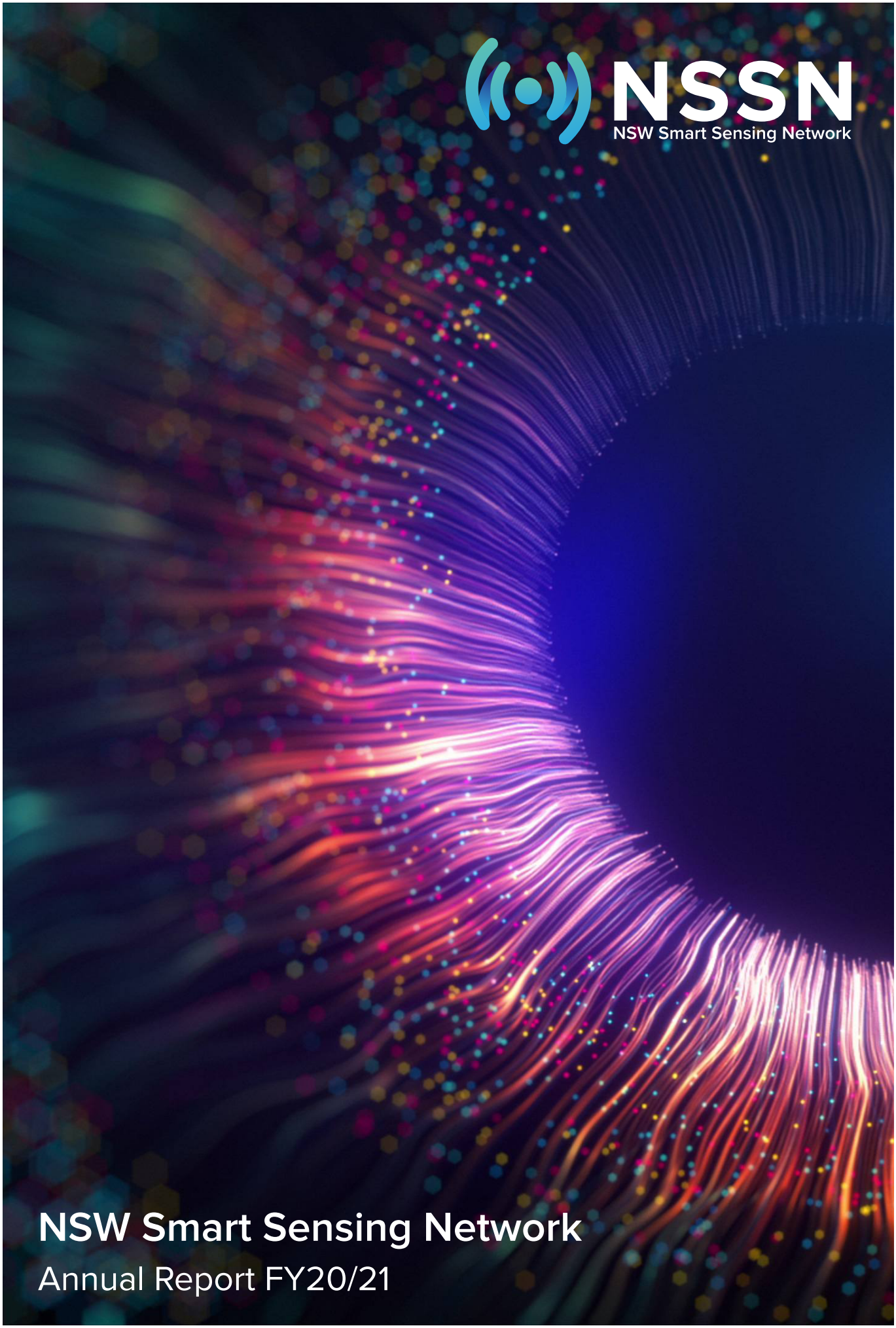



# NSW Smart Sensing Network

## Annual Report FY20/21

Proudly funded by

# FOREWORD BY BOARD CHAIR

**I have been privileged to chair the NSW Smart Sensing Network since its inception, first as Chair of the Steering Committee for the first two years and for the last three as Chair of the seven-member Board.**

**Across that five-year period, I have proudly seen the NSSN evolve from an exciting concept envisioned by former NSW Chief Scientist & Engineer, Professor Mary O'Kane AC, to a dynamic organisation that is truly at the forefront of collaboration, translation and innovation.**

Those three words – collaboration, translation, innovation – go together, for we don't have innovation without translation, we don't have translation without innovation, and we cannot achieve bold ambitions without collaboration.

Despite the continued ravages of a global pandemic, FY20/21 was an intensely busy year for the NSSN. The NSSN Board, which draws upon the expertise and time of esteemed leaders from across the research, industry, and government sectors, farewelled three outgoing members in Marlene Kanga, Peter Runcie, and Paul-Scully Power. In their place, we welcomed three new Board members who bring new perspectives and fresh energy to the Board: Jill Freyne, Ian Oppermann and Sally-Ann Williams.

We also farewelled our foundational co-director from UNSW, Professor Justin Gooding. I acknowledge and thank him for the pivotal role he played in making the NSSN the success that it is today. He handed over to Professor Julien Epps, who brings with him deep expertise in smart sensing and a wealth of experience in university-industry collaboration.

As you will read in this report, the many programs and events of the NSSN continued throughout FY20/21 in a tireless pursuit of collaboration, translation and innovation.

It remains for me to thank and recognise all our NSSN staff, led by Co-Directors, Professors Benjamin Eggleton and Julien Epps, and Chief Operating Officer, Nicholas Haskins, as well as the NSSN Board and Members for their unswerving commitment to the NSW innovation ecosystem and to positioning the state as a leader in smart sensing. I also thank Professor Hugh-Durrant-Whyte and Christina Newman from the Office of the NSW Chief Scientist and Engineer for their continued strategic advice, advocacy, and investment.

We are a Network – of people, institutions and companies – rich in intellectual assets that when linked up spark ideas, create new opportunities and solve complex challenges. Together we are bringing new smart sensing solutions to the marketplace and delivering prosperity to NSW and beyond.

**Dr Susan Pond AM**
**Chair of NSSN Board**



# CO-DIRECTOR'S MESSAGE

**If 2020/21 showed us anything, it was that we can't take anything for granted. The concept of *Fortress Australia* – a safe cocoon locked away from the ills of the rest of the world – was shattered with the arrival of the COVID-19 Delta variant and despite adroit public health policy and strong community support, we still suffered at the hands of a global pandemic.**

Yet, if you looked behind the pandemic headlines, you saw the green shoots of innovation all around us – from exciting developments in the space industry to sovereign capability in medtech manufacturing; from the emerging city in Sydney's west to agtech innovation hubs across regional NSW. It is innovation that will drive our economic recovery from the ravages of COVID-19 and the NSW Government has made its ambitions resoundingly clear with the release in early 2021 of its *Accelerating R&D in NSW Action Plan.*

The NSW Smart Sensing Network (NSSN) is proud to be a part of this bold new agenda to position NSW as a leader in innovation and to place innovation central to our state's economic resilience and prosperity. As the first of a growing number of NSW Innovation Networks, we have served as a model of triple helix collaboration that has guided the development of new networks in areas as diverse as defence, circular economy, space, telecommunications, decarbonisation and more.

The NSSN has spent the last five years activating partnerships between universities, government and industry to translate the world-class research in our member universities to impactful economic, environmental and societal outcomes.

Importantly, we align our efforts not only with the industry sector priorities of the state to deliver prosperity to NSW but to the UN Sustainable Development Goals (SDGs) to help deliver better outcomes globally.  Our Grand Challenge program focusses our resources around key, timely issues where smart sensing can have real impact – areas like water security, bushfires, ageing and infectious disease.

As we celebrate our five year anniversary with an exciting pipeline of projects under active development, we both reflect on the achievements of the last five years and look forward with renewed confidence through the lens of our Strategic Plan 2021-24. The plan was launched in July 2021 and is the product of broad consultation with our university members and our government and industry partners.

We encourage you to read on and learn more about how the NSSN is delivering impact and driving innovation.

**Professor Benjamin Eggleton**
**Co-Director, NSSN**

**Professor Julien Epps**
**Co-Director, NSSN**

# Contents

# ABOUT THE NSW SMART SENSING NETWORK (NSSN)

**The NSW Smart Sensing Network (NSSN) was established in July 2016 with funding from the NSW State Government through the Office of the Chief Scientist & Engineer. It was founded on the premise that the economy and people of New South Wales face key challenges in energy, resources, manufacturing, the environment, transport, agriculture, space and health that cutting-edge research in smart sensing could play a critical role in solving.**

**The market for smart sensing across a broad range of industries is immense and growing. The NSSN brings together the world class research taking place in NSW universities with state government agencies and industry to develop innovative solutions to these key challenges and, at the same time, position NSW as a leader in sensing technology.**

## OUR VISION

NSW is a recognised global leader in smart sensing.

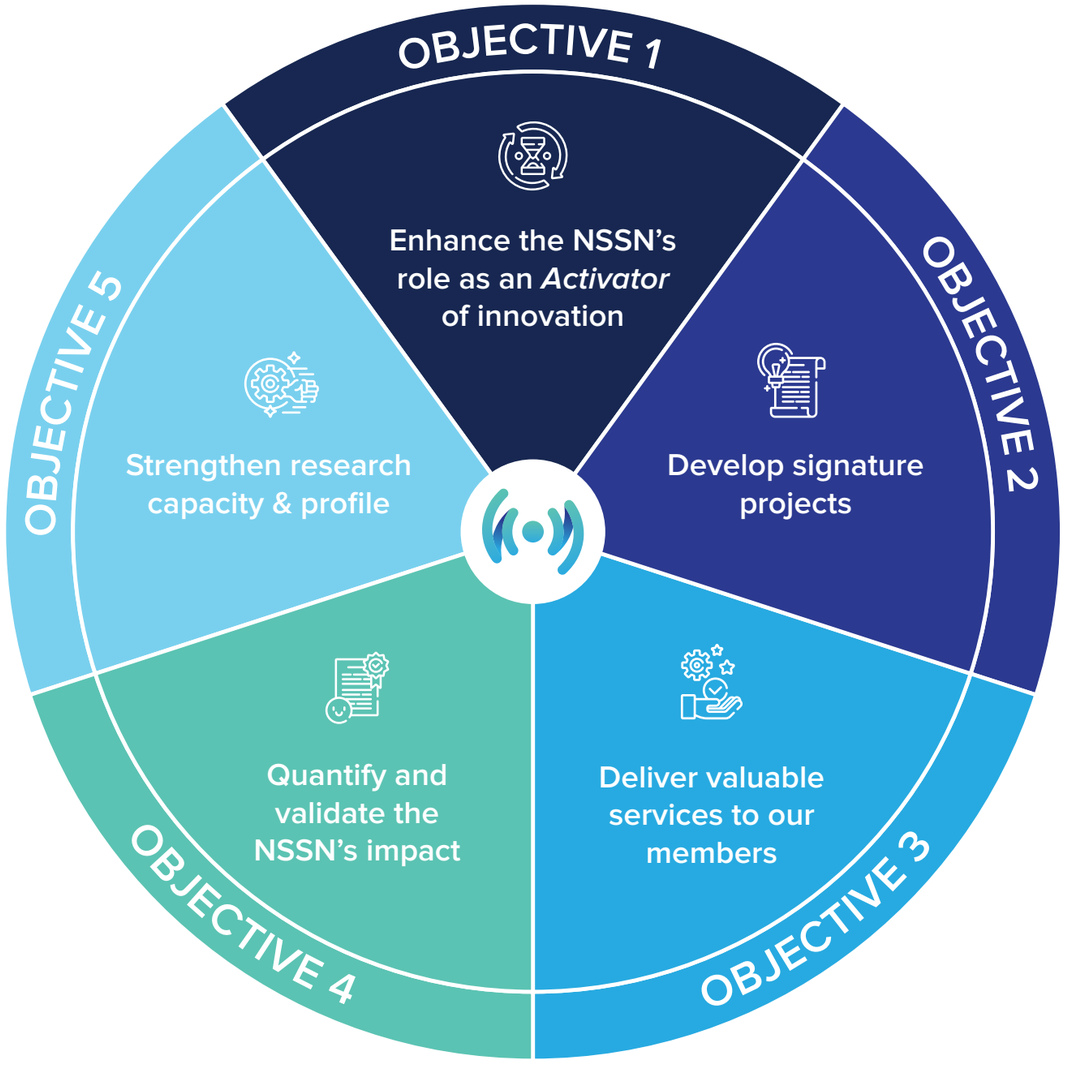
## OUR MISSION

To translate world-class research in smart sensing into compelling solutions that create value for the economy, environment and society of NSW and beyond.

## OUR OBJECTIVES

Our objectives enable us to realise our vision and achieve our mission.

1. Enhance the NSSN's role as an *Activator* of innovation.
2. Develop signature projects.
3. Deliver valuable services to our members.
4. Quantify and validate the NSSN's impact.
5. Strengthen research capacity and profile.



# MEMBERS

**We bring together smart sensing expertise from across the leading universities in NSW & the ACT to develop innovative, interdisciplinary solutions to complex challenges.**

Australian National University

UNIVERSITY OF CANBERRA

MACQUARIE University SYDNEY·AUSTRALIA

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

THE UNIVERSITY OF SYDNEY

UNSW SYDNEY

UTS

WESTERN SYDNEY UNIVERSITY

# PEOPLE

**The NSSN is led by two internationally recognised scientists who are leaders in their respective fields of physics and electrical engineering and bring a wealth of expertise to the network's ambitious program of research, innovation and industry collaboration.**

The NSSN Board, chaired by Dr Susan Pond AM, and consisting of experienced leaders across the policy, research and industry spectrum provide guidance and oversight on network strategy and direction.

The NSSN Members' Committee consists of senior representatives of each of the member universities and the NSW Office of Chief Scientist & Engineer. It ensures that member university and government imperatives guide the strategy and activities of the network.

A lean central team of talented staff lead the research programs and co-ordinate the operations of the network.

## CO-DIRECTORS

Professor Benjamin Eggleton

Professor Julien Epps



# BOARD

**The NSSN Board, chaired by Dr Susan Pond AM, and consisting of experienced leaders across the policy, research and industry spectrum provide guidance and oversight on network strategy and direction.**

Dr Susan Pond AM
Chair

Nick Campbell
Board Member

Dr Jill Freyne
Board Member

Dr Ian Oppermann
Board Member

Jo White
Board Member

Sally-Ann Williams
Board Member

Frank Zeichner Board
Board Member

Christina Newman
Board Member

# MEMBERS' COMMITTEE

**The NSSN Members' Committee consists of the Deputy Vice-Chancellors (Research & Innovation) or equivalent and represents the members' interests in the strategic direction of the Network.**

Professor Julie Cairney
Pro-Vice-Chancellor (Research - Enterprise & Engagement), University of Sydney

Professor Brian Kelly
Pro Vice-Chancellor (Research & Innovation), University of Newcastle

Professor Kathryn McGrath
Deputy Vice-Chancellor (Research), UTS

Professor Keith Nugent
Deputy Vice-Chancellor (Research and Innovation), ANU

Professor Sakkie Pretorius
Deputy Vice-Chancellor (Research), Macquarie University

Professor Sven Rogge
Pro Vice-Chancellor (Research), UNSW

Professor Deborah Sweeney
Deputy Vice-Chancellor and Vice-President, Research & Innovation, Western Sydney University



# STAFF

**The NSSN consists of a lean central team of talented staff who lead the research programs and co-ordinate the operations of the network.**

Nicholas Haskins
Chief Operating Officer

Shahrzad Abbasi
Media and Public Relations Officer

Ivan Chua
Business Development Manager

Jane Evans
MedTech Theme Leader

Dr Tomonori Hu
Environment & AgTech Theme Leader

Dr Eric Magi
Engineer

Dr Don McCallum
Development Manager

Dr Ayu Saraswati
AI/ML Engineer

Danielle Seagrave
Project Administrator

Jimmy Tran
Electronics & Development Engineer

Dr Ramanathan Vaidyanathan
Manufacturing & Fluidics Theme Leader

Dr Zhitao Xiong
Data & Built Environment Theme Leader

# FY20/21 By The Numbers

**10**
ACTIVE R&D PROJECTS
UNDER MANAGEMENT

**$1,867,462**
IN NEW CONTRACT
RESEARCH FUNDING

**$220,000**
GRAND CHALLENGE
FUNDING DISPENSED

**6**
INDUSTRY
ENGAGEMENT EVENTS

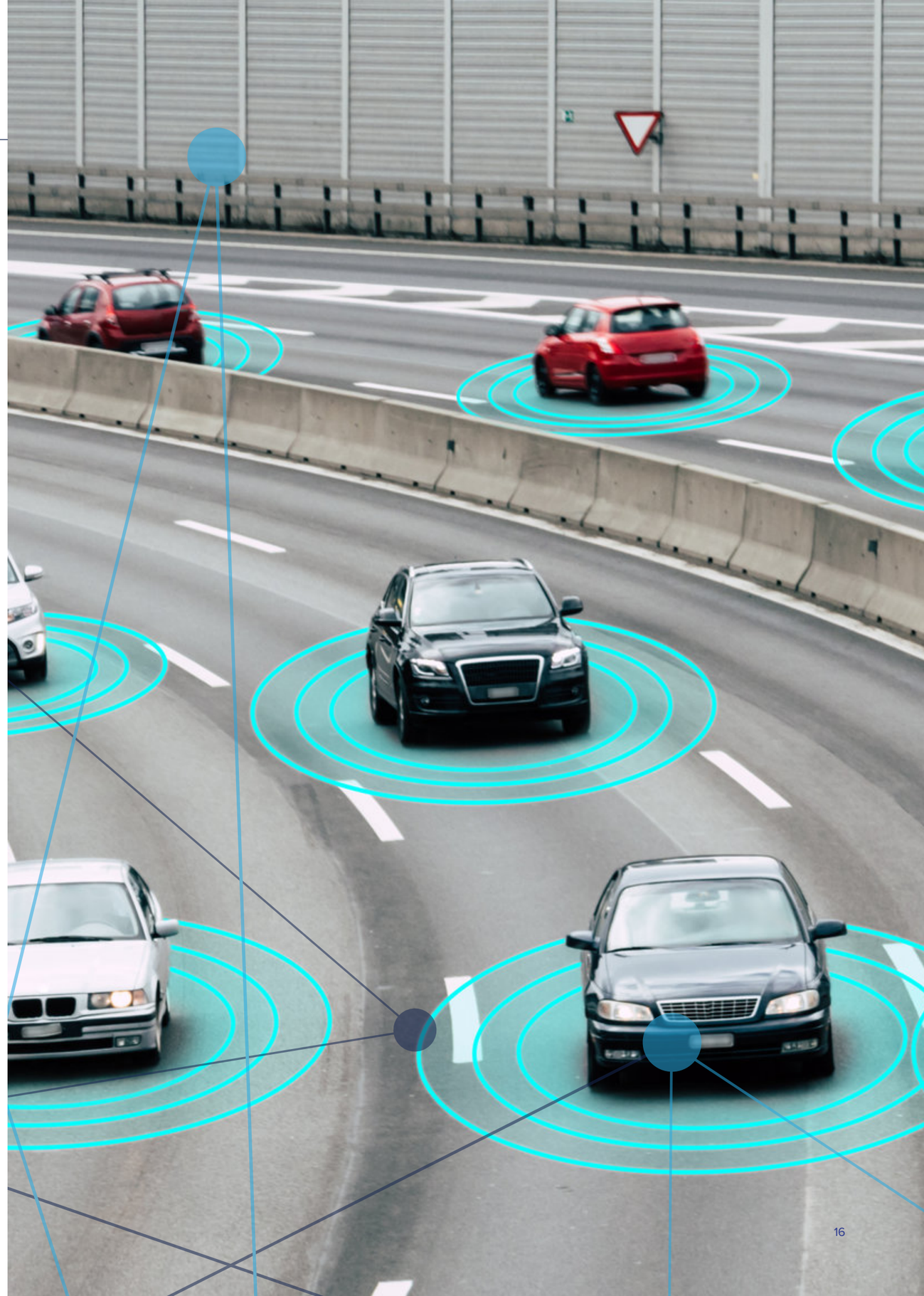
**2,700**
TWITTER FOLLOWERS

**1,570**
LINKEDIN FOLLOWERS

**11**
ACADEMIC
PUBLICATIONS

**32**
ENGAGEMENTS
IN INNOVATION
ECOSYSTEM EVENTS





# EXECUTIVE SUMMARY

**In FY20/21, we were bolstered by the release of the *Accelerating R&D in NSW Action Plan* and its strong support for the triple helix collaboration model that the NSW Smart Sensing Network embodies. We were also gratified by the expansion of the NSW Innovation Networks model, of which the NSSN was the forerunner. We are proud to play an integral role in both these initiatives, providing advice and input as they are rolled out.**

As the NSSN celebrates its fifth year, we also set our sights on our next three-year horizon. The **NSSN Strategic Plan 2021-24** was released in June 2021 following widespread stakeholder consultation. The result is an ambitious plan that sharpens our vision, mission and values and defines five key objectives to guide our development over the next three years:

1. Enhance the NSSN's role as an Activator of innovation
2. Develop signature projects
3. Deliver valuable services to our members
4. Quantify and validate the NSSN's impact
5. Strengthen research capacity & profile

We also farewelled outgoing Co-Director, **Professor Justin Gooding**, who played an instrumental role in the establishment and early success of the NSSN. Professor Gooding is succeeded by incoming Co-Director, **Professor Julien Epps**, Head of School of Electrical Engineering & Telecommunications at UNSW who brings enthusiasm and a strong track record of industry engagement to the Network.

FY20/21 saw solid growth in our **R&D program**, with **10 programs** under management. The Where is all the Water? project commenced with the NSW Department of Planning, Industry & Environment (DPIE), which will deliver valuable new insights to regulators, farmers and irrigators on the quantity and movement of water across NSW. Plan Jericho, our R&D program with the Royal Australian Air Force (RAAF) was extended, and we successfully completed two major industrial transformation programs: *Advanced Pipe Sensing to Reduce Leaks & Breaks* and the CRC-P-funded *HDPE Recycling Program.* These completed programs now graduate to commercialisation and operationalisation phase, with the NSSN remaining actively involved in the translation of research into commercial outcomes and societal impact.

We proudly launched our **Grand Challenge Fund** in early 2021. This fund not only delivers tangible financial return to our member universities but also stimulates collaborative R&D programs in the four NSSN Grand Challenges of Ageing, Bushfires, COVID-19 and Water – all timely and critical issues facing NSW. In the inaugural round, a total of $220,000 was awarded across three projects that partner NSSN member university expertise with industry and government challenges. The fund will become an annual feature of the NSSN calendar and will be offered again in late 2021.

Our **Business Development program** continues to build a strong pipeline of contract research leads and opportunities to our member universities. In FY20/21, the NSSN attracted **$1.9 million** in commissioned research across **7 projects**. A pipeline of future work is laying the foundation for sustained success and return on investment to our stakeholders.

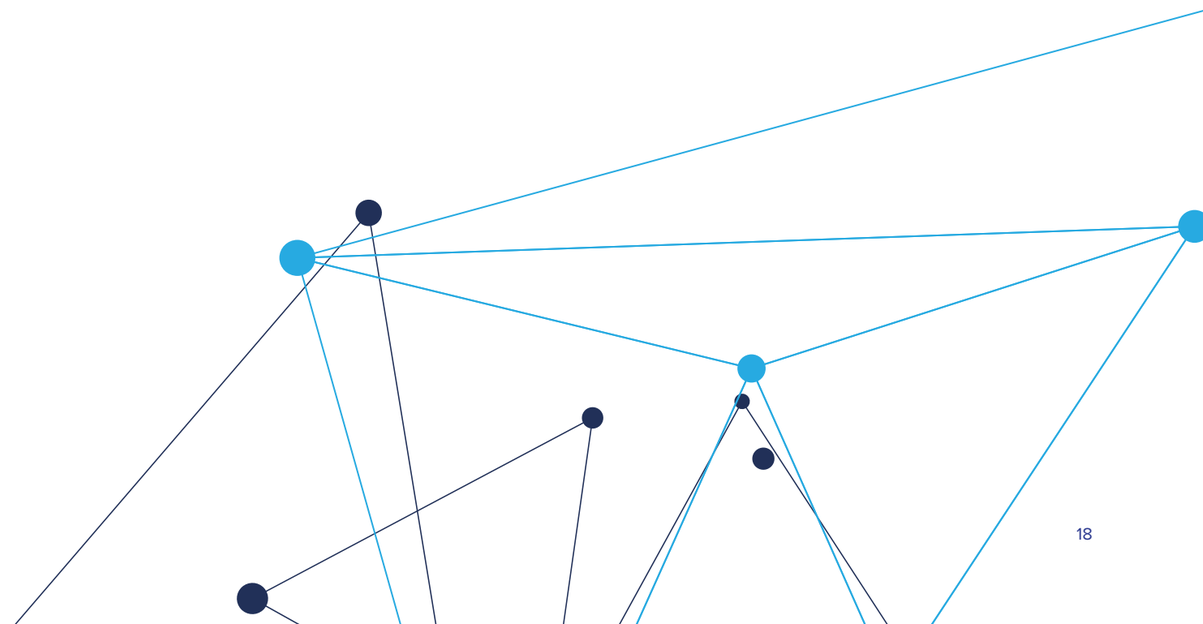
Our **Industry Engagement program** was impacted by COVID-19 and the resultant restricted ability to host face-to-face events. The NSSN hosted **6 events**, aimed at engaging the NSW sensing ecosystem from SMEs right through to industry primes. In February 2021, the NSSN launched its Ageing Grand Challenge with a Forum that brought together researchers with a range of key stakeholders including Johnson & Johnson, Siemens Healthcare, Telstra Health, Ramsay Health, Samsung, MTAA, MTP Connect, CSIRO and NSW Health. In May 2021, the NSSN took its *NSW Sensing Industry Connect* networking event series to Newcastle as part of the Hunter Innovation Festival.

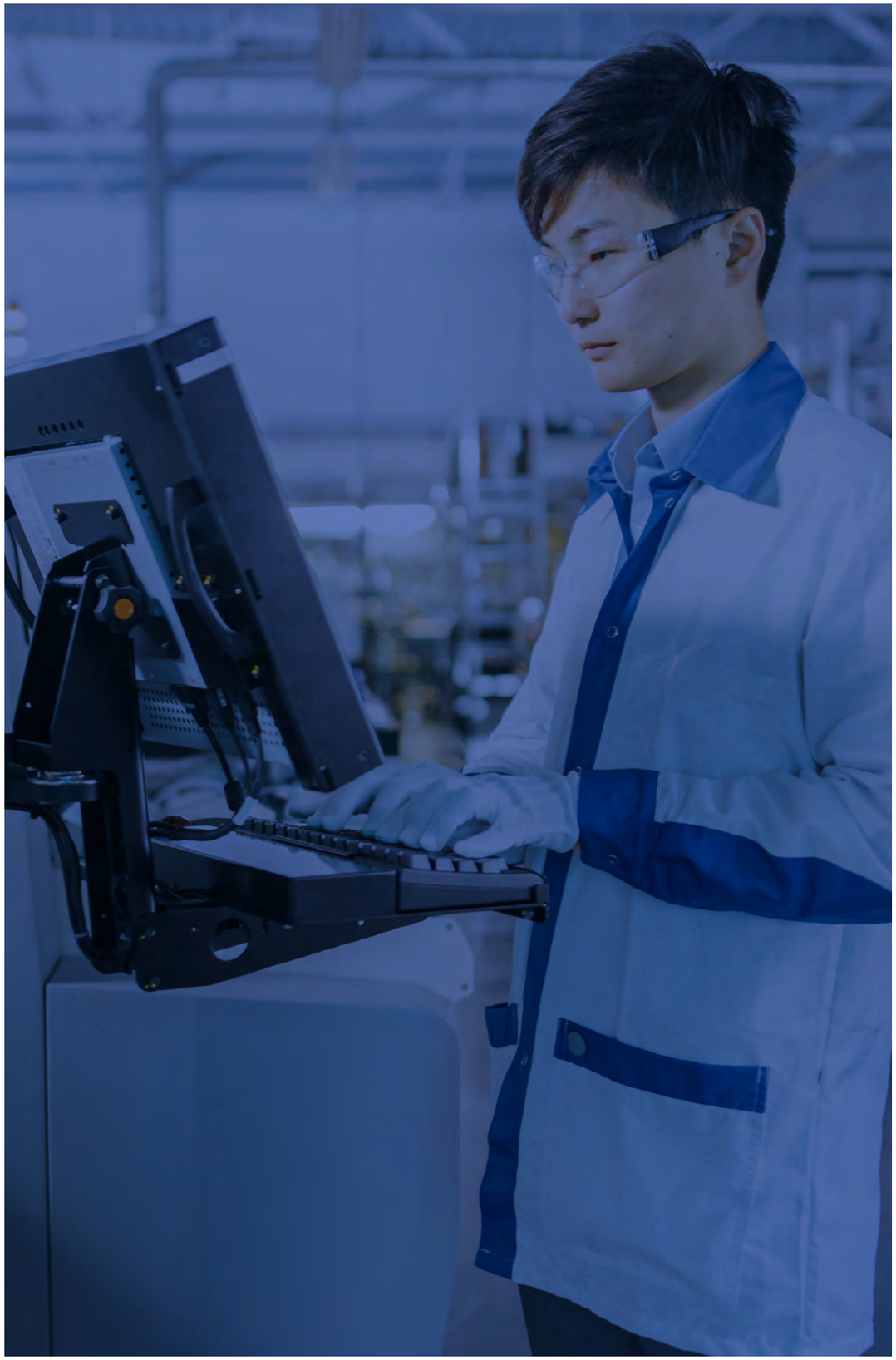
We continued to broaden our audience through our **Public Outreach program**. Across our events and digital, social and traditional media we seek to engage, educate and inform both the scientific and general community on issues relating to smart sensing innovation. Our Twitter reach grew by 40% to **2,700 Twitter followers**. We grew our LinkedIn reach by 30% to **1,570 LinkedIn followers**. The NSSN averaged **1,800 website visits per month**. We saw significant growth in engagement with traditional media channels, securing **50 media mentions** across TV, radio and print media, including outlets like Channel Seven, ABC Radio, The Age Newspaper and Australian Manufacturing Magazine. This serves as a clear demonstration that the NSSN is saying things people care about and profiling NSW as a place of smart sensing innovation.

As we close out the NSSN Strategic Plan 2019-21, we can report with confidence that the NSSN is meeting and exceeding its remit and delivering strong return on investment to our university members and the people of NSW. Our new Strategic Plan 2021-24, launched at the end of June, builds upon strong a foundation and provides a roadmap for the NSSN's sustained success over the next three years and beyond.

We are grateful for the ongoing support of the Office of the Chief Scientist & Engineer and R&D NSW for the NSSN and, more broadly, for its leadership in driving a new innovation agenda for NSW.

We invite you to read on for a more detailed report on the NSSN's achievements in FY20/21.





# NSSN R&D PROGRAM

**The NSSN runs an active research and development program, with 10 active R&D projects under management in FY20/21:**

## 1. PLAN JERICHO

The Jericho Smart Sensing Laboratory (JSSL) at the University of Sydney deepened its work with the RAAF, securing an additional $1 million in funding in FY20/21.

The project aims to develop next generation sensor fusion technology that can assess the physical, acoustic and electromagnetic environment. It consists of three streams of work: UAV swarm detection, radio frequency shaping and sensing, and detecting patterns of life. The project incorporates design concepts at the development stage to ensure the cutting-edge technology has maximum benefit for the end-user.

The JSSL headquarter is located within the Sydney Nanoscience Hub, using specially customised state-of-the-art, environmentally controlled laboratories, specifically designed for research in nanoscale devices and lithography equipment for printing photonic circuits in silicon, as well as packaging and prototyping facilities.

**VALUE:**
$4,000,000

**PARTNERS:**
- Royal Australian Air Force (RAAF)

### UNIVERSITY PARTNERS:

THE UNIVERSITY OF SYDNEY




## 2. ADVANCED PIPE SENSING TO REDUCE LEAKS & BREAKS

This multi-disciplinary, multi-institutional **program** commenced in early 2019 and drew to a close in November 2020. The NSSN led the establishment, project management, communications and ultimate delivery of the program, involving five work packages, eight industry partners and five universities.

While the full impact of the R&D will take years to be realised, Sydney Water has estimated cost savings of over $3 million per year and water savings of 700 million litres per year, directly attributable to the program.

Data analytics advancements realised through the program mean that 80% of the leaks and breaks on all sizes of water pipes can now be predicted with positional accuracy of 200 metres. A significant operational improvement for water utilities.

The program succeeded in significantly raising the Technology Readiness Level (TRL) of a range of innovations that will be deployable in the water industry. Distributed Acoustic Sensing in a water pipe configuration has progressed to TRL 7; Gravimetry Sensing (gravity measurements of water plumes) to TRL6; Quantum Sensing Techniques to TRL4; and Drone-mounted LiDAR techniques to TRL4.

The NSSN continues to work with all program partners to translate R&D undertaken through the program to commercialisation and operationalisation outcomes.

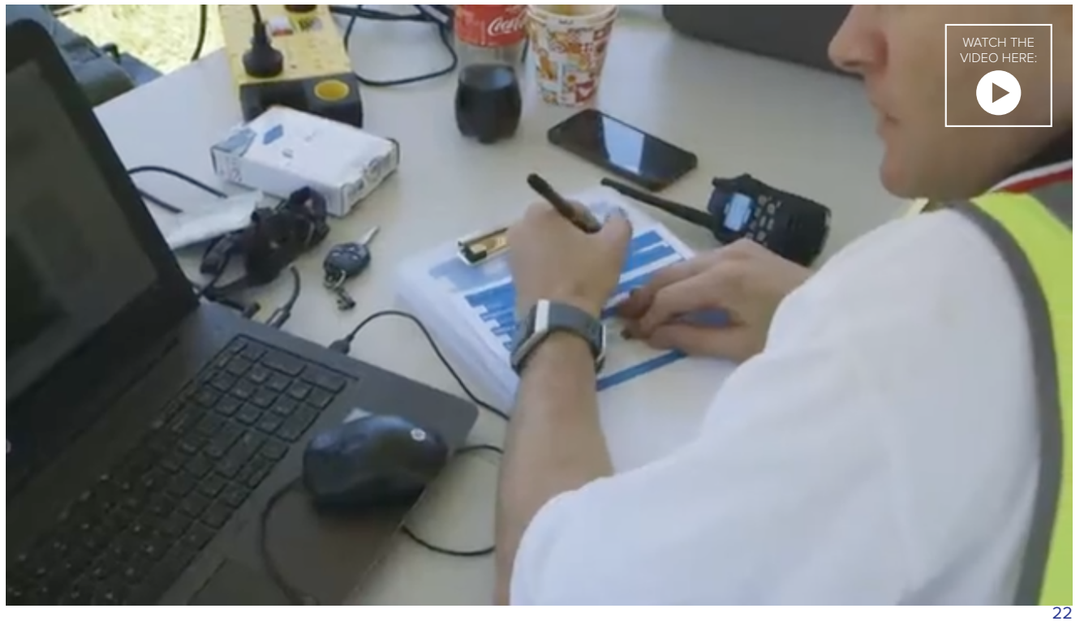
**A full report on the program can be found here.**

**VALUE:**
$3,421,710

**PARTNERS:**
- Sydney Water (principal)
- Hunter Water
- Melbourne Water
- SA Water
- Intelligent Water Networks
- Queensland Urban Utilities
- Water NSW
- UKWIR
- Downer

### UNIVERSITY PARTNERS:

Australian National University · THE UNIVERSITY OF NEWCASTLE AUSTRALIA · UNIVERSITY OF CANBERRA · UNSW SYDNEY · UTS



## 3. INCREASED RECYCLING OF PLASTICS BY SENSING & TREATING LABEL CONTAMINATION

The NSSN managed the successful delivery of this CRC-P project focused on increased re-use of HDPE plastic, involving three member universities, Labelmakers, and NSW-based SME, PEGRAS.

**The project** has the potential to divert hundreds of thousands of tonnes of plastic waste from landfill by eliminating residual contaminants on recycled HDPE chips. It will increase yields of uncontaminated recycled HDPE – a valuable commodity for recycling companies to sell.

The project has raised the TRL of an HDPE sensing device to TRL7 and an associated recycling extruder to TRL6. The NSSN is supporting pathways to commercialisation.

### UNIVERSITY PARTNERS:

UNSW SYDNEY · UTS · THE UNIVERSITY OF SYDNEY

### VALUE:
$1,500,000

### PARTNERS:
- Labelmakers
- Pegras

*Image: NSSN at Labelmakers. From left to right, Aiden Lyons, Ian Dixon, Nicholas Haskins, Stephanus Peters, Nick Florin, Melita Jazbec and Benjamin Madden*



## 4. WHERE IS ALL THE WATER?

Arising from the **NSSN Water Industry Innovation Workshop in October 2019**, this collaborative project uses novel sensing techniques and data analytics to provide better insights into the hydrological cycle across the state. As NSW contends with more extreme swings between drought and flood, the project is seen as vitally important in keeping a clearer account of water quantity and usage.

An interdisciplinary approach fuses data expertise from the University of Sydney's Data Analytics for Resources & Environments (DARE) Centre with quantum sensing at ANU, low-cost sensor device development at Macquarie and hydrology at UNSW.

The project team will develop a technology framework that will ultimately enable evidence-based, integrated management of water resources in NSW, addressing gaps in our current knowledge of water location and movement in the state, thus addressing the question: "Where is All the Water?'

### UNIVERSITY PARTNERS:

MACQUARIE University · Australian National University · UNSW SYDNEY · THE UNIVERSITY OF SYDNEY

### VALUE:
$450,000

### PARTNERS:
- NSW Department of Planning
- Industry & Environment (NSW DPIE)
- Office of the NSW Chief Scientist & Engineer (OCSE)

*Image: Murray river wetlands lagoons & back water river murray darling basin*

## 5. AUTOMATING THE DETECTION OF WHALES AT SEA

With funding from the Commonwealth Government's Business Research & Innovation Initiative (BRII) program, **this project** provided proof-of concept of an innovative system to automate real-time detection of whales. The project combines thermal sensing, behaviour modelling and machine learning to provide more accurate, real-time sensing to protect whales from commercial shipping practices including seismic survey ships. The project was successful in providing proof-of-concept and the NSSN is supporting efforts to secure next-stage development.

**VALUE:**
$94,654

**PARTNERS:**
- Earth Ocean & Space Pty Ltd
- Arbor Carbon

### UNIVERSITY PARTNERS:

THE UNIVERSITY OF SYDNEY

## 6. USING ADVANCED IOT-BASED MACHINE LEARNING FOR IN-HOME QUALITY AGEING

Supported by the **NSSN Grand Challenge Fund** to the value of $100,000, **this project** attracted $152,898 in matched cash funding and $197,421 in-kind support from industry partner, Intellicare Holdings, to enhance a sensing system for quality in-home aged care. The project will improve ability to accurately predict and prevent adverse health events, using advanced and highly personalised techniques that are non-intrusive and invisible to the user.

**VALUE:**
$152,898

**PARTNERS:**
- Intellicare Holdings Pty Ltd

### UNIVERSITY PARTNERS:

THE UNIVERSITY OF SYDNEY

MACQUARIE University

## 7. A NOVEL FUSED SENSOR AND MINIATURISED ELECTRONICS DESIGN FOR THE MONITORING OF A WIDE RANGE OF CARDIORESPIRATORY PARAMETERS FOR HEALTHY AGEING

This project was awarded $80,000 in **NSSN Grand Challenge Funding**, matched by $80,000 in matched cash funding and $130,000 in-kind support from industry partner, 3 Aim Solutions. The project aims to overcome common known issues affecting the adoption of wearable devices for healthy ageing such as sensor fusion, high/intermittent data-rate, battery life and intimate skin contact. It will develop a miniaturised, low-power, novel fused sensor capable of monitoring a wide range of cardiorespiratory parameters including heart rate, rate/effort, blood pressure and vascular stiffness.

**VALUE:**
$80,000

**PARTNERS:**
- 3 Aim Solutions Pty Ltd

### UNIVERSITY PARTNERS:

WESTERN SYDNEY UNIVERSITY

UTS



*Image: Alex Jones, supplied.*

## 8. OPTICAL REMOTE SENSING IN THE WATER COLUMN

Supported by the NSSN Grand Challenge Fund to the value of $40,000, this project attracted $40,000 in matched cash funding and $50,000 in-kind support from government partner, NSW DPIE, to develop optical remote sensing methods for systematic 3D mapping of aquatic environments.

The project will develop a sensing device that measures water temperature, salinity, dissolved oxygen and pigments such as chlorophyll and phycocyanin. The proposed device is novel in that it is both non-contact (overcoming bio-fouling) and near real-time (overcoming long retrieval and analysis times).

**VALUE:**
$40,000

**PARTNERS:**
- NSW DPIE

### UNIVERSITY PARTNERS:

Macquarie University Sydney Australia

UTS

## 9. REMOTE SOIL MOISTURE SENSING USING RF TECHNOLOGY

The NSSN managed the successful delivery of this project to develop a non-invasive soil moisture sensor. The project proved that radiofrequency effectively infers soil moisture and produced a sensor prototype that has been filed for patent.

**VALUE:**
$78,000

**PARTNERS:**
- Sydney Institute of Agriculture

### UNIVERSITY PARTNERS:

The University of Sydney

## 10. RF-BASED SMART SENSING FOR AGED CARE

The NSSN assisted industry partner, Livius, secure a NSW Government Minimum Viable Product grant to scale-up an RF-based smart sensing system for improved aged care resulting from R&D collaboration with research partner, University of Canberra.

**VALUE:**
$50,000

**PARTNERS:**
- Livius

### UNIVERSITY PARTNERS:

University of Canberra



# NSSN GRAND CHALLENGE FUND

**In March 2021, the NSSN launched the inaugural NSSN Grand Challenge Fund in order to foster collaboration and build a cadre of research programs around the NSSN Grand Challenges.**

Grants of up to $100,000 per project are offered to support innovative, collaborative research projects that partner with industry and government. Grants must be matched or exceeded by concomitant industry/government investment.

Applications to the fund are assessed on the following five criteria:

- **Project** – how the proposal advances smart sensing science in its field and presents a tangible, innovative solution to the defined Grand Challenge (40%).
- **Collaboration** – how the proposal integrates and fosters genuine collaboration between NSSN member universities (15%).
- **Partnership** – how the proposal integrates genuine partnership with industry and government partners and responds to a defined industry or government need. 15%
- **Governance** – how the proposal defines a realistic research plan and the measures that will ensure delivery on milestones (15%).
- **Impact** – how the proposal makes a positive impact in the chosen Grand Challenge area and defines a pathway to subsequent funding, commercialisation and/or operationalisation (15%).

Five applications were received in the inaugural round, with three being successful to a total fund dispersal of $220,000.

The annual fund will be offered again in November 2022.

The Grand Challenge concept will be expanded in late 2021. The existing four Grand Challenges of Ageing, Bushfires, COVID-19 and Water will grow to six by adding Smart Cities and Mining.

The NSSN Grand Challenges respond to some of the most gripping challenges of our time. Complex challenges that are critical to our environment, health, economy and society and which demand innovative solutions that will impact future generations.

The Grand Challenges have been selected for the important role smart sensing can play in responding to the issue and where technological innovation holds the promise  to change the game. They have also been selected for the NSSN's unique ability to mobilise the world-class R&D capability across our member universities in partnership with industry and government for practical, impactful outcomes.

# NSSN GRAND CHALLENGES

## Ageing – Smart sensing for healthier, safer ageing, both at home and in care settings

Australia's population is getting older. An ageing society is placing increased pressure on our healthcare system and demands an age-friendly future in which our seniors can live in their own homes with dignity, independence and access to high quality care.

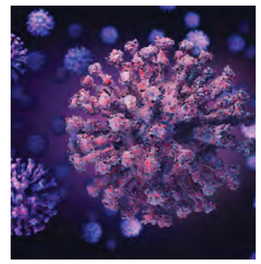
From real-time, wearable monitoring of vital signs to smart homes equipped with automated appliances, smart sensing is at the heart of technology for healthier, safer ageing both at home and in care settings.

## Bushfires – Smart Sensing for bushfire prevention, response & mitigation

The devastating bushfires that ravaged Australia in the summer of 2019-20 galvanised the need for fresh thinking in how we live with and fight bushfires. Climate change will continue to result in more intense, more frequent, more devastating bushfires unless a new approach is taken.

From real-time satellite monitoring to next-generation airborne and ground-based sensor networks, smart sensing holds the key to better bushfire prevention, response and mitigation.

## COVID-19 – Smart sensing to emerge from COVID-19 and prepare for future pandemics



Coronavirus swept the world in 2020, killing over a million people, inundating hospitals and crippling economies. Governments, industry and civil society rushed to respond to the crisis, implementing emergency measures with varying levels of success.

From medical responses to social technologies, smart sensing offers a range of solutions that will help Australia flatten the pandemic's growth, emerge from COVID-19 and prepare for future pandemics.

## Mining –  Smart sensing for a leaner, greener and cleaner mining industry of the future.

Mining is the largest sector of the Australian economy, representing 10% of GDP turnover. However the industry is in a state of rapid transition as coal becomes less favourable, other materials increase in production and the industry looks to modernise.

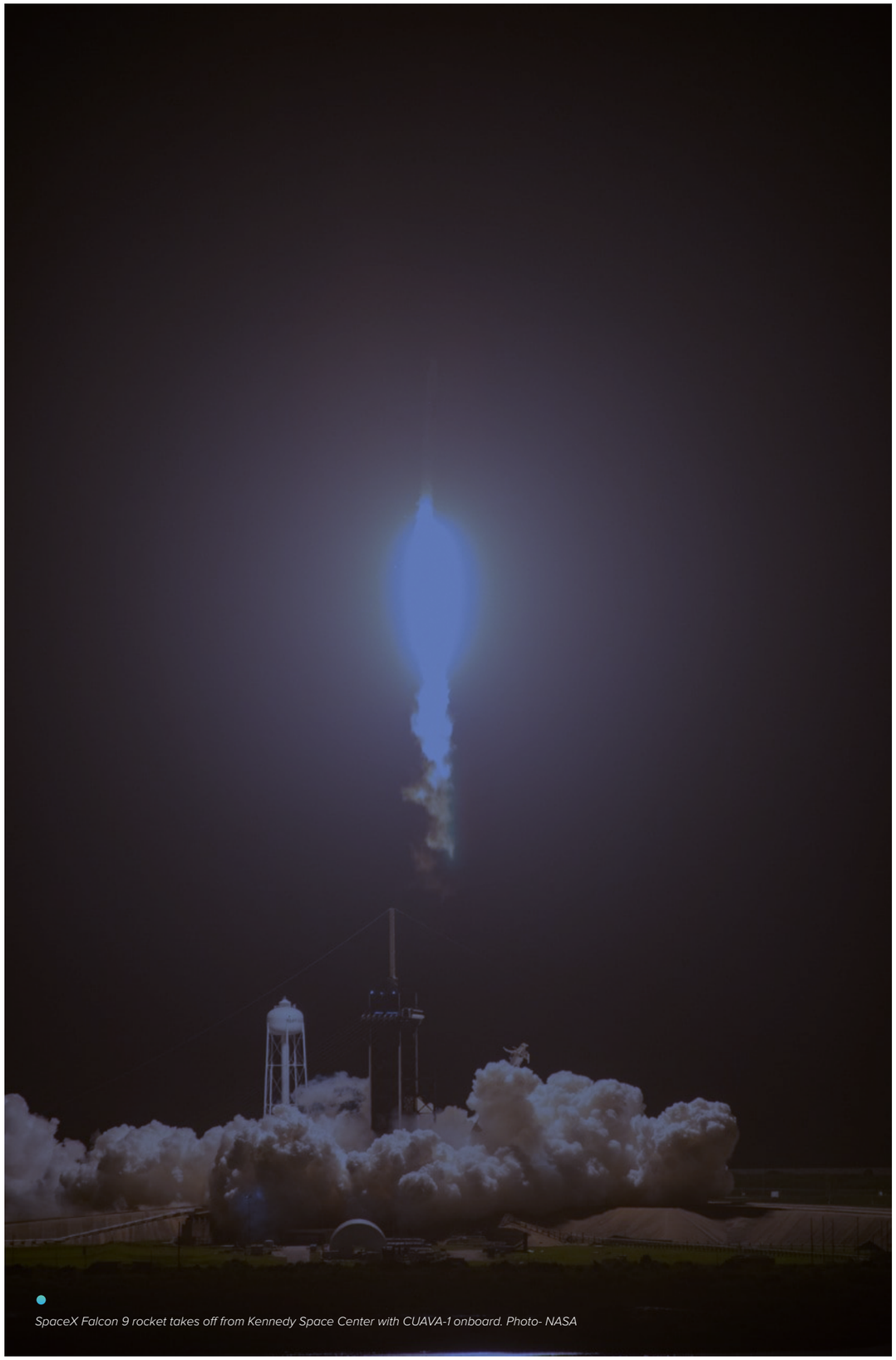
## Smart Places and Buildings – Smart sensing for more vibrant, safe and sustainable spaces

Despite having a large geographical area and modest population Australia is a highly urbanised country with over 86% of the population residing in cities and towns. Australia's population is expected to increase from approximately 26 million to almost 36 million by 2050. Smart sensors that are networked and distributed will monitor infrastructure, provide smart services to residents and make crowded cities dynamic, liveable spaces.

## Water – Smart sensing to better understand our water resources and to build a drought resilient NSW & ACT

It is written into Australia's folklore that we are a land of drought and flooding rains. Water is a precious resource critical to agriculture, cities, biodiversity and to life itself. It requires effective management of both quality and quantity to help navigate both flood events and protracted severe droughts.

Smart sensing is central to better understanding our water resources and to building a drought resilient NSW & ACT.



*SpaceX Falcon 9 rocket takes off from Kennedy Space Center with CUAVA-1 onboard. Photo- NASA*

# NSSN BUSINESS DEVELOPMENT PROGRAM

# BUSINESS DEVELOPMENT PIPELINE

**One of the key ways in which the NSSN delivers financial return on investment to its members is through its business development program. Drawing upon its large network of government and industry partnerships and contacts, the NSSN matches client smart sensing demand with university research supply.**

**In FY20/21, the NSSN attracted $1,867,462 in new commissioned projects across 7 projects (for further detail on each project please see pages 21-27):**

## 1. PLAN JERICHO

**FUNDING:** **$1,000,000** in additional funding to continue project
**FUNDER:** Royal Australian Air Force (RAAF)
**MEMBER UNIVERSITIES:** University of Sydney

## 2. WHERE IS ALL THE WATER?

**FUNDING:** **$450,000**
**FUNDER:** NSW DPIE, NSW OCSE
**MEMBER UNIVERSITIES:** University of Sydney, University of New South Wales (UNSW), The Australian National University (ANU), Macquarie University

## 3. AUTOMATING THE DETECTION OF WHALES AT SEA

**FUNDING:** **$94,564**
**FUNDER:** Commonwealth Government BRII Fund, Earth Ocean & Space Pty Ltd, ArborCarbon
**MEMBER UNIVERSITIES:** University of Sydney

## 4. USING ADVANCED IOT-BASED MACHINE LEARNING FOR IN-HOME QUALITY AGEING

**FUNDING:** **$152,898**
**FUNDER:** Commonwealth Government BRII Fund, Earth Ocean & Space Pty Ltd, ArborCarbon
**MEMBER UNIVERSITIES:** University of Sydney

## 5. A NOVEL FUSED SENSOR AND MINIATURISED ELECTRONICS DESIGN FOR THE MONITORING OF A WIDE RANGE OF CARDIORESPIRATORY PARAMETERS FOR HEALTHY AGEING

**FUNDING:** **$80,000**
**FUNDER:** 3 Aim Solutions Pty Ltd
**MEMBER UNIVERSITIES:** Western Sydney University (WSU), University of Technology Sydney (UTS)

## 6. OPTICAL REMOTE SENSING IN THE WATER COLUMN

**FUNDING:** **$40,000**
**FUNDER:** NSW DPIE
**MEMBER UNIVERSITIES:** Macquarie University, University of Technology Sydney (UTS)

## 7. RF-BASED SMART SENSING FOR AGED CARE

**FUNDING:** **$50,000**
**FUNDER:** Livius
**MEMBER UNIVERSITIES:** University of Canberra

The NSSN's Business Development program actively seeks new partnerships and clients and has built **a business development pipeline** of prospective projects valued at over **$40 million across 22 prospective projects**. Relationships are being nurtured with a range of government and industry partners like Transport for NSW, the Office of National Intelligence and Airbus. Some of which, such as the large-scale ARC Research Hub for Connected Sensors for Health, have already proven successful but fall outside the scope of this report and will be included in the Annual Report for FY21/22.


*Diagram: NSSN Business Development Pipeline indicating R&D projects completed, active and emerging (as at 30 June 2021).*

# LEVERAGING MAJOR FUNDING

**The mounting of large funding bids is becoming an increasingly important – and valued – offering of the NSSN. The Network is uniquely positioned in the preparation of large, complex funding bids that require multi-disciplinary, multi-institutional responses.**

The NSSN possesses specialist skill in the following areas:

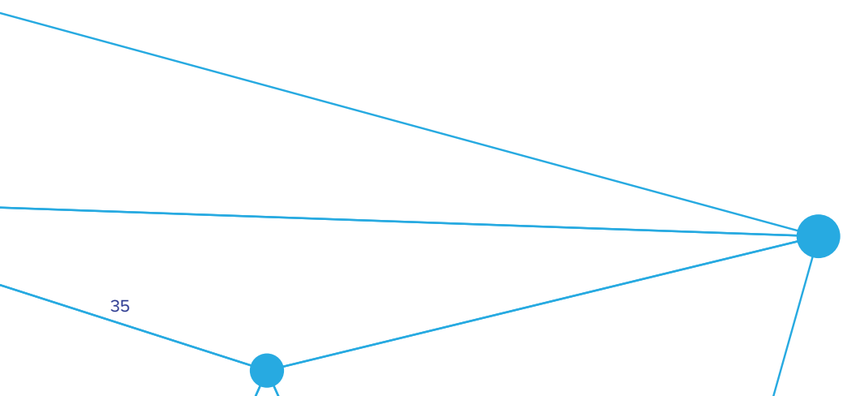
- Grantscaping and the identification of funding opportunities
- Capability mapping and the formation of multi-disciplinary, multi-institutional teams
- Sourcing industry and government project partners
- Bid development and coordination of partners and resources
- Grantwriting and the shaping of proposals

The NSSN led **10 noteworthy major grant proposals** in FY20/21 to a combined value of almost **$24 million**.

These included:

1. Three CRC-P Round 11 proposals to a combined value of $12.3 million.
   *a. A Process to Modify Paper Offcuts to Enhance their Value in Upcycling.*
   *b. Sensor and Data Innovation for Smart Triaging and Wellbeing in Aged Care.*
   *c. Improving Quality of Life and Care for Older Australians using Sensor Fusion.*
2. AMIRA Smart Mine Tailings Dams Fund valued at $6.18 million for *Failure Monitoring and Prediction for Smart Mine Tailing Dams*.
3. BioMedTech Horizons Fund valued at $1.6 million for *Sensor for Resuscitation Technique for Newborns*.
4. NSW Digital Restart Fund Smart Cities Acceleration Fund valued at $1 million for *Air Quality Monitoring Best Practises*.
5. Commonwealth Department of Agriculture, Water & the Environment's Traceability Grants valued at $800,000 for *Seafood Tracking (A low-cost, non-invasive, disposable, and irreversible automatic sensing solution for secure premium food traceability)*.
6. ARC Linkage Project valued at $682,000 for *Air Quality Informatics and Next Generation Sensing Networks*.
7. NSW Medical Research Futures Fund valued at $600,000 for *Strategies & Approaches to Address Community Needs & Support Adherence to Response Strategies*.
8. Office of National Intelligence valued at $600,000 for *Neuromorphic AI for Extreme Edge Intelligence in Space*.

The NSSN also provided advice and assistance to the development of three ARC LIEF bids.





# NSSN DIGITAL CAPABILITY MAP

**The NSSN actively maintains a comprehensive register of its members' strengths. The NSSN Capability Map is available to the public as a searchable online database on the NSSN website and facilitates match making for industry.**

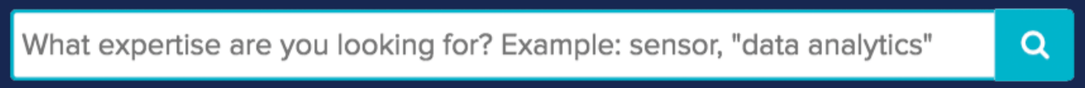




*Image: In May 2020, the NSSN hosted the latest in its NSW Sensing Industry Connect series at the University of Newcastle.*

# NSSN INDUSTRY ENGAGEMENT PROGRAM

# NSSN INDUSTRY ENGAGEMENT EVENTS

**COVID-19 significantly impacted the NSSN's calendar of industry engagement events in FY20/21. The majority of the NSSN's events are aimed at networking and, while a range of events were transitioned online, others were postponed in order to maximise the opportunity for integrated networking. In FY20/21, the NSSN hosted 6 industry engagement events.**

## NSSN AGEING GRAND CHALLENGE FORUM

In February 2021, the NSSN **launched its Ageing Grand Challenge** at Cicada Innovations. The full-day Forum attracted an audience of 50 on-site and 120 online delegates from a range of organisations including Johnson & Johnson, Siemens Healthcare, Telstra Health, Ramsay Health, Samsung, MTAA, MTP Connect, CSIRO and NSW Health.

Opened by The Hon. Gabrielle Upton MP, the Forum consisted of a range of panel discussions, exploring challenges faced by industry as they strive to deliver better outcomes to Australia's ageing population in both in-care and in-home settings. The afternoon featured a moderated co-design workshop with researchers across the Network to devise innovative smart sensing solutions. Collaborative R&D projects resulting from the workshop are being actively developed.

**A highlight video from the Forum can be viewed here.**

*Image: NSSN hosted the Ageing Grand Challenge Forum at Cicada Innovations in February 2021.*


## TOWARDS A WASTE FREE FUTURE: TECHNOLOGY READINESS IN WASTE & RESOURCE RECOVERY

The NSSN partnered with the Australian Academy of Technology & Engineering (ATSE) in May 2021 to deliver a **seminar examining the latest innovations in recycling in Australia**. The event attracted an audience of 90 on-site delegates at the Sydney Start-up Hub and 150 online.

The event was opened by The Hon. Gabrielle Upton MP and moderated by NSSN Chair, Dr Susan Pond AM. The seminar featured talks by industry stakeholders including Dairy Australia, Bega, Labelmakers and Pegras. It coincided with the conclusion of an NSSN-led CRC-P project on HDPE Recycling and the launch of an ATSE publication on technology readiness in waste and resource recovery.

**The full event video can be viewed here.**

*Image: NSSN hosted the Towards a Waste Free Future Seminar in May 2021.*

## NSSN AIR QUALITY SENSING RESEARCH WORKSHOP

In May 2021, the NSSN hosted a **virtual workshop** that brought researchers together with policymakers at federal, state and local levels in a discussion on smart sensing technology and its application to localised air quality monitoring.

The event was opened by Australia's Chief Scientist, Dr Cathy Foley AO, and included representatives from NSW DPIE, City of Sydney, ANSTO and representatives of all eight NSSN member universities.

## DEVELOPING COMMERCIALLY SCALABLE SMART DEVICES

Presented in conjunction with Genesys Electronic Design and Circuitwise, these workshops deliver tailored information sessions on developing commercially scalable electronic smart devices with a focus on IoT, ICT, built environment and MedTech for researchers at NSSN member universities. The series offers practical knowledge shared by industry experts to assist researchers translate research from benchtop to commercialisation.

Due to COVID-19, only one event in the series was offered in FY20/21, virtually at Macquarie University in November. Two other events in the series were postponed.

*Image: Australia's Chief Scientist, Dr Cathy Foley, speaks at the NSSN Air Quality Workshop.*



## NSW SENSING INDUSTRY CONNECT

Presented in conjunction with a local accelerator/incubator/industry hub, this event series offers an opportunity for members of the NSW sensing ecosystem – the manufacturers, designers, researchers and deployers of sensors – to connect and network over casual drinks. Feedback from the event series is that it offers a valuable opportunity for industry partners – particularly SME's and start-ups – to build their profile. The series is succeeding in establishing a smart sensing industry in NSW.

Despite COVID-19 restrictions, two events in the series were held in FY20/21:

### 1. MACQUARIE UNIVERSITY, SEPTEMBER 2020

Hosted in partnership with Macquarie University's **Venture Cafe**, the event attracted a virtual audience of 160 on an interactive platform that encouraged engagement between attendees. Enlightening talks on the power of collaboration between industry, government and universities in MedTech were provided by Investment NSW Director of Industry Development, Ingrid Marsh; Circuitwise General Manager, Serena Ross; and Macquarie University Director of Commercialisation, Anna Grocholsky.

### 2. UNIVERSITY OF NEWCASTLE, MAY 2021

Hosted in partnership with University of Newcastle's **I2N** and an official part of the **Hunter Innovation Festival**, the event attracted 70 participants from across the Hunter region and included talks from Professor Alan Broadfoot, Director of the Newcastle Institute for Energy & Resources; NSSN COO, Nicholas Haskins; and 4Tel CEO, Joanne Wust.

*Image: In May 2020, the NSSN hosted the latest in its NSW Sensing Industry Connect series at the University of Newcastle, keynote speaker: Joanne Wust, CEO, 4Tel.*

*“I just wanted to drop you a note to let you know about some of the value that NSSN brings. Thanks to NSSN, I was able to connect an NSW-based SME with a potential end user – all due to NSSN. I thought you’d like to know about some of the potentially unseen value you bring!”*

**Duncan McInnis,**
**Director of Stakeholder Engagement (NSW & ACT)**
**MTPConnect**



## ENGAGEMENT IN INDUSTRY AND COMMUNITY EVENTS

**Throughout FY20/21, members of the NSSN team attended 32 industry, community or policy events outside the academic environment. Participation in such events is vital in building links with partners, generating leads into the business development pipeline and building the profile of the NSSN. Some highlights include:**

1. Land Forces 2021 (Brisbane) – June 2021
2. BioDigital 2021 – June 2021
3. Smart Energy Conference – May 2021
4. 11th Australian Space Forum (Adelaide) – March 2021
5. Johnson & Johnson’s *The Invisible Future of Health Monitoring* – February 2021
6. IoT Manufacture in Australia: the how and why – December 2020
7. Water on the Horizon Forum – December 2020
8. 3rd AgTech Summit – November 2020
9. AusBiotech 2020 – October 2020
10. MTAA MedTech 2020 – October 2020
11. 10th Australian Space Forum – October 2020
12. Innovation Summit Pacific 2020 – October 2020
13. IEEE Women in Sensors Workshop – September 2020
14. Bushfire DataQuest 2020 – August 2020

## NSSN REPRESENTATION AT NSW GOVERNMENT & AGENCY EVENTS

**The NSSN continues to cultivate high-value relationships with a range of NSW state government agencies to develop collaborative partnerships and build profile. In FY20/21, the NSSN was represented at 23 NSW government events, either as a speaker, panellist or participant. Some highlights include:**

1. OCSE Citizen Science Series: Sensors & Citizen Science – June 2021
2. Investment NSW delegation to BioDigital 2021 – June 2021
3. NSW Government Parking Summit – May 2021
4. NSW Telco Authority Technology Innovation Forum – March 2021
5. NSW AI Summit – February 2021
6. Sydney Water Innovation Forum: Emerging Sensing Technologies – November 2020
7. SmartSat CRC NSW Node Networking events

The NSSN has built particularly strong relationships with **Investment NSW** (Investment Partnerships team), **Transport for NSW** (Customer Strategy & Technology team) and **NSW DPIE** (Water Knowledge team), in addition, of course, to our longstanding close relationship to **OCSE** (with particular mention to Christina Newman, Suzanne Pierce and Carlos Carbonatto-Bowkett).

The NSSN been an actively engaged partner in the rollout of the **Accelerating R&D in NSW Action Plan**. Following considered input to the plan last year, the NSSN was proud to be held up as an example of triple-helix collaboration in both the **Accelerating R&D in NSW Action Plan** (see p19, 41, 65) and the more recent **NSW Higher Education Strategy Action Plan 2021-25** (see p11).

## COLLABORATION WITH OTHER NSW INNOVATION NETWORKS

**The NSSN retains regular contact with its sister NSW Innovation Networks in order to explore collaborative opportunities and share best practice.**

In November 2020, the NSSN co-hosted with the **Defence Innovation Network** an industry forum on space and quantum technologies at Macquarie University. Participants included Airbus, DST, SmartSat CRC and NSW Treasury.

In May 2021, the NSSN hosted the above mentioned *Towards a Waste Free Future* Symposium. **NSW Circular** was consulted in the planning of the event and CEO Lisa McLean moderated the panel session.

Furthermore, the NSSN actively cross-promotes the activities and achievements of its sister NSW innovation networks through its social media platforms.

As the NSW Innovation Networks model continues to grow, the NSSN is often turned to for advice and support. Co-Directors of the **NSW Space Research Network** (SRN) consulted with NSSN Co-Director Ben Eggleton throughout the establishment of the SRN and the NSSN has played an active role in workshops regarding the establishment of the **NSW Decarbonisation Innovation Hub** and **Connectivity Innovation Network**.

As the first of the NSW Innovation Networks, the NSSN takes seriously its commitment to providing advice and support to the growing number of networks and to collaborating for mutual outcomes.

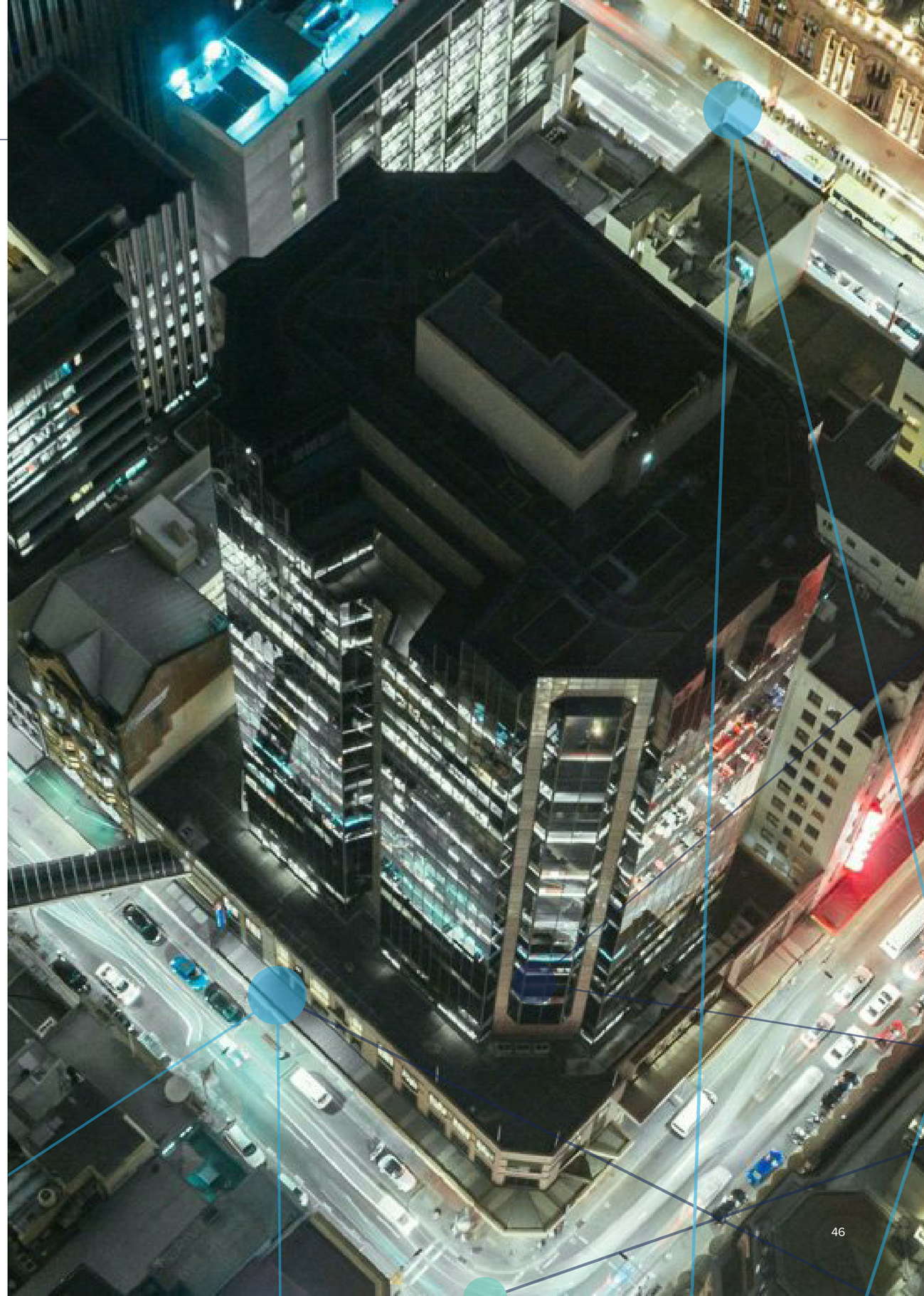
## FROM R&D TO IP COMMERCIALISATION

**As NSSN R&D projects mature and reach completion, the NSSN remains keenly engaged to translate R&D into commercialisation opportunities.**

The completed *Advanced Pipe Sensing to Reduce Leaks & Breaks* program significantly raised the TRL of a range of innovations that will be deployable in the water industry. Distributed Acoustic Sensing in a water pipe configuration has progressed to TRL 7; Gravimetry Sensing (gravity measurements of water plumes) to TRL6; Quantum Sensing Techniques to TRL4; and Drone-mounted LiDAR techniques to TRL4. The NSSN continues to work with Sydney Water and other partners in the water utility industry to advance these technological breakthroughs to commercialisation.

Similarly, the NSSN is working closely with the team from the *HDPE Recycling* program to commercialise research from the project. The project advanced key technology to high TRL, including a sensing device to TRL7 and a recycling extruder to TRL6. The NSSN provided advice and assistance to a NSW Physical Sciences Fund application to advance this technology.

The NSSN-led project with the Sydney Institute of Agriculture resulted in a patent being filed for a novel sensor for soil moisture using RF technology.



# NSSN PUBLIC OUTREACH PROGRAM

Beyond its core stakeholder groups of member universities and industry and government partners, the NSSN is committed to engaging the wider public in the important role smart sensing plays in delivering solutions to environmental, economic and societal challenges.

## SOCIAL MEDIA

Following a year of outstanding growth in our social media engagement in FY19/20, the NSSN experienced sustained growth across all platforms in FY20/21.

**2,700**
TWITTER FOLLOWERS

**40%**
INCREASE ON JUNE 2020

**155**
AVG. LIKES PER MONTH

**55**
AVG. RETWEETS PER MONTH

**56,000**
AVERAGE IMPRESSIONS PER MONTH

**1,570**
LINKEDIN FOLLOWERS

**30%**
INCREASE ON JUNE 2020

The NSSN website is maintained as a comprehensive resource on the remit, structure and activities of the Network.

**1,800**
AVG. VISITS PER MONTH

**77**
NEWS STORIES POSTED FY20/21

## TRADITIONAL MEDIA

Importantly, the NSSN also experienced considerable growth in its traditional media engagement, securing 50 mentions across print, online and broadcast media (representing 30% growth on the previous year) in outlets including:

### TELEVISION

- Channel Seven

### RADIO

- ABC Radio

### NEWSPAPER

- The Age (Melbourne)
- The West Australian

### INDUSTRY PUBLICATIONS

- PACE today
- Australian Printer Magazine
- Utility Magazine
- Build Australia
- Business News
- Australian Manufacturing
- Smart Cities World

### UNIVERSITY MEDIA

- University of Sydney News
- University of Newcastle
- Macquarie Lighthouse
- University of Sydney Newsletter
- Sydney Knowledge Hub
- CUAVA News

### NEWSLETTER

The monthly NSSN Newsletter, *The Sensor*, was delivered 11 times across FY20/21, taking a scheduled hiatus in the month of January. At 30 June 2020, *The Sensor* has a subscription list of 1,815 readers.

**A total of 11 academic publications and conference papers acknowledging the NSSN were published in FY20/21:**

## PUBLICATIONS IN SCIENTIFIC JOURNALS

1. Tong, A., Sorrell, T.C., Black, A.J. et al. Research priorities for COVID-19 sensor technology. *Nature Biotechnology* (2021). (https://doi.org/10.1038/s41587-021-00816-8)
2. Shuyue Li, Yuting Zhuo and Yansong Shen, CFD investigation of high-density polyethylene (HDPE) flakes recycling in the washing process, *Applied Energy*. (To be submitted)
3. Shuyue Li, Yuting Zhuo and Yansong Shen, CFD investigation of the effect of operating conditions on the high-density polyethylene (HDPE) flakes recycling in the washing process, *Resources, Conservation & Recycling*. (To be submitted)
4. Shuyue Li, Yuting Zhuo and Yansong Shen, Experimental study on the washing process of high-density polyethylene (HDPE) flakes in a lab-scale stirred tank. *Resources, Conservation & Recycling*. (To be submitted)
5. Nikoloska, R., Bykerk, L., Vitanage, D., Valls Miro, J., Chen, F., Wang, Y., Liang, B. and Verma, S., 2020, 'Enhancing Sydney Water's Leak Prevention Through Acoustic Monitoring', *AWA Water e-Journal*, vol. 5, no. 2, pp. 15 (doi.org/10.21139/wej.2020.014), ISSN 2206-1991.

## CONFERENCE PAPERS

6. Shuyue Li, Yuting Zhuo and Yansong Shen, Process modelling and optimization of label removal process for HDPE recycling. Towards a Waste Free Future: *Technology Readiness in Waste and Resource Recovery*, 27 April 2021 (Oral presentation).
7. Shuyue Li, Yuting Zhuo and Yansong Shen, CFD investigation of high-density polyethylene (HDPE) flakes recycling in the washing process, *The 8th Asian Particle Technology Symposium*, 11 October - 14 October, 2021 (Oral presentation)
8. Shuyue Li, Yuting Zhuo and Yansong Shen, Design of the laboratory scale stirred tank test rig for HDPE washing process. Towards a Waste Free Future: Technology Readiness in Waste and Resource Recovery, 27 April 2021.
9. B. Liang, J. Xu, Z. Li, S. Liang, Y. Wang, F. Chen, D. Vitanage, R. Nikoloska, "Critical and Small Pipe Prediction within 200m of failure", OzWater21, 2021.

## OTHER

10. Wakefield-Rann R, Florin N, Downes J. Recycling plastic bottles is good, but reusing them is better, *The Conversation,* 05 Nov 2021,
11. Retamal M, Dominish E, Wakefield-Rann R, Florin N. Think all your plastic is being recycled? New research shows it can end up in the ocean, *The Conversation*, 03 Mar 2021,

**The NSSN delivered a total of 3 presentations to academic conferences and 32 engagements in events outside the academic environment.**

## PRESENTATIONS TO ACADEMIC CONFERENCES

1. Presentation to Running out of Water, Professor Ben Eggleton, NSSN Co-Director. August 2020.
2. Presentation to CLEO Pacific Rim 2020, Professor Ben Eggleton, NSSN Co-Director. July 2020.
3. Presentation to the OSA Advanced Photonics Congress, Professor Ben Eggleton, NSSN Co-Director. July 2020.



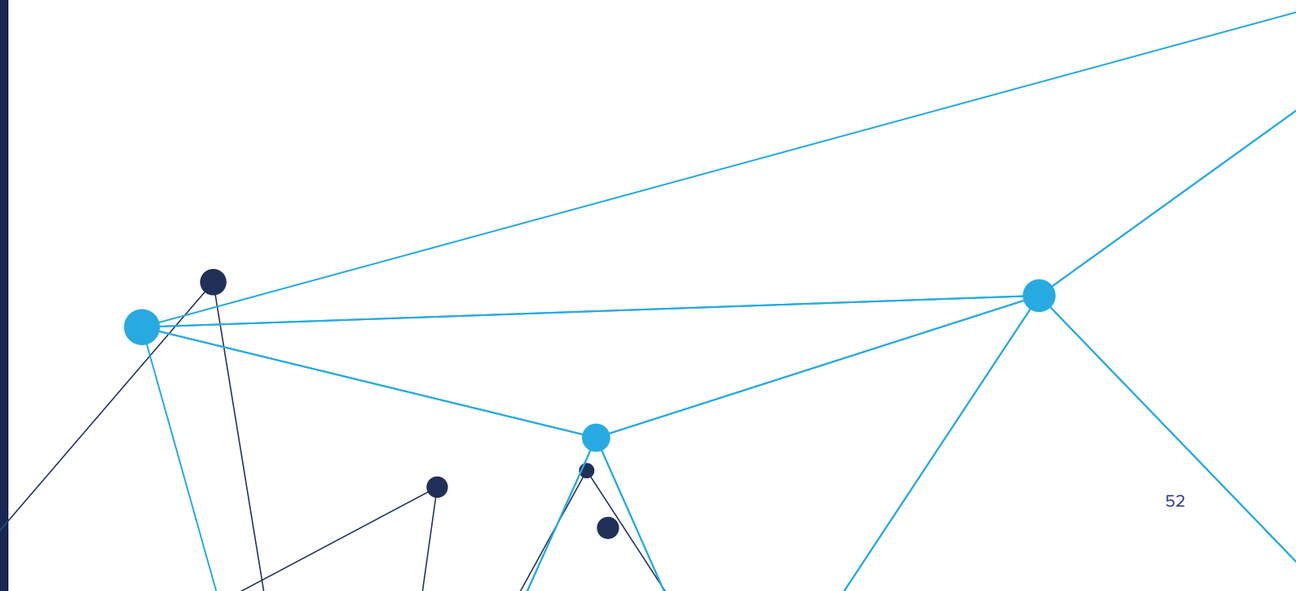
## THOUGHT LEADERSHIP

**The NSSN's expert team of theme leaders and engineers retain a scholarly remit outside of their business development activities and, as such, are continuously abreast of research trends in smart sensing. This expertise is shared regularly with NSSN members, stakeholders and the wider public. Through the dissemination of thought pieces via NSSN's communication platforms and various other outlets, the NSSN is contributing to a national discourse on smart sensing.**

**Across FY20/21, 8 thought pieces from the NSSN were published:**

1. *Printed solar offers new opportunities* – Australian Printer Magazine. September 2020. Prof. Paul Dastoor, NSSN Ambassador at the University of Newcastle.
2. *Navigating Australia's emerging circular economy* – Australian Printer Magazine. November 2020. Dr Don McCallum, NSSN Development Manager. NSSN Fifth Funding Deed Final Report 19
3. *Embracing smart sensing technology to mobilise a pandemic healthcare response.* NSSN website and other channels. February 2021. Dr Ramanathan Vaidyanathan, NSSN's Research Theme Leader in Manufacturing and Microfluidics.
4. *Translate technology between industries* – Australian Printer Magazine. March 2021. Dr Don McCallum, NSSN Development Manager.
5. *AI to assist Aussie firefighters in bushfire prediction and response* – NSSN website and other channels. Dr Ayu Saruswati, NSSN AI/ML Engineer.
6. *New "Sunwatch" detects harmful ultraviolet rays in real-time* – NSSN website and other channels. April 2021. Dr Noushin Nasiri, NSSN Ambassador at Macquarie University.
7. *NSW's incredible commitment to R&D throughout the pandemic* – NSSN website and other channels. June 2021. Dr Tomonori Hu, NSSN Environment and Agtech Theme Leader.
8. *Space technologies and remote sensing* – ABC Radio (digital channels). May 2021. Dr Paul Scully-Power, NSSN Special Envoy for Space & Defence.

**In preparing this report we recognise the contributions of the entire NSSN team and Board. The NSSN thanks the NSW Office of the Chief Scientist and Engineer for its ongoing guidance and support.**



NSSN
NSW Smart Sensing Network

## CONTACT

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Produced by the NSW Smart Sensing Network (NSSN), November 2021. 


Australian National University

UNIVERSITY OF CANBERRA

MACQUARIE University
SYDNEY·AUSTRALIA

THE UNIVERSITY OF NEWCASTLE
AUSTRALIA

THE UNIVERSITY OF SYDNEY

UNSW SYDNEY

UTS

WESTERN SYDNEY UNIVERSITY