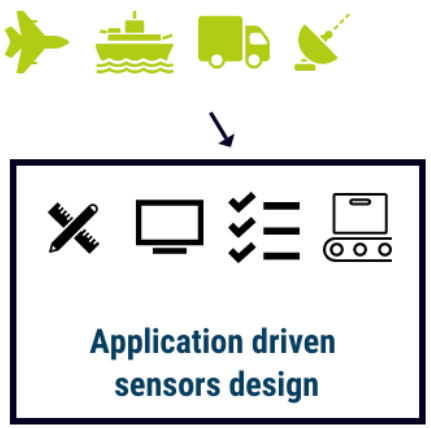


Milestone 3.2

Commercially viable set of EO products and services (Agriculture and farming, Mining and Resources, Defence, Transport and Logistics, Telecommunications)

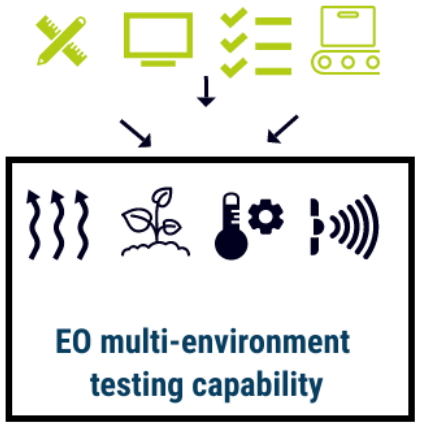
Milestone 3.3

Specialised EO sensor design processes tailored to industry needs and end-user applications



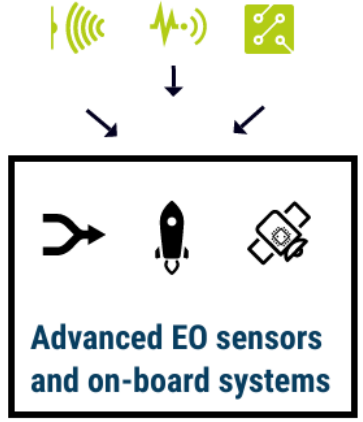
Milestone 3.4

Sovereign pre-operational testing capability for EO sensors, satellite payloads, products and algorithms across multiple environments



Milestone 3.5

Advanced EO sensors and on-board processing systems developed and incorporated into SmartSat CRC adjacent missions



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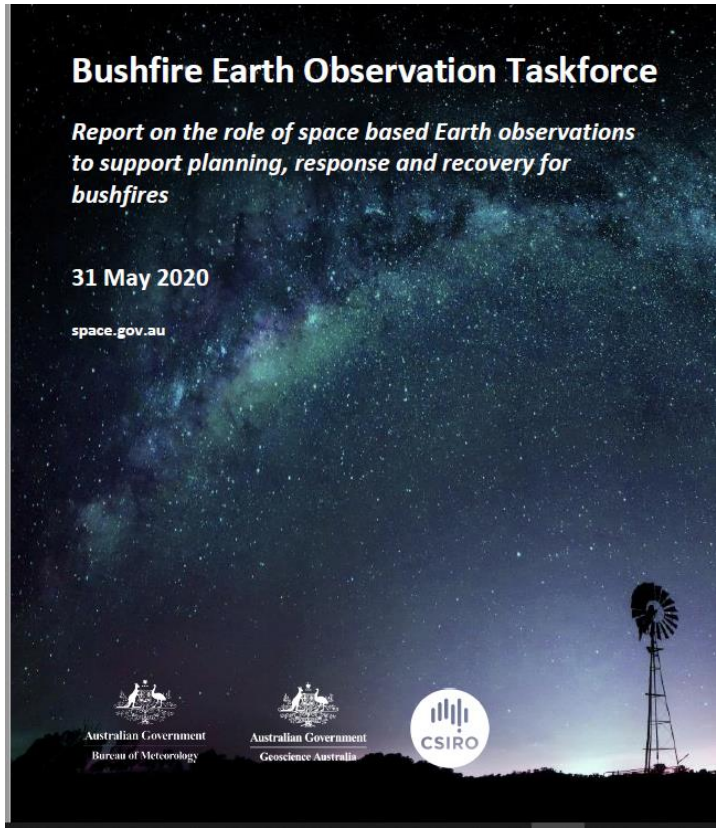
www.industry.gov.au/publications/bushfire-earth-observation-taskforce-report



	SUCCESSES	LIMITATIONS
PRE-FIRE: prevention & preparedness	✓ Grassland curing data available every 8 days ✓ Flammability ratings available every 16 days ✓ Wide range of datasets available to be used to perform risk assessments incl weather monitoring ✓ Staff from federal agencies integrated into state emergency service teams	× Require integrated early fire detection platform providing high resolution data × Complete, up-to-date foundational data sets not readily available × Fuel state data not yet nationally operational × Location of fire break construction is occasionally not known
DURING-FIRE: response	✓ Collaboration and sharing of resources ✓ Line scanning aircraft available to provide near-real time imagery of fires ✓ Hotspots for strategic fire mapping ✓ Weather observation ✓ Water bodies mapping for large aircraft to re-stock	× Tasking of high-resolution data via satellite too slow × Insufficient coverage of multiple large fires via airborne × Difficult to know if detected hotspots are false positives × Commercial licencing arrangement are a barrier to data sharing × Resolution & frequency of data available for tactical response
POST-FIRE: recovery	✓ High resolution drone imagery available for built severity mapping ✓ Burn extent mapping of vegetation available	× Ability to have burnt extent mapping within a week post fire before regrowth begins × Airborne collection not having wide enough coverage × More timely imagery for severity mapping × No national agreement on classifying burn severity

Figure 14 – Summary of the successes and limitations

Identified EO Opportunities Across Stages of Bushfire Management

CRC SmartSAT - CAPABILITIES FOCUS

MITIGATION

Pre-fire

- Fuel load
- Fuel moisture content
- Flammability

MONITORING & RESPONSE

During-fire

- Fire detection
- Fire extent
- Fire power-intensity

RECOVERY

Post-fire

- Burn extent
- Burn severity
- Burn history
- Vegetation recovery

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Image Sources: The Habitat Advocate, CNN, The Guardian

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Potential “fire” application projects

MITIGATION

Pre-fire

- Fuel load
- Fuel moisture content
- Flammability

Australian National University

Monitoring bushfire fuel flammability:

Gaps and opportunities for SmartSat CRC to remedy current limitations

Dr Marta Yebra

Director, ANU Bushfire Initiative
Fenner School of Environment & Society
Research School of Aerospace, Mechanical and Environmental Engineering
Institute for Space

Australian National University

@myebra12

Summary

Current capability:

- Fuel moisture content (500m, 4 days→ Currently working with GA to transition the system to Digital Earth Australia and apply the algorithm to Sentinel-2A/B (20m, 5 days)
- Fuel load still heavily depend on Lidar data acquisition (insufficient areal coverage in time and space)

Needs/Opportunities for SmartSatCRC

- **Short term:**
    - More efficient algorithms for real time data production data (decrease data volumes and compute resources)
    - Multi-sensor integration (SAR+optical)

- **Medium term**: **OzFuel** to provide an innovative **SWIR vegetation condition sensor** system (tuned to eucalypt forest) from concept to pre-flight maturity using **small format cooled detector and controller**.
- **Longer term** to operate Ozfuel from LEO to provide near-real time information

Current funded “fire” application projects

MONITORING & RESPONSE

During-fire

- Fire detection
- Fire extent
- Fire power-intensity

Real Time Fire Analytics

a new SmartSat CRC project

Building an earth observation data assimilation ecosystem for real-time surveillance, measurement, and verification of fire activity and impacts in the landscape.

Presenter: Simon Jones (RMIT)

PIs: Karin Reinke, Mariela Soto-Berelov, Simon Oliver, Norman Mueller, Simeon Telfer, Steve Salathiel, Anthony Cheeseman, Stuart Matthews, Andrew Edwards, Danielle Wright

Project partners:

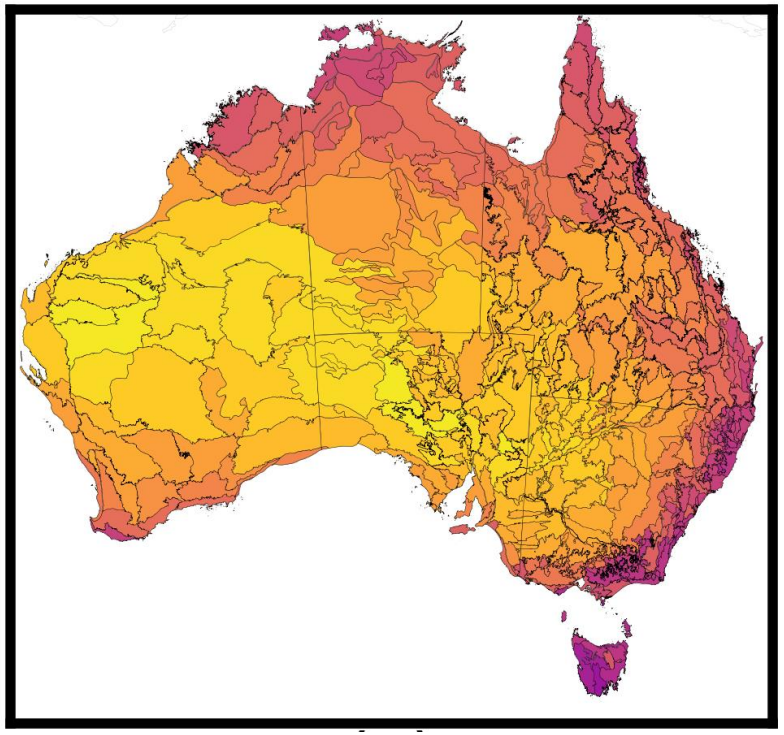
RMIT University, Geoscience Australia, South Australian Government Department of Environment Water and Natural Resources, Department of Environment Land Water and Planning VIC, NSW Rural Fire Service, Charles Darwin University / Bushfires NT, Country Fire Authority, VIC

Leveraging Our Capability (1)

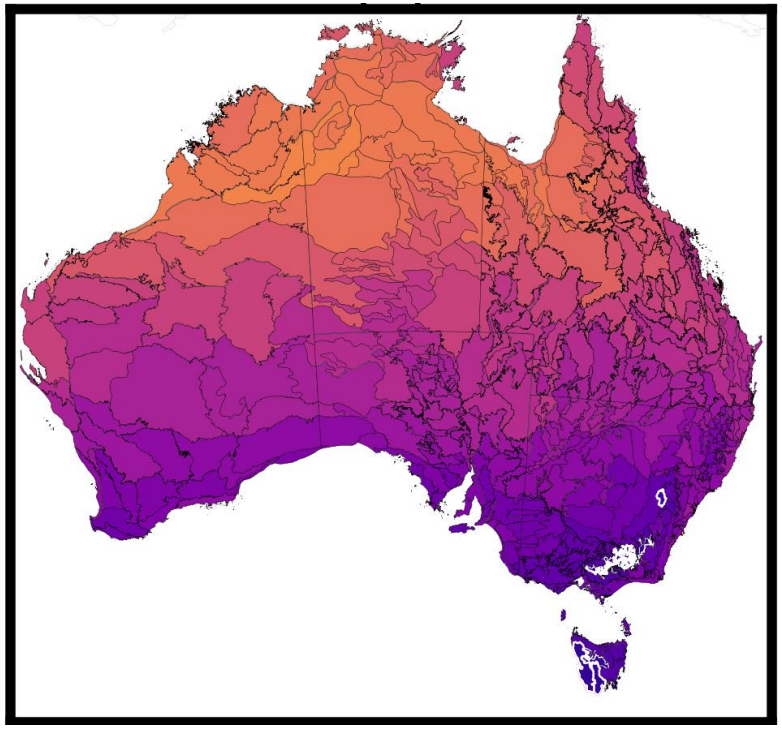
AHI-BRIGHT (RMIT)

bushfire&natural HAZARDSCRC

Early Summer



Early Winter



Uses dynamic statistical multi-spectral thresholds:

Sensitive to:

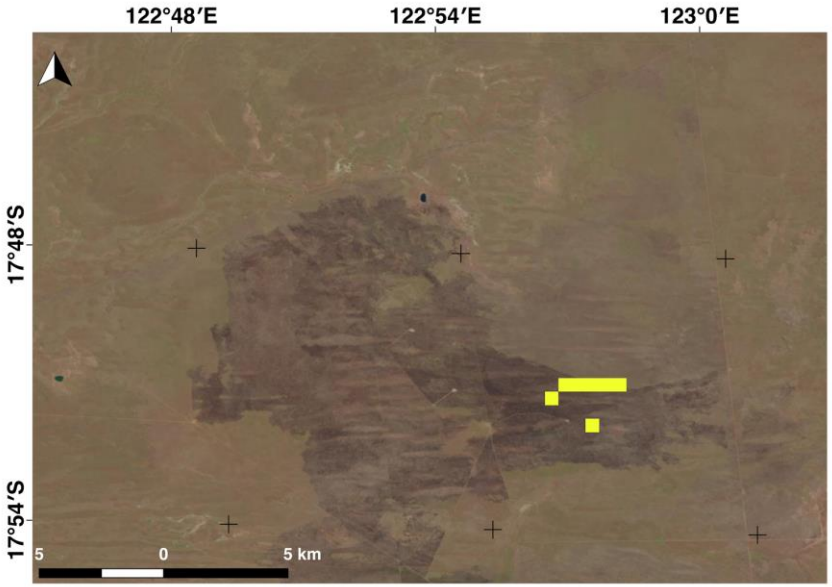
- biogeographical region,
- sub-season, and
- time-of day

C. B. Engel, S. D. Jones and K. Reinke, (2020) "A Seasonal-Window Ensemble-Based Thresholding Technique Used to Detect Active Fires in Geostationary Remotely Sensed Data," in IEEE Transactions on Geoscience and Remote Sensing, doi: 10.1109/TGRS.2020.3018455.

Leveraging Our Capability (2)

Case study: Broome Wildfire, September 2015

500m AHI-FSA fire line activity (yellow) and MODIS hotspots (red outline) compared to burnt area Landsat-8 (background)



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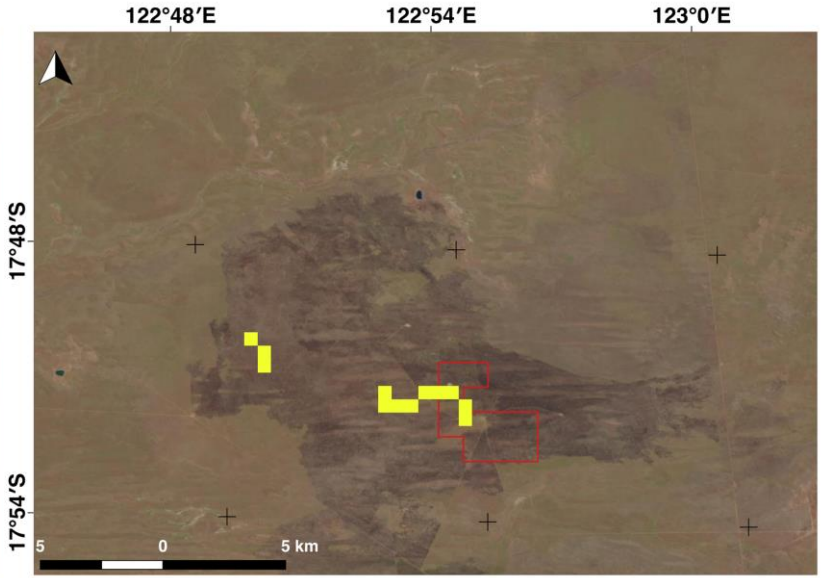

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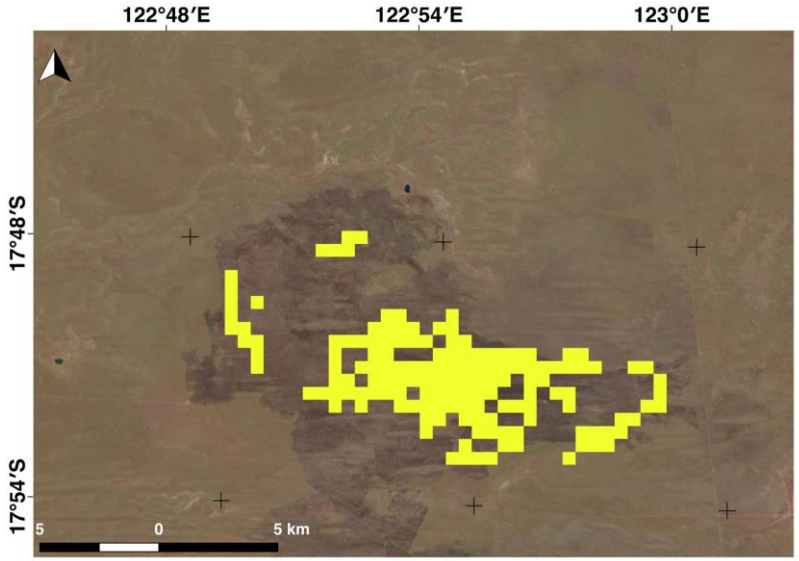
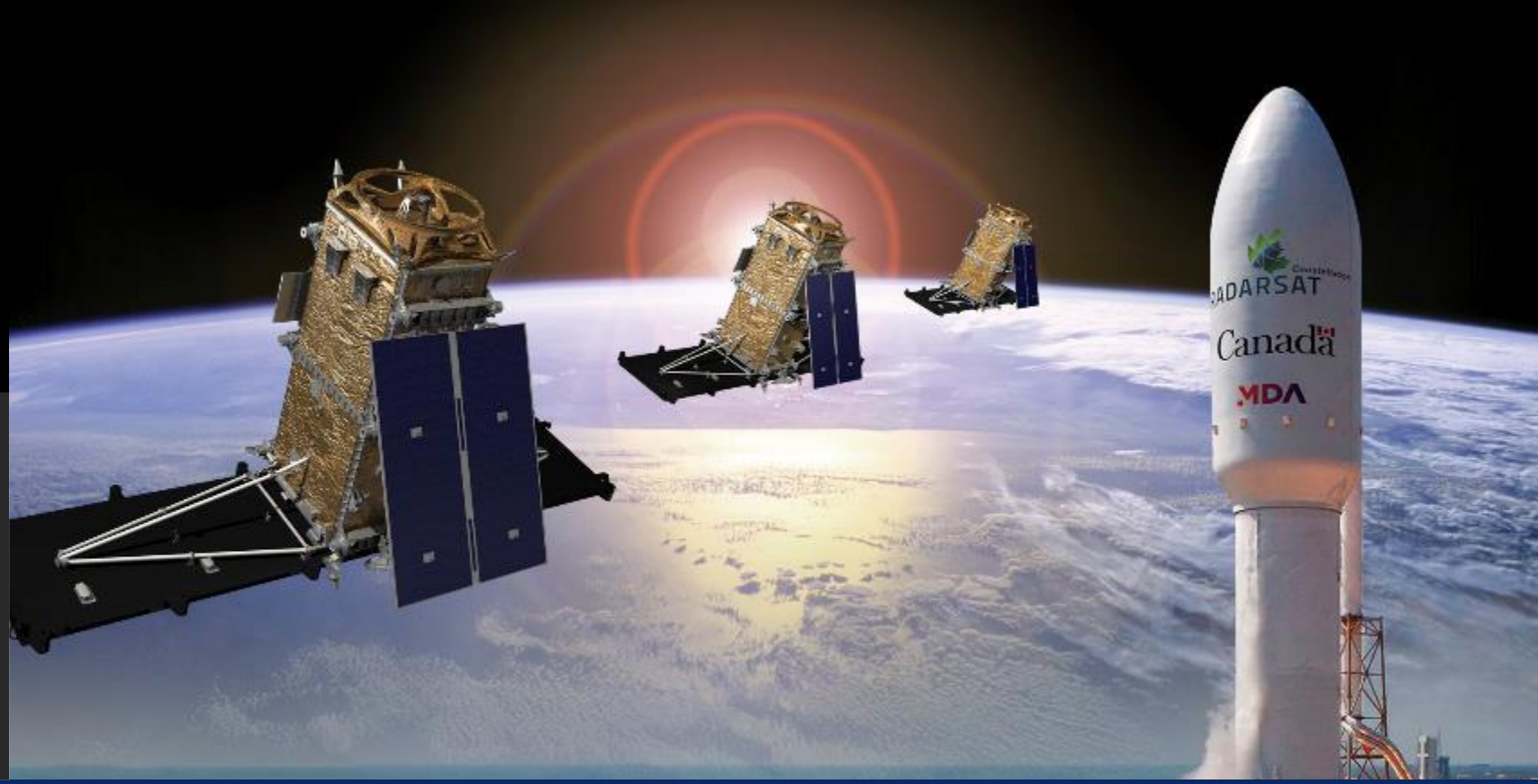


01:40 -06:00 UTC

Chathura Wickramasinghe, Luke Wallace, Karin Reinke & Simon Jones (2018) Intercomparison of Himawari-8 AHI-FSA with MODIS and VIIRS active fire products, International Journal of Digital Earth, DOI: 10.1080/17538947.2018.1527402

INNOVATION
IN SPACE
AND DEFENCE



WILDFIRESAT – INDUSTRY PERSPECTIVE

12-OCT-2020

Mark Senez – Project Engineer | Christos Koulas – Project Manager

Current funded “fire” application projects

RECOVERY

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Planned Fire Applications 2021 –

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OPPORTUNITIES FOR IMPROVEMENT

- Frequency of image collection
- Detection under smoke and cloud
- Optimisation for different vegetation structural forms and communities
- Increased engagement with end-user

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Image Sources: The Habitat Advocate, CNN, The Guardian

CRC SmartSAT and Bushfire & Natural Hazards Partners - 2020 Workshop Results

Identified Project Ideas

Based on top areas of interest and opportunity uncovered in the workshop, and take into consideration the specific interest of key end-users (i.e. BNHCRC, AFAC) and SmartSatCRC industry and research partners.

1. Improved and up to date knowledge on fuel loads (fuel types, condition, structure, quantity, moisture) through the integration of multi-sensor EO spectral information

- Research topic: fusion of multi-sensor EO spectral information for more up-to-date fuel load information.

2. Eyes on the ground: seeing through forest canopy – integrating EO (SAR, optical) and on-ground sensor data for improved risk knowledge

- Research topic : characterise the fuel load and environmental conditions of vegetation below forest canopy

3. Multi-sensor multi-platform (space, air, ground, social/call-in) data integration for improved fire detection and fire behaviour modelling

- Research topic: approach to integrate data from multiple sources (space, air, ground, social/call-in) and across multiple platforms to enable faster more comprehensive information on fire detection and fire behaviour

4. Validation of fire risk assessment EO-derived products through the introduction of indigenous knowledge

- Research topic : EO product validation is critical to ensure end users can rely on product outcomes for decision making, yet the amount of the on-the-ground validation data is very limited and particularly challenging to obtain in Australia.

Indigenous communities gather significant amount of knowledge on the state of the land, vegetation and waterbodies across the country, particularly in some of the most remote areas. A project could develop a mutually beneficial approach for near-real time knowledge sharing and transfer with EO-product developers and indigenous communities.

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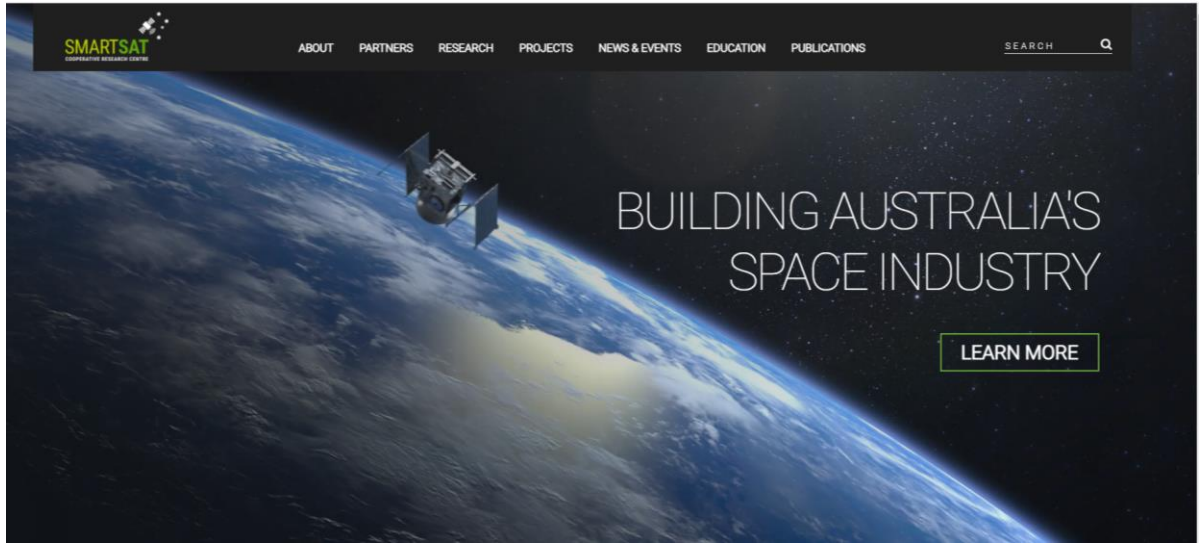
Engagement ……

- Project partnerships
  - 1 year $up to $100k
  - Multi-year larger scale projects
  - Project concept calls
- PhD Projects and Funding
- Aurora Start-up Cluster
- State nodes and associated funding
- Challenges and competitions



www.smartsartcrc.com

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COOPERATIVE RESEARCH CENTRE

Earth Observation Australia Inc.

www.eoa.org.au

- 600+ members
- All national + state agencies
- 4 Industry Rep. Groups

5 national priorities of the Plan to build Australia's EO capacity

Continued National Coordination Priorities + Actions

Outcomes: 2017-2021

Implementation from – 2017:

- EO included in Research Infrastructure
- Digital Earth Australia
- EO as part of Aust. Space Agency
- EO as part of QLD Space Strategy
- Formal national EO coordination
- Earth Observation for Government Network
- Advancing Earth Observation Forum 2020/21

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Thank you!

smartsatcrc.com

Stuart Phinn
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