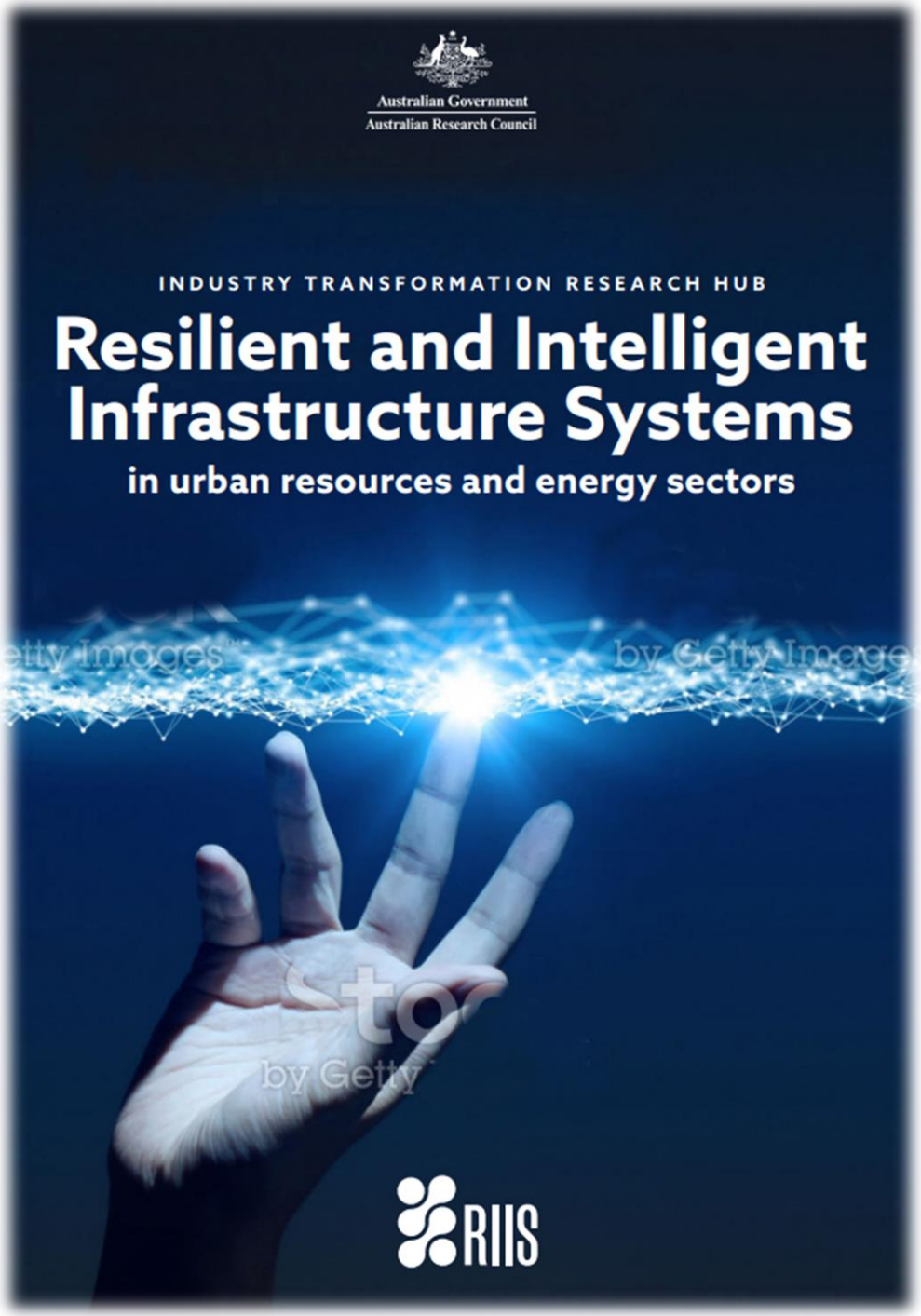

ARC Industry Transformation Research Hub

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WESTERN SYDNEY UNIVERSITY
QUT
THE UNIVERSITY OF MELBOURNE
UNSW SYDNEY

Vision

"Towards productive, connected, sustainable and smart infrastructure"

RIIS is an industry and ARC funded research and innovation hub for smart infrastructure. It engages with industry, government, and the community to develop and implement science-based policy and integrated practical solutions to the current and future challenges facing Australia's urban resources and energy infrastructure.

- Targeted sensing and data collection
- Contact and non-contact data-driven structural integrity assessment
- Data analytics and cyber security
- Physics augmented AI and machine learning for real-time performance analysis
- Robotics and autonomous systems
- Quantification of damage and degradation
- Remaining service life assessment, prolonging life technologies
- Failure analysis and pre-emptive repair
- Digital twining, augmented reality and decision support for asset management

RIIS
RESILIENT, INTELLIGENT INFRASTRUCTURE SYSTEMS

MEETING THE CHALLENGES OF Infrastructure Engineering & Asset Management

Over $400 billion are derived from infrastructure annually, contributing more than any other sector to Australia's GDP.

Billions of dollars are expended each year on Australia's infrastructure.

Transport for NSW will be investing $57.5 billion over the next four years on NSW's transportation network.

The Federal Government in turn will spend $110 billion on infrastructure over the next 10 years.

Infrastructure is in decline and lacks resilience to cope with increased demand and expected growth in economy and population.

By 2030 most hard infrastructure will in have passed useful design life and will be in a substandard state of repair.

Urgent need for technologies to predict infrastructure integrity, renewal needs, pre-empt failure, remaining service life, and prolong life.

Deliver sustainable, resilient, smart, connected, and efficient infrastructure systems.

Resilient Intelligent Infrastructures Systems (RIIS)

The 4th industrial revolution for Australia's Infrastructure

New Technologies

- Rapid advance in sensing and digital technologies
- Data analytics, machine learning, artificial intelligence (AI), internet of things (IoT)
- High-performance computing

Drivers of Change and growth

- In the energy sector, digital technologies are used to manage off-grid systems to reduce cost and minimise carbon foot-print.
- In mining, oil and gas industries, the use of data-driven technologies, automation and robotics is adding $1 billion to the domestic supply chain, and in the process generating 5000 new jobs.
- It is estimated that an increase of even 1% in the efficiency in mining operations translates to a productivity gain of approximately $2.5 billion per annum.

Resilient Intelligent Infrastructures Systems (RIIS)

The 4th industrial revolution for Australia's Infrastructure

Opportunities

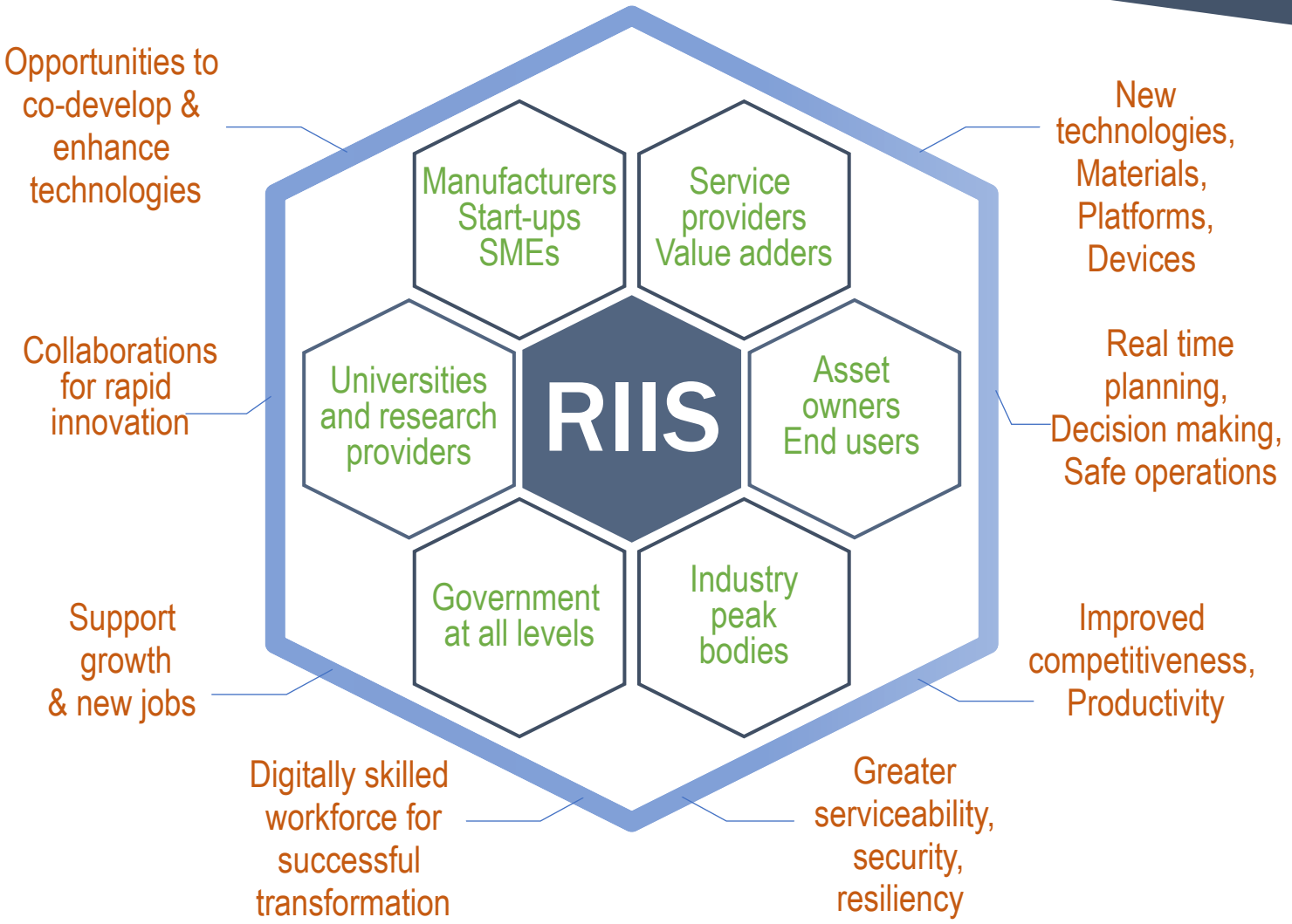
- Adoption of digital technologies in infrastructure engineering has been agonisingly slow.
- Lack exposure to digital technologies and technologists
- Lack of fit-for-purpose sensing mobility platforms.
- Lack of tailored data acquisition, transmission and storage systems.
- Lack of realistic material modelling and computational simulations of boundary value and initial value problems.
- Lack of capabilities for real-time data analytics and predictive machine learning
- Lack of training

Opportunities

- The current 'best practice' for asset management often comprise visual inspection in conjunction with ad-hoc maintenance and, coupled occasionally with rudimentary analysis and modelling.
- Performance monitoring is achieved through localised sensing, such as displacement and inclination transducers, strain
- gauges, and/or the use of discrete sensors for acquiring data.
- Uneconomical, inefficient and tedious; pointwise, lacking the necessary densification for data analysis.
- Data used is primarily for visualisation and precedent-based decision making.
- No real-time diagnostic and prognostic analyses

COLLABORATION

To create resilient intelligent infrastructure systems



The Team

- 4 Universities
- 9 Schools
- 5 Institutes/Centres
- 22 CIs
- 18 Industry Partners
- 5 Government Agencies
- 11 Postdoctoral Fellows
- 24 PhD Students

RIIS
RESILIENT, INTELLIGENT INFRASTRUCTURE SYSTEMS

Industry Partners

Lindenbaum Pty Ltd

Roboworks Pty Ltd

Azure Mining Technology Pty Ltd

AAM Pty Ltd

Spatial Vision Innovations Pty Ltd

BHP Group Limited

South East Water Corporation

Linke & Linke Surveys Pty Ltd

Asset Institute Limited

Mincka Engineering Pty Ltd

Roobuck Pty Ltd

Kumul Petroleum Holdings Limited

Crypses Pty Ltd

N2n Ai Pty Ltd

Emerson Automation Solutions

FrontierSI

Geoscape Australia

Research and Innovation Themes

RIIS
RESILIENT, INTELLIGENT INFRASTRUCTURE SYSTEMS

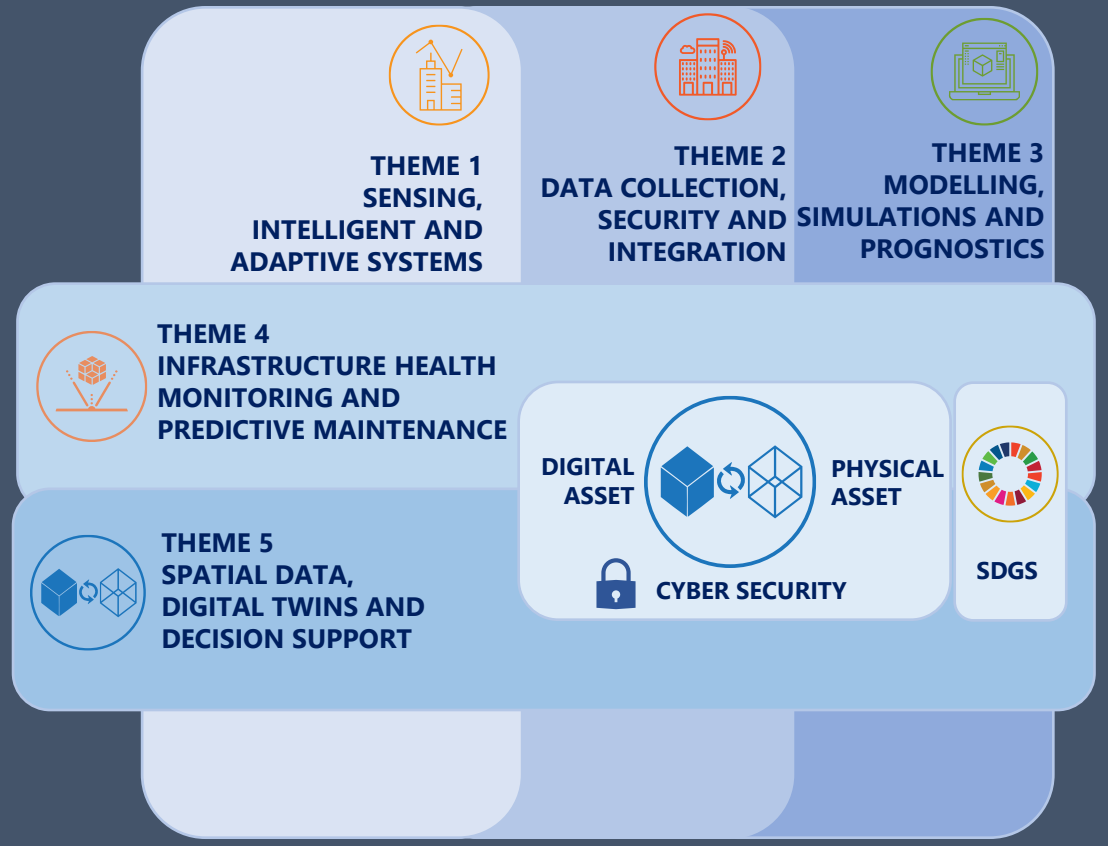
THEME 1 Sensing, intelligent and adaptive systems
- Robust, low energy sensors and actuators
- Ubiquitous positioning, sensing & communications
- Internet of Things (IoT) & sensing platforms
- Signal processing, network and sensing optimization

THEME 2 Data collection, security and integration
- Robotics, satellite, UAV, autonomous systems for data collection
- Big data management storage & transmission
- Data security, robustness and reliability

THEME 3 Modelling, simulations and prognostics
- Predictive modelling simulation & performance assessment
- Physics-informed artificial intelligence machine learning & explanation
- Real-time analytics – adaptive decisions

THEME 4 Infrastructure health monitoring and predictive maintenance
- Degradation quantification & failure prediction
- Risk & safety
- Service life assessment
- Remedial & renewal technologies

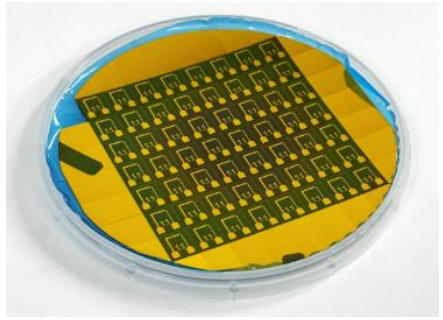
THEME 5 Spatial data, digital twins and decision support
- Integration & structuring of data & prognosis
- Digital twins & decision support
- Visualisation, virtual reality & interactive guidance systems
- Adaptive, intelligent & resilient design

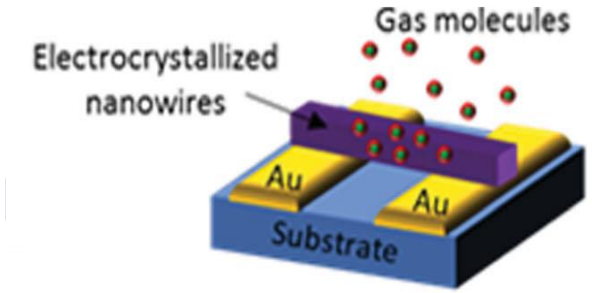


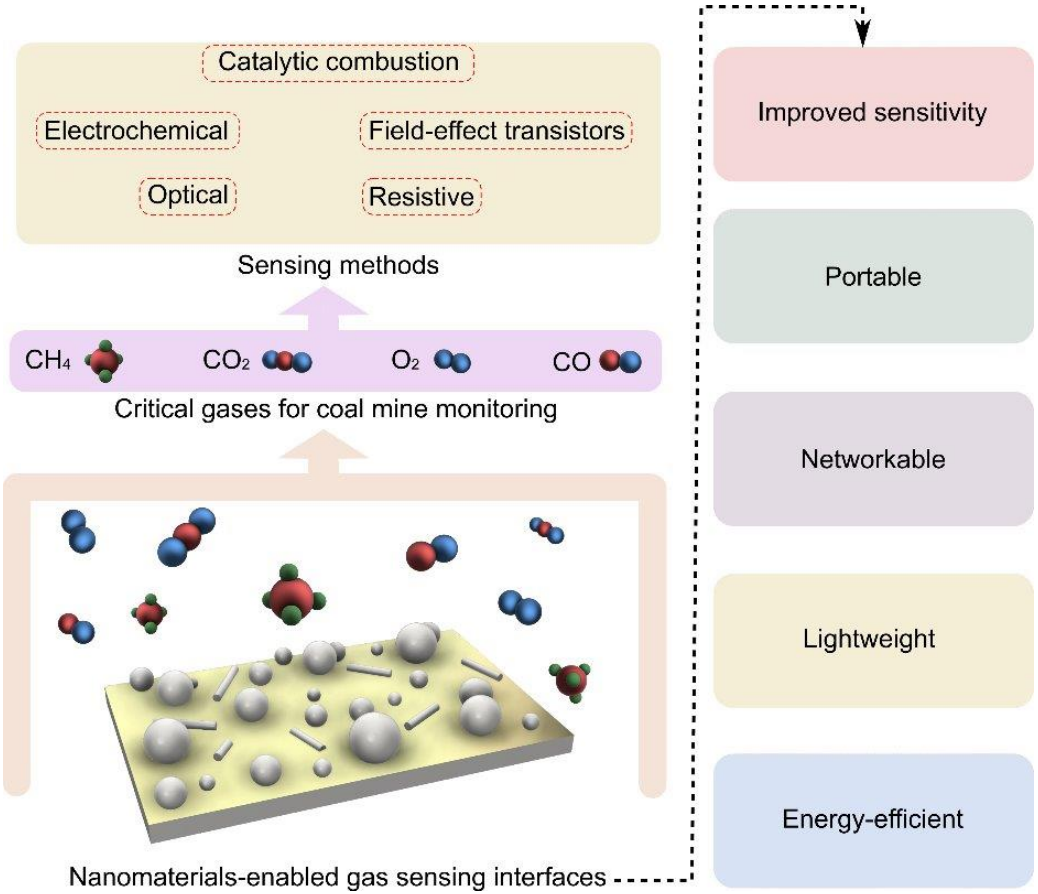
Theme 1

Nanosensor Technology for Safe Mining

Azure Mining Technology

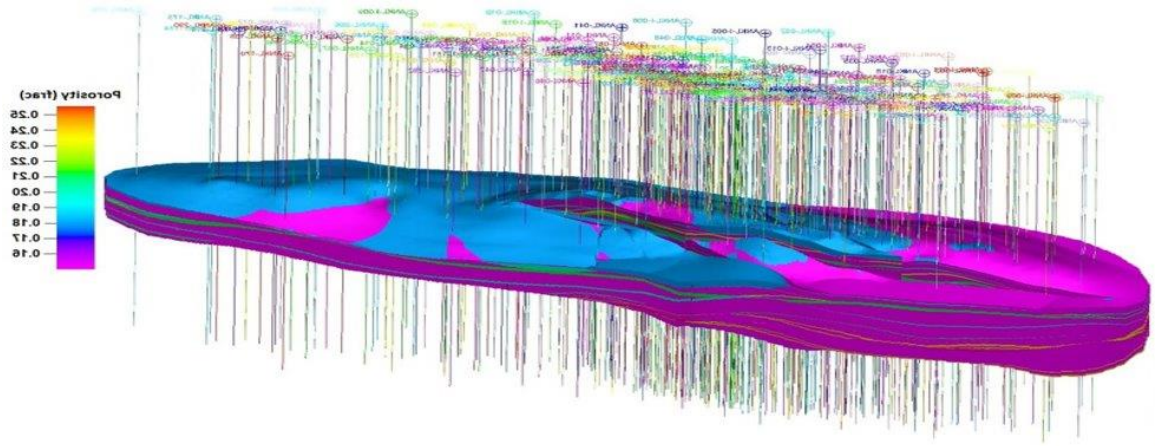


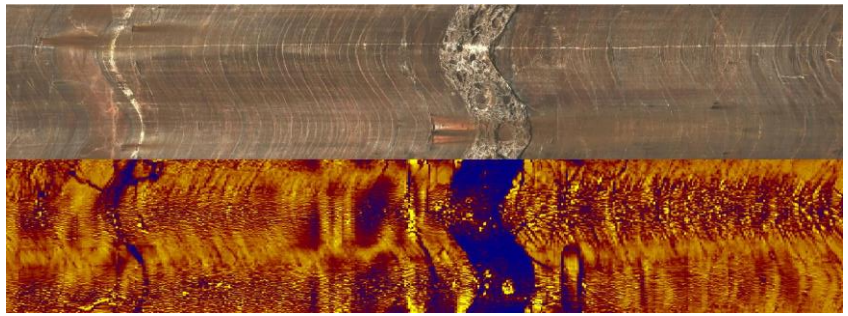


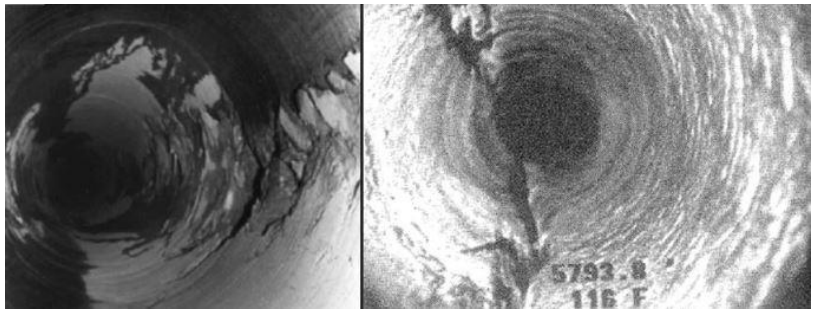


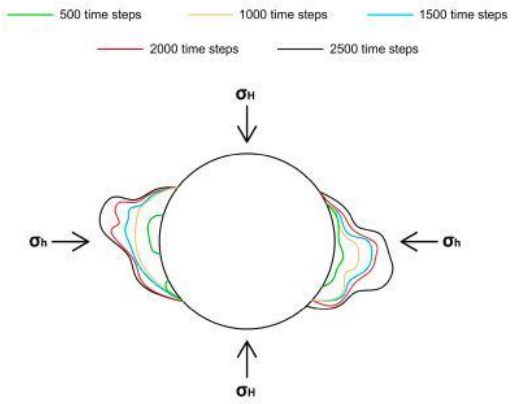
Theme 1

Characterisation and 3D Reconstruction Based on Photogrammetry, Acoustics, geophysical, AI and Edge Computing



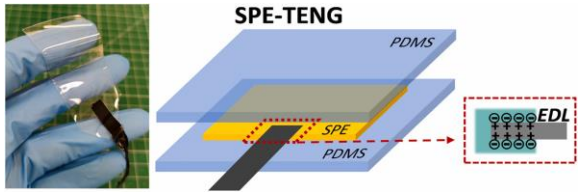


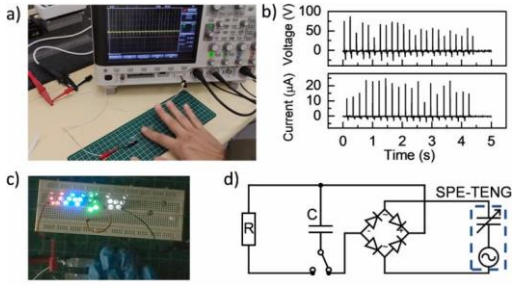




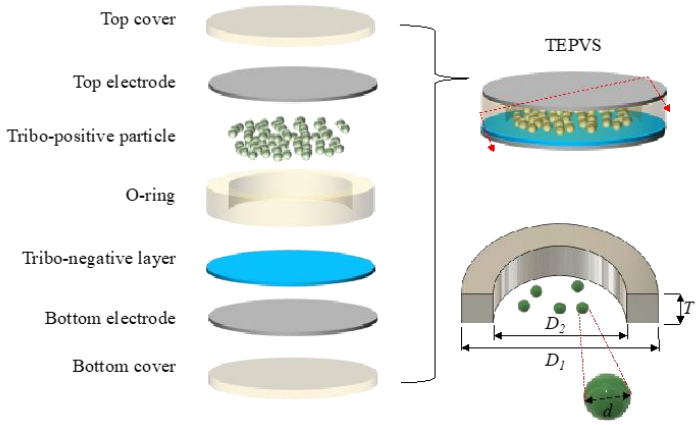
Theme 1

Self-powered sensor system for remote condition monitoring

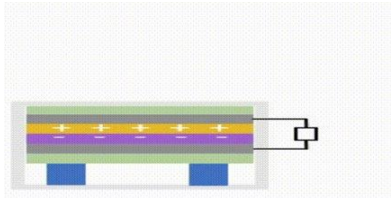




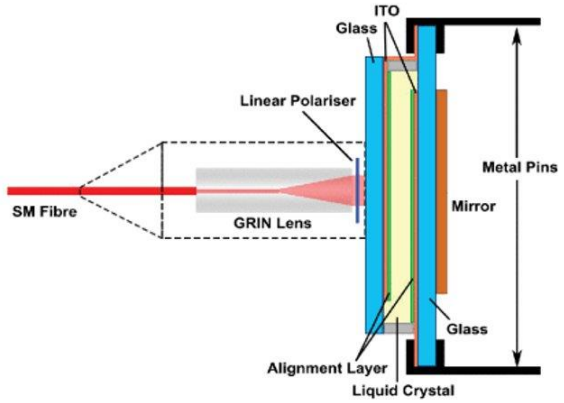
Bouncing particles vibration sensor



Clapping vibration sensor



Optical transducer



Theme 2

Underground Navigation and Obstacle Avoidance for Unmanned Equipment

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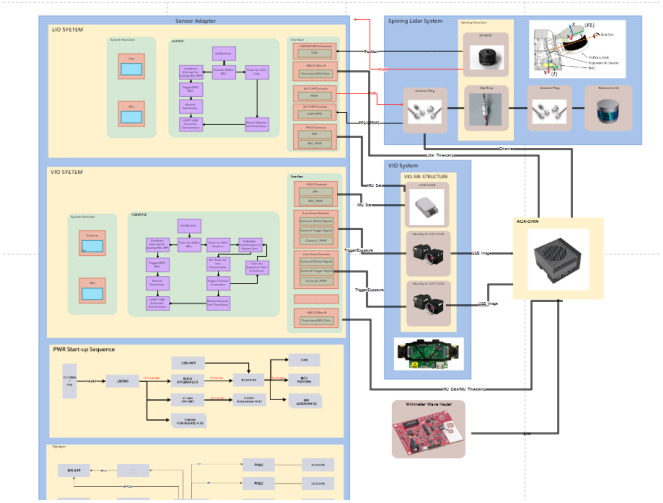
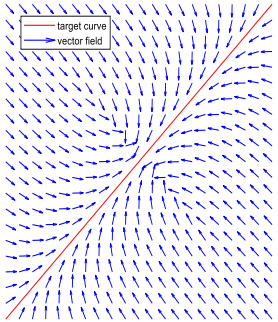
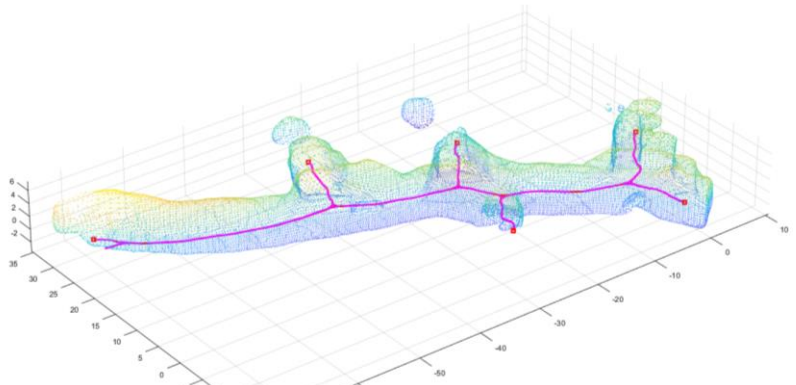
Aims

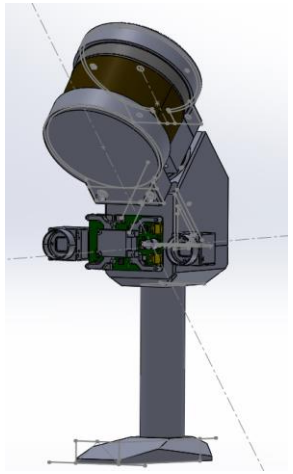
Integrate multiple sensors to achieve high accurate positioning, path planning, navigation, and obstacle avoidance for future autonomous operation in an underground mine.

- Vector Field Strategy for Autonomous Subterranean Exploration
- Hardware development, multi-sensor integration including time synchronisation









Theme 2

Photogrammetry Based Tracking and Navigation for Underground Spaces

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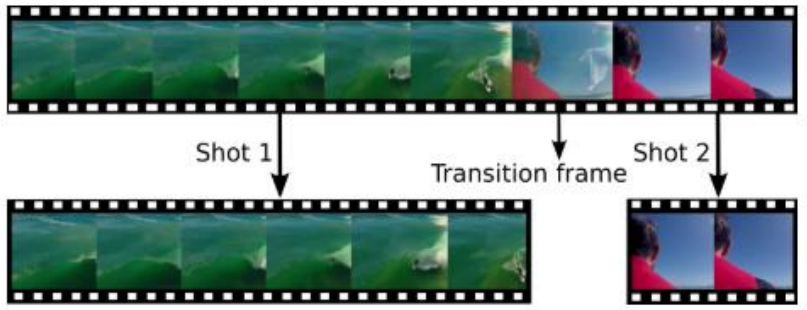
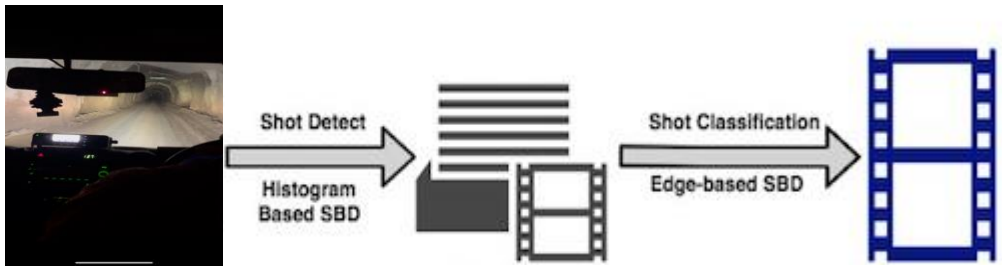
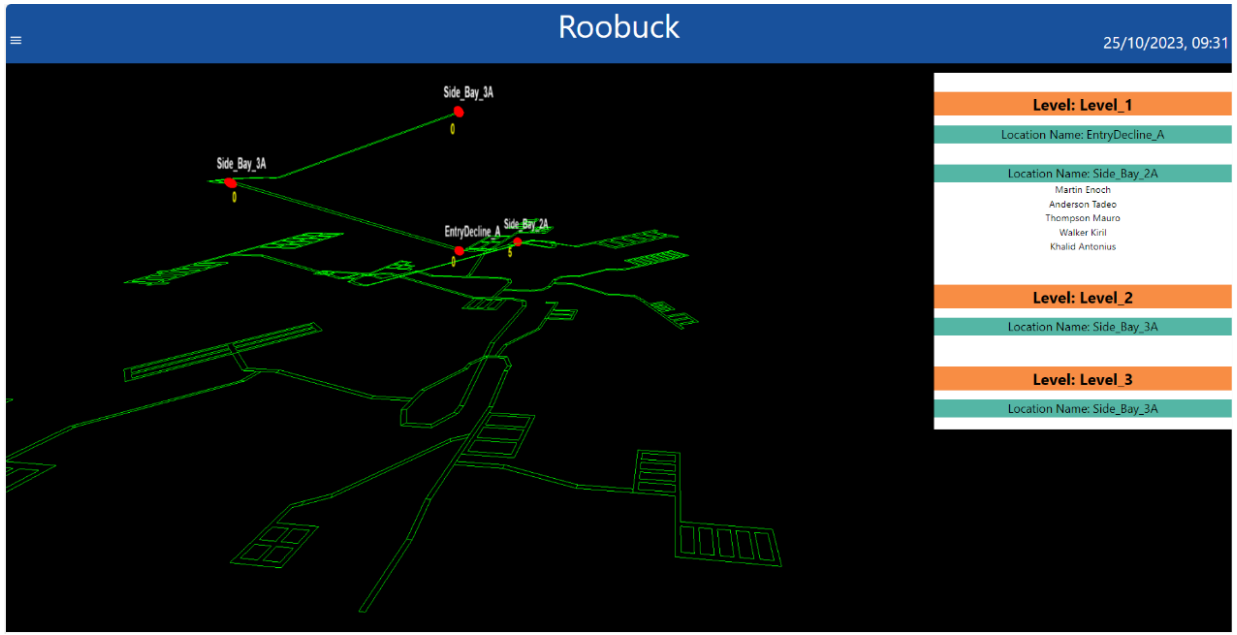
Aims

- Camera based vehicle tracking – using image to identify the location of a vehicle in a tunnel
- Classifying and identifying transition frames within the camera footage by visual feature descriptor (done)
- Keyframes and intra-frame image identification from camera shots (undergoing)
- Designing a similarity image identification algorithm based on the keyframes (undergoing







Theme 2

A Digital Technology for the Characterisation of Ore Grade and Distribution in a Rock Core

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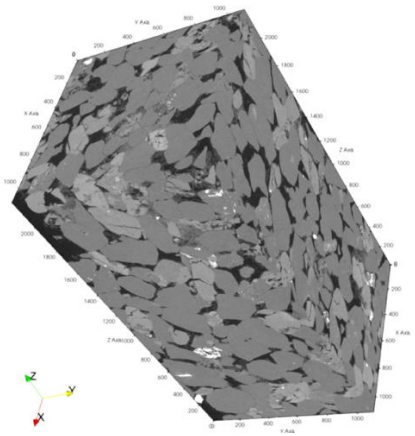
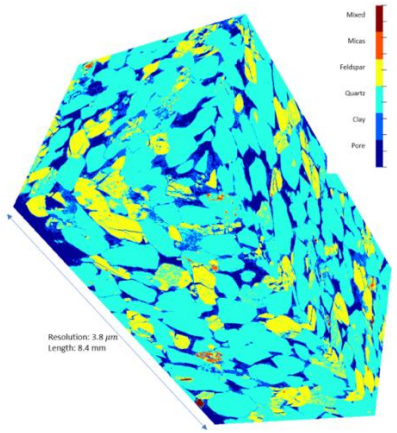
Aims

- Develop convolutional neural networks (CNN) for multi-species segmentation of porous media images. This will convert a greyscale micro-CT image into a "coloured image" where the materials in each voxel are classified and segmented. This simple technology coupled with limited ML training will permit reliable reserve estimations, estimation of reservoir yield, and prediction and upscaling of physical properties of rock cores.





Theme 3

Physics Informed ML for forward and Inverse Analysis

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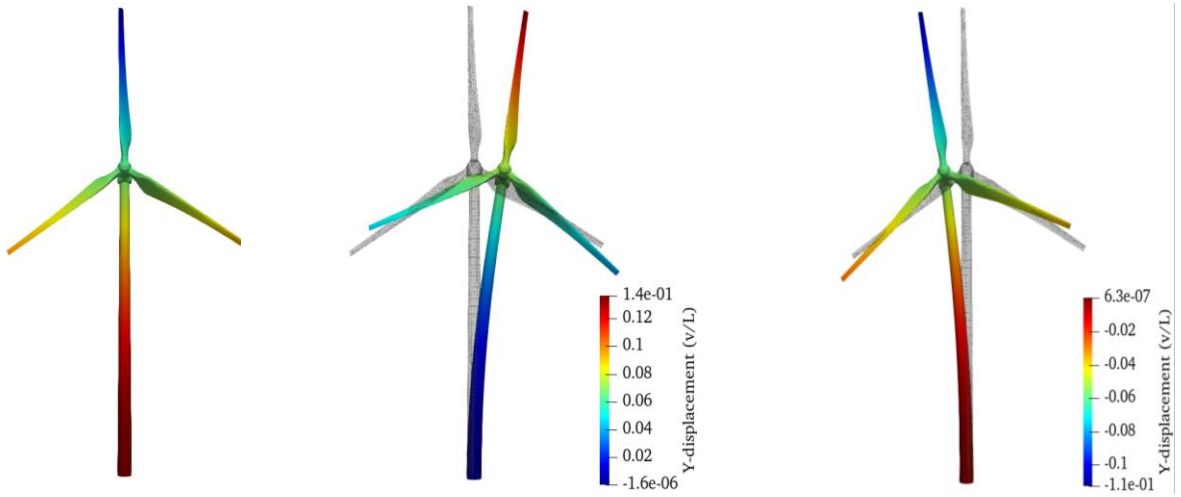
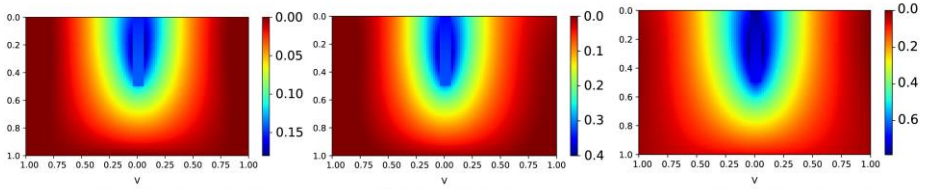
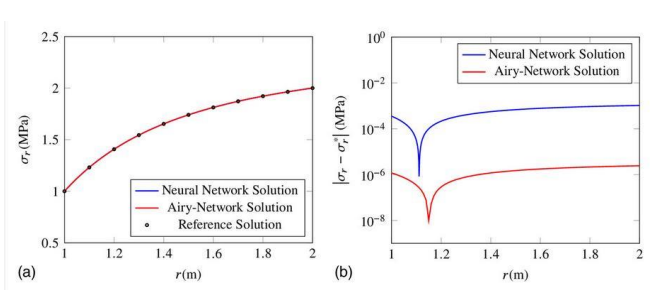
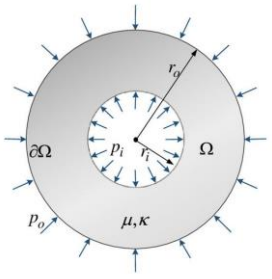
Aims

- Extend the predictive capacity of ML and permit forward and inverse analysis in real time based on sparse data









Theme 3

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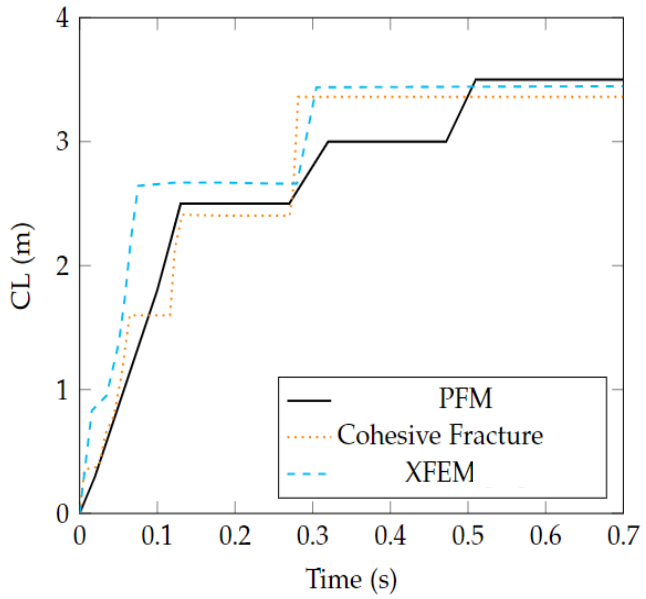

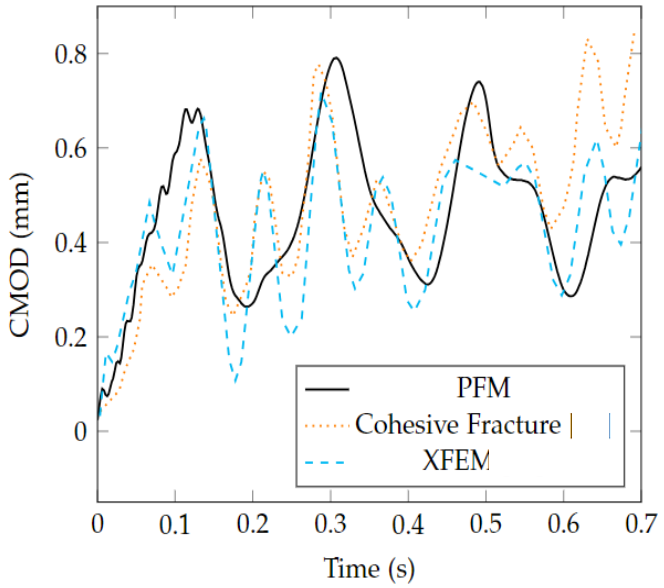

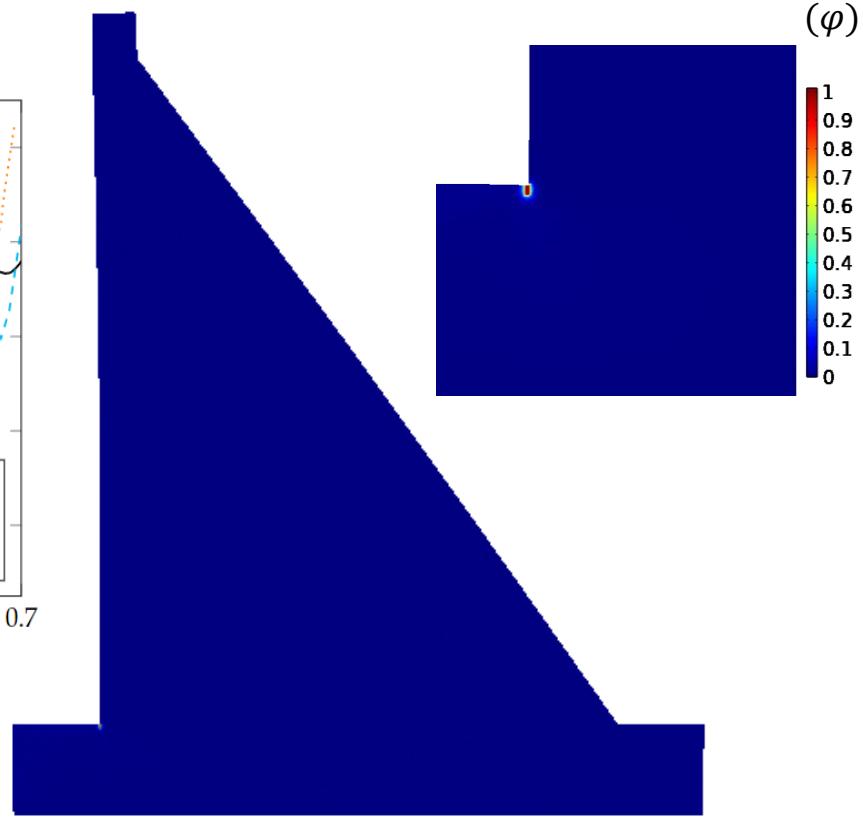

Theme 3

Structural Integrity Assessment through Anomaly Detection Using Dynamic Signature Analytics

- Ports Australia
- RMS

Remotely Operated/Autonomous Submersibles for Pier Defect Detection and Integrity Assessment

- Ports Australia

Degradation modelling and remaining service life assessment of piers

- Ports Australia

Theme 4

Automated Scan-vs-BIM for Real-Time Construction Progress Management

Aims

- Address the research gap between conventional data collection/processing approaches and demands for intelligent real time decision support during construction
- Automate spatial data processing, including imagery/laser point cloud data fusion
- Investigate robotic and autonomous for delivering real-time reporting of project progress including daily schedule update and cost analysis against project plan , in addition to resource tracking

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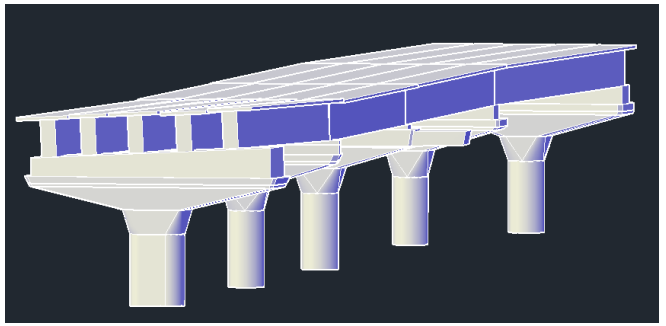

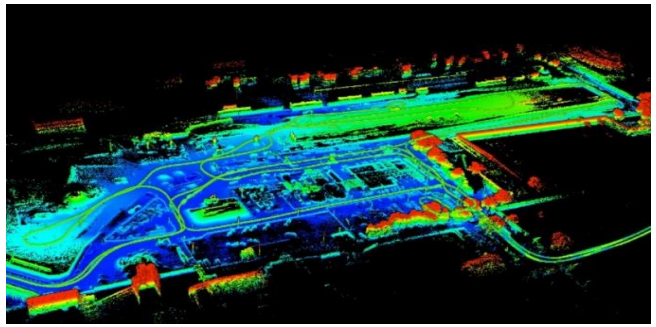

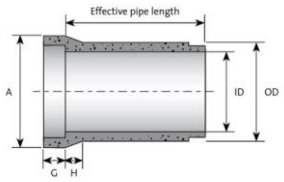

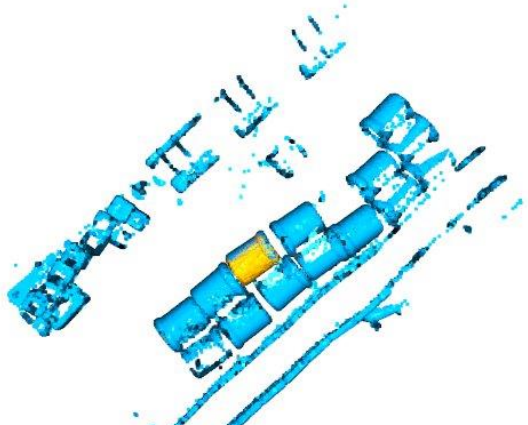

Theme 5

Real-Time Monitoring for Affected Catchments for Predictive Flash Flooding

Aims

- Capture data from distributed sensors (water level, rainfall, soil moisture) across a river catchment in real time using sensor deployment.
- Develop a pipeline in transmitting live data in RIIS database for integration into a digital twin.
- Develop predictive modelling and ML / AI algorithms within a system development architecture for flood maps utilising live data sets.

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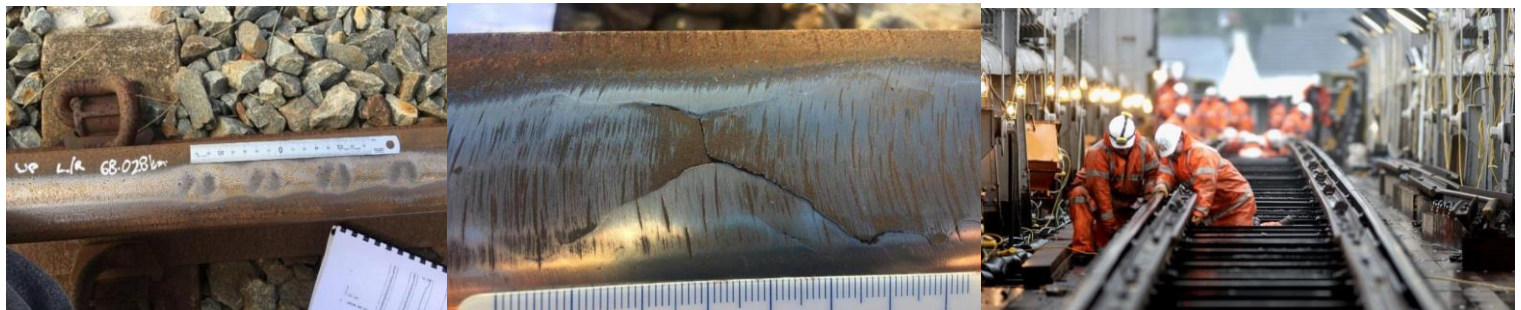
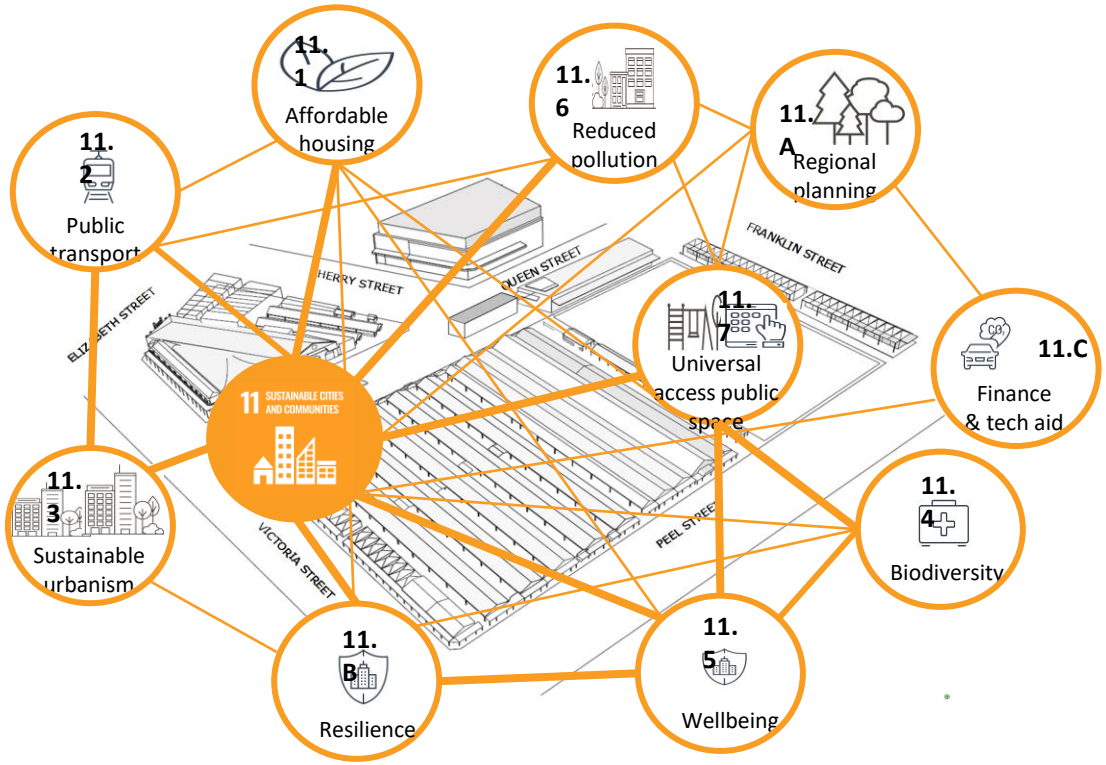
Predictive Maintenance Strategies for Railway Surface Defects

Aims

- Rail maintainers currently use time-based (scheduled) approaches to balance the costs and benefits of inspections and maintenance.
- Changing to condition-based inspection and maintenance planning has the potential to reduce costs and improve rail surface condition.
- Design an automated detection process for the health of underground and above-ground infrastructure – real time





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Thank You

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