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Northern Australia Communications Analysis

Directions Paper

A. Marshall[1], M. Dezuanni[1], K. Wockner[2], H. Babacan[3],
J. Burgess[1], F. Crawford, M. Foth[1], R. Gregory[4],
P. Mitchell[1], T. Neale[4], S. Rogers[5] & R. Wallace[6].

CRCNA
DEVELOPING NORTHERN AUSTRALIA

Authorship

[1] Queensland University of Technology, [2] Premise, [3] James Cook University, [4] Regional Development Australia Northern Territory, [5] Centre for Appropriate Technology, [6] Charles Darwin University

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The author(s) confirm(s) that this document has been reviewed and approved by the project's steering committee and by its program leader. These reviewers evaluated its:

- originality
- methodology
- rigour
- compliance with ethical guidelines
- conclusions against results
- conformity with the principles of the Australian Code for the Responsible Conduct of Research
- (NHMRC 2018), and provided constructive feedback which was considered and addressed

by the author(s

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Glossary

ACCAN refers to the Australian Communications Consumer Action Network, the peak advocacy group for Australian communications consumers. ACCAN receives Australian government funding, part of which it distributes to researchers.

ACCC refers to the Australian Competition and Consumer Commission, an independent authority of the Australian government with a mandate to protect consumer rights, business rights and obligations, and perform industry regulation and price monitoring as well prevent illegal anti-competitive behaviour.

ACMA is the Australian Communications and Media Authority, an Australian government regulator created to oversee the convergence of telecommunications, broadcasting, radio communications and the internet, and is responsible for ensuring media and communications works for all Australians.

AgTech or agriculture technology refers to the application of new technology to the agriculture industry, as well as the entrance of new players (start-ups, etc.) in that industry.

Carrier refers to those who operate key telecommunications facilities.

Customer Service Guarantee (CSG) is a standard for essential service monitored by ACMA. It sets minimum performance standards for telecommunication as well as sets timelines for the repairing of faults.

Digital ability refers to an individual's capacity to apply technical skills (such as internet skills) to participate in social and economic activities using digital technologies and online.

Digital connectivity refers to the level of connection to digital technologies and networks through infrastructure and service providers.

Digital health refers to electronically connecting points of care so that health information can be shared securely. MyHealth, a national program coordinated through all states and territories along with non-government health services, is an example of such a system.

Digital inclusion is about ensuring disadvantaged individuals, groups and regions have access to and the skills to use digital technologies and information technology networks.

Digital inclusion ecosystem is a cross-geographical, cross-sectoral, multi-level network of organisations who work independently and in collaboration to improve reliable and affordable access to telecommunications and internet services and improve digital ability to effectively use these connections in work and life.

Digital literacy refers to an individual's ability to find, evaluate, and compose clear information through writing and other media on various digital platforms. It builds on and expands traditional literacy.

Ehealth describes an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies

Fixed line broadband (FTTN, FTTP, FTTC) refers to an internet connection delivered physically through wires and cables by an ISP.

Fixed wireless broadband refers to telecommunication infrastructure that provides broadband internet access to a single location through radio waves, without the need for phone or cable lines.

Hotspot refers to a physical location, typically public places, served by an access point that is used to connect devices to one another using Wi-Fi.

Last mile access is the delivery of content for the 'last mile' or 'last kilometre'. This refers to the distance from an Internet Service Provider (ISP) to the end customer.

Media literacy refers to skills needed to effectively engage with digital media, like the skills needed to safely navigate the web and validate information on social media.

NBN refers to the National Broadband Network, an Australian government national infrastructure project designed to replace existing copper telephony networks with optical fibre, improve Australian household internet speeds, and connect and improve regional and remote access to the Internet. The NBN is managed and implemented through the government-owned company, NBN Co.

Precision agriculture is a farm management strategy based on observing, measuring and responding to inter- and intra-field variability in crops, the goal being to optimize returns while preserving resources.

Regional, rural and remote communications coalition (RRRCC) is an alliance established to advocate the communications needs of regional, rural, and remote Australians. The RRRCC is comprised of various organizations with similar concerns around connectivity in the bush.

Retail Service Provider (RSP) is an organization that deals with the consumer of internet services. An RSP typically arranges with wholesale service providers like NBN Co. to provide service to the end user.

Sky Muster refers to the two currently operating satellites operated by NBN Co., launched in 2015 and 2016 to provide fast broadband in very remote and offshore areas.

Smart farming is a farm management strategy based on using digital technology to increase the quantity and quality of agricultural products.

Telecommunications is electronic communication at a distance using various different technologies (telephone, broadcast, cable, internet, etc.).

Telehealth refers to the delivery and facilitation of health and health-related services including medical care, provider and patient education, health information services, and self-care via telecommunications and digital communication technologies (catalyst.nejm.org › what-is-telehealth).

Universal Services Obligation (USO) is a consumer protection standard, established by the Australian government, that ensures access to landline telephones and payphones to people regardless of where they live or work.

Consortium Partners

Executive Summary

The Cooperative Research Centre for Developing Northern Australia (CRCNA) has invested in this Northern Australia Communications Analysis to investigate the impacts and relevance of digital inclusion for developing northern Australia. A consortium of university and industry partners led by Queensland University of Technology (QUT) has identified impediments and solutions to economic and social development through digital inclusion in Northern Australia. While our focus is pan-Northern digital infrastructure and services, and social infrastructure and digital capability, we offer some insights into the CRCNA's focus areas (First Nations, health, agriculture sectors), which appear in the Addendum to this Directions Paper.

This project aimed to produce a five-year road map for digital inclusion investment, policy, programs and research in Northern Australia. This roadmap and recommendations are designed to contribute to the CRCNA's vision of a prosperous, sustainable, vibrant and healthy Northern Australia by helping to bolster economic growth and social cohesion through digital inclusion.

Five-year road map

The proposed five-year road map is based on three over-arching recommendations.

1. Invest in digital connectivity infrastructure and innovative solutions for ubiquitous, affordable and robust access. In the short term, fill immediate deficits in connectivity infrastructure (no service and under service) with innovative placed-based solutions. In the longer term, plan and invest in pan-northern and region-wide solutions.

2. Devise, fund and support an inclusive digital inclusion ecosystem strategy across industry, all levels of government, and the community sector. In the short term, connect and resource organisations and businesses to share knowledge and resources across sectors and geographies. In the longer term, strategically fund and support new initiatives that will bring cohesion and expanse to Northern Australia's digital inclusion ecosystem.

3. Promote place-based tactics for workforce development through building digital capacity. In the short term, sponsor community-based digital literacy and mentoring programs. In the longer term, incentivise and support regional businesses and educational institutions to embed digital knowledge and skills development into local programs.

This road map (see Table i), which includes priorities for infrastructure, policy, programs and research, is informed by our extensive investigation of two key components of digital inclusion in Northern Australia: (1) physical infrastructure and service provision, and (2) social infrastructure and capacity building, which are summarised below. In Table i we offer some possible pathways to delivery and impact, which are fleshed out in Section 5.0: Future Directions.

Table i: Digital inclusion roadmap for Northern Australia (summary only, see Section 5.0 for detailed roadmap).

INFRASTRUCTURE		
Priorities	**Pathways to delivery**	**Impact**
Years 1 – 3: • **Get people connected by facilitating improvements to last mile access.** • **Fund, design and replicate place-based, scalable infrastructure solutions.** *Years 3 – 5:* • **Explore collaborative pan-northern and whole-of-region strategies for connectivity solutions, which are co-designed and funded by business/government investment.**	• CRCNA to invest in research that identifies place-based barriers to connectivity and novel technical solutions and partnerships. • State/territory and local governments to fund last mile regional and local infrastructure solutions and educate the public about existing and new options. • Federal government to lead the co-design, funding and execution of broadscale connectivity solutions, possibly in partnership with neighbouring countries.	• Households and businesses in Northern Australia are sufficiently connected to participate and compete in global digital economies.

POLICY		
Priorities	**Pathways to delivery**	**Impact**
Years 1 – 3: • **Create a unified vision for digital inclusion in Northern Australia by engaging governments, industry and consumers in developing a strategy for access, affordability, and digital ability.** • **Strengthen Northern Australia digital inclusion ecosystem by fostering links between government, industry and community nodes.** *Years 3 – 5:* • **Implement the above-mentioned strategy by vertically integrating both connectivity and digital inclusion considerations with broader economic and social development, and emphasise skills training.**	• Industry and business to further advocate for digital connectivity to be counted as an essential service, similar to energy and transport. • Telcos to design and offer more tailored services that meet the specific needs of Northern Australia. • Federal government to lead and implement digital inclusion for Northern Australia strategy, and deliver public awareness/education campaign/s), which could be co-funded by telcos. • Government and industry to provide physical and digital platforms for stakeholders to share knowledge/resources and collaborate across sectors and geographies.	• Northern Australia has the appropriate structural and cultural conditions to enable rapid development and scaling of place-based physical and social infrastructure initiatives under a unified vision and strategy for digital inclusion in Northern Australia.

PROGRAMS

Priorities	Pathways to delivery	Impact
Years 1 – 3: • **Educate telecommunications consumers in NORTHERN AUSTRALIA about necessity and options to connect by leverage existing programs and resources (e.g. ACCAN, Be Connected).** *Years 3 – 5:* • **Renew approach to consumer engagement by developing and delivering new place-based programs.**	• CRCNA to invest in research that identifies and counteracts mis/disinformation regarding digital inclusion. • Education and community institutions to integrate digital knowledge and skills training into existing/new programs. • Local governments to foster and fund digital mentoring programs in communities.	• Northern Australia grows and retains a digitally engaged, skilled and knowledgeable workforce to improve and sustain development and livability.

RESEARCH

Priorities	Pathways to delivery	Impact
Years 1 – 3: • **Fund research into known gaps in knowledge, skills and solutions for connectivity and digital inclusion, e.g. Northern-specific ethics and equity issues.** *Years 3 – 5:* • **Integrate research and researchers into priority initiatives so that prioritisation is evidence-based, and to ensure cohesion and complementarity of vision and outcomes.**	• CRCNA to strategically invest in above-mentioned areas. • Federal and state governments to fund and facilitate new partnerships that bring previously siloed expertise and resources together for novel research.	• Northern Australia's vision, strategy and interventions to DI are informed by robust evidence and innovative solutions that meet specific contextual needs and challenges.

Digital connectivity infrastructure and service provision

Provision of reliable broadband and mobile services is still lacking in many areas of Northern Australia. In relation to broadband internet, being rolled out between 2011 and 2020, the NBN solutions most prevalent in Northern Australia (fixed wireless and satellite) have connected many individuals, families and businesses to the internet for the first time. However, restrictions on these services mean they will not be adequate to meet future high-speed broadband and data needs of individuals, families, communities, businesses, governments and industries. While Telstra, Optus and Vodafone continue to expand their 3G and 4G mobile networks in Northern Australia, large parts of the North lack enough service and there are limited plans for 5G in Northern Australia. This research has drawn an important distinction between 'no service' and 'under service'. For example, many remote towns and Indigenous communities now have 3G/4G mobile coverage, however reliable access to the internet is hamstrung by over-crowding of the local network at peak times. Moreover, mobile voice and data are comparatively more expensive than fixed-line services.

Physical infrastructure findings

Access and affordability are inter-related and should be addressed together at a national level. This requires a strategic approach that addresses immediate deficits with novel solutions and longer-term investment in digital connectivity infrastructure and services. As part of this, under service should be acknowledged and addressed. While more and more Northern Australians are becoming connected, many networks are becoming too over-burdened leading to unreliable services and outages. Furthermore, distinctions between modest everyday consumption and the growing data and speed demands of industry should be defined, projected and accommodated.

A pan-northern and whole-of-region strategy is required to structurally connect the North. Key drivers for these investments include business viability, safety and emergency response, supply chain efficiencies, attracting and retaining skilled workers, and health and social wellbeing. Government-led policy reform could spearhead digital inclusion in Northern Australia. While incremental policy changes have made a difference to Northern Australians, we see an opportunity for Australia to consider the broad range of mechanisms it has available (such as industry partnerships for nation-building infrastructure investment) to systematically and comprehensively solve connectivity for the North. Potential opportunities to collaborate with ASEAN countries (e.g. Papua New Guinea, Indonesia) should also be considered.

Social infrastructure and digital capacity

Social infrastructure – public and private institutions and programs that sustain communities – are essential to digital inclusion in Northern Australia. Our research has found that high expectations are placed on libraries, not-for-profits, local governments and community groups to provide knowledge and support to Northern Australians wishing to get connected and acquire necessary digital knowledge and skills. However, these organisations are often under-resourced to meet these demands. Meanwhile, federal and state governments, large businesses and peak industry groups are contributing relatively little to the local social infrastructure ecosystems necessary to meaningfully progress digital inclusion in Northern Australia. One issue is that top-down approaches to distribution of grant funding, and rollout of national programs, often do not effectively make their way into rural and remote communities. Furthermore, models of service delivery relevant to digital inclusion – such as e-government – often do not cater to the specific contextual challenges of Northern Australians. Another critical component of digital inclusion in Northern Australia is the need for digital knowledge and skills to be oriented towards, and taught in, local contexts as it is critical for workforce development and being competitive in the global

market. Without investment in formal and informal training to upskill workers in the North with diverse STEAM[1] skills, these industries will not thrive.

Social infrastructure findings

The structural and cultural conditions necessary for digital inclusion in Northern Australia are different to the rest of Australia. Policy and programs developed at the national level (often for urban participants) often do not translate well into regional, rural and remote communities. Therefore, criteria for designing policy and funding programs that 'make sense' in the South are often illogical, inequitable and impractical in the North. Currently, the Northern Australia digital inclusion ecosystem is patchy and siloed. There are also some organisations whose resources could be deployed in DI work to fill these gaps (e.g. health clinics, businesses), but they do not identify as being critical to digital capacity building, because it is not their core business. Furthermore, some important industries that have obligations in this space seem absent from the conversations (e.g. banking and legal sector) and could step up to play a more central role. An over-arching vision and coordinated strategy across sectors, geographies and agencies could help identify and fill gaps in the existing networks.

Northern Australia will require a digitally skilled population to socially and economically progress the region. Technological advances in existing industries, and creation of new technology-driven industries and businesses, are needed to help diversify regional economies. A key issue for developing Northern Australia is attracting and retaining a talented workforce. Northern Australia could benefit from finding ways to grow their own digitally capable workforce.

Workforce development through digital inclusion could be emphasised in the developing Northern Australia agenda. The research found that the digital inclusion agenda has been focused on getting people connected, but little attention has been paid to the question of what happens next. How will we equip Northern Australians with the necessary skills and knowledge to not only survive, but thrive, in the digital economy?

From here

Overall, whole-of-region, cross-sectoral, multi-level investment and planning is required for digital inclusion in Northern Australia. This strategic plan must engage and employ well-supported local organisations, communities and businesses who will implement place-based solutions. Indeed, the Australian Government's Developing Northern Australia agenda, which aims to unlock the region's full economic and social potential, may not be met if digital inclusion is not developed as part of its long-term plan.

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[1] *Science, Technology, Engineering, Arts and Mathematics.*

1. Introduction

Broadband internet connections and telecommunications networks are essential for socio-economic development in Northern Australia. More broadly, digital inclusion – which includes access to internet and telecommunications, affordability of connections, and digital ability to use technologies – is essential for economic prosperity, social inclusion and community cohesiveness. The Australian Digital Inclusion Index (ADII) (Thomas *et al* 2019) reveals that many Northern Australians are missing out on the benefits of digital inclusion. Given that Deloitte's Connected Continent II report estimates Australia's digital economy will be worth $139 billion by 2020 (7.3% of GDP), bolstering digital inclusion is an essential component of the task of developing Northern Australia. Furthermore, because digital exclusion exacerbates social and economic disadvantages, such as low-income status, low levels of education, and reduced access to services, digital inclusion in the North is both a developmental and moral imperative.

The CRCNA engaged a consortium of university and industry partners to investigate the 'state of play' of digital inclusion across the North through a Northern Australia Communications Analysis, with a focus on agriculture, health and Indigenous-led businesses. The scope of the research undertaken by the consortium included identifying digital inclusion priorities for Northern Australia in terms of physical infrastructure, policy, governance and programs. We undertook this research in four phases.

- Phase 1: Background and digital infrastructure
    - Investigate critical background issues informing the current state of play of digital inclusion in Northern Australia.
    - Audit infrastructure and services for telecommunications and internet access.
    - Analyse digital connectivity deficits and make recommendations.
- Phase 2: Social infrastructure and digital capability
    - Identify key stakeholders and activities in the existing digital inclusion ecosystem in Northern Australia.
    - Engage stakeholders to collaboratively define problems and solutions regarding the essential role of social infrastructure in bringing digital inclusion to life in Northern Australia.
    - Conduct analysis and make recommendations.
- Phase 3: Sectoral insights and impacts
    - Review First Nations' perspectives and make recommendations.
    - Review health perspectives and make recommendations.
    - Review agricultural perspectives and make recommendations.
- Phase 4: Pan-Northern Australia digital inclusion
    - Cross-sectoral SWOT Analysis
    - Five-year road map and next steps

This work was undertaken by a consortium of university and industry partners including the QUT Digital Media Research Centre (DMRC) (lead institution), The Cairns Institute at James Cook University, the Northern Institute at Charles Darwin University, Regional Development Australia Northern Territory, and the Centre for Appropriate Technology.

Premise was engaged by the CRCNA to work in partnership with this consortium to investigate and produce three case studies and a technical note for the agricultural sector. These resources are referenced in Appendix A & B.

See Appendix C for a full description of consortium organisations and team members.

1.1 Aims

The aim of the project was to produce a Directions Paper detailing a five-year road map for digital inclusion investment, policy, programs and research in Northern Australia. This roadmap and recommendations are designed to help bolster economic growth and social cohesion, thus contributing to the CRCNA's vision of a prosperous, sustainable, vibrant and healthy Northern Australia.

The project specifically aimed to contribute to three of CRCNA's strategic objectives.

1. Improving supply chain efficiencies through building digital capacity at all stages.
2. Generating new jobs through helping to facilitate Northern Australia's transition to the digital economy.
3. Improving wellbeing of the Northern Australian community by fostering the important link between digital inclusion, wellbeing and social cohesion.

1.2 Scope

This situation analysis commissioned by the CRCNA has a truly pan-Northern focus. Our mandate was to assess communications and digital inclusion across all geographic regions and sectors of Northern Australia and to produce a five-year road map for improved digital, social and economic inclusion. To do this, we have engaged a broad range of stakeholders with divergent interests and resources. Overcoming physical (and sometimes ideological) distances between various stakeholder groups was a challenging yet necessary component of our research. Given this mandate and its inherent challenges, we defined the project's scope as follows.

In scope:

- Investigation of mainstream access to telecommunications and internet infrastructure, services and social infrastructure.
- Investigation of the most pertinent regulation, legislation and policy (federal and state/territory level) impacting end users.

Out of scope:

- Investigation of highly specialised telecommunications and internet infrastructure and services.
- Investigation of specific local government regulation, legislation and policy impacting end users related to digital inclusion.
- Intricate policy analysis.
- Specific insights and future directions for individual sectors and industries other than agriculture, health and First Nations communities. (e.g. emergency and disability services).

We further base this report on some key assumptions.

1. Telecommunications and internet infrastructure are essential utilities (like roads, water, power and ports). Therefore, their provision is ultimately the responsibility of government and the telecommunications industry. While several communities and co-ops have taken it

upon themselves to erect 'last mile' access, we assert that these measures are insufficient for the long-term connectivity needs of Northern Australia.

2. Social infrastructure is essential to digital inclusion across the North. This report mainly addresses system-level responses to the digital inclusion needs of Northern Australia. As part of this approach, local and social services organisations must embrace digital technologies and literacies as inherent to their roles in their communities.

3. Government and services, broader industries and the not-for-profit sector must work together to address deficits and seize opportunities from grassroots to national and international levels. To this end, we propose both short-term, mostly bottom-up solutions to address immediate deficits, and long-term, mostly top-down (but consultative), strategic approaches to future-proofing Northern Australia in the digital economy.

1.3 Methodology

The project was driven by a 'social living lab' methodology (Dezuanni *et al* 2018, Hughes *et al* 2018), which aims to identify solutions to problems through conversation, design, analysis and iteration. As per the methodology's emphasis on informal peer-to-peer learning, the consortium brought together an array of stakeholders – in this case, researchers, industry, government and community – to explore shared interests, challenges, barriers and possibilities for digital inclusion in Northern Australia.

This consortium developed the project's outputs by adhering to co-design (Burkett n.d.) principles of:

- Using person-centred approaches to understand the lived experience of diverse communities in Northern Australia.

- Starting with a desired or aspirational end in mind – in this case, imagining a fully digitally included Northern Australia.

- Drawing on many perspectives, people, experts and disciplines.

- Applying a critical lens to key issues to focus on practical, real world solutions.

To do this, we gathered and triangulated data from a range of sources (Flick 2006), including desk-based research, ideation sessions, interviews, and case studies.

- Desk-based research included document analysis, research evaluation and mapping, resulting in a Literature and Context Review incorporated into this report.

- Ideation sessions involved members of participant organisations and key stakeholders coming together for co-design worships in Cairns and Darwin. Data were collected by recording all sessions and collecting and transcribing notes from the collaborative sessions.

- Interviews (10 audio-recorded) were undertaken in person and via Zoom video conference software, lasting between 30 and 90 minutes each to understand stakeholder priorities and solicit solutions to issues arising from the data collection and analysis. Several informal, unrecorded discussions were also held between researchers and participants before, during and after workshop events in Cairns and Darwin.

- Case studies (informed by audio interviews) in the agricultural sector were undertaken by Premise to ascertain the connectivity requirements, impediments and technology of farmers in Northern Australia. This informed Premise's contributions, which are in Appendix A & B to this Directions Paper.

The research participants were organisational leaders representing governments at all levels, industry and the community sector. They included CEOs, directors, educators, researchers,

clinicians, policy makers, innovators and practitioners from various sectors including health, education, social services and agriculture. Organisations that were represented at workshops and in interviews (other than consortium members) include, but are not limited to: telcos and retail service providers (e.g. Telstra, Hitnet), First Nations organisations (e.g. First Nations Media, enViZion), research institutions (e.g. University of Southern Queensland, CSIRO), regional councils (e.g. FNQROC[2]), primary health service providers (e.g. NT Primary Health Network, CHHHS[3]), charities and not-for-profits (e.g. Mission Australia, Infoxchange), industry and advocacy organisations (e.g. NT Farmers, AgForce), and VET institutions and schools (e.g. Alice Springs School of the Air).

Data were analysed thematically (Flick 2006) around key concepts, such as the pillars of digital inclusion (access, affordability, digital ability) and the sectoral focus areas (First Nations, agriculture, health). Throughout the project, we collected and analysed more data from different sources. As more information and insights came to light, we were able to identify and explore relevant concepts, themes, issues, problems and solutions. We also listened back to interviews, took notes, read and re-read over observational notes, and held discussions amongst consortium members to interrogate and refine our interpretations of the data. After data collection was completed, we also re-engaged stakeholders in the research process by sharing regular Communiqués and inviting comment.

Figure 1: Northern Australia Digital Connectivity Forum, Cairns (Image: The Cairns Institute).

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[2] *Far North Queensland Regional Organisation of Councils.*
[3] *Cairns and Hinterland Hospital and Health Service.*

1.4 Structure of the paper

The body of this report prioritises pan-Northern insights and recommendations and is structured as follows.

- **Background**: Drawing on historical, policy and research documents, we provide a contextual background to digital inclusion in Northern Australia identifying legacy and current issues impacting digital inclusion across Northern Australia.

- **Infrastructure and service provision**: We identify existing telecommunications and internet access that is readily available to individuals, communities and businesses in the North.

- **Social infrastructure and digital capability**: We define and describe the social infrastructure – public and private institutions and programs that sustain communities – that supports digital inclusion in the North, along with existing digital capability.

- **Future directions**: We present a five-year road map for investment in digital inclusion infrastructure, policy, programs and research.

- **Sectoral insights and findings**: In an addendum to the main document, we assess the impacts of digital in/exclusion on three sectors: First Nations, agriculture and health sectors. The findings in these sections supplement the broad recommendations made in the Future Directions section.

NB: Northern Australian geographic and background information is provided in Appendix D.

2. Background

In 2015 the Australian Government released its White Paper for Developing Northern Australia, which emphasised strategic investment, planning and action in five key areas: land; water; business, trade and investment; infrastructure; workforce and governance. While connectivity infrastructure, in general, was prioritised and has since been progressed through, for example, substantial investment in roads (Australian Government 2018), there has been modest attention paid to digital connectivity. While communications projects are eligible for funding under the Northern Australia Infrastructure Facility (NAIF), there is no over-arching strategic agenda for future-proofing Northern Australia's telecommunications and internet needs.

The recent national Infrastructure Audit (Infrastructure Australia 2019) has, however, highlighted hard telecommunications and social infrastructure as essential to the Nation's progression. The audit acknowledged the following challenges, which are pertinent to the Northern Australia context:

- Australia's comparative performance for fixed broadband speeds is poor. While Australia ranks 59th on Ookla's Speedtest Global Index, NBN Co asserts that Australia currently ranks 22nd when government-validated subscription speed data that is representative of the entire population is used (AlphaBeta 2019). By NBN Co's own measure, Australia lags other nations such as Singapore (1st), South Korea (4th), Spain (11th), and New Zealand (15th).

- Failure to rapidly improve speeds could be a constraint on boosting productivity and livability. Improved speeds and data allowances will also be vital to realising the ambitious vision and goals set out in the *Australia's Tech Future* report (Australian Government 2018a).

- While Australia's mobile footprint includes over 99% of the population, it covers only one-third of the total landmass, meaning there is limited service particularly in rural and remote areas along transport corridors; and,

- Access to high-quality, affordable social services – health and aged care, education, green/blue/recreation spaces, arts/culture, social housing and justice and emergency services – has a direct impact on the social and economic wellbeing of all Australians. While Australia has high-performing social infrastructure, it could be improved by updating assets and networks to create more digitally equipped and flexible spaces for service delivery.

This 2019 national audit supersedes the 2015 *Northern Australia* Infrastructure Audit (Infrastructure Australia 2015, p. 164), which identified the following critical issues for 'communications infrastructure' (many of which remain current, as per Section 3.0 in this Directions Paper):

- Dramatic increases in expectations for connection to broadband digital services and particularly for mobile connectivity.

- Major increases in digital traffic and the number and range of devices compounded by growth in population and the economy.

- Increasing demand for various kinds of mobile technology, capable of accessing the cellular network, Wi-Fi and fixed radio.

- The lack of competitive infrastructure for both fixed and mobile telecommunications in the north, and therefore lack of wholesale and retail competition and choice.

- The poor service quality both for mobile and fixed data service relative not only to other parts of Australia, but to other parts of the world.

- A regulatory environment that does little to encourage shared access to the available infrastructure.
- The need for a relevant USO for data to address the digital divide for the north, over and above the current minimum functionality.

Considering these audits, our consortium asserts that digital communications must be prioritised as essential to NA's development and, importantly, must be accompanied by well-resourced social infrastructure to sustain it. Indeed, broadband internet is widely accepted as being essential to social and economic development in Australia (Freeman, Park & Middleton 2016).

The CRCNA has invested in this Northern Australia Communications Analysis to investigate the impacts and relevance of digital inclusion for developing Northern Australia. Our mandate is to identify impediments and solutions to enterprise and social development through digital participation in Northern Australia. While our focus is pan-Northern digital inclusion, we offer insights into agriculture, health and First Nations sectors (in alignment with the CRCNA's focus areas). We begin by reviewing legacy issues for digital inclusion and Northern Australia.

2.1 Telecommunications legacy

Owing to the tyranny of distance, Northern Australia has always faced significant communications challenges (Goddin, 2006). As technologies have evolved over time and been rolled out across the country, Northern Australians have inevitably been the last consumers to gain access. For example, Australia's first telegraph line, which by the mid-1860s, linked all the regional centres in south east Australia, did not come to Northern Australia until after Stuart's third crossing of the Northern Territory. Indeed, the overland telegraph line was not completed until 1872 (NMA n.d.).

Moreover, when services have come online, the range and quality of services available have not matched those in the more populous southern regions. Wireless radio was established across the country from 1905 onwards providing regional, rural and remote Australia (including Northern Australia) its first real-time communications link with the larger Australian cities and the rest of the world. This was superseded by copper landlines rolled out between the 1940s and 1980s (NBN Co. n.d.).

To this day, radio and landlines remain a lifeline for Northern Australians. For example, in natural disasters like cyclones and floods, Northern Australians rely on the Australian Broadcasting Corporation's (ABC) emergency radio coverage. This reliance on the national broadcaster, and the technology used to access it, was demonstrated in the substantial backlash from regional Australians and their government representatives against the proposed closure of five regional ABC offices including redundancy of 400 staff (Kidd 2014). These frustrations were compounded when the ABC ceased its shortwave radio transmission service to the Northern Territory in January 2017 (ABC 2017). In the same year, the Australian Competition and Consumer Commission (ACCC) decided not to declare[4] domestic mobile roaming, because it determined that it would likely not lead to lower prices or better coverage or quality of services for regional Australians (ACCC 2017). Such a declaration would have meant that domestic mobile roaming would have become regulated by the ACCC, which would have benefited regional Australia.

Lack of reliable access to digital communications has been accompanied by issues of affordability and value for money, particularly in the regions (ACCAN 2019). This has been driven by many factors, most notably the privatisation of the national telecommunications provider in the 1990s and

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[4] *When a service is "declared" by the ACCC, it lays down rules and pricing structures that telecommunications providers are obliged to operate under.*

the ''natural monopoly'' (Grant 2004, p. 56) that followed. Essentially, the sparse populations in Northern Australia cannot attract or sustain the substantial investment required from privatised and commercially operating for-profit telcos to provide equitable services. This inequity between urban and non-urban, and hence north and south, becomes more pronounced – and has new consequences – as faster connections and more data are offered to city consumers at more affordable prices.

Overall, throughout the history of telecommunication in Australia, Bandais and Siva (2005, p. 237) observe that:

> 'various Federal Government reports and inquiries have citied inadequate infrastructure, lack of service provision, the high cost of access and 'thin' markets as key impediments. Whilst these difficulties are not restricted to rural and remote Australia, they tend to impact disproportionately on regional communities, notably in education and health service provision. Particularly at risk are the indigenous communities in rural and remote regions of Australia.'

Given that the entirety of Northern Australia is classified as regional, rural or remote, the above-identified issues have a pronounced impact on social and economic development in the North. This is unlikely to improve significantly if the big market players continue to maintain and strengthen their dominance in telecommunications in remote areas, thereby stifling innovative solutions being developed by smaller players. This represents the very heart of the digital connectivity infrastructure and service issues in Northern Australia.

2.2 Legislation, regulation and policy

The Australian telecommunications industry is comprised of *carriers* (those who operate key telecommunications facilities) and *service providers* (those who use carriers' facilities to provide phone, internet services and/or content services to the public). Some companies are both carriers and service providers (e.g. Telstra, Optus, Vodafone); they own and service their own networks. These operators are governed by several federal Acts, including the Telstra Corporation Act (1991) that includes two key sections relating to obligatory telecommunications provision in Australia:

1. **The Universal Service Obligation** (USO)[5] which stipulates that all people in Australia, wherever they reside or carry on business, will continue to have reasonable access, on an equitable basis, to standard telephone services and payphones and that this service should be fulfilled as efficiently and economically as practicable; and

2. **The Customer Service Guarantee** (CSG) which stipulates that Australian Communications and Media Authority (ACMA) will hold carriage service operators to performance standards, including ensuring damages are paid to customers for contravention.

Given that telecommunications and digital technologies have advanced so rapidly since the 1990s, the USO has been debated and reviewed many times, with several bodies calling for telecommunications and internet technologies to be added to the USO (ACCAN 2018). However, the Productivity Commission's most recent inquiry (Australian Government 2017) into the relevance of the current USO said there would be no change to the USO until:

- Broadband services are available to 100% of Australian premises, on request, at the completion of the NBN rollout in 2020;

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5 *Since data collection concluded for this project the Universal Service Obligation (USO) has been replaced with the Universal Service Guarantee (USG), which provides all Australian homes and businesses with access to both broadband and voice services, regardless of their location.*

- Voice services are available to 100% of Australian premises on request;

- Any proposed new service delivery arrangements are more cost-effective than the existing USO contract (including any transitional costs); and

- A new consumer safeguards framework is in place following a review and associated public consultation process.

This decision – particularly the continued provision of copper landlines in rural and remote areas until reliable Voice over Internet Protocol (VoIP) options are available – was welcomed by regional Australia, including the North. Conversely, this finding underscores the reality that internet-based communications, which underpin digital inclusion, are far-from ubiquitous in non-urban areas. It is also worth noting that mobile phone service (including mobile broadband) is not regulated in Australia (ACCC 2017a), which means mobile network coverage is at the discretion of mobile telecommunications operators who are collectively represented by the Australian Mobile Telecommunications Association (AMTA).

The Australian Communications Consumer Action Network (ACCAN) has identified the main barriers that prevent regional, rural and remote Australians from maximising the economic and social benefits that today's telecommunication services can provide: these include insufficient infrastructure and equipment; lack of affordability and insufficient awareness, digital literacy and user appropriate services (ACCAN n.d.). Moreover, within this complex regulatory and legislative environment, and particularly in regional, rural and remote areas, many consumers and businesses are confused about what technologies and services are available, how and where to access the most appropriate deals, and whom to seek help and advice from.

At a business level, our research suggested that many owners and managers are unaware of the services that could be utilised for their companies. For example, it is difficult for farmers to consider how the Internet of Things (IoT) or Augmented Reality (AR) could be implemented in their business if their NBN Sky Muster satellite connections seem to struggle with handling video communication. While there are specialist products and services available (see Section 3.2), these are not always well promoted. At a consumer level, Northern Australians are often not offered the mainstream services available in cities (e.g. unlimited broadband bundles). They must, therefore, make sense of the alternatives which, as a rule, are not well promoted and explained to consumers.[6] For example, the NBN 'Check your address' tool[7] shows only the fixed-line and fixed wireless footprint, thereby causing remote consumers (who fall outside this footprint) to think they cannot access the NBN at all (even though they can access NBN Sky Muster satellite).

In response, the ACCC has called for better transparency from telcos about network coverage, quality, expansions and improvements, and measures to improve the costs of deploying and improving networks. The ACCC's proposed actions included asking industry to do more, such as developing metrics that could be used to provide a more accurate assessment of mobile tower performance. The ACCC also proposed that federal and state governments could more adequately deal with competition considerations when designing subsidy programs to expand coverage of or to improve telecommunications networks (ACCC 2017b).

In a broad review of policy impacting digital inclusion in rural and remote Australia, Marshall et. al (2019) observe that lack of adequate policy at the national, state and local levels has significantly contributed to consumer dissatisfaction and poor digital inclusion of Australia's non-urban population. The authors reveal high-level trends and issues that impact Northern Australia.

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[6] *There is little incentive for service providers to meet these educational and service needs in areas where they are unlikely to make substantial advances to their customer base.*
[7] *https://www.nbnco.com.au/connect-home-or-business/check-your-address*

1. There is a strong reliance by federal policy makers for trickle down solutions for regional, rural and remote consumers. These policies are not meeting this consumer group's needs. Furthermore, there are comparatively fewer subsidiary policy approaches at state, regional and local levels. This may contribute to lower levels of digital inclusion in agricultural regions.

2. There is a tendency towards monopolistic, nationally developed infrastructure systems, such as the Telstra network and the NBN. Even though these services do not meet the connectivity needs of all Australians, it is difficult for other operators to compete to meet that need. We note, however, that a free-market solution would pose other service and financial risks, and that regional, rural and remote telecommunications are subsidised in various ways.

3. There is little policy and service delivery focus on lifting digital capacity, with the exception of *Australia's Tech Future* (Australian Government 2018a). There seems to be an assumption that digital innovation (such as AgTech) will naturally flow from improving the connectivity of infrastructure. This, however, will not be the case if digital ability – critical skills to make effective use of the internet – is not strategically addressed.

4. Local governments and other key regional organisations do not always highlight digital connectivity as a strategic priority. While other infrastructure (e.g. roads, water) and capacity-building efforts (e.g. employment, education) is vital, it is essential that internet-enabled opportunities are equally factored in these plans.

5. There is a disconnect between federal, state and local level policies related to digital infrastructure provision and inclusion. There needs to be a coordinated strategy and approach across all levels of government to address access, affordability and digital ability in rural and remote Australia. This includes thinking about novel ways that governments can partner with industry to devise new solutions.

See Appendix E for a review of five of the most recent and relevant national policies in more detail, including specific implications for Northern Australia.

2.3 Digital inclusion in Australia

Given the legacy and current issues identified above, it is not surprising that Northern Australia has poor digital inclusion. While access to services at affordable rates is essential for digital inclusion, it is also essential that individuals, families, communities and businesses have the knowledge and skills to put these technologies into productive use.

> *'Digital inclusion is not just about computers, the internet or even technology. It is about using technology as a channel to improve skills, to enhance quality of life, to drive education and to promote economic well-being across all elements of society.'*
>
> *(Australian Digital Inclusion Index, 2019).*

Now in its fourth iteration, the Australian Digital Inclusion Index (ADII) is Australia's first and most comprehensive study of digital inclusion; it is based on an annual national survey of 50,000 Australians, from which a subset of 16,000 also complete a survey booklet. The ADII compiles numerous variables into a score ranging from 0 to 100, with a 'perfectly included' individual scoring

100 (Thomas *et al* 2019). More specifically, the Index measures the extent to and effectiveness with which people can *access*, *afford*, and *use* digital media and communication technologies. While it is a highly valuable resource, the ADII has been criticised for its failure to collect data in remote areas, including Indigenous communities and outstations. In response, the 2018 Index includes a case study of the community of Ali Curung in the NT, which gives novel insights into localised challenges (more on this in Section 5.1). However, more could be done to generate more robust evidence of digital participation in remote Indigenous communities (see Rennie (2019) and Rennie *et al* (2016) for qualitative insights).

Our understanding of digital inclusion in Australia, including in regional, rural and remote areas, is supplemented by other datasets, such as the ABS's reports on *Household Use of Information Technology* (2018a) and *Internet Activity* (ABS 2018b), and the *National Aboriginal and Torres Strait Islander Social Survey, 2014-15* (2016).[8] These sources are particularly useful to help us identify instances of digital in/exclusion as a contributing factor to social in/exclusion. For example, in 2014-15, households located in major cities were more likely to have internet access at home (88%) than those in remote or very remote parts of Australia (77%) (ABS 2018a). Another insight is that, in the same reporting period, Aboriginal and Torres Strait Islander people with profound/severe disability were less likely than people with no disability to have access to the internet at home (58% compared with 78%) (2017). The link between digital inclusion and social inclusion in the context of Northern Australia is explored below.

A recent report on digital inclusion in Western Australia (Bankwest Curtin Economics Centre 2018), Australia's largest and most disparate state, echoes the above insights for individuals and households. It further reveals the struggles of small and large businesses to overcome deficits in access, affordability and digital ability. Insights include the following:

- While 95.4% of all businesses reported having internet access in 2016-17, 18.1% of small businesses in WA rated their mobile quality as low.

- For businesses with fewer than 200 employees, a lack of access to digital infrastructure was reported as a significant factor affecting IT use, along with a lack of skills.

- Businesses with 200+ employees are far more likely to use the internet for information sharing or data exchange.

Overall, the report indicates that digital connectivity is perceived as being more important and accessible to big businesses, which puts less-resourced small and family business under pressure in the digital economy.

Finally, the ABS Business use of Information Technology statistics (2015-16) (ABS 2017) provides further business-level insights into digital inclusion in regional Australia.

- More than three in five businesses that reported security incidents or breaches in the Agriculture, forestry and fishing industry experienced corruption of hardware or software as a result of a security incident or breach (61%).
- Businesses in the Agriculture, forestry and fishing industry reported insufficient knowledge of cloud computing services (30%) as the factor that most limited or prevented their use of paid cloud computing services.
- Lack of access to digital infrastructure (17%) was recorded as the factor that most significantly changed the way the industry used ICT.

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[8] *Shortcomings of digital inclusion research in remote Australia are exacerbated now that the ABS no longer collects data on Internet Activity. The ACCC data collection on Internet activity is not sufficiently granular to usefully inform digital inclusion issues in Northern Australia.*

- Agriculture, forestry and fishing industry had the highest proportion of businesses that reported the use of mobile wireless (28%), fixed wireless (22%) and satellite (15%) as their main type of internet connection.

This final point shows that 65% of agriculture, forestry and fishing businesses primarily rely on broadband provided by means *other than* fixed-line services. This is significant because fixed-line services are more reliable and affordable than mobile, fixed wireless and satellite. These insights focus on the agriculture, forestry and fishing industries, which are prevalent in Northern Australia, but they also echo the broader challenges for Northern Australian businesses and individuals to get online and effectively and safely participate in the digital economy.

2.4 Social inclusion

This research is grounded in the principle that digital inclusion is a vital aspect of social inclusion and economic success, not only for individuals and families, but for businesses, communities, and regions (Notley & Foth, 2008). Indeed, Freeman *et al* (2016) observe that the key drivers for broadband access in rural Australia, including Northern Australia, are business development, education, emergency communication, and health. Given that it is people who will take Northern Australia forward, it is essential to understand and invest in their social wellbeing, including through digital inclusion.

Digital inclusion and social inclusion are deeply intertwined in two ways (Helsper 2008). First, social disadvantage based on geography, gender, race, income, education and other factors is often an antecedent to digital exclusion. For example, rural and remote Australians are more likely to lack access to affordable internet and relevant digital knowledge and skills to participate in society. Second, low levels of digital inclusion can compound social disadvantage. For example, because rural and remote residents are often unable to access and use digital technologies, their capacity to attain knowledge, skills and support to improve their social or economic circumstances is thwarted. Indeed, remoteness is a strong indicator of digital exclusion in Australia (Park 2017). There is also evidence that this 'city-country divide' is widening (Thomas *et al* 2019), including in Northern Australia.

Northern Australians experience higher levels of digital and social exclusion owing to a range of interwoven social, economic, and demographic factors that converge and escalate in more isolated geographic areas, such as rural farms and Indigenous communities. Park (2017) further unpacks what she terms the ''double jeopardy'' of remoteness and social exclusion in rural Australia, using data from the Australian Bureau of Statistics (ABS) to uncover several socio-demographic factors, which exacerbate digital exclusion of remote residents, including: higher proportion of the population identifying as being of Aboriginal and Torres Strait Islander descent; aging populations; higher unemployment rates; lower education levels; and reliance on agricultural industries.

Scholars have sought to unpack various social factors contributing to digital in/exclusion in rural Australia. Rennie (2019) and colleagues (Rennie *et al* 2016; Ewing, Rennie & Thomas 2015) have explored cultural factors impacting uptake, use and outcomes of the internet in remote Indigenous communities, and how they should inform telecommunications policy. They highlight, for example, how cultural practices such as 'demand sharing' led to a preference for personal mobile devices over shared satellite services, which should be respected and factored into digital interventions in remote communities (Rennie 2019). Other factors impacting digital inclusion of these communities include administrative processes to access the internet and methods of billing (e.g. direct debit, card card) (Rennie *et al* 2016). Additionally, Dezuanni *et al* (2018) investigated ways to foster digital participation in rural communities to enhance interest-driven community activities. In one example, they found that digital technologies enabled rural seniors to tell old stories in new ways, leading to greater social participation.

While many of these findings may be broadly applicable to populations and industry sectors across Northern Australia, it is important to understand that each individual family, business and community has specific contextual challenges to digital and social inclusion. Moreover, it is essential that social barriers to digital inclusion are addressed in parallel to the infrastructure deficits (explored in the next section), which often receive more attention. As Park concludes, 'when implementing digital strategies, both supply (infrastructure) and demand (education levels, industry sector, employment opportunities, socio-demographics) factors must be considered' (Park 2017, p. 399).

3. Infrastructure and service audit

In this audit, we focus primarily on mainstream, commercially available telecommunications and internet infrastructure and associated services. We also review public infrastructure/services, as well as less conventional, alternative and supplementary telecommunications and internet available in Northern Australia. In alignment with the way the telecommunications industry is regulated in Australia, we distinguish between 'carriers' (who provide the network infrastructure or physical hardware that exists in Northern Australia) and 'service providers' who provide the retail services and coverage to consumers in Northern Australia. While the provision of different technologies and services is often unified, in Section 3.1 we delineate mobile phone/broadband infrastructure and fixed-line (or alternative) broadband infrastructure. In Section 3.2, we address service provision (for mobile phone, mobile broadband and 'regular' broadband) together, given that service providers often offer all three services (sometimes in bundles).

Figure 2: Fixed wireless infrastructure in Weipa, Qld (Image: MarchNet).

3.1 Network infrastructure

Northern Australia's telecommunications and broadband infrastructure is a complex web of varying technologies owned and operated by several different carriers (NBN, Telstra, Optus, Vocus). While the vast majority of Northern Australians are connected to this network in some way, many individuals and businesses experience 'under service' owing to a range of issues that are explored below.

3.1.1 National Broadband Network

The National Broadband Network (NBN), announced in 2009, was 'designed to address the market failure of investment in broadband infrastructure' (Freeman & Park 2015, p. 467), which is a particular issue in sparsely populated areas such as Northern Australia. Although the NBN promised new, ubiquitous high-speed fibre-to-the-premises broadband for 90 per cent of all Australian homes, schools and workplaces and to connect all other premises with next-generation wireless and satellite technologies (Australian Government 2009), the eventual solution included upgrading and repurposing of existing infrastructure including copper phone lines. 'The rollout of the complex Multi Technology Mix (MTM) – which resulted from successive governments changing the plan several times – has been hampered by changes of government, delays in construction, and poor regulation of the telecommunications industry' (Freeman & Park 2015).

The NBN's MTM includes fixed-line connections in urban areas (e.g. Fibre to the node, Fibre to the Curb, Fibre to the Building, etc.) and Fixed Wireless and Sky Muster satellite services in regional, rural and remote areas (NBN Co. 2018). It is widely accepted that the fixed-line services offered in urban areas are typically faster, more reliable and cheaper than wireless and satellite in remote areas. In summary, access, availability, affordability and quality of internet services, the underpinnings of digital inclusion in Australia, depend largely on where you live.[9] Further challenges associated with NBN solutions for much of Northern Australia – satellite and fixed wireless technologies – are well documented by Better Internet for Rural, Regional and Remote Australia (BIRRR 2018, p. 4), as summarised below.

- **(Un)reliability of regional connections** including no 'back-up' or alternative options for consumers during the frequent outages (sometimes caused by poor weather for satellite and power outages for other services).

- **High latency of satellite** connection is causing issues for consumers when they require cloud and remote desktop programs or applications requiring low latency (e.g. VoIP, Skype, Zoom, telehealth applications, share trading).

- **Lack of information** on alternative or complementary technology, such as antennas, boosters and equipment to improve signal reception.

- **Delayed repairs** of voice and broadband services due to location.

- **High costs of data** when compared to metropolitan connections, owing to the inability to bundle plans due to limited, smaller providers, high cost of mobile broadband due to only one carrier in many areas, no business plans on NBN Sky Muster[10] or ability to purchase more data under the Fair Use Policy (FUP).

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[9] *The recently announced Universal Service Guarantee – developed by Australia's Productivity Commission – will aim to address this disparity by ensuring all Australians have access to voice and broadband services. In 2020 it will replace the Universal Service Obligation.*
[10] *NBN has since released business plans on Sky Muster that offer, for example, committed bandwidth and virtual ISP (More here: https://www.nbnco.com.au/business/product-and-technical-information/business-satellite-service).*

- **Lack of consumer digital knowledge** and independent advice on how to get connected and stay connected, including confusion with telecommunications in the current climate and unawareness of consumer rights under the existing Universal Service Obligation (USO).

On the other hand, the NBN has undoubtedly connected many Northern Australians who otherwise would still be without internet access. Northern Australia has a mix of urban, regional, rural and remote populations, and the NBN solutions for these regions widely differ.

- **In urban and regional Northern Australia, the NBN solution is usually fixed line**. For example, Fibre to the node (FTTN) is available in Karratha, Fibre to the Premises (FTTP) is available in Cairns, Fibre to the Curb (FTTC) is available in Mareeba, and Fibre to the Building (FTTB) is available in Darwin.

- **In rural Northern Australia, the NBN solution is usually fixed wireless**. For example, fixed wireless is available in some rural towns near Cairns such as Mount Molloy, Koah and Kuranda.

- **In remote Northern Australia (outside of urban areas in remote Northern Australia, and in all very remote Northern Australia) the solution is SkyMuster™ satellite**. SkyMuster™ is available to any resident living outside the footprint on the above-mentioned technologies, ranging from just a few kilometres from a regional or rural centre to the most isolated parts of Northern Australia.

'There is no doubt that … $1.2 billion investment in the NBN satellites has been a game-changer… It's a wonderful thing that the Australian Government has invested that much, to be honest.'

– Research participant

Understandably, fixed-line and fixed wireless connections are concentrated in the higher density southern parts of Australia. However, the NBN has been rolled out into many rural and remote places in Northern Australia. Figure 3 shows all fixed line and fixed wireless connections available in Northern Australia. These connections have been made in some remote areas, such as Nhulunbuy (NT), Port Hedland (WA) and Weipa (QLD). However, the coverage footprint is relatively limited (for example, as shown in Figure 4, which shows the patchy FTTN coverage in Port Hedland).
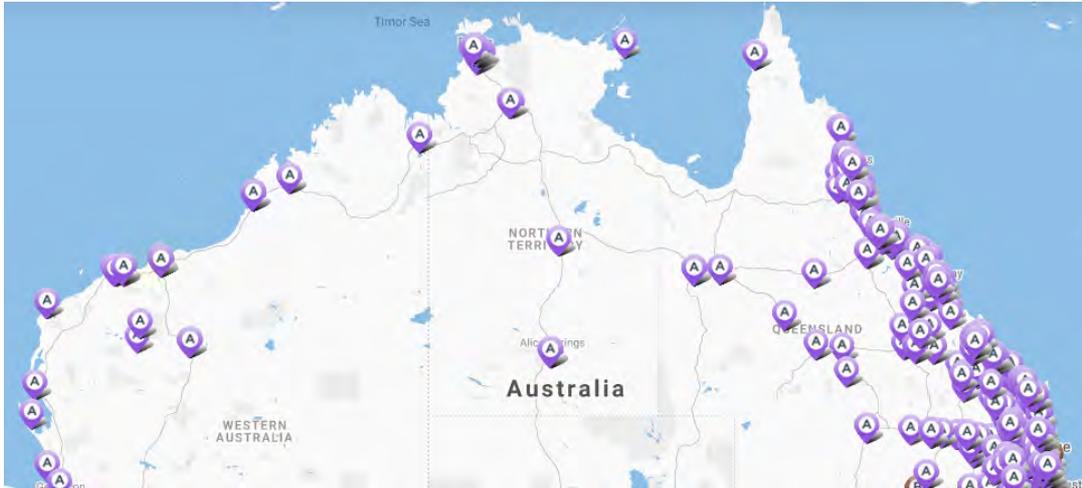
Figure 3: NBN fixed-line and fixed wireless connections in Northern Australia (March 2020).

Figure 4: FTTN NBN coverage in Port Hedland (WA) (purple is 'service available', brown is 'build commenced', as at March 2020).

3.1.2 Telecommunications networks

Telstra has the most extensive telecommunications network infrastructure in Australia and holds by far the largest share of the Northern Australia telecommunications market. Formerly state-owned, Telstra was privatised in 1997 but remains subject to the Telstra Corporations Act (1991). Under this Act, the Universal Service Obligation (USO) provides that all Australians have reasonable and equitable access to standard telephone services and payphones (see Section 2.2). This responsibility does not extend to mobile networks. Despite this, Telstra remains the largest mobile carrier across Northern Australia. Telstra's mobile network is shown in Figure 5.

It is well documented that 5G offers superior speed (and other benefits) to 3G and 4G (Rockman, 2019). While Telstra anticipates this will cover up to 4 million Australians to some degree, this is unlikely to include rural and remote areas. Telstra's 5G coverage is limited to select parts of towns and cities with most sites operating in CBD areas and airports during the initial rollout (Donnelly 2020).[11] According to Telstra's 5G map (telstra.com.au/5g), at February 2020 there were some 5G connections in north and central Queensland (Rockhampton, Mackay and Cairns) but none in the NT or Northern WA[12].

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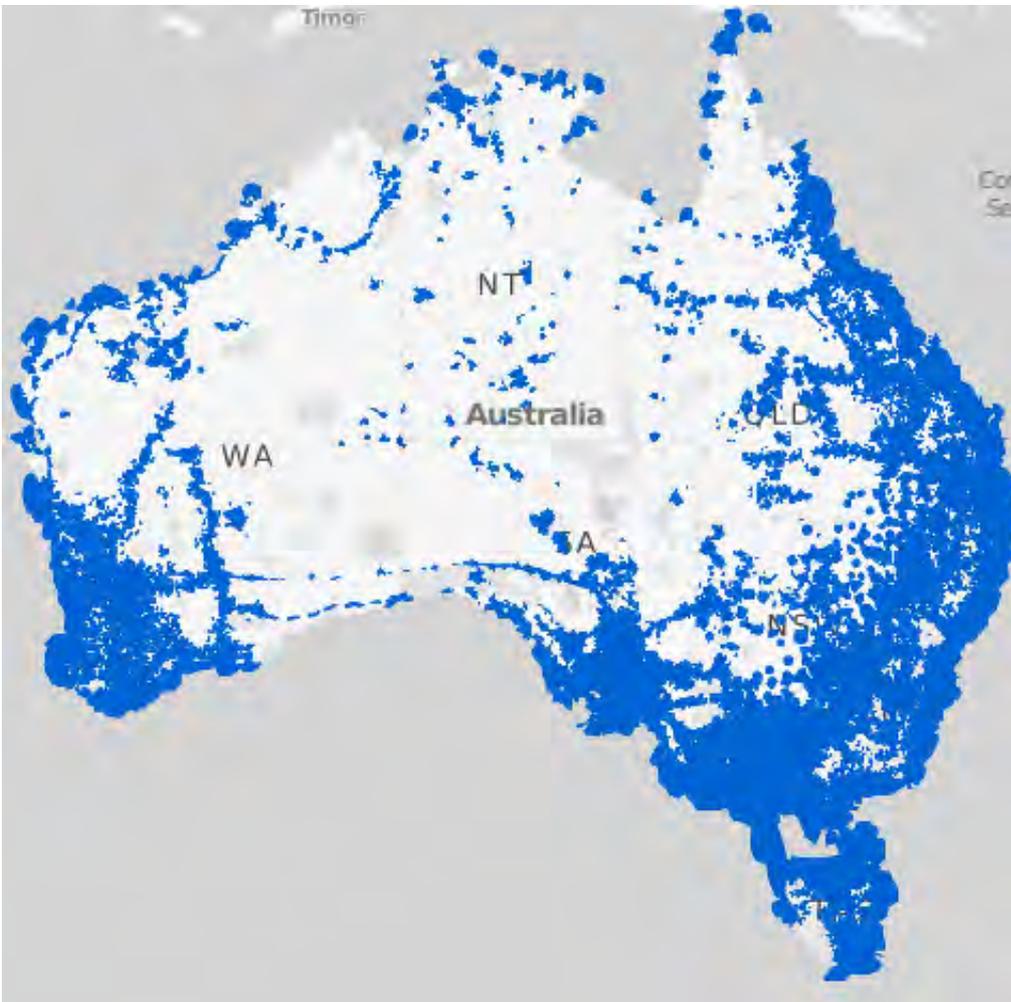
[11] *Optus and Vodafone also offer 5G in urban areas.*
[12] *There are particular challenges associated with 5G, including the need to deploy many small cells within close range to each other, which is much more viable in urban areas (Daggs et al 2018).*

Further, telecommunications network infrastructure, such as 3G/4G mobile phone towers and small cells, has been provided by other telcos in Northern Australia, namely Optus and Vodafone. In some instances, this adds to the overall coverage for mobiles services and provides options for consumers. For example, Darwin has a high concentration of mobile infrastructure across several providers (see Figure 6). Outside of the Northern Australia's cities, however, Telstra has the superior network and provides the greatest geographic coverage and thus holds the monopoly. Even people who live in Northern Australia's urban areas – such as Alice Springs and Townsville – tend to choose Telstra over the alternatives, so they can remain connected when they leave these areas for work or private travel purposes.
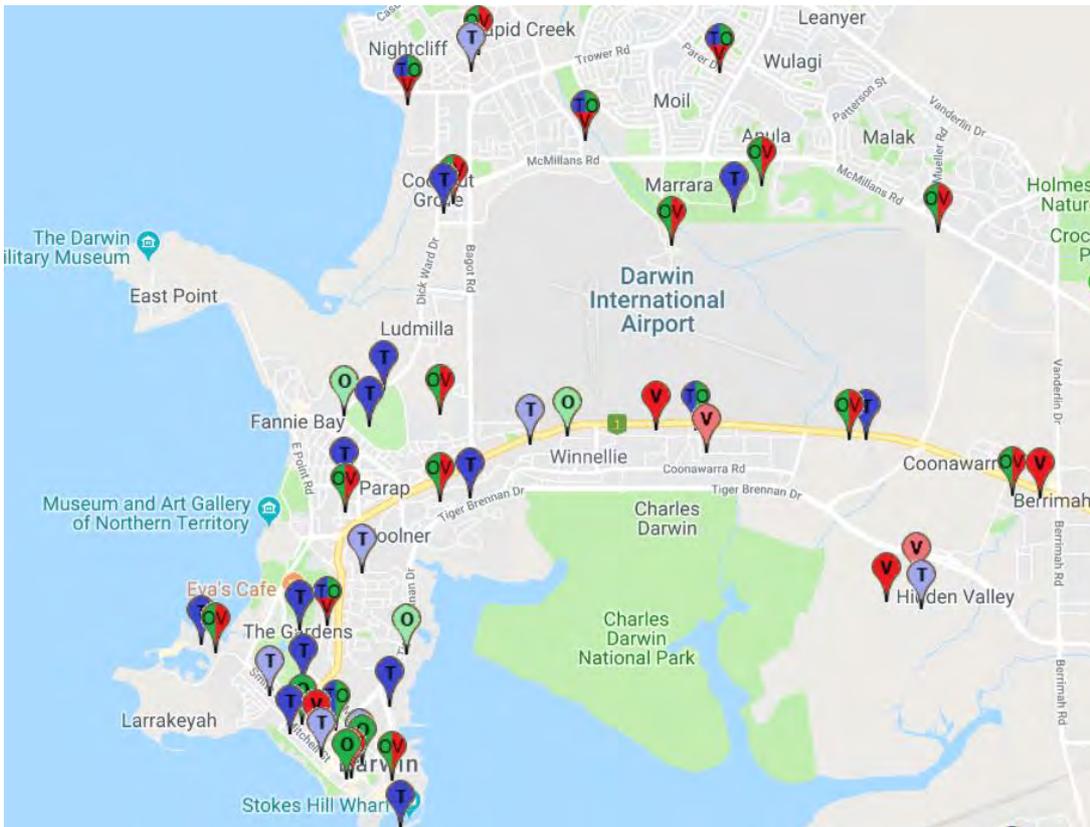
Figure 6: Telecommunications towers in Darwin, June 2019. V = Vodafone, O = Optus, T = Telstra (Source: OzTowers.com.au).

Northern Australia's mobile network has benefited from the federal Mobile Black Spot Program. The Government has committed $380 million to the Mobile Black Spot Program to invest in telecommunications infrastructure to improve mobile coverage and competition across Australia. This Program is supported by co-contributions from state and local governments, mobile network operators (Optus, Telstra and Vodafone), businesses and local communities. Rounds 1-4 has delivered 1047 new base stations across Australia (713 of these were operational as at 28 June 2019). The Program has delivered much needed telecommunications and digital connectivity in many areas of Northern Australia. However, large black spots still exist in many areas, including economic and social hubs and arterials that need to be connected, as well as along major transport routes such as the Stuart Highway (NT), Burke Developmental Road (QLD), and Great Northern Highway (WA).

3.1.3 Private networks

There are some digital connectivity providers that, unlike those mentioned above, do not ultimately rely on existing NBN or mobile network infrastructure. For example, ports and mining operations often build their own essential infrastructure (power lines, backbone fibre). For example, Rio Tinto built a fibre backbone from Perth to Karratha, which it distributed to its mine sites in the Pilbara. However, such private networks are not always shared with the broader community and patching them after the fact is expensive.

Other major private networks operate on an international scale. For example, **Vocus** provides high-speed, enterprise-grade internet to businesses and communities via its fibre network (see Figure 7). Vocus (and other telecommunications companies like it) do not assist individuals and communities get connected; although some large companies have made arrangements to 'share' their connections with locals. For example, the Town of Port Hedland is currently putting together a business case to collaborate with Vocus to connect with its backbone fibre network. In 2018, Vocus activated its *Australia Singapore Cable*, a first-of-its-kind 4,600km submarine cable system that links Australia to Singapore, with DC interconnects in Perth, Jakarta, and Singapore, and drop-off at all major data centres in Australia, including Sydney and Melbourne. It is a four-pair fibre network that delivers up to 60Tbps of capacity, providing connectivity, bandwidth, and reliability for businesses wanting to reach Asia and the rest of the world (VOCUS n.d.). Additionally, **AARNET** offers an enterprise-grade solution to universities and research institutions around Australia, including James Cook University in Townsville and Cairns, and Charles Darwin University in Darwin. As shown in Figure 8, it connects Australia's university sector with others around the world.

Figure 7: Vocus network (Savvas, 2019).

Figure 8: AARNET national network (AARNET, n.d.).

3.2 Telecommunications and broadband internet services

There are three mainstream service providers operating in Northern Australia: Telstra, Optus and Vodafone. While the majority of these companies' customers are in urban areas, they have created some products, packages and resources specifically for regional consumers, including in Northern Australia. While the creation of these products is welcome, it can nevertheless involve additional costs for consumers.

The **Telstra Regional Australia** website[13] enables regional customers to shop for appropriate devices and services to meet their needs. For example, the Blue Tick handset offers enhanced voice coverage in regional and rural locations, satellite handsets/sleeves and plans to provide reliable communications in remote areas, and repeater devices to extend coverage, such as the Telstra Go Mobile Repeater and Telstra Smart Antenna 4G. Notably, Telstra does not offer NBN SkyMuster ™ services, but provides an alternative satellite broadband service for enterprise consumers (AARNET n.d.). Telstra also offers a satellite-based, enterprise service for IoT applications (Telstra n.d.)

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[13] https://www.telstra.com.au/coverage-networks/telstra-regional-australia
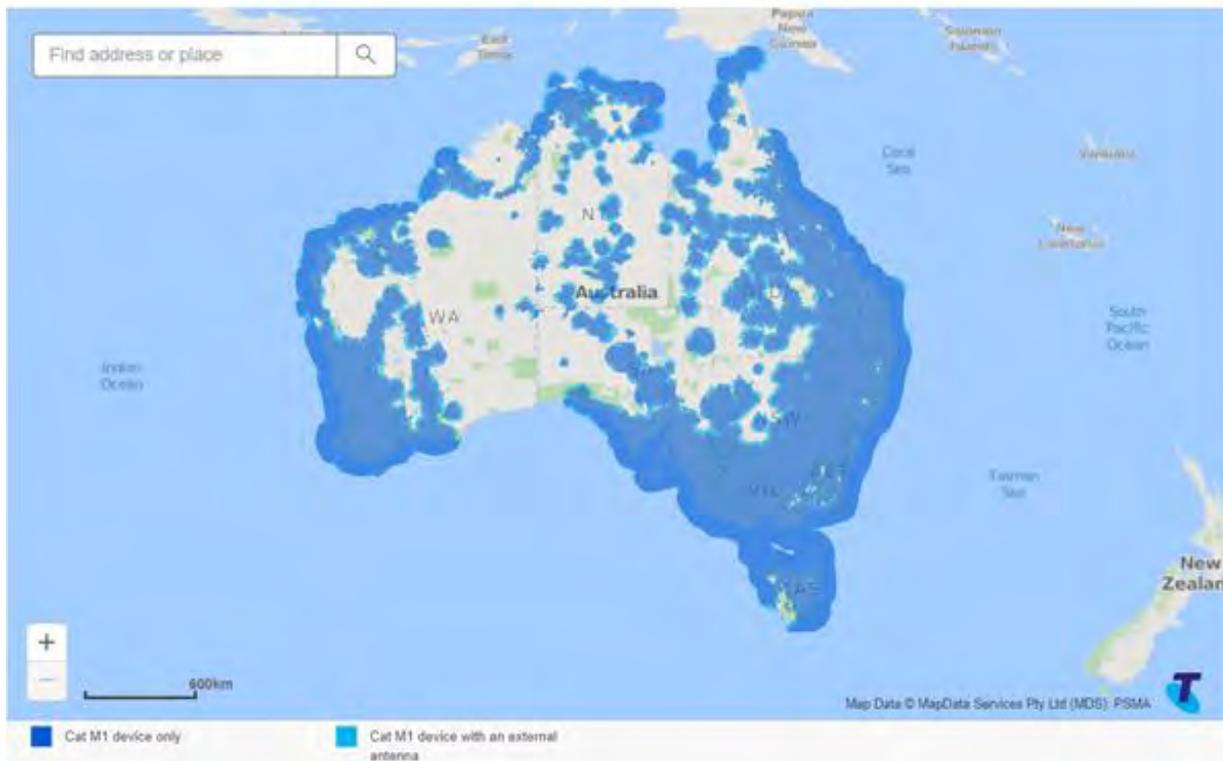
Figure 9: LTE-M coverage on the Telstra IoT Network (Telstra, n.d.).

Vodafone Regional Connect[14] is a hub of 'ideas and actions to help bridge the digital divide'. For example, Vodafone suggests that the Mobile Blackspot Program has missed opportunities for infrastructure-sharing in regional Australia, citing that 'not one of Telstra's 429 round one funded towers have another mobile carrier's equipment installed on them'. Vodafone has produced and is trialling a Regional Coverage Hub product, a self-install small cell solution that provides households with 4G voice and data services as well as IoT connectivity.

The **Optus Regional Hub**[15] details Optus's investment in regional coverage, including 2500 towers across 1000+ regional towns. The Hub features news from the regions, including Northern Australia. For example, in Townsville, Optus has built six new 4G network towers and will invest a further $3.5M in the area over the next 12 months. Optus also recently completed a Building-Coverage (IBC) solution for parts of the Townsville Hospital, addressing internal black spots identified by the hospital and the Townsville community.

Other entities specialise in providing bespoke solutions for remote areas. **Activ8Me** (activ8me.net.au) is a market leader in Northern Australia for the provision of NBN fixed wireless and SkyMuster™ services (along with others such as SkyMesh and Habour ISP). They also design, install and maintain solutions for government agencies, commercial entities and communities, such as the Activ8me Business Hub. Notably, Activ8Me recently partnered with the Royal Flying Doctor Service (RFDS) to install NBN ground stations to remote airstrips frequented by the RFDS that were previously black spots. Furthermore, industry-based projects and partnerships have funded essential connectivity infrastructure. For example, **Wi-Sky** (now an RSP) began as a partnership between the Richmond Shire Council and Olga Downs Station in Far North

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14 https://www.vodafone.com.au/red-wire/infrastructure-sharing-regional-australia
15 https://www.optus.com.au/about/network/regional-coverage

Queensland to erect tower creating a 46km-long wireless connection to a base station in Richmond (Barker 2016). Finally, **Northern RDA Alliance** (RDANT, RDA Kimberley, Central Desert Regional Council, Distant Curve and others) has implemented a Remote High-Speed Wireless Technology Pilot, which has successfully connected two remote Indigenous communities (Engawala and Atitjere) to Nextgen fibre via long-distance point-to-point microwave technology. The project demonstrates the potential of low-cost, small-scale telecommunication solutions for remote regions in some of the NT's smallest communities (RDA n.d.).

While the availability and quality of these services have steadily improved over time, as mentioned in 2.0, affordability is a pertinent issue for consumers in Northern Australia (ACCAN 2019a). Aside from policy-level analysis of the issues, other research has found some context-specific factors that compound cost for RRR consumers. For example, Marshall *et al* (2019) identify a 'layering up' phenomenon whereby, because services are unreliable, rural consumers purchase several devices and plans in the hope that one will work at any given time. This can be accompanied by commercially available and DIY 'add on' hardware, such as Yagi antennas, that aim to bolster signals. Recent changes to NBN Co's wholesale pricing have, however, enabled service providers to offer Northern Australians better value for money. For example, from October 2017 service providers were able to double the data offered to Sky Muster customers from 75GB/month to 150GB/month (Simon 2017). Furthermore, in August 2019 NBN Co released a new product, Sky Muster Plus, that provides unmetered data for activities like web browsing (static images and text only) (NBN Co. 2019), which was well received by remote households.

3.3 Digital connectivity in South East Asia

We conclude this audit by providing some context with regards to digital connectivity infrastructure in neighbouring countries. While it is beyond the scope of this project to deeply investigate connectivity and digital inclusion internationally, we found some that Australia shares some commonalities and differences in the barriers/opportunities for digital connectivity. For example, rural populations in South-East Asian countries experience the city-country digital divide. In Australia, this divide is characterised by a lack of availability or reduced choice of quality and affordable broadband services (OECD 2019, p. 46). Conversely, South East Asian countries have a more advanced mobile network than many OECD counties, including Australia (see Figure 10).
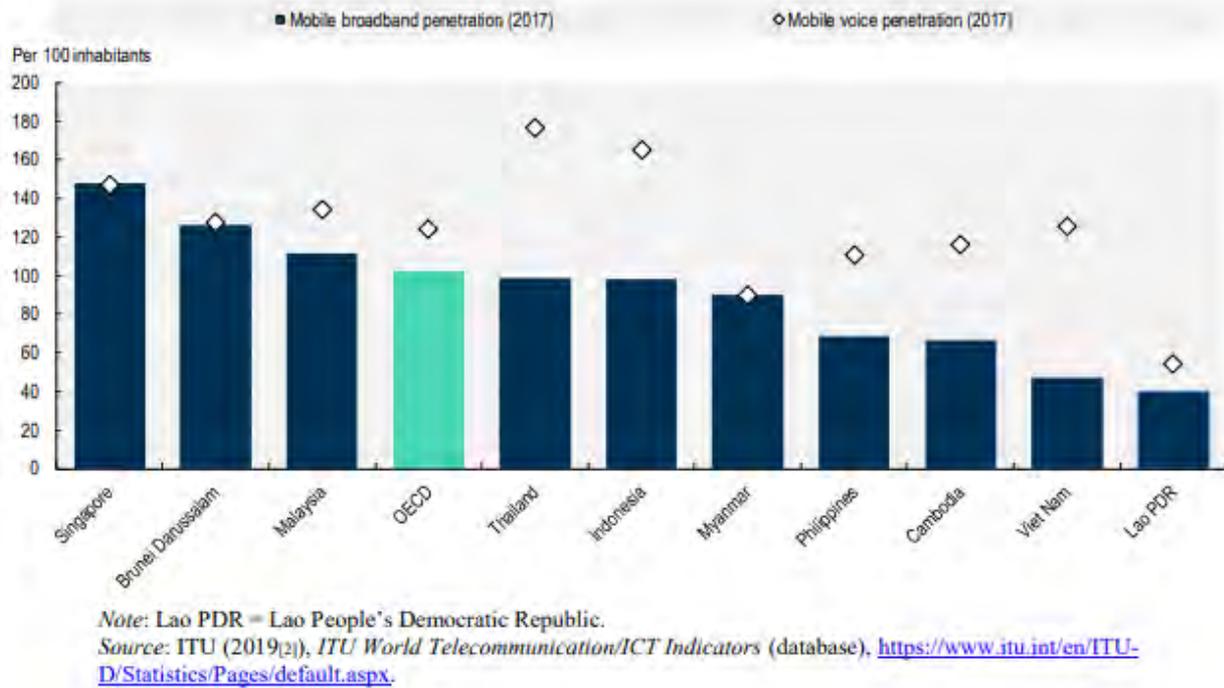
Figure 10: Mobile broadband subscription per 100 inhabitants in SEA and the OECD (2017) (OECD, 2019, p. 36).

Through the ASEAN network, there are opportunities for Australia to partner with SEA governments and peak telecommunications providers to solve access and affordability problems in Northern Australia and SEA. For example, we may seek investment from SEA countries to improve mobile telecommunications networks in Northern Australia. Moreover, Australia could partner with PNG and Indonesia, our closest geographic neighbours, to deliver a satellite broadband mesh covering large parts of the Asia-Pacific region. This could mimic the recent efforts by Facebook, SpaceX and Samsung to use constellations of low-orbit satellites to connect rural users in developing countries to high-speed internet (Horn 2020). While there are significant issues to be negotiated here (akin to recent controversy regarding Huawei 5G networks in Australia and elsewhere) (Zhou & Fang 2019) and interference with astronomers' observations (Lu 2019), novel and bold solutions are necessary to sufficiently connect Northern Australia.

Indeed, low-orbit satellite innovations are already being pioneered by Australian institutions. For example, the Australian National University's Institute for Space (inspace.anu.edu.au) is developing a new constellation of satellites to help Australia's property management, insurance, geological, agriculture and defense industries pinpoint how bushfires are likely to start and spread (Johnston 2020). Relatedly, in Alice Springs, global communications company Viasat Inc. has partnered with the Centre for Appropriate Technology Ltd (CfAT) and Indigenous Business Australia to build a Real-Time Earth (RTE) facility that will be used to track the next generation of low earth orbiting satellites (SBS 2019). Strategic partnerships and significant investment in these types of ground-breaking projects will be required to deliver future-proof digital connectivity to Northern Australia. Other options could be explored, such as establishing a state-owned regional telecommunications carrier, along with more conservative approaches, like large-scale rollout of point-to-point microwave technology to connect more Northern Australians to fibre broadband.

3.4 Physical infrastructure findings summary

Our infrastructure audit and stakeholder engagement revealed several critical insights and options for ways forward under the following themes.

Theme 1. Strategic direction, leadership and investment.

A whole-of-region strategy is required to structurally connect the North. In the absence of investment in adequate nation-building digital connectivity infrastructure in Northern Australia, nimble operators and cooperatives are 'plugging holes' using own funds or grants. The authors' view is that the developing Northern Australia agenda would be more easily realised if this piecemeal approach to digital infrastructure and service could be supplemented by a pan-Northern strategy. Led by the federal government, large telcos and international innovators in this space (e.g. Loon), strategic solutions could include collaborations with nearby ASEAN countries to, for example, provide a satellite-enabled mesh over the pacific region, including Northern Australia.

Government-led policy reform could spearhead digital connectivity in Northern Australia. The authors recognise recent new and updated policies and initiatives that have contributed to better connections for Northern Australians. For example, NBN Sky Muster plans no longer count the use of essential internet services including email, general web browsing and critical software updates as part of monthly data allowances. As well, in 2020 the USO is due to be replaced with the Universal Service Guarantee, which will guarantee Northern Australians access to voice and broadband services. While these incremental efforts do make a difference to Northern Australians, we see an opportunity for governments and industry to consider the broad range of mechanisms it has available to systemically and comprehensively solve connectivity for Northern Australia.

Theme 2. Access and affordability.

Access and affordability are inter-related and should be addressed together at a national level. While more Northern Australians than ever before have mobile phone and broadband coverage, connections can be unreliable and expensive. This could be addressed from two angles. First, more money could be invested in improving mainstream infrastructure and services at local scales, such as building more towers, laying more fibre or releasing more data on satellite connections. Second, gaps in service not able to be serviced by NBN and the major telcos at this time could be filled with innovate solutions. This could involve governments incentivising and supporting smaller, nimble operators to design infrastructure and plans to meet the specific needs of Northern consumers in the immediate future. In the longer term, we see a need for more radical solutions, such as investing in constellation satellites with neighbouring countries.

As part of this, 'under service' should be acknowledged and addressed. When investing in infrastructure, distinctions must be made between no service and under service. For example, remote outstations with a single Wi-Fi hotspot to be shared by a whole community may be 'connected', but this is not enough for individuals and families to flourish. Moreover, what should be considered adequate for households should be adjusted for the greater demands on businesses. For example, domestic use of email and web-browsing has lower data, latency and speed requirements than AgTech solutions like IoT, automation, artificial intelligence (AI), and augmented reality (AR). While some gains are being made to meet the demands of remote small business and distance education (e.g. NBN SkyMuster Plus provides unmetered data for all activities except video streaming and VPN traffic), more policy and product reform is needed to address issues of equity of access and affordability of the various types of connections available now and into the future. Northern Australia industries and communities need end-to-end, fit-for-purpose solutions that with future-proof Northern Australia, which may necessitate investment in further infrastructure in the North (e.g. 5G).

CASE STUDY: Northern Territory Government Satellite to All Remote Sites (STARS)

The Northern Territory School of Distance Education, now in its 40th year of operation, is a world leader in the delivery of remote and distance education services. In 2009, the NT Government (NTG) funded its own satellite infrastructure (STARS) to provide remote students will access to broadband internet. This facility remains in place and is being evolved alongside newer infrastructure, such as NBN Sky Muster and its dedicated Education Portal.

In its submission to the 2015 Regional Telecommunications review (Northern Territory Government 2015, p. 5) the Northern Territory Government reported that:

> 'Northern Territory schools have enterprise class computers, software and networks providing students and teachers with access to a global pool of digital resources and online learning opportunities. Through Northern Territory and Australian Government programs all Year 9-12 students now have 1:1 access to a computer'.

This digital connectivity is critical to support the virtual classroom whereby expert teaching skills can be provided to a number of small remote communities simultaneously. Furthermore,

> 'the ability to broadcast our stories using rich media solutions provides real 21st century skills opportunities for remote teachers and students. This will change our educational environment from a pure consumer of educational content from the national pool, to a contributor of quality content from any location in the Northern Territory'.

The NTG noted that appropriate, reliable telecommunications services will be essential to meet education needs now and into the future. Given that the NBN solution for education in remote areas in Sky Muster, they suggest that more needs to be done to improve infrastructure. As noted above, the dedicated Sky Muster Education Port is making a difference. However, NTG notes that its own STARS satellite is likely to exceed the capabilities of the NBN Long Term Satellite Solution.

Our research revealed opportunities for other governments and sectors to potentially invest in their own infrastructure or to strategically co-invest with other governments, industries or businesses. For example, perhaps it is possible for the NT Health and Education departments to share this satellite to deliver their services in parallel to remote locations.

Source: NTG:DCIS 2015

4. Social infrastructure and digital capability analysis

Figure 11: Wordle created from participants' responses to activities related to social infrastructure, Cairns workshop 16 August 2019.

For digital inclusion to be realised in Northern Australia, physical telecommunications infrastructure and affordable services must be 'brought to life' by essential social infrastructure. That is, digital connectivity alone will not develop Northern Australia: people, skills and networks are essential for leveraging telecommunications and the internet access to realise outcomes across sectors and geographies (Gurstein 2003).

Social infrastructure consists of organisations and services, and the connections between them, that build community. These networks of schools, government services, health centres, leisure and recreation facilities, libraries, community centres, religious facilities, local shops, open spaces, transport and utility services and emergency services (Brown & Barber 2012) provide the foundations for social and economic growth and cohesion. Furthermore, social infrastructure plays a growing role in building local digital capability for individuals and communities. For example, libraries are becoming hubs for creative and digital activities, including activities for community development, cultural participation and economic productivity (Light *et al* 2017).

While the audit of physical infrastructure relied mainly on desktop-based research, our analysis of social infrastructure required a highly consultative approach. The insights in this section are principally drawn from our panel and ideation sessions in Cairns and Darwin, along with stakeholder interviews. Using a design thinking double-diamond methodology (Design Council n.d.) we explicitly

asked workshop participants to work in cross-sector and cross-geographical groups to collaboratively define problems and solutions in relation to their social infrastructure networks in Northern Queensland, NT and Northern WA. We then asked them to consider pan-Northern approaches to building a robust digital inclusion ecosystem in Northern Australia.

In the context of developing Northern Australia, we define a digital inclusion ecosystem as a cross-geographical, cross-sectoral, multi-level network of organizations who work independently and in collaboration to improve reliable and affordable access to online technologies, and digital ability, to effectively use these connections in work and life.

This concept is useful to frame our review of digital capability in Northern Australia as being inherently interconnected with other social and economic systems and programs.

4.1 National digital ability programs

While inadequate digital infrastructure and services are perhaps the most pressing digital inclusion issues for developing Northern Australia (see Section 3), low levels of digital ability (or digital literacy) are also of concern. In 2017 the Australian Government recognised the importance of a digitally capable population, committing $20 million to fund small grants in the first 3 years of its flagship digital inclusion program, **Be Connected**. Be Connected (beconnectednetwork.org.au) is a nation-wide initiative of the Office of eSafety that aims to empower all Australians to thrive in a digital world through social and economic participation online. Be Connected is about upskilling Australians in digital literacy, including using digital devices; finding new friends who share interests and hobbies; and shopping and selling online, safely and securely. The program is coordinated by the Good Things Foundation, which manages a national network of 3000 community partner organisations that foster digital participation locally by, for example, delivering

Be Connected course material available on its learning portal. Despite significant public and private investment in this and other digital capacity building programs (*TechSavvy Seniors*, *GetOnlineQld* and *Digital Springboard*), Northern Australians are far less likely to have access to such programs than other Australians (Figure 12 maps the Be Connected partner organisations, showing 166 partners in Northern Australia compared to 2510 in Southern Australia). It is not surprising that regional, rural and remote community groups in the North struggle to apply for grants and administer such programs. These organisations – which often rely on the time and goodwill of a few volunteers – are under-resourced to deliver such programs in terms of supplying digital devices and Wi-Fi to access materials; recruiting facilitators with appropriate knowledge and skills; and having accessible and convenient locations to host sessions (i.e. participants may have to travel very long distances). These organisations also often lack independent, robust evidence to support their funding applications, because, for example, large data sets (e.g. ADII) often do not include data from the most remote regions that, ironically, requite more insight and support.

'Digital inclusion programs and interventions actually need to be place-based … they need to be useful to drive locally-identified community outcomes, and are a means to an end, not an end in themselves.'

– Research participant

Figure 12: Be Connected partner locations (February 2020).

The ADII (Thomas *et al* 2019) (see Section 2.3) reveals that Northern Australians lag well behind other Australians on the digital ability sub-index, which evidences the urgent need for the above-mentioned initiatives to better service Northern Australia. For example, Western Australians who live in 'other WA' (anywhere outside Perth and South West WA) score just 55.2 for overall digital inclusion (compared to the national score of 61.9). Moreover, 'other WA' scores 44.0 on the digital ability sub-index, which measures attitudes, basic skills and activities. In comparison, the average Australian scores 50.8 on the digital ability sub-index, and central Perth region scores 56.5. This data underscores the current deficits in Northern Australians' opportunities to learn critical skills for digital participation.

4.2 Northern Australia's digital inclusion ecosystem

Social infrastructure organisations are most effective in developing digital capability when they are part of a broader, thriving digital inclusion ecosystem. We introduced the term 'digital inclusion ecosystem' to our data collection and analysis to denote the valuable role of each stakeholder, and to emphasise that the links between them are equally important as their individual contributions. Accordingly, in this research we focus on system-level findings and recommendations rather than focusing on individual actors or sectors, such as businesses, organisations or communities. We do, however, refer to case studies and examples of areas where good progress is being made and where solutions may be scalable and/or transferable.

Across the Northern Australia digital inclusion ecosystem, we have identified several node types, which tend to play particular roles in the network.

1. **Carriers and service providers (telcos)** determine what technologies and plans are offered and at what cost (e.g. Telstra, which has the largest customer base in Northern Australia).

2. **Governments and regulators** set the policy environment within which service providers operate, (e.g. NBN which provides and regulates wholesale broadband and ACCC which regulates telcos) and administer digital inclusion-related programs and funding (e.g. Smart Cities, Regional Deals, Be Connected, ACCAN grants).

3. **Local/community organisations** educate and support individuals, families and small business to get connected and use digital technologies (e.g. libraries, CWA, RDA, NRM, arts organisations, Indigenous knowledge/art centres) often supported by government funding.

4. **Industry groups, peak bodies and development organisations** often represent larger regions or industries, and campaign at the national and state level for digital inclusion and facilitate networking between disparate constituents (e.g. RDAs, NFF, Advance Cairns).

5. **Education institutions** (e.g. school, TAFE, VET, tertiary, community organisation) provide digital knowledge and skills at all stages of Northern Australians' lives.

6. **Business** (large and small) that provide employment and skills development.

7. **Nimble innovators** provide bespoke technical and social solutions for digital inclusion in specific, often smaller and more remote, sectors or regions (e.g. CfAT, Hitnet, Wi-Sky, Distance Curve).

8. **Media, broadcasters and social media** – national and community-level media organisations as well as social media platforms – contribute significantly to digital awareness and digital literacy, along with providing forums for public storytelling and debate (e.g. ABC's HeyWire (abc.net.au/heywire), CAAMA radio (caama.com.au), and the BIRRR Facebook group (facebook.com/groups/BIRRR).
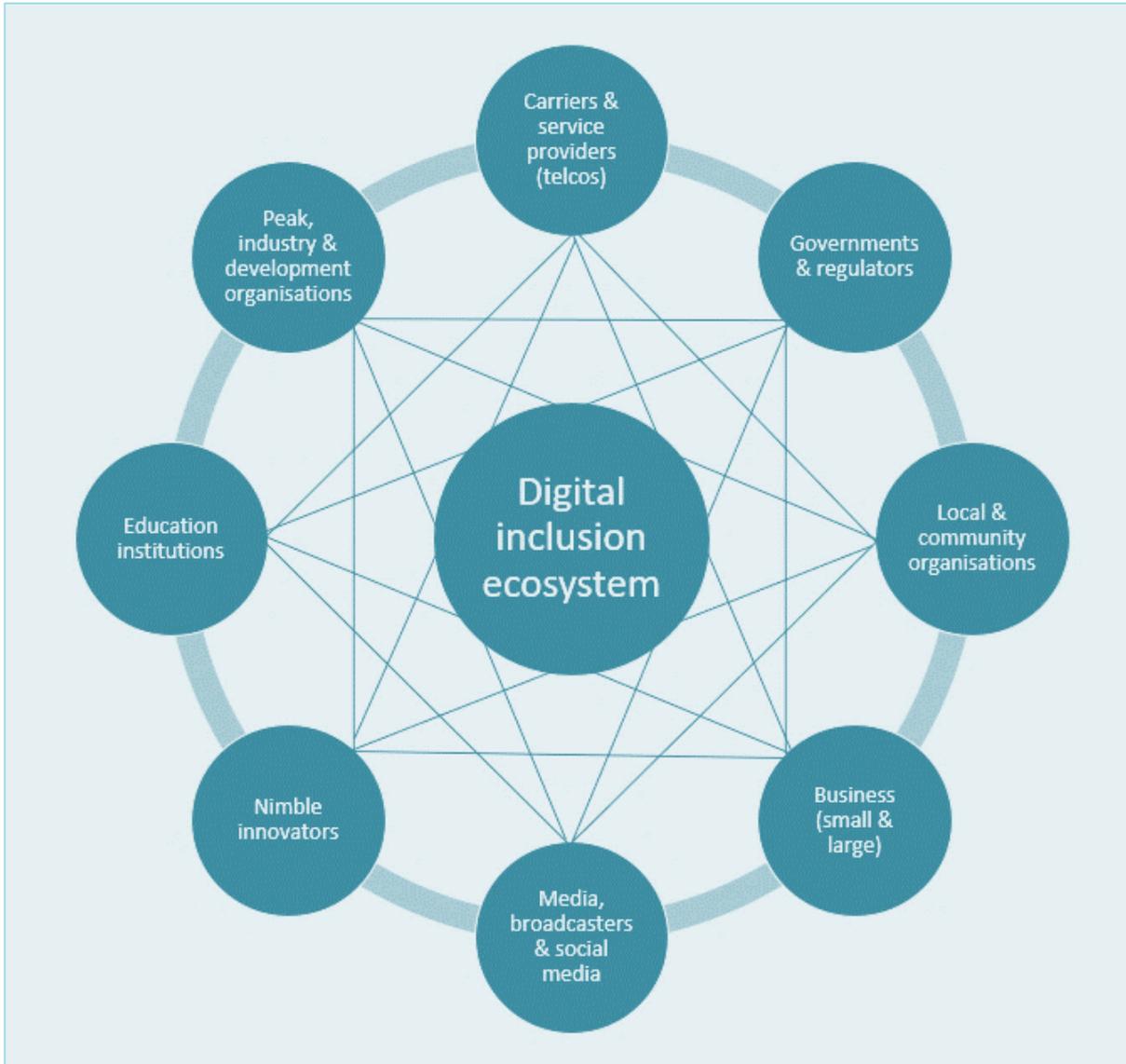
Figure 13: Digital inclusion ecosystem.

In mapping this ecosystem, several contextual complexities arose that must be understood and catered for in further investigations into digital inclusion ecosystems and their composite stakeholder groups and relationships:

1. Diverse and geographically disparate communities, from remote Indigenous outstations of under 50 people, to well-serviced cities like Townsville and Darwin.

2. The different types of formal classifications for places and populations in Northern Australia. For example, ABS classifications (such as outer regional, remote and very remote) may be combined with other settlement type descriptors (such as urban and non-urban). This means it is possible for places, such as Alice Springs and Katherine in the NT, to be both urban and remote.

3. Jurisdictional barriers (legislation, policy, funding) prevent cross-border collaboration across WA, NT and Qld networks.

Overall, workshop participants overwhelmingly told us that, given their stretched human and physical resources, the sharing of knowledge, skills and resources is essential for them to foster a level of digital participation necessary to support the developing Northern Australia agenda. The

research also found that locally grown ideas inherently consider specific, contextual opportunities and challenges in ways the 'one-size-fits-all' programs do not.

4.3 Digital skills and education

The research findings show a clear and important link between digital inclusion and education. Specifically, participants identified that digital knowledge and skills development – in all sectors – is critical for workforce development in the North. That is, if Northern Australia is to thrive in the digital economy, we must propagate and support people to acquire and sustain digital knowledge and skills that are required now and in the future. For example, with automation becoming mainstream in cropping processes, Northern Australia must (re)train its farmers (and students) so that they remain relevant and productive contributors to the economy[16].

Importantly, digital skills for workforce development can only be realised through life-long digital literacy support for Northern Australians. As shown in Figure 14, digital skills exist on a spectrum that spans the lifecycle from early education to specialised training, and across life spheres (Skov 2017), which include occupying the roles of digital friend/family member, digital worker, digital consumer, and digital citizen.
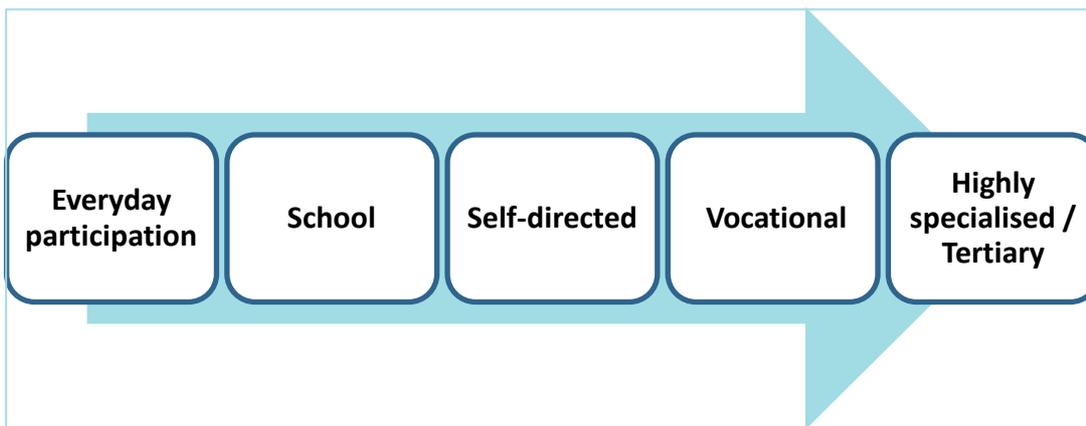
Figure 14: Spectrum of digital skills over a life course.

Examples of such digital skills common to the Northern Australia context include the following, with an agricultural household in mind:

- **Everyday participation**: Doing personal and business banking online, such as invoicing and payroll.

- **School**: From completing homework through an online portal to conducting research using digital databases for an essay.

- **Self-directed**: Learning how to build a vegetable patch or treat weeds using YouTube videos.

- **Vocational**: Undertaking accreditation modules or using the National Livestock Identification System (NLIS).

- **Highly specialised**: Undertaking tertiary study in precision agriculture.

Relatedly, research participants observed anecdotally that digital knowledge and skills are now required in traditional trades and vocations, such as mechanics and manufacturing. However, opportunities to learn such skills are unevenly distributed in the community. For example, if parents

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[16] *For a case study on blockchain, AgTech and digital/creative skills in regional Australia, see Foth & McQueenie (2019).*

are digitally savvy, their children are more likely to incrementally develop digital knowledge and skills over time and are then able to pursue technical careers. On the other hand, children from low socio-economic families are sometimes limited to school-based resources and curricula. While mobile phone use has somewhat filled the gap between those with and without devices and skills, as mentioned previously, research has shown that mobile-only use currently has significant drawbacks such as cost and limited functionality, particularly related to the completion of specialised tasks.

4.3.1 Media literacy and consumer protections

More specific insights were also garnered with regards to individual-level digital literacy which, if not addressed, will continue to compound digital, social and economic exclusion in Northern Australia. Participants highlighted that many Northern Australians lack enough capacity to use digital technologies to access online content and services safely and ethically. This digital media literacy is a broader issue in Australia, including amongst disadvantaged populations such as young people (Notley & Dezuanni 2019), people with a disability (Leep 2017) and Indigenous Australians (Rennie *et al* 2016).

The research also revealed connections between media/digital literary and consumer protection for Northern Australians. For example, participants were acutely aware of the privacy drawbacks of the *MyHealthRecord*. Although the benefits seemed obvious, particularly for itinerant primary health consumers that frequently travel across long distances, questions were raised about the privacy, integrity and security of personal information. While such concerns are not confined to the North, some are exacerbated in specific social and cultural contexts in Northern Australia. For example, multi-national agricultural companies are harvesting big data from farming machinery, often without the knowledge or consent of farmers (Wiseman & Sanderson 2019, Wiseman *et al* 2019). As another example, some Australian telecommunications providers have previously exploited low levels of digital literacy in Indigenous communities to sell inappropriate products and services. For example, in November 2019, Telstra apologised for acting unethically in some NT Indigenous communities, including selling phones to people who could not afford them (Roberts 2019).

Finally, the findings revealed that the opportunities of individuals, families and businesses are substantially thwarted by low levels of digital/media literacy. For the most digitally and physically isolated Northern Australians, this is largely a case of 'you don't know what you don't know'.

4.4 Social infrastructure findings summary

Our analysis of stakeholder perspectives to building digital capability several critical insights and options for ways forward under the following themes.

Theme 1. Cultural and structural features of the digital inclusion ecosystem.

Things are done differently in the North. Policy and programs developed at the national level (often for urban participants) often do not translate well into regional, rural and remote communities. For example, small business education is not always relevant to rural businesses. As well, top-down digital inclusion funding models at federal and state/territory levels can promote fierce, and sometimes counter-effective, competition between stakeholders over scarce resources. Criteria for designing policy and funding programs that 'make sense' in the South are often illogical and inequitable in the North, which can result in unintended outcomes.

The Northern Australia digital inclusion ecosystem is patchy and siloed. There is a lack of an over-arching vision or a coordinated strategy across sectors, geographies and agencies that identifies gaps in the existing network(s). There are some organisations that could be implicated in digital work to fill these gaps (e.g. health clinics, businesses), but they do not identify as being critical to digital capacity building, as this is not their core business. Some important industries that have

obligations in this space seem absent from the conversations (e.g. banking and legal sector). Stakeholders are currently siloed in their resourcing, planning and service delivery. There are assumptions that 'someone else' will take responsibility for broader coordination across actors and regions. This can lead to a lack of sharing of valuable resources and knowledge.

Northern Australia requires strategic leadership and resourcing to enable its digital inclusion ecosystem to thrive, grow and adapt to change. Links between existing and new 'nodes' in the system need to be established and strengthened, and stakeholders need forums to share knowledge and resources. Also, appropriate governance structures that accommodate the unique Northern context should be developed.

Theme 2. Digital knowledge, skills and workforce development.

Northern Australia will require a digitally skilled population to socially and economically progress the region. Technological advances in existing industries, and the creation of new technology-driven industries and businesses, are needed to help diversify regional economies and maintain global competitiveness. This is occurring in some places, such as Karratha (a wealthy mining city in the Pilbara, WA), which is supporting various novel technology industries and initiatives, such as autonomous passenger vehicles (SMH 2019).

A key issue for developing Northern Australia is attracting and retaining a talented workforce. Many Northern Australians migrate south for their tertiary education and often do not return. Participants identified that Northern Australia must find ways to 'grow our own' digitally capable workforce. This goes beyond providing digital connectivity infrastructure to supporting distance education. It requires investing in infrastructure and systems that educate people in place and identifying new career pathways that are locally specific and tailored to the unique circumstances of Northern Australia.

We found there is little evidence of how the digital skills and knowledge that underpin all vocational training will be integrated into workforce planning. Moreover, research participants said it's not just the employer-based workforce that needs digital upskilling. More also needs to be done to digitally-enable entrepreneurs to start businesses in regional areas. Given that start-ups tend to involve young people, supporting them to establish tech businesses in the regions will also assist to keep school-leavers and other young people in Northern Australia. Moreover, e-changers (Salt 2016) could be attracted to Northern Australia if more robust digital connectivity could be achieved to support their work, businesses and lifestyle.

Moreover, as Northern Australia faces increasing challenges related to climate change, there is a great need for key Northern industries like mining, agriculture and manufacturing to transition towards clean energy industries, which points to technology-enabled solutions. Also, improved digital connectivity and capability could help Northern Australia to economically diversify into new sectors, such as the creative industries (Cunningham *et al* 2019).

5. Future directions

Figure 15: Walk/bike path in Karratha, Western Australia (Image: Amber Marshall)

5.1 SWOT analysis

We present the following SWOT analysis as a summary of the high-level issues addressed in the paper. We use these findings as the basis for formulating the overall recommendations and five-year road map for developing Northern Australia through digital inclusion.

Table 1: SWOT analysis

STRENGTHS	WEAKNESSES
Physical infrastructure • **Federal programs (NBN, Mobile Black Spot) have connected some Northern Australians for the first time.** • **Nimble operators are filling gaps in service and fostering innovative solutions.** *Social infrastructure* • **Many stakeholders in Northern Australia understand the imperative for digital inclusion in Northern Australia and are poised to assist, bringing resilience and innovative solutions.** • **Some Northern Australia institutions have successfully developed place-based education systems to 'grow their own' skilled workforce (e.g. JCU's medicine program), which could be copied and scaled to build digital capacity.**	*Physical infrastructure* • Lack of universal, reliable, affordable telecommunications and internet infrastructure and services • A lack of coordinated planning across Northern Australia is leading to fragmented and potential duplication of digital connectivity infrastructure and service in some areas, but under/no service in others. • Legislation and regulation do not include provision of internet and mobile phones services to all Australians, and sparse populations in Northern Australia mean traditional cost-benefit does not 'add up.' *Social infrastructure* • Community organisations are under increasing pressure to provide support to deliver programs but are under-resourced to do so and lack a robust evidence base to reference in funding applications. • There is a lack of coordination across sectors and between government levels for digital inclusion-related activities, leading to gaps in service and duplication of programs.
OPPORTUNITIES	**THREATS**
Physical infrastructure • **Strengthen the developing Northern Australia strategy by investing in whole-of-region telecommunications and internet infrastructure strategy.**	*Physical infrastructure* • As the digital economy advances rapidly, current connections will not be adequate (coverage, data, speed). • The natural monopoly in the telco industry will likely continue to thwart competition in Northern Australia.

- **Link in with energy and transport sector infrastructure and policy agenda.**
- **Potential to participate and compete in increasingly digitised global supply chains.**

Social infrastructure

- **The North could lead Australia in its policies, programs and research for activating a robust digital inclusion ecosystem in Northern Australia (e.g. capitalise on entrepreneurship and e-changers)**
- **Businesses shifting their operations away from metropolitan areas to save costs, and for lifestyle benefits, plus export opportunities (e.g. Cairns and Darwin ports).**
- **Economic diversification through digital innovation could lead to new professions and industries.**

Social infrastructure

- Competition for scarce program funding amongst community organisations can discourage collaboration.
- Physical distance and unreliable digital connectivity limits options for educational opportunities and online collaboration.

Both physical and social infrastructure

- Northern Australians' advocacy and lobbying capacity is minimized owing to limited voting power and representation in federal parliament.

5.2 Recommendations and actions

Having provided findings throughout this report about how different stakeholder groups can contribute to building and sustaining an effective digital ecosystem in Northern Australia, we now turn to high-level recommendations and make suggestions as to how the major players can action them.

1. Invest in digital connectivity infrastructure and innovative solutions for access.

Provision of reliable broadband and mobile services is still lacking in many areas in Northern Australia. Furthermore, existing services will not meet future need. There is a lack of whole-of-region strategy to achieve the ubiquitous broadband and mobile service across Northern Australia needed for economic growth and social cohesion.

While smaller market players are developing innovative ways to deliver mobile/internet products to consumers who otherwise would be under-serviced, affordability is a key issue. Regulation, legislation and policy at all levels should reformed in ways that create the conditions in which equitable services are possible in Northern Australia.

See Section 3 (Infrastructure ad service audit) for findings that support this recommendation.

Who can action this and how?

Table 2 shows high-level recommendations and actions for solving digital connectivity for Northern Australia.

Table 2: High-level recommendations and actions table #1.

WHO	HOW

CRCNA (or other research funding body)	• Invest in research that:
	  o quantifies the cost of digital exclusion across sectors and use this to justify its advocacy for digital inclusion in Northern Australia.
	  o develops innovative models to deliver affordable, reliable, local, fit-for-purpose digital connectivity into regional, rural and remote areas; and
	  o supports local people to innovate in place and, where possible, scale and replicated those solutions across Northern Australia.
	  o uncovers specific sector issues e.g. big data and farming.
	  o identifies ways to share hardware and methodologies across sectors (e.g. health and education).
	• Consider developing new criteria and benchmarks for assessing the value of projects that do justice to the digital inclusion requirements related to sector or business level research.

Governments	• Through new legislation/regulation and funding criteria, incentivise greenfield developments (ports, mines, energy, etc.) to invest in digital connectivity infrastructure from the outset and that they consider how such access may be shared with communities en route to these sites, as well as on site. • Incentivise commercial spaces (e.g. shopping centres, leisure centres) to provide digital connectivity on site. • Continue to solve the broader infrastructure issues through initiatives at each level of government. At a *federal* level, investigate the broad range of mechanisms it has available to systemically and comprehensively solve connectivity for North. At a *state* level, work with federal government to devise pan-Northern solutions, including co-designing solutions with communities and oversee implementation. At the *local* level, educate constituents about available services for improving digital connectivity and digital ability. • Consider new 'logics' for digital inclusion investment/decision-making in the North. Traditional cost-benefit analysis does not capture the value or necessity of digital connectivity in the north, particularly as it relates to the risks of *not* getting connected (See Walker, Porter & Marsh 2012, Huigen & Stafford Smith 2009).
Industry and businesses	• Advocate for broad acceptance for digital connectivity being as essential for developing Northern Australia as other forms of connectivity, such as roads and energy. This is important because developing Northern Australia objectives may not be met if telecommunications and internet connectivity is not significantly improved to deliver universal, reliable and robust service across

	Northern Australia for homes, schools, businesses and community services. • Leverage/share existing and new infrastructure • Ensure telecommunications and internet infrastructure is considered alongside other essential infrastructure during greenfield planning, including connections for nearby communities and public Wi-Fi where appropriate.

Telcos	• Design and offer more services that meet the specific needs of Northern Australian families and businesses. For example, mobile phone plans that cater for remote workers who may spend weeks or months out of range and then use significant amounts of data in short bursts. The larger telcos could also consider:
	   o More readily sharing infrastructure (e.g. mobile phone towers) in rural and remote areas, so that customers of all these providers have coverage.
	   o Rolling out 5G in more places in Northern Australia.
	   o Design services based on customer preferences e.g. like existing ticketing systems for data use on remote cattle properties, which will help bolster attraction and retention of workers.

Local councils & community groups	• Help educate and mobilise existing social infrastructure to help solve problems as grassroots initiatives. This could be achieved by providing opportunities to share solutions and information and broker partnerships. These groups could also:
	   o Lobby government and collect evidence as a collective (e.g. FNQROC's mobile back spot research, Digital Economy Group, 2019).
	   o Run local digital literacy sessions (Digital Inclusions, n.d.).
	   o Establish online repositories, and other cross-sector and cross-geographic platforms (e.g. BIRRR-style).
	   o Identify ways to share hardware, methodologies across sectors (e.g. health and education).

2. Devise, fund and support an inclusive digital inclusion ecosystem strategy across industry, all levels of government, and the community sector.

Participants in our workshops in Cairns and Darwin overwhelmingly called for a multi-level, cross-sectoral strategy for developing a robust digital inclusion ecosystem in Northern Australia. For this to be successful, we believe a nationally led digital inclusion strategy is required that is co-designed with stakeholders throughout Northern Australia, perhaps through an annual forum. A national (online and face-to-face) digital inclusion forum (like the *Digital Inclusion Policy and Research Conference* in the UK) could provide a space for representing interests, presenting evidence, and debating how Northern Australia (and Australia) can effectively move in the digital economy.

At the same time, grassroots initiatives and programs need to be funded and supported to allow locals to define and execute digital inclusion solutions that work in context. Within this broader agenda, more specific digital inclusion programs and outcomes could be possible. For example,

technology adoption could be bolstered in industries such as agriculture and the arts, online social communities could be accessed (and new ones established) for isolated and vulnerable people.

These initiatives could be accompanied by awareness campaigns at various levels to educate the general public and help ensure (Northern) Australians understand and participate in digital inclusion programs at home and work.

See Section 4 (Social infrastructure and digital capability analysis) for findings that support this recommendation, especially Sections 4.1 and 4.2.

Who can action this and how?

Table 3 shows high-level recommendations and actions for achieving an inclusive digital inclusion ecosystem in Northern Australia.

Table 3: High-level recommendations and actions table #2.

WHO	HOW
CRCNA (or other research funding body)	• Invest in research that can inform a national digital inclusion strategy, including programs that: quantify the cost of digital exclusion across sectors, and use this to justify its advocacy for digital inclusion in Northern Australia, investigate societal barriers to support for digital inclusion in the North (e.g. the misguided perception that internet services are primarily used for entertainment, such as video streaming services). • Invest in research that develops individual-, community- and industry-level digital inclusion evaluation tools that help people to identify their needs and pathways to improving digital inclusion (See Dezuanni *et al* 2018b).
Governments	• Federal Government to co-fund a national/Northern digital inclusion conference in conjunction with states/territories, educational institutions and industry (as described above). • State/Territory government to play a conduit role in coordinating partnerships and knowledge/resource sharing across sectors and geographies. This could be achieved through an online map/directory of the digital inclusion ecosystem (perhaps funded by a corporate sponsor (e.g. telco, big business), whereby entities nominate themselves as nodes in the system and update details, projects, program, events, etc. This would help fill gaps and reduce duplication. • Invest in place-based digital inclusion initiatives by Northern Australians, for Northern Australians. Emphasis should be on scalable (where appropriate) initiatives that leverage local skills/knowledge and solve context-specific issues. This should be funded by *federal* and *state* governments but led by *local* governments (where feasible). Funding and support should also come from big business and telcos. • Ensure that national digital inclusion programs have strategic plans and resources to appropriately deploy in regional Australia (including Northern Australia), including repurposing content and mode of delivery where necessary.
Education institutions	• Northern Australians need greater exposure to the possibilities of being digitally connected and how digital technologies can be leveraged in all spheres of life, now and into the future. Therefore,

		digital knowledge and skills training could be integrated into all levels of education, from primary school to specialised training. This could include developing (and promoting existing) resources for clear consumer advice for Northern Australians, perhaps in conjunction with regulatory and advocacy bodies (e.g. ACCAN, ACCC, ACMA).
Local councils, community groups & businesses	•	Community-led education programs could be conducted by businesses, schools, and other groups to assist everyday people to engage in everyday digital participation. Where possible, groups should submit collaborative projects to funding bodies and share resources, skills and knowledge across communities. This could be facilitated by councils or representative industry organisations (e.g. AgForce)
	•	Contribute to above-mentioned digital inclusion map/directory, keeping details and programs updated.
Industry & government	•	Fund and host a Northern Australia-led Grand Digital Inclusion/Innovation Challenge for addressing Australia's most compelling digital inclusion problems (e.g. biosecurity risks, automation, global market access). This could be achieved through a competitive awards program whereby teams bid for funding to solve cross-sectoral, inclusive solutions that bolster the overall digital inclusion ecosystem.
All	•	Ensure First Nations perspectives and solutions are at the core of digital inclusion planning. Our research found that First Nations perspectives in digital inclusion in Northern Australia are sometimes confined to programs and policy for remote communities. Given the high representation of First Nations people in Northern Australia, equitable and successful digital inclusion initiatives depend on drawing insights and knowledge of Indigenous industries, organisations, groups and individuals. Furthermore, these organisations have led the digital inclusion debate nationally, conducted research and proposed workable solutions that could be enacted across Northern Australia (e.g. First Nations Media's Policy Action Plan (2019) (see Section 7.2 for details).

3. Promote place-based tactics for workforce development through building digital capacity.

Digital skills development must be part of a broader agenda to integrate these skills into social and economic programs. Not only should social infrastructure be bolstered to help teach skills, there must be pathways for individuals to use and further develop their skills in meaningful ways. This could be achieved through cooperation and coordination between educational institutions and industry guided by a broader goal of training and retaining a digitally skilled workforce that can help take Northern Australia forward.

See Section 4 (Social infrastructure and digital capability analysis) for findings that support this recommendation, especially Section 4.3 including 4.3.1).

Who can action this and how?

Table 4 shows high-level recommendations and actions for achieving workforce development through building digital capacity in Northern Australia.

Table 4: High-level recommendations and actions table #3.

WHO	HOW
CRCNA (or other research funding body)	• Fund research into how digital inclusion can directly be integrated in industry/regional development, including how to link in with education sectors (school, VET, university, etc.).
Governments	• Embed digital knowledge and skills development into economic/social programs. At the *federal* and *state* levels, fund/facilitate businesses to teach specials technical skills and carry out technological innovation in partnership with regional educational institutions and social inclusion programs. At the *local* level, foster digital literacy through schools and community programs throughout an individual's life course. Local digital mentor programs (such as Digital Rangers who mentor people in their homes/businesses or in community kiosks) could see volunteers (or paid people) sharing their digital knowledge/skills with others in the community using technologies, applications and terminology that makes sense in context.
Industry and large businesses	• Devise, fund and action industry-level strategies to improve digital inclusion for their stakeholders (workers, communities, households, etc.) to share the load with governments and community organizations. Research participants proposed online platforms or annual face-to-face forums.
Education institutions	• Partner with regional industry to future-proof the local workforce. • Invest in place-based technological innovations which are used to equip students with relevant skills for the future.
Local councils, community groups & businesses	• Partner with the education sector to build their future workforce. Sectors like agriculture and health face significant workforce attraction, retention and development issues. This is compounded by the increased need for workers to acquire digital knowledge and skills associated with using equipment and communicating with stakeholders. Educators and practitioners must work together to provide vocational training in place and create direct pathways from education to work, thereby 'growing their own' skilled workforce.

5.3 Five-year road map

While the recommendations above are aimed at a broad audience of leaders in Northern Australia, this roadmap is to help guide the CRCNA's decision-making for investment in and advocacy for digital inclusion going forward. This map presents clear actions and activities the CRCNA could consider undertaking across infrastructure, policy, program and research that could help ensure the recommendations of this report are realised in Northern Australia.

Table 5: Five-year road map for digital inclusion in Northern Australia.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
1. INFRASTRUCTURE	*Priority 1.1:* Get people connected by facilitating last mile access.		*Priority 1.3:* Whole-of-region connectivity strategy co-designed and funded by business/gov investment in collaboration with neighbouring countries (e.g. low orbit satellite).		
		Priority 1.2: Design, fund and replicate place-based, scalable infrastructure solutions.			
2. POLICY	*Priority 2.1:* Create a unified vision for digital inclusion in Northern Australia by engaging governments, industry and consumers in developing a strategy for access, affordability, and digital ability.		*Priority 2.3:* Vertically integrate digital strategy with economic and social development (emphasis on skills, inclusion, social connections).		
		Priority 2.2: Strengthen Northern Australia digital inclusion ecosystem by fostering links between government, industry and community nodes			
3. PROGRAMS	*Priority 3.1*: Educate consumers about necessity and options to connect by leverage existing programs and resources.				
		Priority 3.2: Renew approach to digital literacy/ability/skills education by developing and delivering new community-led, place-based programs e.g. digital mentoring, rangers & kiosks.			
4. RESEARCH	*Priority 4.1:* Grow the evidence base for the needs, issues and applications of digital connectivity in Northern Australia.		*Priority 4.3:* Ensure whole-of-region strategy and other policy and programs are evidence-based by integrating research and researchers into above-mentioned priority initiatives (including measurement).		
		Priority 4.2: Understand needs of different consumers by researching needs of specific sectors, groups and communities e.g. AgTech adoption.			

5.3.1 Infrastructure

Priority 1.1: Get people connected by facilitating last mile access.

Actions:

- Federal government to provide funding and incentives for telcos – including smaller, nimble service providers – to partner with Northern institutions to design and implement place-based solutions;

- Local government, industry and community organisations to offer more digital literacy programs in collaboration with each other; and,

- Peak bodies to advocate at state and federal level for equality of access.

Priority 1.2: Design, fund and replicate place-based, scalable infrastructure solutions.

Actions:

- CRCNA (or other funding body) to invest in research that quantifies the need for access and identifies innovative technical solutions;

- Local and state/territory governments to fund (or enter co-ops) with businesses and industry groups to extend existing networks;

- Telcos to design and offer more services that meet the specific needs of Northern Australian families and businesses (e.g. mobile plans for intermittently heavy users).

Priority 1.3: Whole-of-region connectivity strategy co-designed and funded by business/government investment in collaboration with neighbouring countries (e.g. low orbit satellite).

Actions:

- CRCNA (or other funding body) to fund research into viable technical and economical options for whole-of-region connectivity;

- Big business/industry (agriculture, mining, manufacturing) to spearhead appeals to federal, state and territory governments to consider strategies and options.

5.3.2 Policy

Priority 2.1: Engaging governments, industry and consumers in developing a strategy for access, affordability, and digital ability across Northern Australia.

Actions:

- CRCNA (or other funding body) to fund research that can inform a national strategy (and possible awareness campaign), including programs that quantify the cost of digital exclusion across sectors;

- Federal and state governments to invest in place-based digital inclusion initiatives (for access, affordability and digital ability) that are assessed on new logics for what 'makes sense' to do in Northern Australia compared to other parts of Australia. First Nations perspectives to be at the core of vision, strategy and implementation.

Priority 2.2: Strengthen Northern Australia digital inclusion ecosystem by fostering links between government, industry and community nodes.

Actions:

- Federal and/or state/territory governments to create platforms (physical conferences and digital forums) for stakeholders in the Northern Australia digital inclusion ecosystem to share, learn and collaborate. The Australia Government's *Digital Technology Hub* (currently under public consultation) will be a good start, but such platforms need to service all levels of the community;

- CRCNA (or other funding body) to fund research on existing synergies across sectors and geographies regarding digital infrastructure, resources and methodologies, and foster networks as appropriate.

Priority 2.3: Vertically integrate digital inclusion strategy with economic and social development (emphasis on skills, inclusion, social connections).

Actions:

- Education institutions at all levels (school, VET, tertiary) to actively embed digital and STEAM skills training into courses, even in traditional industries that are not always considered to be digital or technical;

- State and federal government to incentivise Northern industry and businesses to partner with educational institutions so that students can learn and apply digital skills on the job.

5.3.3 Programs

Priority 3.1: Educate consumers about necessity and options to connect by leverage existing programs and resources (e.g. ACCAN, ACCC, Be Connected, Infoxchange)

Actions:

- Federal and state government programs to ensure there is funding, strategies and tactics for existing digital inclusion programs to target and reach Northern Australians, especially in rural and remote areas. Content to be tailored to local needs and interests;

- Telcos to take more responsibility for educating Northern Australia consumers about options and consulting with locals to develop new products and services.

Priority 3.2: Renew approaches to digital literacy/ability/skills education by developing and delivering new community-led, place-based programs e.g. digital mentoring, digital rangers.

Actions:

- Federal and state/territory governments, telcos and big business to fund new programs that are designed and delivered by locals, for locals. Program administrators should prioritise Northern-specific needs and target previously excluded participants;

- Local governments and community organisations to foster communication between funding bodies and hard-to-reach Northern Australians with the least digital literacy (e.g. promoting digital ability opportunism and assisting with grant applications, which already happens in many communities).

5.3.4 Research

Priority 4.1: Grow the evidence base for the needs, issues and applications of digital connectivity in Northern Australia.

Actions:

- Federal government to fund a national/pan-Northern digital inclusion policy and research conference (annually) together with states/territories, industry and educational institutions, as well as a grant challenge for digital inclusion and innovation across Northern Australia.

- CRCNA (or other funding body) to fund research into Northern-specific:
  - technical solutions (e.g. last mile access);
  - consumer issues (e.g. service plans, pricing, etc.);
  - digital ability issues (e.g. evidence-based, targeted programs for various sectors and communities)
  - ethics and equity issues (e.g. new ways to measure the cost-benefit of wide-spread digital inclusion);
  - data safety and cyber security issues (e.g. big data on farms).

Priority 4.2: Understand needs of different consumers by researching needs of specific sectors, groups and communities.

Actions:

- CRCNA (or other funding body) to fund research that investigates how specific groups could leverage opportunities in the digital economy, such as:
  - barriers to digital literacy and technology adoption on farms;
  - digital supply chains and technologies (e.g. blockchain);
  - global market development through ecommerce; and,
  - big data collection, analysis and application.

Priority 4.3: Ensure whole-of-region strategy and other policy and programs are evidence-based by integrating research and researchers into above-mentioned priority initiatives (including measurement).

Actions:

- CRCNA (or other funding body) to actively participate in Northern Australia-wide digital inclusion strategies across infrastructure, policy and programs, and to link researchers and research institutions with decision makers;

- CRCNA (or other funding body) to ensure other research projects actively consider telecommunications and broadband connectivity in their R&D programs, even in industries and practices that are not 'traditionally' digital/technical.

6. Addendum: Sectoral insights

This addendum provides sectoral-level insights into digital inclusion for developing Northern Australia. It is intended to supplement the pan-Northern situation analysis and recommendations detailed above.

First, we contribute to the Traditional Owner-led business development priority area by identifying the specific challenges and opportunities for the digital inclusion of First Nations peoples, including digital skills development and workforce capacity building. We also investigate how First Nations perspectives and innovations can be integrated into the broader agenda for developing Northern Australia through digital inclusion.

Second, we contribute to the Northern Australia health service delivery priority area by identifying how digital in/exclusion impacts e-health and telehealth initiatives in the North to enhance flow of information, support timely decision-making and treatment options, and workforce skills and capability. We also explore ways to exploit digital connectivity and technologies to overcome contextual challenges such as a highly distributed population, cost of service delivery, and patient/provider resistance to change.

Third, we contribute to the agriculture, food, and aquaculture priority area by outlining ways that barriers may be overcome, and opportunities exploited, so that farmers can improve productivity and innovate using digital technologies, as well participate more broadly in society. These insights will assist the individuals, families and communities in Northern Australia to grow, develop and diversify in the digital economy.

In the conclusion, we make sector-specific recommendations that link in with priorities, pathways and impacts detailed in the pan-Northern digital inclusion roadmap.

6.1 First Nations

First Nations people comprise 15% of the Northern Australian population. While many Indigenous communities in Northern Australia reside in urban centres like Darwin and Townsville, remote Indigenous communities are prevalent in the Cape (Qld), throughout Central Australia and the Top End (NT), and in the Kimberley and Pilbara (WA). The map and table below (Altman & Markham 2014) evidence several types of First Nations' interests in Northern Australia, such as land ownership, population, and numbers and distribution of 'discrete Indigenous communities. Given that the Australian Government's initial Developing Northern Australia agenda was criticised for its under-representation of such interests (Altman & Markham 2014), we have prioritised them here in our analysis of digital inclusion in the North.
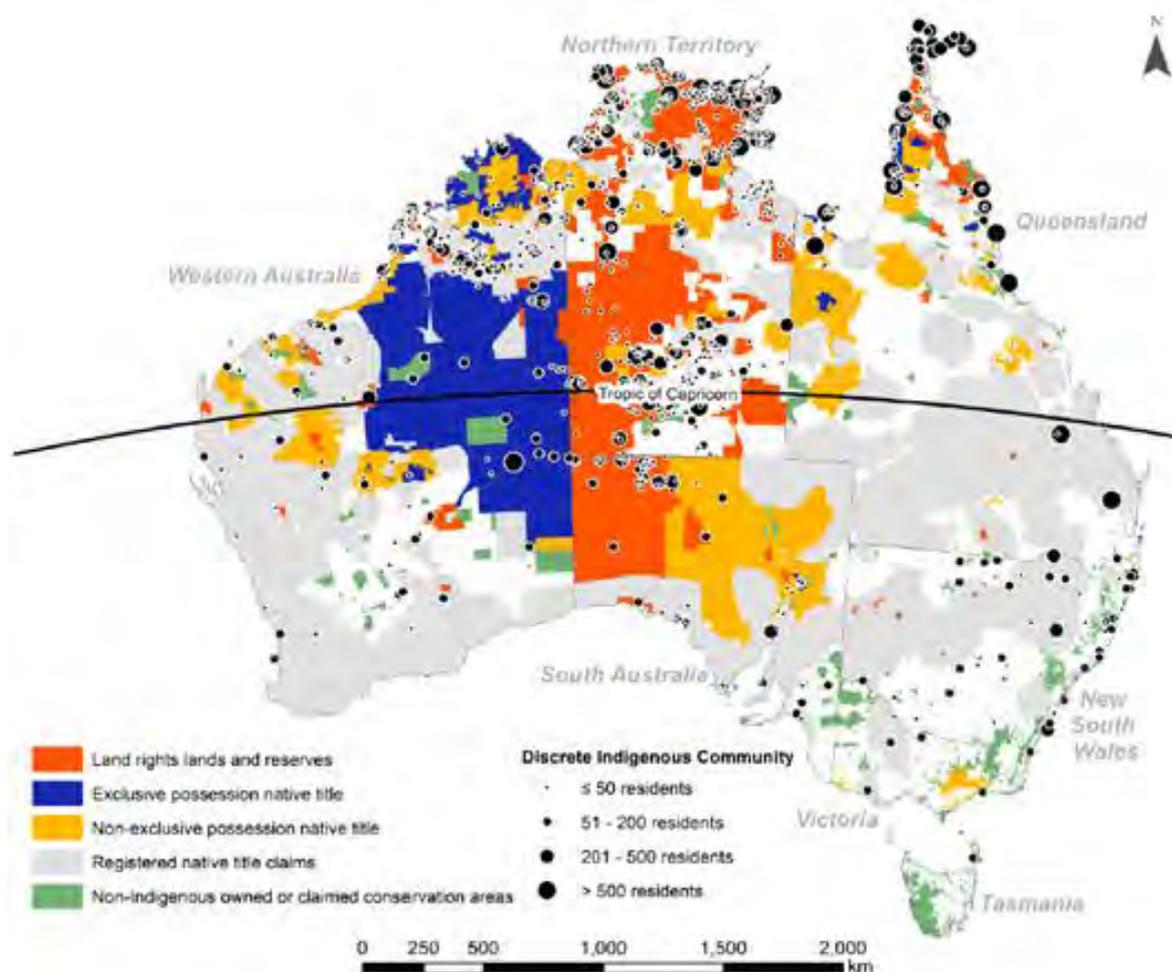
Figure 16: Discrete Indigenous communities (2006) on Indigenous lands (Altman & Markham, 2014).

	Area (km²)	Area (%)	Population	Indigenous population	% population Indigenous
Northern Australia	3,004,451	100.0	1,055,304	158,565	15.0
Land rights & reserves	592,829	19.7	56,031	48,796	87.1
Exclusive possession NT	443,458	14.8	10,969	8,939	81.5
Non-exclusive possession NT	405,213	13.5	7,076	1,788	25.3
Registered claims	831,637	27.7	355,156	38,990	11.0
Non-Indigenous owned or claimed conservation areas	79,935	2.7	5,641	1,084	19.2
Remainder of Northern Australia	651,378	21.7	620,431	58,969	9.5

Figure 17: Indigenous land interests and population (Altman & Markham, 2014).

The ADII has also been criticised for its lack of data from remote areas, including First Nations communities. In response to this deficit, the 2018 ADII report (Thomas *et al* 2018) administered a supplementary survey in the remote Indigenous community of Ali Curung, 380km north of Alice Springs. Although the sample size is small (112 people in a community of 500), the survey provides an Index score (42.9) and qualitative insight into the extent and nature of digital inclusion for Indigenous communities. While all communities are different, this ADII case study does

highlight some challenges for access, affordability and digital ability that are common across First Nations communities in Northern Australia.

- **Access**: while most people in the community (up to 90%) are connected to the internet, nearly all rely on mobile broadband despite satellite connections being available in their area.

- **Affordability**: Most people are on pre-paid mobile plans, which offer far less value for money than contracts, especially for data.

- **Digital ability**: Despite the constraints on access and affordability, these consumers are more likely than the average Australian to use the internet to engage in shopping and banking, access government services, keep up with the news, communicate via voice and messaging services and stream or download content.

Overall, the authors observe that 'while local patterns of use suggest the internet is an important lifeline for those in remote communities, accessing it comes at a higher cost than it does for those in the cities and towns' (Thomas *et al* 2018, p. 19).

6.1.1 Legacy connectivity issues

Since the early 2000s, Australians governments have introduced several telecommunications initiatives that aimed to meet specific telecommunications needs of remote communities, including the *Telecommunications Action Plan for Remote Indigenous Communities* (TAPRIC) (2002), *Backing Indigenous Ability* (2007-2010), and the *Indigenous Communication Program* (ICP) (2009-2014). However, rather than improve access to digital technologies and connections, much of this funding went to payphones (Rennie *et al* 2016). More recent schemes have sought to bring digital connectivity to Indigenous communities as part of the Closing the Gap agenda (e.g. WA's Remote Indigenous Public Internet Access (RIPIA) program). However, Rennie, *et al* observe that 'one result [of these specific initiatives] has been that, for over a decade, the dominant mode of provision was shared facilities in the form of dedicated computer rooms or shared computers in existing public spaces' (2016, p. 39).

The necessity for Indigenous community members to share devices and connections remains prevalent today. One contributing factor is the practice of 'demand sharing', which is a cultural expectation that material items should be shared amongst family members. For example, a single mobile phone may be used by several family members. Consumer preferences for mobile phones over other devices in remote communities, is an expression of convenience, agency and group behavior, as well as information sharing and social network effects (Rennie *et al* 2016). Such preferences, however, may compound digital exclusion in various ways. For example, individuals may be limited in their capacity to tailor phone settings to their needs and interests.

More broadly, policy, regulation and market factors also impact digital connectivity and participation in remote Indigenous communities. Rennie, *et al* (2016, p. 32) argue that this has resulted from a confluence of mismatched and inadequate Indigenous and communications policy. For example, when internet connections became mainstream in the 1990s, state and national government departments began to re-design their health and social services on the assumption of universal access. This led to a wicked problem, which persists today in remote Indigenous communities (and other disadvantaged populations in Australia): those in most need of services are the most likely to be digitally excluded from accessing that support. Product offerings and pricing structures of telcos can also lead to further digital exclusion of, and in some cases predation on, vulnerable people. For example, in November 2019, Telstra apologised for its unethical practices in some NT Indigenous communities, including selling phones to people who couldn't afford them (Roberts 2019).

6.1.2 Last mile connectivity solutions

Despite the challenges to digital participation outlined above, overall, digital inclusion is improving in Indigenous communities, both urban and non-urban. However, access and affordability, particularly in remote communities, continue to pose significant challenges (Thomas *et al* 2019). Our research found that place-based solutions to address context-specific access issues are emerging. Several operators (including not-for-profits) are providing fit-for-purpose hardware, software, service plans and content for remote consumers in Northern Australia, in particular in Indigenous communities. For example, the Centre for Appropriate Technology (CfAT) (https://cfat.org.au/) based in Alice Springs provides solutions to infrastructure challenges that people face in maintaining their relationship with country. The focus is primarily: reliable power, water supply, digital connectivity, built infrastructure, training and skills development. Their telecommunications solutions include CfAT Mobile Hotspots (see Figure 18), a one-user-at-a-time facility to extend mobile coverage in fringe areas with poor coverage.

While CfAT is focused on mobile broadband and telecommunications access, Hitnet (hitnet.com.au) provides integrated digital connectivity and digital participation solutions to promote health and social inclusion in communities across Australia (see Figure 19) and parts of Asia. This is achieved through:

- **Community Hubs** – indoor and outdoor touchscreens that help people to connect, be informed and engaged with the digital economy through curated and frequently updated content.

- **Co-created Content** – working with clients and communities to co-create the content and thereby build digital skills.

- **Community WiFi** – Wi-Fi hotspots that enable mobile users to connect to the world wide web, including curated websites and apps for inexperienced users.

Figure 18: CfAT community hotspots.

Figure 19: Hitnet community hotspots.

Initiatives like these are welcome and effective for providing last mile connections to some of Northern Australia's most remote consumers, but they do not solve access issues entirely. While they help to reduce the number of consumers with 'no service' at all, these solutions often result in 'under-service'. For example, hotspots can become overloaded quickly with several people connecting simultaneously. Moreover, maintenance services are far less responsive in remote communities than in urban centres.

Furthermore, the most common way to connect to a Wi-Fi hotspot is with a mobile phone, which compounds access and affordability issues. Namely, mobile-only use has been shown to negatively impact affordability because pre-paid data plans offer far less value for money than data allocations on contracts. Reliance on mobile phones can also impede on access because mobile-only users have far less data available than fixed line customers. Finally, mobile-only use and low digital ability are inter-related because mobile devices lack some of the technical capacities of desktop or laptop computers (Rennie *et al* 2019).

'While some (Indigenous) communities have got quite good infrastructure where they're able to connect to the fibre backbone, some communities aren't able to do that. So, they're still replying on even 3G for technologies, which is really inhibiting the communities' opportunities to develop.'

– Research participant

6.1.3 Advocacy and initiatives

Digital inclusion of First Nations people has been progressed and advocated through several organisations across Northern Australia. In Northern Queensland, DHIVE (dhive.net.au) is a Cairns-based Digital Social Impact Venture that brings together Aboriginal and Torres Strait Islander people, refugees, new immigrants and people living with a disability to provide opportunities to actively participate in the digital economy. In particular, in collaboration with industry partners, DHIVE aims to train and mentor students to become employable digital technology professionals, interactive designers and digital innovators. Likewise, Ingeous Studios (ingeousstudios.com) is an Indigenous design agency based in Cairns that has actively participated in digital inclusion debates in Australia, including proposing establishment of a First Nations Technology Council of Australia.

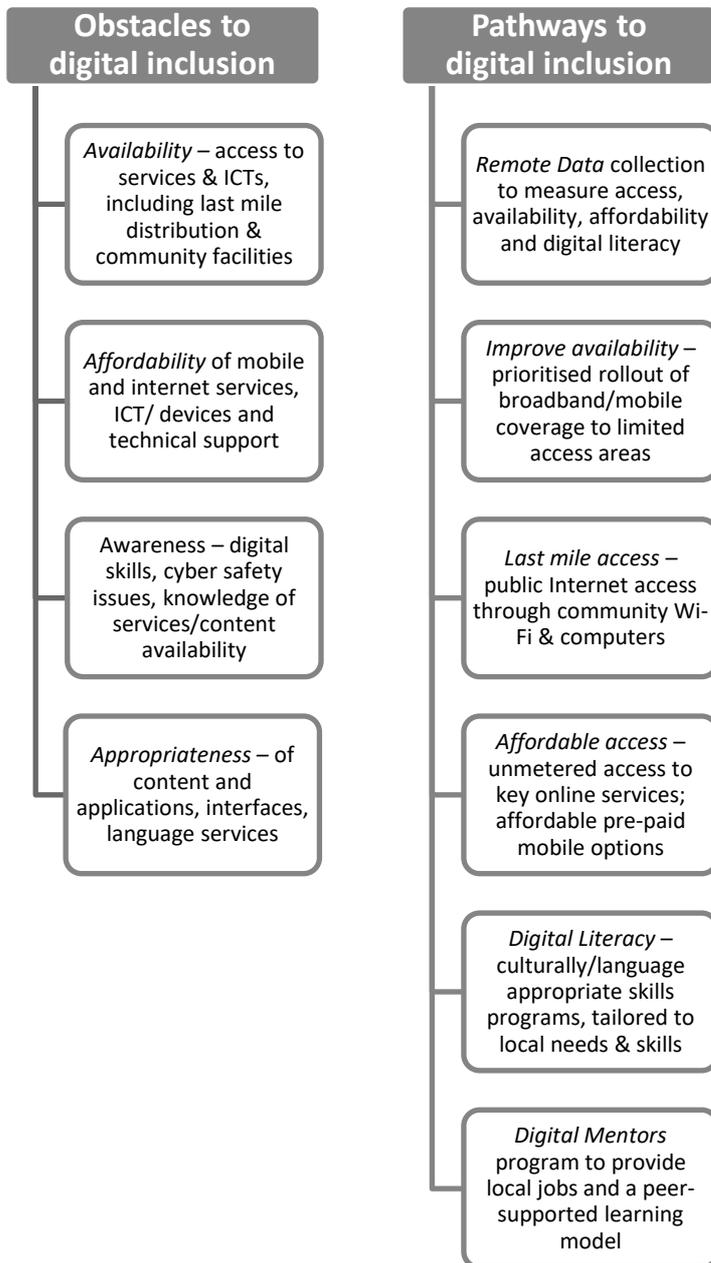| Obstacles to digital inclusion	Pathways to digital inclusion
Availability – access to services & ICTs, including last mile distribution & community facilities	*Remote Data* collection to measure access, availability, affordability and digital literacy
Affordability of mobile and internet services, ICT/ devices and technical support	*Improve availability* – prioritised rollout of broadband/mobile coverage to limited access areas
Awareness – digital skills, cyber safety issues, knowledge of services/content availability	*Last mile access* – public Internet access through community Wi-Fi & computers
Appropriateness – of content and applications, interfaces, language services	*Affordable access* – unmetered access to key online services; affordable pre-paid mobile options
	Digital Literacy – culturally/language appropriate skills programs, tailored to local needs & skills
	Digital Mentors program to provide local jobs and a peer-supported learning model

Figure 20: Obstacles and pathways to First Nations digital inclusion (First Nations Media, 2019).

One of the most enduring and influential initiatives in this area has been the Broadband for the Bush's Indigenous Focus Day: an annual gathering of remote and regional communities, industry stakeholders and government to discuss and progress the digital inclusion agenda for First Nations people. At the 2019 event in Alice Springs hosted by First Nations Media, the group produced a Policy Action Plan (First Nations Media, 2019) to reiterate calls for Indigenous Digital Inclusion to be considered a Closing the Gap target. This Plan identifies four key barriers to digital inclusion and six strategies to overcome them, as summarised in Figure 20.

Notably, these obstacles and pathways are relevant to the broader Northern Australia context. Northern Australia has unique opportunities and challenges that must be addressed in specific ways that depart from blanket national policy and programs. First Nations Media also offers helpful principles for rolling out the Policy Action Plan across Northern Australia and its diverse populations and industries. At the heart of these principles is the need for local communities and businesses to be self-determining and sustainable in the long term. This could be driven by co-creation of digital solutions in-situ, home-grown digital skills and capacity, and flexibility in delivery of services to account for different manifestations of disadvantage in rural and remote areas.

'For those communities that are challenged in terms of digital infrastructure, things like ATMs, you know, if there's a problem they can't even do business. And because so many people these days rely on credit and EFTPOS cards, and rarely carry cash, either the business can't make a sale or process a transaction or rely on IOUs with community members. So, I would imagine that business growth would be quite challenged without good digital services.

– Research participant

It is also timely and imperative to acknowledge that First Nations peoples have various conceptions of sovereignty, including Indigenous Data Sovereignty (Cunneen 2011, Kukutai & Taylor 2016). This is important to consider in the context of advocacy and Indigenous policy. For example, O'Malley and Smith (2019) consider the Darwin Smart City strategy a continuation of neocolonialism and a further exertion of power and control into their (data) sovereignty.

6.1.4 Enterprise and innovation

Indigenous enterprise is growing in Northern Australia in various sectors including agriculture, tourism and the arts. Individuals, communities, businesses and alliances are leveraging digital technology to access domestic and international markets and acquire new knowledge, skills and processes for production and delivery. For example, the North Australian Indigenous Land and Sea Management Alliance Ltd (NAILSMA) (nailsma.org.au) provides leadership in policy and planning (e.g. water), implements state and federal programs, and brokers partnerships to support innovative Indigenous enterprises. One of their digital inclusion-related, knowledge-sharing initiatives is *RangerTube* (nailsma.org.au/rangertube) a place for sharing videos about the work land and sea managers are undertaking on their country. Also, NAILSMA has an I-Tracker program, short for 'Indigenous Tracker', that supports Indigenous people to monitor, manage and research their natural and cultural resources using hand-held and smart devices.

Other digitally enabled Indigenous enterprises are occurring in the tourism and art sectors. For example, community art centres have online stores where worldwide customers can purchase artwork and merchandise, learn about culture, and donate to social projects (e.g. Yuendumu (warlu.com) and Haasts Bluff (ikuntji.com.au), which won Australia's Small Business Champion (2020). These community arts centres not only facilitate digital trade, they are essential social infrastructure in the broader digital inclusion ecosystem in Northern Australia.

As another example, the mission of Cape York Digital Network Pty Ltd is to 'provide managed information and communication technology services to communities and commercial users in the Cape York region and to support the economic, social and employment development of the Cape York region, its people and the environment' (cydn.com.au). Their services, which directly contribute to digital inclusion of Northern Queenslanders, include internet and email services, IT consulting, web hosting, videoconferencing, computer hire, and IT design, installation and maintenance (e.g. for Councils). This all-service agency is addressing deficits in access and affordability of digital technologies and provides in situ support for locals.

Finally, in the NT, inDigiMOB (2019) is an Indigenous digital mentoring project funded by Telstra. In 2016, the program has been piloted in four Alice Springs town camps (Karnte, Hidden Valley, Trucking Yards and Larapinta Valley) and several remote communities, including Yuendumu and Yuelamu. Throughout 2017, 2018 and into 2019 inDigiMOB has extended its digital inclusion program to additional remote Northern Territory communities, including East Arnhem Land and Groote Eylandt and additional town camps in Alice Springs. These placed-based, targeted digital mentoring and literacy programs are effective for imparting useful and appropriate skills to Northern Australians that work to increase digital participation. In our recommendations, we call for more funding and programs to deliver similar programs tailored to different industries, geographies and individuals.

CASE STUDY: Creative Barkly: Sustaining the arts and creative sector in remote Australia

RDA NT partnered with Griffith University, Barkly Regional Arts, and other stakeholders to deliver the Creative Barkly project. This three-year project aimed to examine how the creative industries builds and sustains regions, using the Barkly region as a case study. Taking an ecological approach, this project developed specific ways to measure to the economic and community health and well-being value of arts. The creation of a robust evidence base will directly inform future policy, investment and program development across regional Australia.

The researchers mapped the arts and creative sector ecology in the Barkly. They found that digital connectivity, technologies and media are already embedded in the social infrastructure by way of Facebook groups and online galleries. Also, arts centres in the Barkly are becoming places for digital media production (alongside media organisations as such as radio and television stations). While digital media is often created in the better-resourced populous areas, arts organisations, such as CAAMA, want to increase participation from smaller remote communities in practicing film, photography, sound recording, audio editing, social media, web design, vision mixing, live web streaming, and lighting. Common barriers include limited digital connectivity, literacy and digital ability.

Digital media facilities also play a key role in community development, local employment and digital skills transfer, which makes them critical stakeholders in the local digital inclusion ecosystem.

One of the report's key recommendations is as follows:

'Online and digital media are key areas for developing the Barkly arts ecology. Survey results indicate that remote artists are extensively using social media platforms to buy and sell arts related products and services. They are also accessing arts tutorials and mentoring online and distributing arts products such as music film clips and other promotional materials via YouTube and similar platforms.

'RECOMMENDATION: We recommend that policy makers recognise the profound role of such online activity in remote arts and creative industries and resource them accordingly.' (Bartlett *et al* 2019, p. 197).

6.1.5 Sectoral findings

1. **First Nations people are providing leadership in digital inclusion in Northern Australia.** Organisations such as First Nations Media are undertaking impactful research (ACCAN 2019b) and proposing policy that points to specific, contextually appropriate efforts that could be made to improve digital inclusion across Northern Australia, including in remote Indigenous communities.

2. **Digital inclusion efforts across Northern Australia could be more inclusive by incorporating First Nations perspectives into broader development of policy, programs and research**. Given the expansive interests First Nations people have in developing Northern Australia, and their leadership in this field, it makes sense to incorporate and privilege Indigenous perspectives at all stages of planning and implementation of development programs. Full, lively and inclusive digital, social and economic participation can only be realised if all people and groups are engaged and consulted in the process. Through this kind of consultation, we will be better able to devise

strategies and programs that address inequalities in access, affordability and digital ability in Northern Australia's disadvantaged populations.

3. **Knowledge-sharing through various forms is critical to digital inclusion in Northern Australia**. Knowldedge-sharing through oral histories and storytelling is an innate feature of Indigenous culture that could be applied, amplified and extended in various ways to promote digital inclusion in Northern Austraila. A proposal from this sector was to host regional, state and national forums (like the IFD) where people from across sectors and geographies come together and find ways to leverage and share digital technologies, knowledge and other resources.

4. **Indigenous-led enterprise could more widely leverage digital technologies.** While sectors such as art and tourism are embracing digital technologies, notwithstanding access issues, there are opportunities to substantially grow their online presence and to capitalise on interent connectivity in new ways. For example, Indigenous food businesses could create digital stories detailing the provenance of food.

6.2 Health

Developing Northern Australia is contingent on a healthy population. In this report, we take a broad view of what constitutes 'health' to include well-being and liveable communities, which are entwined with economic prosperity. For example, retaining and growing a healthy workforce makes sound business sense. Health as an industry is also imperative to economic and social development, because health and social services is one of Northern Australia's largest employment sectors. Given the digitisation of many health services and processes, it is essential to progress the health sector and digital inclusion together. While Northern Australia is already well progressed in adopting digital health, including e-health (digital health administration such as e-records) and telehealth (audio and video-based patient/clinician interactions), more could be done to ensure all stakeholders in the health services supply chains (patients/customers, clinicians, pharmacists, carers, community workers, etc.) are connected, skilled and supported to participate fully.

In 2018, the World Health Organisation (WHO) published a directions paper for the development of digital health across European national health systems. Reflecting Australian aspirations, including for Northern Australia, the paper described the digitalisation of health systems as encompassing:

> 'the establishment and ongoing maintenance of certain basic elements of infrastructure, including but not limited to hospital information systems, electronic health records and associated clinical support systems, electronic prescription and dispensing systems, telehealth and telemedicine (the provision of health care from a distance), registers and registries, mobile health, public health surveillance, and information portals for patients and health professionals. All of these elements can benefit from being linked through unique digital identifiers for citizens, health service entities and the health workforce.' (WHO 2018, p. 9).

The WHO report establishes that achieving the potential of such digitalisation is bound by organisational, socio-cultural, and legal considerations. To embed health digitalisation effectively in practice requires a policy umbrella, regulatory structures, the positive engagement of end users and those involved in delivery, and the development of new professional procedures and ethical protocols.

6.2.1 Contextual challenges

Challenges to health care provision in Northern Australia is underpinned by several factors. Statistically Australians living in rural and remote areas (such as Northern Australia) have lower life expectancy, higher rates of disease, injury and chronic conditions, alongside less access to and use of health services than those living in urbanised areas. Mental health is poorer, with suicide rates above the national average. For chronic conditions such as diabetes the death rate can be between 2.5 to 4 times the rate for urban residents. Lifestyle issues particular to remote and rural Northern Australia impact health outcomes. For instance, many high-income FIFO workers in the mining industry rated as obese and with mental health issues (WA Mental Health Commission 2018). Similar concerns are evident in low income remote Indigenous communities (Australian Institute of Health and Welfare 2018). Some mining towns like Port Hedland (WA) and Mt Isa (QLD) are impacted by ill health caused by accumulating mining dust. Road accidents mean services are required at unpredictable times and places. Extreme weather requires swift and effective health responses.

Against the backdrop of such challenges, research participants identified several challenges to digital inclusion for health provision, including digital health initiatives such as e-health and telehealth, that are specific to the Northern Australia context.

- Much health care in Northern Australia is now reliant on having access to, and the ability to use, digital technology and skills. Research has shown, for example, that 'telehealth has improved social and emotional wellbeing, clinical outcomes and access to health services for Indigenous Australians' (Caffery *et al* 2016, p. 48). Therefore, equivalent or better health outcomes can be achieved via digital health without the inevitable disruption caused by the need to travel thousands of kilometres to a regional centre or capital city.

- Digital communication over distance (e.g. between remote health clinics and centralised health departments) can be unreliable and expensive, with a lack of technical support leading to prolonged outages (and therefore risk to life and wellbeing).

- Many clinicians lack the digital ability to effectively and efficiently use digital technologies for administration and treatment. This puts a strain on human resources.

- There is a lack of robust internet connectivity in the towns and communities that house health clinics, which detracts from liveability and therefore impacting workforce retention.

- Many remote doctors are still using paper-based systems. This can be attributed (at least in part) to insufficient digital connectivity *and* the demographic characterises of remote doctors, i.e., older people (with grown-up children) who are not as technologically savvy as younger doctors.

- E-health systems rely on every person in the supply chain entering and updating information. However, with some clinicians still using paper-based systems, or being unable to proficiently use the technology, e-health data can be incomplete or compromised. Furthermore, privacy and cybersecurity concerns remain as well.

'There are lots of telehealth trials happening in our region. But, of course, it's only as good as one end. If one end is having a challenge, then the whole thing gets messed up. You've really got to have everyone in the pipeline having the same high standard of access and reliability. And we just see more and more of a push by government for telehealth, but there's huge gap in quality (of connections).'

– Research participant

6.2.2 Policy landscape

In 2008, the COAG Heath Council commissioned a Deloitte report on a National e-health strategy (Deloitte 2008). Despite being a large and successful industry, the report suggested that health was a laggard regarding information technology. Introducing digital health to remote and rural regions had an obvious financial incentive in reducing the cost of bridging distance. With regards to Northern Australia specifically, the report focused on developing the liveability of the North while doing something to address appalling health statistics among Indigenous people. There was a strong case for national policy settings to allow for interoperability between jurisdictions and between private and public sectors, with a focus on better health for individuals, using the extensive information that could flow digitally to practitioners and citizens. Since then, the policy process has been the overarching responsibility of the federal Department of Health and the Australian Digital Health Agency.

Presently at the national level, e-government (such as *MyGov*, *MyHealthRecord* and Centrelink) policy supports efficiency, economy and quality of services, including health and wellbeing (Australian Government 2019c). This centralised, 'one size fits all' model has the potential to further isolate marginalised populations from essential services such as welfare. For example, online reporting for Centrelink benefits is often not possible for many Northern Australians who lack the access and skills to successfully access online portals. At a time of increasing privatisation and outsourcing, a commitment to a national health service and improving Indigenous health, means increasing policy work to achieve digital inclusion, preferably with the involvement of both public and private operators[17].

State and Territory policy initiatives with a more local focus are also impacting on digital health. In WA, Royalties for Regions funds telehealth in regional and remote areas. Here, the policy focus is on supporting local decision-making for regional expenditure and increasing the capacity of local governments to shape healthy and liveable communities. Queensland Health has developed a wellbeing policy with an accompanying Act and Agency (see hw.qld.gov.au). This focuses on preventative health and addressing the rise of chronic conditions while prioritising regional, rural and remote areas. Finally, prior to the national rollout of the national *MyHealthRecord*, the NT Government rolled out *My eHealth* Record (NT), which continues to be maintained. More broadly, the NT's Digital Health Services works closely with its key eHealth collaboration partners, the Aboriginal Medical Services Alliance Northern Territory (AMSANT) and the Northern Territory (NT) PHN.

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*'The move to digital health is a change exercise, as well, for the community ….
Helping people to be confident in using the technology and be confident that this
is a really good alternative for some of their healthcare.'*

– Research participant

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[17] *Relatedly, cashless welfare cards and the like (digital technologies for compulsory income management) has drawn criticism in Australia (Marston et al 2020) and abroad, for several reasons including big data being used for surveillance and exploitation of disadvantaged people (Dobson 2019).*

6.2.3 Digital health programs

In this report we focus on e-health and telehealth as key instantiations of digital health in Northern Australia. See the glossary for definitions of each.

E-health

At the national level, the *MyHealthRecord* (myhealthrecord.gov.au) program was launched in February 2019 with a 90% participation rate and the involvement of 15,000 health organisations. This program has COAG support, but it is too soon to know how far all-government cooperation will go in practice. *MyHealthRecord* sits alongside the Medicare national program, which funds telehealth services according to a pre-established set of criteria. These are subject to change as the potential of e-health continues to evolve.

Queensland, the most populous region of Northern Australia, leads the way in program development. All the State's 16 Hospital and Health Services have been digitally linked and in 2019 legislation was passed to create a new Health and Wellbeing Agency (hw.qld.gov.au) to improve health and reduce health inequities across related to income, Indigeneity and remoteness. The Cairns Hospital was one of two 'exemplar' hospitals adopting advanced version of the integrated electronic medical record (ieMR) program. The Cairns and Hinterland Hospital and Health Service report significant health outcomes of this program, such as reduction in inappropriate pathology testing (Queensland Audit Offices 2018). However, the rollout of the ieMR at Cairns Hospital ($4.2 million excluding the cost of labour) was almost double the project budget.

Telehealth
Possibly out of sheer necessity to cover vast distances and service sparse populations, telehealth is well progressed in the NT and WA.

In the Northern Territory, Telstra has worked with the Territory government to provide innovative telehealth solutions across the region. Telstra has worked with NT Health and the Aboriginal Medical Services Alliance NT (AMSANT) to pilot several innovations. An independent evaluation of the Northern Territory's telehealth trial has recommended that the project continue and that the telehealth network be developed further until the services are embedded into routine practice.

In Western Australia telehealth programs immediately attracted government support because of costs in flying remote patients to Perth where most specialist services are located. The WA Department of Health (n.d.) claims that airmiles in 2012-2017 equalled two return trips to the moon. Since then accessibility to telehealth has expanded year by year in the Kimberley (45% Indigenous) and Pilbara (14% Indigenous). Telstra, Aboriginal controlled medical services, and private IT companies have been integral to this, supported by the Royalties for Regions (RFR) Telehealth Investment Fund and extensive sponsorship by mining companies.

6.2.4 Digital health supply chain

Through our desktop-based research and qualitative data collection and analysis, several areas for digital health innovations across the supply chain came to the fore.

Individuals: A key barrier to uptake of e-health, in the North and across Australia, is concerns about data privacy. Northern Australians are concerned that their personal data will be monetised and sold to (or hacked by) external parties. Research participants said that more needs to be done to educate and empower individuals to access and manage their own ehealth accounts. While *MyHealthRecord*, for example, enables users to adjust privacy settings, many Northern Australians do not know this is possible or lack the skills to make changes themselves.

Clinicians: Uptake and promotion of ehealth and telehealth in Northern Australia varies amongst clinicians and patients. While Northern-based practitioners have spearheaded digital health initiatives in Australia, some clinicians may resist such programs for various reasons. For example, GPs may resist using video consultations because of a lack of financial incentives to do so and

risks (perceived and real) in making diagnoses and prescribing treatments online. Having said that, in 2019 Medicare announced that telehealth consultations for remote Australians could be bulk billed (Hunt 2019).

Moreover, for the benefits of digital health to be fully realised, research participants said there still needs to be trusting relationships established first on face-to-face basis. Telehealth is most effective when clinicians spend time in communities first, and then provide ongoing services from afar.

Service providers: Research participants overwhelmingly said that health service providers are chronically under-resourced to provide the care necessary to Northern Australia. One issue is inability to attract and retain a robust workforce (especially in remote areas), leading to overburdening of staff and, therefore, risks to wellbeing and health outcomes. Digitally enabled solutions could significantly relieve pressure on service providers, but there are several barriers, including lack of digital knowledge and skills to implement and maintain ICT systems. Data security is also an issue for service providers. Moreover, resources such as the national Digital Health Cyber Security Centre[18] are largely out of reach for many service providers owing to unreliable access and lack of digital ability.

Industry: At the industry level, service providers often operate in silos. The state/territory-based health systems are particularly insular, which means resources and knowledge are not readily shared across Northern Australia's health sector. Research participants identified that cross-sectoral and cross-geographic partnerships are needed to overcome barriers to digital inclusion to better health outcomes in Northern Australia. For example, the Royal Flying Doctor Service recently partnered with Activ8Me to install NBN ground stations to remote airstrips frequented by the RFDS (Royal Flying Doctor Service n.d.). Strategic partnerships can also help address skill (including digital skills) shortages in health. For example, James Cook University trains GPs in Cairns and Townville and deploys them to regional service providers for their practical education.

'Whole of government is going online and it's expected that people will access services and self-help online. And that relates to having reliable internet, to be able to do that. But then, it also comes down to that socio-economic divide where if people have lesser education, have less money in their pockets to buy computers, have the opportunity to learn and get involved in the digital environment, then they're excluded from access to those service.'

– Research participant

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18 *digitalhealth.gov.au/about-the-agency/digital-health-cyber-security-centre/about*

6.2.5 Sectoral findings

1. **Quality of digital hardware, software and connections is sometimes compromised in remote areas.** Participants noted that clinicians in remote health facilities do not have the same quality of connections as their peers in more urban areas. Moreover, they sometimes work with dated or undermaintained hardware and software, because technological resources are more different to distribute and maintain in remote areas. Remote technical solutions need to be better resourced and coordinated so that ehealth and telehealth can be supported across networks and facilities.

2. **Efforts are still needed to build confidence and capability in the digital health supply chain.** At a high level, this includes 'grow our own' digitally capable health workforce (e.g. through place-based education such as JCU's medicine program). At the grassroots level, this includes listening to patients' and clinicians' ethical and security concerns, addressing their issues, and improving systems where possible.

3. **Digital health should be rolled out in stages, learning along the way.** There is scope for relatively low risk allied health services (e.g. physiotherapy, speech pathology) to take a leadership role in normalising telehealth in the broader Northern Australia health sector[19]. On the patient side, in the home context individuals and families could adopt their existing hardware (such as video for distance education) for health consultations, given that appropriate software can be installed.

4. **Stakeholders along the supply chain, particularly clinicians, require support structures and policies that enable them to safely and comfortably play their part.** For example, training and incentives for clinicians could help to keep e-records up to date, and more robust legal frameworks for GPs to confidently adopt, promote and use telehealth, could help progress digital health in Northern Australia. Moreover, education and system changes could help support individuals to have greater control over their personal data.

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[19] *We acknowledge there may be challenges to delivering these services online owing lack of tactile contact between patient and clinician.*

CASE STUDY: Telehealth a game changer in remote Aboriginal communities.

In *Telehealth a game changer: closing the gap in remote Aboriginal communities* (St Clair *et al* 2019), the authors capture some of the detail on how issues of connectivity can be successfully addressed across all three issues of access, affordability and ability case. They detail how the conscious coordination, commitment and continuity required to overcome a lack of broadband access has meant a relatively limited uptake of telehealth services in the NT, compounded in remote Aboriginal communities by affordability and ability issues.

Through collaboration between multiple organisations — Northern Institute, Aboriginal Medical Services Alliance NT, Laynhapuy Aboriginal Community Controlled Health Services (LHS), eMerge (a local information and communications technology company), Telstra Health, and Broadband for the Bush Alliance — funding was obtained from the Regional Economic Infrastructure Fund (NT Government, $407,540) to provide access to reliable broadband for three very remote Aboriginal communities.'. This funding ensured access and affordability for the first twelve months. The article is not clear on what will happen in the long-term regarding affordability for remote and rural areas.

The importance of local knowledge in interpreting messages sent digitally is highlighted where delivery is across differing social contexts including language. LHS employ a full time GP/physician delivering telehealth services from Sydney. This doctor had worked in the LHS area for two years and retains local knowledge and relationship with those living in these remote communities. This enabled effective mediation, mentorship and linkage between the wider world of telehealth services and the local community. Value is added through working with the local Aboriginal Health Workers to build capacity in both health diagnostics and digital skills while respecting local cultural protocols as to health delivery. Residents are linked to visual information on health issues as needed. Feedback from all involved has been positive across financial, technical and health providers and end users.

Our research echoed the findings and sentiment of this study. Namely, telehealth cannot completely substitute for face-to-face treatment. However, telehealth can improve continuity of care online once an initial diagnosis and patient-doctor relationships has been established. Furthermore, this case study further reinforces our call for place-based, locally led solutions for deficits in digital connectivity and skills.

6.3 Agriculture

Digital inclusion is essential for developing Northern Australia's agricultural industries and communities. The Australian National Farmers' Federation (NFF) is one of the founding organisations of the Rural, Regional and Remote Communications Coalition (RRRCC), a strong voice in the rural digital inclusion debate. In its submission to the 2018 Telecommunications Regional Review, NFF points out the social and economic imperatives for digital inclusion.

'Reliable broadband and telephone services are not only essential for survival in the Australian bush, they are also crucial to the creation of new opportunities in agriculture. State-of-the-art tools such as Big Data and fast internet greatly increase on-farm productivity by enabling farmers to digitally analyse soil moisture, meteorological records and satellite'.

(National Farmers' Federation 2018, p 5)

According to the ADII (Thomas *et al* 2019) Australian farmers score more poorly than people in other occupations in incomparable social, geographic and economic circumstances (Marshall *et al* 2020). For example, the 2017/18 data for farmers across Australia shows a low overall score of 45.4 which is significantly lower than the national score for rural Australia (52.8) and the overall Australian score (59.2). It is therefore essential that we begin to unpack the nuances of digital exclusion in agricultural Northern Australia. Traditionally, telecommunications research, policy and investment in agricultural Australia has emphasised lack of infrastructure and has paid less attention to the impacts and opportunities of digital participation. However, increasing attention is being paid to the range of digital literacies that are essential for living and working on farms. Therefore, in our review of digital inclusion in Northern Australia agriculture, we emphasise digital ability at the family, community and industry levels.

6.3.1 Farming in the digital economy

Agricultural communities in Northern Australia operate in an uncertain policy and physical environment. Several economic, social and environmental issues underpin the challenges farmers face in getting and staying connected in the rural and remote areas. Drought, fires, attraction/retention of workers, and industry regulations all put financial, physical and emotional pressure of families, businesses and communities. These challenges highlight and exacerbate the need for agricultural communities in Northern Australia to be connected to each other and the world, particularly in times of crisis. At the same time, opportunities to deliver products to the Asia-Pacific region, especially China, are ripe for development with the aid of digital technologies such as IoT and export smart contracts enabled by blockchain (Foth 2017).

CSIRO has developed a *Digital Maturity Index*, which provides a comprehensive and coherent framework for digital innovation in Australian agriculture. The five pillars of digital maturity that comprise the Index are shown in Figure 21 (Zhang *et al* n.d.). The accompanying *Digital Maturity Assessment Tool* (digital-maturity-assessment.it.csiro.au) can be completed by farm managers and decision makers so that they can gain a better understanding of their current digital maturity and areas for improvement.

Pillar	Description of the pillar	Description of a digitally transformed agribusiness
Strategy & Culture	This pillar focusses on (1) the agribusiness' priority and planning towards digitally transforming its business, and (2) the enabling environment promoted by the agribusiness and its industry.	The agribusiness places a high priority and value on digitising and automating the business. It has a clearly-defined path towards a digital future where utilising digital technologies and automating business operations is key for business growth and transformation. The agribusiness has a culture that fosters innovation and collaboration, which is strongly supported by a favourable, enabling environment from industry.
Technology	This pillar focusses on (1) communication infrastructure that supports agribusiness' data and digital technology needs, (2) in-business digital technologies that assist business operations and decision-making, and (3) new digital technologies in the market place.	The agribusiness' communication infrastructure fully supports its data and digital technology needs. Digital technologies are effective and fully utilised in the business, coupled with strong technical support. The agribusiness completely understands, and finds it easy to choose, new digital technologies that meet their needs.
Data & Analytics	This pillar focusses on (1) the collection and use of data, (2) analytical tools for supporting data-driven decision-making, and (3) data interoperability across the supply chain.	The agribusiness collects all relevant data that are of high quality. All data can be easily accessed in-business and through the supply chain. Data from multiple sources is integrated and analysed to inform decision-making, supported by decision tools and/or systems.
Capability	This pillar focuses on agribusiness' knowledge, skills and abilities in working with digital technologies and data.	The agribusiness has comprehensive knowledge, skills and abilities to fully utilise digital technologies and data for decision-making. The business knows where to source expertise and prioritises upskilling staff.
Data rules	This pillar focusses on data management and sharing to ensure the integrity and security of data.	The agribusiness has well-established systems and allocated staff to manage data. Data sharing between businesses are fully governed by agreements for appropriate use.

Figure 21: Pillars comprising an assessment of digital maturity in agriculture (Deloitte, 2018).

Our research shows that a disparity exists between large farming operations that have the knowledge, capital and resources to succeed in each pillar area, and the 'everyday farmer' who often does not. Everyday farmers are on a broad spectrum of digital engagement, from early adopters and advocates to those with low interest and ability (Marshall *et al* 2019). Research participants identified specific areas in which many farmers are lagging behind in the digital economy, such as managing and leveraging big data and adopting automation. Such innovations bring risks that are also poorly understood by many farmers nationally and internationally (Wiseman & Sanderson 2019). For example, John Deere is an industry leader in digital farming technologies such as big data collection and analysis, remote control, machine learning and automation. While farmers conveniently access these services through the *MyJohnDeere* portal, there has been controversy in the USA over end-user license agreements that have been imposed on farmers who lack the digital literacy to understand these agreements.

Other participants identified that high-tech on-farm solutions can be out of reach of everyday farmers owing to the costs, time and expertise required to choose, implement and maintain technologies such as remote sensing and IoT, drones, robotic harvesting, weighbridges, cameras/monitoring, stock tracking/virtual fencing, and remote weather monitoring. When larger operations and farming conglomerates can achieve economies of scale by rolling out such solutions across several properties, family-owned and operated farmers cannot compete. More needs to be done to educate farmer on appropriate and affordable options (see Appendix B for a decision tree tool developed by Premise). Moreover, partnerships between several farming businesses (and other local organisations, including councils) could be formed in order to put AgTech in closer reach of more farmers in Northern Australia.

'While a lot of on-farm smart stuff is happening, how we use sensors, how we use Wi-Fi networks, and so on, the reality is AgTech is getting more and more advanced. Farmers want to use the latest, smartest technology. But they also want to be connected to customers and supply chains faster than ever, and they just don't have that. So, we're actually less and less efficient and less and less competitive in the global environment if you think about those factors weighing down on business's ability to do business.'

– Research participant

6.3.2 Advocacy and initiatives

National and state advocacy groups in the agricultural sector are increasingly concerned with digital inclusion for both social and economic development. Formed in 2016, the Regional, Rural and Remote Communications Coalition (RRRCC) is a consortium of 21 organisations that has lobbied federal government for better digital connectivity in the bush. As shown in Figure 22, members are predominantly from the agricultural sector. The RRRCC (2019) believes there are five fundamental approaches required to support equitable connectivity for regional, rural and remote customers:

1. **A universal service obligation that is technologically neutral** and provides access to both voice and data connectivity to all people regardless of where they live;

2. **Customer service guarantees and reliability measures** to underpin the provision of voice and data services, to deliver the equivalent level of accountability as that which applies to services provided in metropolitan areas;

3. **Long term public funding for open access mobile** coverage expansion in regional, rural, and remote Australia;

4. **Fair and equitable access to Sky Muster** for those with a genuine need for the service, and access which reflects the health, educational, social connectivity and business needs of regional, rural and remote Australia; and

5. **Fully resourced capacity building programs** that build digital capability and development of effective problem-solving support for regional, rural and remote businesses and consumers.

On the basis of these principles, the RRRCC has made in-person representations to the federal Government, first in 2017 and again in September 2019, and has also made several submissions including to the Regional Telecommunications Review (2018), Joint Standing Committee on the National Broadband Network (2018), and Consumer Safeguards Review (2019).

Figure 22: RRRCC member organisations.

In Queensland, AgForce has been agitating for improved digital inclusion, including in Northern Queensland. In its recent high-profile 'Stand up for Queensland ag' campaign (standupforregqld.org.au), AgForce names digital inclusion as one of six key issues for Queensland farmers, along with electricity, drought, infrastructure, business closures and community services. They cite affordability as a key issue in rural Queensland and note the 'digital divide' is widening between Brisbane and the rest of the State.

Local organisations and councils are also beginning to prioritise and advocate for digital inclusion in Northern Queensland. For example, the Far North Queensland Regional Organisation of Councils (FNQROC) recently engaged Digital Economy Group Consulting (DEGC) to 'undertake independent mobile coverage testing and prepare a report to support an advocacy program aimed to target additional investment in the region and reduce the mobile Black Spots that impact the safety, welfare and economic foundations of the region' (Whereat 2019, p. 1). This data will be used to evidence the need for new interventions in the area, such as targeting Mobile Black Spot Program funding; forming partnerships with telcos (Telstra, Optus, Vodafone) to identify shared interests and goals; and fostering local skills digital capacity to future-proof solutions.

In the Northern Territory, the NT Cattleman's Association (a member of the RRRCC) has been particularly active in the digital inclusion space. It names 'Connectivity in NT' as the first of three priority issues for farmers, along with biosecurity and infrastructure (ntca.org.au/policy-and-issues). Many Association members are also represented on communications issues by the NT chapter of the Isolated Children's Parents' Association (ICPA). ICPA has a strong presence nationally, and was instrumental in NBN's release of Sky Muster Education Port which enables preschool, primary and secondary school students, who are either home schooled or who are enrolled in approved distance education schools, to access a set amount of data for education (BIRRR 2016).

Additionally, the NT Farmers' Association has contributed to the Digital Territory Action Plan (2018-2019). Specifically, the NT Farmers' Association helped collect the field data to build digital land use maps for 1.35 million square kilometres of NT land. This information assists the agricultural sector to make informed decisions about what crops to grow, where to grow them, and the availability of water, and provide critical information for biosecurity risk management and emergency disease preparedness (Northern Territory Government n.d.).

Finally, in WA the Centre for Digital Agriculture (CDA) is creating opportunities for farmers across Western Australia to lead their own on-farm experiments as part of a new big data approach to agriculture research by Curtin University and Murdoch University. The program encourages growers to alter a single aspect of their farming system – such as their fertiliser, chemical, crop variety or cultivation practice – and measure the yield response. This type of engagement, which introduces farmers incrementally to AgTech, could be applied to help progress agricultural across from the grassroots up.

6.3.3 AgTech adoption

In research commissioned by the CSIRO's 'Accelerating Precision Agriculture to Decision Agriculture' (P2D), Zhang *et al* (2017) investigated the needs and drivers for the present and future of digital agriculture in Australia. Namely, a cross-industry producer survey was undertaken in relation to *precision agriculture* (using computers and sensors to help manage in-field variability, usually in cropping) and *decision agriculture* (data-driven approaches to farm management enabled by Internet of Things (IoT), data science, cloud computing, robotics and sensors). Key findings regarding telecommunications infrastructure, on-farm data collection, and attitudes towards data of interest to the present research are as follows:

- The vast majority of respondents (94%) across all forms of agriculture had an internet connection for their business, with landline and mobile phone networks the most prevalent connection options;

- Nearly half (49%) of the respondents did not have any specific on-farm telecommunication infrastructure and had no plans to install any;

- Respondents had very limited knowledge about the options available to connect devices on their farm, with 61% of respondents reporting that they knew nothing at all or very little;

- Approximately half of the respondents (53%) relied on themselves to sort out communication needs, including choosing devices and services, and troubleshooting;

- Among livestock industries, 91% of respondents collected at least one type of data, led by financial data (79%), veterinary medicine record (63%), animal breeding data (57%), and individual animal or herd production data (56%), which were also rated amongst the most useful for on-farm decision making; and

- Respondents were more willing to share data with other farmers and research institutions and felt least comfortable sharing with technology and service providers. Furthermore, respondents were more hesitant to share information which involved their farming operations than other data such as weather and soil test data.

The present research demonstrated that these sentiments are echoed across Northern agricultural industries. In particular, we make the following observations.

- Some farmers lack knowledge and skills to research, choose and implement digital connectivity and agricultural technology options. For farmers, it can be a case of 'they don't know what they don't know', which compounds digital exclusion as the digital economy progresses without them.

- Some farmers do not see value in investing in and learning new technologies for farm management. Traditional practices have sustained their farms for many generations, and the high cost in time and money for new systems can be unattractive or overwhelming.

- Farmers are collecting increasing varieties and amounts of data on their properties. While some have the capacity to analyse and use this data to inform decision-making, many do not have the tools and expertise to leverage the data they collect to improve productivity.

- There is a sense that automation and machines will (and already are) replace many manual jobs. For example, drones are used for remote fence and stock monitor, and sensors can be used to monitor turkey nest dams and water tanks. While the time and cost savings are welcomed, digital technology could threaten traditional farming jobs.

Our consortium partner, Premise, researched case studies of successful on-farm connectivity and AgTech adoption in Northern Australia (see Appendix A for case studies and Appendix B for decision tree). Through interviews with several stakeholder groups including RSPs (e.g. Activ8Me), digital inclusion advocates (e.g. BIRRR), and end users, Premise concluded that farmers who are interested in AgTech typically want the following digital technologies: soil moisture sensors/irrigation management, walk-over weigh bridges, security/monitoring cameras, remote weather monitoring, stock tracking/virtual fencing, staff safety tracking, and communications beyond the house.

A key barrier to implementing such technologies is lack of knowledge of what infrastructure and service plans are available/required (e.g. mobile, loRaWAN/LPWAN, Fixed wireless, satellite) and who to engage to deploy and maintain the technology. Premise found a plethora of operators who specialise in on-farm digital technologies (e.g. ecosat, Farmbot, Unidata, IoTag, Observant and GoannaAg) but that these were unknown to many farmers. In response to some of these challenges, the Food Agility CRC has launched their AgTech Finder (agtechfinder.com).

CASE STUDY: Zetifi Off-Grid Connectivity

Here we feature one of the case studies undertaken by Premise in parallel with the consortium's research. Below is an abridged version of the full case study (see Appendix A).

In 2018, Zetifi (a start-up founded Dan Winson that designs systems for off-grid, regional connectivity) began developing a bespoke walk over weigh bridge solution for Bec and Jay of Mathison Station, 100km west of Katherine, NT. Bec and Jay used a satellite broadband connection and radio landline telephones, with no mobile phone service. At the time, walkover weigh bridges were then using 3G mobile telecommunications technology, which wasn't going to work on Mathison Station due to its remote location. Satellite connectivity was too expensive to implement, and radio UHF was also unsuitable.

Zetifi proposed a prototype hardware to enable multiple Wi-Fi 'bubbles' at remote locations across their property. Soon, these bubbles will be located to allow their new walkover weigh bridges, remote weather monitoring stations, and security cameras to work. The addition of the Wi-Fi bubbles will enable staff to send/receive information (including Internet, data, voice, texts) while they are out in the field rather than having to drive up to 1.5 hours to get back to the office. This will mean real-time updates for people back at the office.

With regard to the walkover weigh bridges, data can be collected on a daily basis which will enable weight gain analysis to assist with mustering decisions. This remote monitoring will also mean that Bec and Jay no longer need to add data manually, thereby saving time in travel, data collection, and data entry. There are also safety advantages to these bubbles; if there are approaching storms staff can access the Bureau of Meteorology radar, if there is smoke they can access the Northern Australia Fire Information website to see if a bushfire is nearby, and if someone is injured staff can quickly raise the alarm from a nearby bubble rather than taking valuable and sometimes critical time to travel back to the office.

This a fantastic example of a place-based infrastructure solution of the kind we advocate for in our recommendations. In the short term, these novel innovations can plug gaps in service while longer-term planning for infrastructure investment hopefully takes place at the government and industry levels.

6.3.4 Future of Northern Australia agriculture

Our research indicates that the Northern agriculture community is broadly welcoming of, and optimistic about, AgTech innovations. While many farmers understand and appreciate benefits such as increased productivity and improved land management, there are concerns at all levels about Northern Australia's capacity to develop rapidly.

At the individual level, research participants lamented the lack of interest some farmers show in participating in the digital revolution, along with a severe lack of knowledge and skills. Remote farmers in particular 'don't know what they don't know', and therefore may continue to perpetuate traditional farming practices that can be inefficient and damaging to the environment.

At the community level, we heard concerns that robots and AI will replace jobs, thereby detracting from regional population development. While repetitive, time-consuming and risky jobs (like harvesting, seeding, soil tillage crop monitoring, weed removal, pest removal and chemical treatment) will be done by machines in the future, this is an opportunity to create better jobs in the agricultural sector. As Sarah Nolet, CEO of AgThentic, suggests, 'AI will unlock potential in new areas of agriculture, and these new businesses will need employees' (Nolet 2017).

At an industry level, there is an economic imperative to evolve quickly or risk being left behind in the digital age. CSIRO's Artificial Intelligence (AI) Roadmap (2019) suggests that Natural Resources and Environment is one of three growth sectors in Australia for AI development. AI could significantly enhance natural resource management to reduce the costs and improve the productivity of agriculture, mining, fisheries, forestry and environmental management. Northern Australia has an opportunity to lead Australia in this area, but significant barriers to digital inclusion (access, affordability, digital ability) must be addressed before (or in conjunction with) the AgTech revolution.

> *'To achieve NFF's vision of a $100 billion-dollar agricultural industry, the sector deserves well- developed initiatives and reforms that will assist public policy settings in fostering growth and productivity, establishing a new market of opportunity and championing innovation and ambition. This includes adequate connectivity in order to capture the next generation of farming technology.'*
>
> *(National Farmers federation, 2018, p. 7).*

In today's fast-paced digital economy, it stands to reason that Northern agricultural industries are at risk of falling behind, and in some cases already are, owing to wide-spread lack of reliable internet access, high cost of digital devices and internet plans, and low levels of digital ability. Failing to capitalise on the opportunities afforded by digital technologies – such as achieving supply chain efficiencies, attracting and retaining skilled workers, and increasing productivity – will make it difficult for the Northern Australia agricultural sector to compete with tech-savvy operators in the national and international market. There are also opportunities for local innovation and growth in the AgTech sector, which depend on the digital expertise and skills of farmers in situ.

6.3.5 Sectoral findings

1. **Digital literacy is a key barrier**. Targeted digital ability programs need to be delivered in rural agricultural communities that meet the specific needs of households and businesses. Furthermore, in tandem with digital ability programs, digital mentors need to be recruited, developed and supported in rural and remote communities to facilitate both formal and informal learning, including one-on-one and group sessions. Importantly cross-sector sharing of digital inclusion knowledge and resources could be improved.

2. **AgTech adoption will not happen by itself**. While there have been significant developments in agricultural technologies in recent years, their uptake in Northern Australia amongst 'everyday farmers' has been stifled by a general lack of knowledge and understanding of what technologies to adopt and how. This point was reinforced by the CRCNA's beef industry situational analysis that identifies 'a need to improve translation of R&D to farm practices for most of the Northern Australia beef industry' (Chilcott *et al* forthcoming in Dale *et al* 2020, p. 12). One way to involve and educate farmers in AgTech is to recruit them to take part in on-farm research, thereby empowering them to collect and analyse their own data (e.g. Curtin University and Murdoch University's WA-based project (Curtin University 2019)).

3. **Innovation risks are real and should be actively managed.** Industry leaders and their institutions could agitate for governments and industry to develop sector-wide policy, protocols and governance arrangements for managing risks associated with big data. Wiseman & Andersen (2019) posit that large representative bodies may be best placed to coordinate such activities. Regulatory bodies (such as AMCA and the ACCC) contribute in

this area, and, as is the case in the US and NZ, voluntary agricultural data codes of practice could be developed and implemented.

4. **The agricultural industry may not be able to skill-up quickly enough**. Industry and businesses need digital skills and capacity now to capitalize on opportunities and to keep up with the rapid development of the digital economy. Digital disruption is not on the horizon, it is here. Northern Australia agriculture is not responding fast enough to develop its digital capacities to be able to take full advantage of global markets, improvements to productivity, and product diversification through technological innovations.

6.4 Sectoral priorities

The following sector-level recommendations complement, but may also stand apart from, those that comprise the pan-Northern digital inclusion roadmap.

Table 6: Sectoral priorities, pathways and impacts for digital inclusion in Northern Australia.

FIRST NATIONS[20]		
Priorities	**Pathways to delivery**	**Impact**
Infrastructure: **Scale up proven last-mile access solutions in remote communities**	• Communities (with collaborators/funding/support) to build their own last mile access infrastructure in place, and obtain technical/digital skills at the same time	• Individuals are empowered to solve own problems, are employed locally to do the manual/technical work, and learn vocational skills
Policy: **Include digital inclusion targets as part of closing the gap agenda**	• Federal/state governments to write digital inclusion into closing the gap interventions and evaluation	• Social, economic and digital inclusion are addressed to together for greater community cohesion and prosperity • More funding, initiatives and educational resources allocated to digital inclusion issues
Programs: **Devise place-based, culturally appropriate digital literacy programs and scale into remote communities across Northern Australia**	• Local/state/territory governments and community orgs to engage First Nations people programs to co-design useful digital literacy programs	• First Nations people learn relevant skills that help them to improve their social and economic circumstances through digital participation (e.g. government services, connectedness with family/culture, artistic pursuits, business prospects)
Research: **Fund research on how digital technologies can be leveraged to bolster Indigenous-led**	• CRCNA to include digital capacity building in its Indigenous-led business priority area	• Indigenous communities and businesses are connected to opportunities and efficiencies offered by the digital economy

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[20] *Research findings that inform First Nations-related priorities, pathways and impacts are in Section 6.1.5.*

Priorities	Pathways to delivery	Impact
enterprise (e.g. arts, agriculture, tourism)		

HEALTH[21]		
Priorities	**Pathways to delivery**	**Impact**
Infrastructure: **Provide up-to-date, compatible hardware and software, including training and maintenance (especially in remote areas).**	• State governments and PHNs to devise pan-Northern digital health strategy detailing initiatives, processes and evaluation.	• Northern Australia's health systems share knowledge, skills and resources, providing efficiencies and continuity of care across jurisdictions.
Policy: **Institute more robust legal, ethical and processual frameworks for digital health.**	• State/territory governments to devise and implement digital health guidelines for all supply chain workers (e.g. nurses, pharmacists, administrators) • State/territory governments to consider.	• Clinicians and others in the health supply chain are supported by policies and practices that enable them to safely and confidently practice digital health.
Programs: **Test and upscale ehealth and telehealth programs across Northern Australia through consultation and education of health workforce.**	• State/territory governments to provide general digital health literacy training to staff and provide resourcing relief when new initiatives are implemented. • PHNs to trial telehealth in allied health services that are less risky to deliver online (e.g. speech pathology)	• Northern health services and workers are better skilled, prepared and willing to embrace digital health, thereby revolutionising Northern health systems.
Research: **Fund research into Northern-specific data literacy and security issues across supply chains.**	• CRCNA to include digital capacity building in its health priority area.	• Digital health is actively integrated into overall health programs, leading to innovations and efficiencies.

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[21] *Research findings that inform Health-related priorities, pathways and impacts are in Section 6.2.5.*

AGRICULTURE[22]		
Priorities	Pathways to delivery	Impact
Infrastructure: **Get farmers reliably and affordably connected by facilitating improvements to last mile access.**	• Co-ops/partnerships of state/territory/local governments (and farmers) to co-design and implement local solutions (e.g. the Wi-Sky model)	• Northern households and businesses are sufficiently connected to participate and compete in global digital economies. • Farmers can attract and retain skilled staff by offering digital connectivity access.
Policy: **Enable and facilitate digital communications and AgTech adoption on farms by incentivising farmers and service providers to work together to solve issues.**	• Federal/state/territory governments to provide seed funding for innovative digital connectivity and AgTech programs.	• Farming communities are supported to devise and fund their own on-farm, purpose-build solutions that make sense for their households and businesses.
Programs: **Digital ability and mentoring programs that educate farmers in place (including participating in research).**	• Governments to fund community organisations – who understand contextual needs – to devise and implement digital ability and mentoring programs, including in conjunction with existing programs (e.g. add digital skills to weed management training).	• Farmers learn about technologies that will help them in life and business, rather than generic digital skills that may not be applicable to farming. • Farmers engage with, understand and address industry-specific risks and security issues related to digital technologies.
Research: **Fund research that investigates the links between everyday farmers' low levels of digital inclusion and disinclination (in numerous cases) to uptake AgTech.**	• CRCNA to invest in research that identifies opportunities for, and barriers to, digital connectivity and AgTech adoption in Northern Australia. • Involve farmers in research data collection and findings dissemination.	• Policy and programs are informed by targeted evidence that currently is missing but needed in the agricultural sector.

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[22] *Research findings that inform Agriculture-related priorities, pathways and impacts are in Section 6.3.5.*

7. Conclusion

This research has shed new light on digital inclusion in Northern Australia. A consortium of university and industry partners investigated barriers to, and opportunities for, digital access, affordability and ability across industry and community sectors in Northern Queensland, the Northern Territory and Northern Western Australia. The pan-Northern key findings, recommendations priority areas are as follows.

In the priority area of **digital connectivity infrastructure**, the findings reveal that reliable, affordable mobile and broadband services are still lacking in many areas, and that future demands on data and speed are unlikely to be met through existing networks and services (see Section 3.4, Themes 1 and 2). The consequent recommendation is to invest in both short term, last mile access solutions and long term, whole-of-region strategy to connect the North (see Section 5.2, Recommendation). **Year 1-3** priorities include privileging last mile access and designing, funding and replicating place-based, scalable infrastructure solutions (see Section 5.3, Road map priorities 1.1, 1.2, 2.1, 3.1 and 4.1). The **year 3-5** priority is a whole-of-region connectivity strategy evidenced-based and co-designed and funded by business/government, possibly in collaboration with international partners (see Section 5.3, Road map priorities 1.3 and 4.3).

In the priority area of **social infrastructure**, we found that community organisations, service providers, council libraries, etc. in the North play a crucial role of creating spaces for people to access digital technologies and learn how to use them, but many are siloed in their approach and are under-resourced (see Section 4.4, Theme 1). The consequent recommendation is to devise and implement a multi-level, cross-sectoral strategy for developing a robust digital inclusion ecosystem in Northern Australia, including means to share knowledge and resources (see Section 5.2, Recommendation 2). **Year 1-3** priorities include creating a vision for digital access, affordability and ability across Northern Australia, and a strategy to grow and strengthen the digital inclusion ecosystem (see Section 5.3, Road map priorities 2.1, 2.2 and 3.1). **Year 3-5** priories include vertically integrating digital inclusion strategy into economic and social development interventions (see Section 5.3, Road map priorities 2.3, 4.2 and 4.3).

In the priority area of **digital skills and capacity building**, the findings indicate that policy and programs need to be specifically tailored to the needs and interests of Northern communities and industries (See Section 4.4, Theme 2). The consequent recommendation is to embed digital skills development into social and economic programs, and to implement place-based digital literacy training and mentoring (see Section 5.2, Recommendation 3). The **year 1-3** priority is to understand and educate consumers about existing options for digital skill across the life course (see Section 5.3, Road map priorities 3.1, 4.1 and 4.2). The **year 3-5** priority is to develop place-based digital literacy and mentoring programs in alignment with formal and informal education programs (see Section 5.3, Road map priorities 2.3, 3.2 and 4.3).

Our five-year road map (Table 5, p. 43). captured these insights and outlined how the recommendations may be actioned, and by whom, in the areas of infrastructure, policy and programs. The role of research in realising the five-year plan includes evidencing the need for digital connectivity by investigating known gaps in knowledge, understanding the needs of different consumers by researching needs of specific sectors/groups/communities, and embedding research and evaluation into priority initiatives.

In an addendum to this pan-Northern analysis, more specific insight into the First Nations, health and agricultural sectors were provided (see Section 6.4).

With regards to **First Nations**, the research revealed that geographic, social and economic disadvantage compound digital exclusion, particularly in remote communities. Consequent priorities include: upscaling proven last mile access solutions, including digital inclusion in closing

the gap targets, devising place-based digital literacy programs, and research into digital inclusion for Indigenous-led enterprise.

With regards to **health**, the research revealed inadequate technology, limited digital skills, and insufficient policies and protocols for clinicians are undermining the progression of digital health in Northern Australia. Consequent priority areas include: updating and maintaining hardware/software and associated training, instituting more robust cross-jurisdictional legal, ethical and processual frameworks for ehealth and telehealth delivery, testing and scaling digital health programs in lower risk disciplines first, and researching Northern-specific data literacy and security issues across supply chains.

With regards to **agriculture**, the research revealed that barriers to digital inclusion are low levels of digital literacy and AgTech adoptions, risks to businesses and sectors related to big data, and little confidence that the sector can digitally upskill their workforce to survive and thrive in the digital economy. Consequent priority areas include: reliable and affordable access, collaboration between industry and service providers, digital ability and mentoring programs in place, and research to understand farmers' (lack of) digital ability and AgTech uptake.

Taken together, the pan-Northern and sectoral analyses have provided a road map for Northern Australia and three of its core sectors to bolster digital inclusion as a key pillar of the developing Northern Australia agenda.

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Appendix A – Case studies by Premise

CRCNA

Northern Australia Communications Analysis

APPENDIX A – CASE STUDIES

1. INTRODUCTION

CRCNA's Northern Australia Communications Analysis project is a collaborative project between QUT, JCU, CDU, CfAT, RDANT and Premise. The first objective for Premise in this project is to develop case studies showcasing digital connectivity for agricultural producers in Northern Australia (WA, NT and QLD – anywhere above the Tropic of Capricorn). The case studies, which we documented in collaboration with stakeholders, detail the journeys of particular Northern Australian producers. Ultimately, we want to tell positive stories for others to learn from. Each case study focuses on how an agricultural business worked with a particular provider to get appropriate connectivity for their enterprise.

Case study participants were identified through the consortium's network or independently interested parties. The list of questions, outlined below, for a phone interviews were created with input from the consortium, though tailored accordingly for each interview undertaken. The interview transcript was used to write the case study, with follow-up information requested if necessary. A draft case study was returned to the participant for confirmation of content. All requested edits were incorporated for the production of a final version.

1. What is the background of your business (ag or telco as appropriate)?

2. How did you engage with the telecommunications/connectivity company you have partnered with? How did you find out about them, start to work with them?

3. Describe what the site connectivity was like and is like now? Explain data, voice and ag tech connectivity separately. Include information on office/admin processes, mobile phone usage, staff connectivity for work and personal, education/family, health (ie skype doctor/health professional?), ag tech.

4. How do you get voice and data off site?

5. What are the positives of improved connectivity? Business? Family? Staff? Education? Etc.

6. What are some ballpark figures for the improvements made? Any monthly plan commitments?

7. Any additional future tech desires? Short and Long term?

8. Have there been missed opportunities in the past? Why?

9. Any lessons learned, or words of advice to others?

2. CASE STUDY – ACTIV8ME

DIY Plug and Play Tech

Activ8me is an Australian Internet Service Provider (ISP) with a history of developing and implementing remote, robust connectivity solutions. In 2008, Activ8me won a Federal government tender to provide communications to remote Indigenous communities, initially developing and installing a free-standing booth, providing VOIP telephone. This booth was rolled-out to 301 remote Indigenous communities across Australia. In 2014, the booth's capability was expanded to include public Wi-Fi and then, in 2016, the ability to upgrade to deliver NBN. As at writing, 84 booths have been upgraded. In addition to the free-standing booth, in 2018 Activ8me installed another of their Wi-Fi solutions at 24 remote Indigenous communities. One of the unique features of these solutions was the provision of Internet as a Pay-As-You-Go (PAYG) service, rather than a monthly plan. This allowed many people to connect to the Internet for the first time.

Active8me's ability to deliver pre-paid casual Internet access to a multitude of users was of interest to JoAnn Resing of the Queensland Government's Department of Agriculture and Fisheries (DAF). She has been a

champion of rural and regional connectivity for the past decade, is a keen innovator and digital problem-solver, and is always looking for solutions to better connect rural Australian businesses to digital opportunities to enhance lives, businesses and communities. Her project work delivers results through creative collaborative partnerships with industry, government NGOs and the commercial sector.

In 2018, Activ8me and JoAnn started a collaboration that included OBE Beef, Chappel Accounting and 10 remote properties working together to develop a business-grade Internet solution able to service the varied needs of a large, multi-person compound. This six-month project successfully developed a prototype (leveraging the technology of Activ8me's existing solutions) which was later commercialised by Activ8me. Activ8me called this innovation Business Hub; a customised smart router that receives Internet from multiple NBN Sky Muster™ dishes which is then relayed across the property as separate Wi-Fi networks, e.g., business, private (family), public, and Internet of Things (IOT). All outgoing networks are password-protected and provide the business with a closed operational network, and can provide free Guest Wi-Fi and a portal where staff or guests can buy their own data on a casual plan. The business network can be prioritised over the other networks to ensure that more important operational transactions take precedence. The Business Hub also arrives as a 'Plug and Play' kit ready for DIY installation by tech-savvy members of staff. Additional hardware can be connected to the Business Hub to increase the Wi-Fi signal zone externally and internally, use Wi-Fi Calling, and receive data from IOT and sensor equipment. The Business Hub is an affordable solution that allows agricultural businesses to confidently manage various forms of data, including business, personal, public (staff), and ag tech. It is a solution that has been well received by various businesses ranging from remote farms and roadhouses to caravan parks and motels.

The North Australian Pastoral Company (NAPCO) purchased the Business Hub for five of its properties and then rolled it out to a further four. NAPCO wanted a solution for their permanent and transient staff workforce; an Internet service that didn't interfere with their already established corporate network. Previously, NAPCO properties had no, or minimal, Internet with strongly restricted Wi-Fi access for their staff. As a result of the Business Hub, NAPCO staff have access to their own Internet plans and can easily connect with friends and family using Skype, Facebook and Wi-Fi calling. NAPCO provides their staff with an initial amount of data each month. Staff can also top up their allocation by purchasing additional data every month if they choose. NAPCO believes this has improved conditions for their staff, leading to better retention of workers.

NAPCO runs their network for education separately to take advantage of the various education packages available through NBN Sky Muster™. NAPCO also has a corporate network and utilises the Cloud and a private VPN to connect back to the Brisbane head office.

Due to the 'plug and play' capability of the Business Hub DIY kit, there is no installation cost, i.e., Activ8me's field services are not required to come to site for set-up. NAPCO used their own staff, the manual provided, and remote installation support provided by Activ8me to plug in the Business Hub and install the extended wireless hardware at the applicable buildings. Extended wireless hardware provides a 'Central Hotspot' with Wi-Fi coverage up to a radius of 150m from the hotspot. Where coverage was required over a greater distance from the 'Central Hotspot', point-to-point hardware was installed providing 'Remote Hotspots'. This was done generally to increase coverage at living quarters. The DIY kit, which includes the hardware to install the smart router and cabling, starts at approximately $3,000. Data plan expenses can range from $60 to $600 per NBN Sky Muster™ service per month and PAYG Data Pins for staff/guests range from $5 to $35.

In the future, there is potential for NAPCO to implement remote sensors in an IOT network that will improve their data collection capabilities and ensure reliable dashboard monitoring over their business network.

Activ8me and NAPCO continue to collaborate on how to utilise the Business Hub to its full capability and their future connectivity needs.

As the world becomes increasingly reliant on the Internet to both share and gather data, it is important to understand the challenges faced by those who don't live in areas where access to the Internet is taken for granted. For most businesses in this day and age, reliable access to the Internet is critical to their operations and their continued success. Equally, individuals across the world rely on the Internet for their social interactions. Activ8me's commercial solutions and their partnership with NAPCO have demonstrated that not only can connectivity issues for remote communities and properties be addressed, they can be done so affordably and relatively simply.

3. CASE STUDY - ZETIFI

Off-Grid Connectivity

Zetifi founder, Dan Winson, was working as a teacher for TAFE NSW when he recognised that the connectivity solutions available for rural Australia were inadequate. With the support of his boss at TAFE NSW, who allowed him to work a flexible schedule while developing his new technology, Dan began designing a system for off-grid, regional connectivity and, in 2017 he formed a company. Over the past couple of years, Dan has been working with producers in rural and regional Australia to build networks using off-the-shelf hardware.

The lessons learned in building these networks led to Research and Development (R&D) projects with the Department of Primary Industry and Resources Northern Territory (DPIR NT) and the invention of new, as yet unnamed, technology that Dan is now looking to commercialise. In 2019, Zetifi raised funding from angel investors and is participating in the SparkLabs Cultiv8 and Telstra muru-D accelerator programs to take help take this new technology to market.

Mathison Station is a cattle property 100km west of Katherine, NT. It is run by Bec and Jay who are currently using NBN Sky Muster™ at the house for their business and administration requirements, through a connection with the satellite earth station in Kalgoorlie. This connection can be unreliable, particularly during the wet season (due to cloud cover). They are also part of the radio telephone network which has old infrastructure which is becoming difficult to maintain. Bec and Jay purchased an additional data package for staff (Sky Muster), but apart from this they do not have any other connections, for voice or data, on their property.

In 2018, Zetifi (then called Agrinet) was undertaking research trials in the Northern Territory at Kidman Springs. Bec and Jay attended a Kidman Springs field day and saw the work Zetifi had been doing. Bec and Jay had been in previous discussion with Central Queensland University about implementing walkover weigh bridge technology on their farm. However, walkover weigh bridges were then using 3G mobile telecommunications technology, which wasn't going to work on Mathison Station due to its remote location. Satellite connectivity was too expensive to implement, and radio UHF was also unsuitable.

Since their meeting, Bec and Jay have been working with Zetifi to improve their property's connectivity using Zetifi's prototype hardware that will soon enable them to have multiple Wi-Fi 'bubbles' at remote locations across their property. These bubbles will be located to allow their new walkover weigh bridges, remote

weather monitoring stations, and security cameras to work. Staff will be told where the bubbles are during their induction.

The addition of the Wi-Fi bubbles will enable staff to send/receive information (including Internet, data, voice, texts) while they are out in the field rather than having to drive up to 1.5 hours to get back to the office. This will mean real-time updates for people back at the office. There are also safety advantages to these bubbles; if there are approaching storms staff can access the Bureau of Meteorology radar, if there is smoke they can access the Northern Australia Fire Information website to see if a bushfire is nearby, and if someone is injured staff can quickly raise the alarm from a nearby bubble rather than taking valuable and sometimes critical time to travel back to the office.

With regard to the walkover weigh bridges, data can be collected on a daily basis which will enable weight gain analysis to assist with mustering decisions. This remote monitoring will also mean that Bec and Jay no longer need to add data manually, thereby saving time in travel, data collection, and data entry.

The cost of a typical set-up with a few Wi-Fi bubbles is currently between $5,000 and $20,000 for an initial roll-out. The weather stations are approximately $2,000 each.

Looking into the future, Bec and Jay would like to add capability to the walkover weigh bridge software in relation to monitoring breeding and calving. They also intend to install a remote gate opener (for security and biosecurity issues) and invest in other labour-saving options like a drone to check fence lines.

This project has highlighted Zetifi's capability to add Wi-Fi bubbles across large and remote properties to improve connectivity and greatly improve working conditions on the site. The potential benefits of embracing Zetifi should not be underestimated. While Bec and Jay have already realised operational efficiencies and improved safety and communication on Mathison Station, they are eager to investigate new ways that Zetifi can help them to manage their property. Zetifi offers a flexible solution to increasing connectivity and improving the reliability of the connection across a remote site in a way that is affordable and can be tailored to the individual requirements of the user or the operation.

4. CASE STUDY - BIRRR

The beginnings of better bush connectivity in rural, regional and remote Australia

Kylie Stretton (Charters Towers QLD) and Kristy Sparrow (Alpha QLD) understand all too well the problems that can come from living in the digital age and not having access to reliable and affordable online services including the Internet. In 2014, frustrated with unexplained excessive usage on their mobile broadband data, they set up a Facebook group to share stories and information with other people in similar situations. Kristy struggled with educating her children through distance education and they both dealt with very limited Internet to run their businesses. The Facebook group snowballed quickly and, in a very short period, with the help of some media exposure, they gathered a community of more than 11,400 people. This was the foundation of what became an advocacy group called Better Internet for Rural, Regional and Remote Australia (BIRRR).

BIRRR now has a website that contains a wealth of information about connectivity options for people living in rural and remote areas. When Kylie and Kristy first joined forces to set up the Facebook group, they discovered that they had both had similar experiences trying to navigate through the often confusing and impenetrable information available from Internet providers and telecommunications companies. In addition, they discovered a lot of misinformation about regional connectivity and many myths surrounding what services regional users could access.

Through their work with BIRRR, Kristy and Kylie, who are assisted by many volunteers including four additional administrators located throughout regional Australia, have managed to connect with thousands of people across remote Australia who are also simply trying to access a service that most Australians take for granted. Through the Facebook group, BIRRR have run several surveys (in conjunction with James Cook University's Dr. Rachel Hay) that have given them keen insight into the Internet connection issues that are at the forefront of people in remote locations. For those in extremely remote locations, BIRRR have found that the priority is simply to have an Internet connection that works; "reliability is more important than speed".

As well as being a repository for information about the options for people in remote locations and a place where people can find explanations in clear and simple language, BIRRR is an advocate for improving the provision of connectivity to people who live in remote locations. BIRRR has made several submissions to government enquiries, including: the Regional Telecommunications Independent Review Committee (RTIRC) in 2015, the Productivity Commission Universal Service Obligation in 2017, the NBN Joint Standing Committee in 2017, the NBN Joint Standing Committee NBN Rollout in Rural, Regional and Remote Australia in 2018, RTIRC in 2018, Regional Connectivity Program in 2019, Design of Alternate Voice Trials in 2020 and Digital Tech Hub 2020. BIRRR's submissions to these committees and reviews have provided much needed data and insight into the needs of people in rural and remote communities and businesses, and ways in which these needs might be addressed in the future.

BIRRR has had an impact on the services to remote and rural Internet users. They have achieved unmetered data for education on Telstra mobile broadband services, as well as doubling the data limit and the introduction of plus plans with unmetered content on nbn Sky Muster. They are working with the NBN to be more transparent, for example, regarding non-standard fixed wireless installation, and they have negotiated escalation processes with many regional providers. BIRRR has developed a desk check process to advise regional users on their best connection options and worked hard to improve the telecommunications information that is available.

When mutual frustration brought them together and Kylie and Kristy first set up their Facebook group in 2014, their aims were fairly small; they wanted to talk to other people in similar situations and share stories and knowledge so that all could make better choices in the future regarding how they accessed communication services. Little did they know that the simple act of providing a meeting place where people could talk to each other would lead to them founding the peak advocacy group for rural and remote communication users in Australia. As the demand for assistance with rural and regional communications continues to grow, BIRRR volunteers continuously add updated information to their website to fill the knowledge vacuum and to help Australia's regional and remote population take their rightful place in the digital age.

5. CASE STUDY - NAILSMA

Remote Tracking in Northern Australia

Northern Australia covers a vast and remote area of around 3 million square metres, from Karratha in WA to Rockhampton in Queensland. More than 45% of that consists of indigenous lands. The North Australian Indigenous Land and Sea Management Alliance Ltd (NAILSMA) is an Indigenous-led, not-for-profit company operating across north Australia that works to assist Indigenous people to manage their country sustainably for future generations. The origins of NAILSMA can be traced to the early 1990s, where a growing northern Indigenous estate and population meant a change in how the north is viewed, not just by Indigenous people,

but by society at large. In 2001, NAILSMA became a member of the CRC for Tropical Savannah Management to support emerging Indigenous land and sea management efforts.

Over the past 10-15 years, NAILSMA's focus has shifted toward working closely with individual community groups or registered Aboriginal groups. These are a mix of long-standing relationships, from work in the past, to newer groups. NAILSMA is always looking to source funding to invest in the most remote areas of the north, and to create partnerships and relationships with communities or groups regardless of tenure. NAILSMA brokers partnerships with industry leaders to support innovative Indigenous enterprises by delivering hands-on workshops, tools and knowledge in remote areas. NAILSMA is a leader in finding practical solutions to support Indigenous people to manage their land and sea resources into the future.

NAILSMA works with many remote communities which, generally, do not have the same infrastructure as the more regional entities. The infrastructure these remote communities do have tends to be less robust, meaning that they constantly face issues relating to communications technology and/or connectivity. For example, after a single natural disaster such as a flood or cyclone, infrastructure in a remote community (including power and water) can be out for a month.

Internet connectivity is a huge issue for people in remote communities, including Indigenous groups. The lack of access to reliable Internet or even telephone services means that people in these communities can miss out on opportunities. As Ricky Archer, CEO of NAILSMA said, "You can be out in the bush for a week and miss the email!". Also, the group doesn't have the time, resources, or skills to manage a technologically complex solution.

One of the projects NAILSMA supported was the management of feral animals on Normanby Station, southern Cape York, Queensland. Running as a pastoral lease, Normanby Staction is a small-scale cultural tourism and environmental management group with a workforce of rangers who stay on site during the week. As part of CRCNA's Business on Country – Land Use Diversification on the Indigenous Estate project, NAILSMA partnered Normanby Station with the CSIRO to deliver technology (developed in-house by CSIRO) to collar and tag feral animals, including wild pigs and cattle, on site with the goal of using the live data to track where the animals go to enable better management decisions and track what impacts the animals are having to the site. Previously, Normanby Station, located only one hour to Cooktown, had poor connectivity access on all fronts – no internet and only half the roads from Cooktown are sealed. Because of this, all the surveying and numbering of animals was based on modelling for numbers on larger areas, sometimes using maps as old as ten years.

In order to get the project up and running, the CSIRO had to build two remote logging stations in their Townsville base. They then sent to the site a base station and placed the two remote logging stations at remote locations on the site. The base station is a radio connection (UHF/HF) and a satellite takes a ping every hour. The remote logging stations monitor the collars and tags that have been placed on the feral animals and send the data back to the base station where it can be viewed on a smart phone or tablet in real time. Rather than making decisions based on old data and assumptions, decisions can now be made in real time and based on up-to-the-minute data.

The initial roll-out of this project showed that the more things you can get up and running, the more potential there is for even more services and enhancements. Activ8me upgraded the Wi-Fi connection to provide community Wi-Fi (further information on these community Wi-Fi connections is available in Activ8me's case study in this appendix). However, as this connection only worked during daylight hours, the manager upgraded to a NBN Sky Muster™ connection so the feral animals could be tracked 24/7. This enhanced connectivity has other benefits; it no longer takes five minutes to download an email! Also, there is no longer a need to scan and fax documents as the system can better handle emailing larger files. The

improvement in connectivity had also contributed to better working conditions that improves staff retention, better roads, and more visitors who want to experience the cultural tourism offered by Normanby Station.

This initial project on Normanby Station has led to another larger-scale project which will see four indigenous organisations partnering with Australia's national science agency (CSIRO), Northern Australia's two leading universities (James Cook University and Charles Darwin University), and the global satellite company Kineis. The 3 ½ year project seeks to create a "road map" for the administration of unmanaged herds. It will develop technology and practises to efficiently handle unmanaged cattle and buffalo in Northern Australia to support economic development, landscape restoration and protection of cultural and environmental assets. Currently, indigenous communities gain little benefit from the unmanaged cattle and buffalo on their lands. Feral herds damage biodiversity, cultural assets, water resources, and ground cover. They are also expensive and difficult to manage.

The project will combine the world's largest satellite herd tracking program, unprecedented spatial data sets, innovative data-driven planning tools, and training in best-practice ethical mustering and handling methods. During the project 1000 buffalo and cattle will be tagged and tracked by satellite across some of Australia's most remote locations: the Arafura swamp catchment in Arnhem Land NT, as well as, the Upper Normanby and Archer River catchments on Cape York Peninsula QLD. A combined area of 22,314 square kilometres.

The goals of this project include:

- Foster indigenous led economic development, environmental management and education;

- Develop indigenous capability in ethical mustering and handling of feral cattle/buffalo;

- Double local participation and leadership of mustering and animal handling activities at the project sites;

- Create employment opportunities in areas with chronic under-employment, through an increase in economic opportunity; and

- Lead to a more resilient landscape that's better equipped to cope with key biodiversity threats such as fire, predation by cats on small mammals, and climate change.

Indigenous communities in Northern Australia will benefit from the project through the creation of online training with step by step instructions, tutorials and videos on the project's processes and technology. Towards the end of the project regional workshops will also be held in Arnhem Land and Cape York. Reference designs and software for the animal tracking ear tags will also be available for free under creative commons.

6. CASE STUDY - ORIGO.FARM

Murchison House Station – whole-of-station connectivity solution

Murchison House Station is one of the oldest pastoral stations in Western Australia. It is a 350,000 acre property near the town of Kalbarri, which is 650km north of Perth. The Station is used to run cattle and rangeland goats. Until March 2018, there was very limited mobile and Internet connectivity with NBN Sky Muster™ at the homestead, and nothing over most of the Station. Mobile phone signals could be picked up in only a very few spots. Data was restricted to 50GB of peak time download a month, the equivalent of one afternoon of school holiday gaming. Dropouts were frequent and tests showed that download speeds were much lower than advertised. Due to the lack of Internet connectivity between their homestead and across

their vast property, the owners of Murchison House Station partnered with Origo.farm in a project supported by Meat and Livestock Australia (MLA) aimed at rolling out a whole-of-farm digital connectivity solution in a remote location.

The project is being conducted in three phases with Phase 1 now complete. It involved evaluation of the most appropriate digital connectivity solutions to provide Internet coverage and data handling across the Station as well as developing a remote stock-water management system. The project initially planned to use Wi-Fi transmitters, but the proposed units were not suitable for the application. Therefore, a 900 MHz meshing radio system was used, which is better at covering the broken limestone landscape. Apart from Origo.farm's Intellectual Property (electronics and software), all technology used is off-the-shelf and easily sourced from local hardware and irrigation stores, or through mail order. The system has also utilised old windmill and shortwave radio system towers as repeater towers.

The system allows all tanks to be controlled with flow meters and level sensors that are connected to sensors that run 24/7, with updates each minute. Data is very precise, and graphs are easily interpreted, so that trough sensors are not required. Rather the outflows from the tank can be used to determine when livestock are drinking because water will exit the system for a certain duration/volume, and then stop. This means that, rather than station staff having to drive up to 1050 km per week in summer, to check water levels and usage, smart phone alerts will notify staff when anything drops below normal levels, significantly reducing costs of vehicle maintenance, and labour, and improving Station safety. It is estimated that savings of approximately $50,000 per year from vehicle maintenance and labour efficiencies are being achieved.

Additionally, the Murchison House Station homestead needed to be connected to fast NBN broadband. This was achieved through installation of fibre to the node (FTN) NBN to a neighbouring house 12km away in the town of Kalbarri. A private wireless local area network point-to-point signal is used to transmit to the homestead and to three base stations across the station. This is achieved by transmitting the signal to a receiving tower on the top of a hill at the Station. The signal is then transmitted down to towers at water tanks, and on to the homestead. As the homestead is located in a big hollow, only about 8m above sea level, the signal had to be sent around the hills. The result is fast broadband to the homestead as well as connectivity around the 'home paddocks'. This gives the Station owners unlimited data, and speeds are equivalent to people connected to NBN fixed-line services in Kalbarri. Because a local farm network has been created with all infrastructure located on the Station, there is no slow-down of speeds within the Station network itself; the only limiting factors for speed are the speeds of the NBN in Kalbarri. It is planned for this network to soon be expanded.

In effect, there are two different networks in place:

i) An autonomous Internet of Things (IoT) 900 MHz mesh network across the Station. This includes an IoT server on the Station so the whole IoT monitoring and control system can work, even without Internet (or so-called Cloud Systems), illustrated in the following graphic; and

ii) An Internet access network, with point-to-point links and access points.
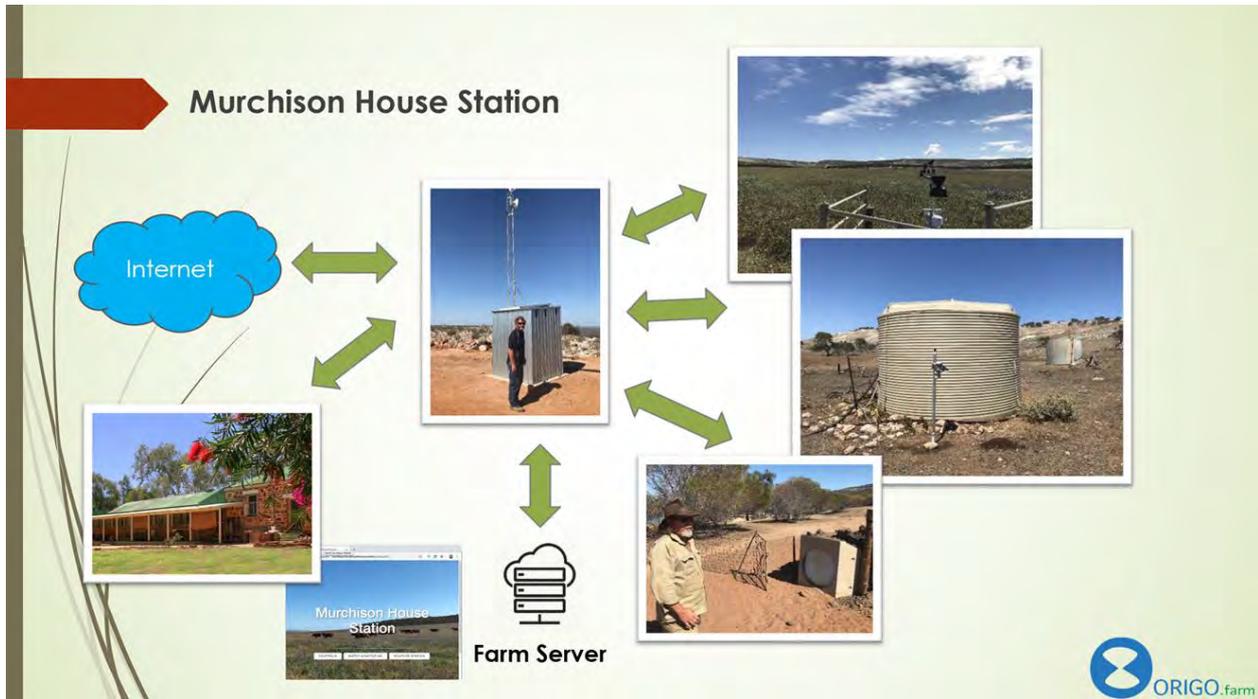
All data generated goes to the dashboard (example below) in the office in the homestead, rather than the cloud, which protects the producer's data from entering the public domain. This is an important requirement for many larger producers, who see risk in exposing their farm data because it can then be potentially interrogated. The same type of system can be set up for both extensive and intensive producers, larger or smaller scales.
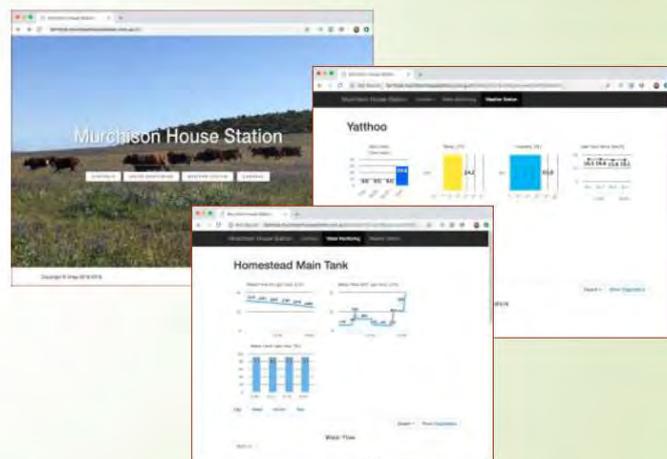
The system is independent of the major telcos and the Internet, with data running directly back to a server at the homestead. The data belongs to the owners and still works if the Telstra signal or NBN Internet goes down. The system can also be rolled out to include other remote properties.

Phase 2 of the project is currently underway and will select, install, and evaluate suitable IoT devices to leverage the benefit of whole-of-station connectivity, using the IoT 900 MHz Mesh network, and develop automated mustering technology and other features. Similar to remote water management, mustering is another area where digital connectivity would improve efficiency, safety, and cost-effectiveness of station operations. Phase 2 will therefore involve installation of remote cameras and automatic gates for monitoring and managing livestock. The furthest yards (65km from the homestead), installed with cameras, will enable monitoring of the number of goats in an area, and the same signal will be used to remotely open and shut gates, allowing more efficient targeting of musters. This will provide ongoing cost savings and mitigate costs, and potential safety risks, when light aircraft, helicopters, and motorbikes are sent to locations where there are, at that time, no goats. Future applications might extend to facial recognition technology to identify wild dogs.

The third phase is concerned with controlling irrigation; sluice gates or centre pivot irrigation will be controlled from a smart phone or tablet rather than requiring manual intervention.

Some of the major learnings so far of the project design and development are that:

1. Serviceability is crucial in harsh environments. All wires need to be inside pipes or conduits to be protected from vermin and birds, as well as sunlight.
2. The system needs to be simple and user friendly and farmers must be able to order and receive new parts for repairs and maintenance through the mail.
3. Data needs to be kept out of the public domain to protect the interests of producers and station owners.
4. Producers know what they want and need, and service providers must work with them and utilise available (mature) technology in appropriate combinations to provide solutions.
5. Long Range (LoRa) is not the only option for connectivity. Mesh networks and Telstra has just set up the largest IoT network in Australia are viable options.
6. The data requirements of producers are on par with international benchmarks for small to medium size businesses. Currently NBN Sky Muster™ allows only one to two concurrent users. Producers need the capacity for at least three to five concurrent users.

Through this project, Origo.farm has been able to conduct research and development to ensure livestock producers can use tools common in other industries, enabling producers to save on resources and time, and assisting with the creation of sustainable red meat operations for the future. The project has enabled Origo.farm to develop systems that are fit-for-purpose, rugged, and priced in such a way that the industry can take full advantage of them. The project has also provided Origo.farm with reference information for the development of further technology for the industry. The owners of Murchison House Station are already reaping the benefits of partnering with Origo.farm and are looking forward to the delivery of further functionality in the next phases of the project.

7. CONCLUSION

Connectivity options and availability for remote and regional Australian consumers has started to change. In the last few years, the options available have increased, albeit still at a cost to the consumer. Individual tech companies have developed their own tools to allow regional consumers to save on resources and time. Often systems are fit-for-purpose, rugged, and priced in such a way that the industry can take full advantage of them; generally both the tech company and client reap the benefits of partnering.

However, remote and regional Australia is still at a disadvantage to their city counterparts when it comes to connectivity. The services they require are still likely to be more complicated and expensive to acquire, set-up and continue to run. Additionally, the 'base-level' of consumer knowledge required by the remote and regional consumer needs to be of a higher standard, and usually, due to their remote and regional status, this knowledge is more difficult to access and attain (for example, phone calls and accessing web sites is difficult without connectivity, or telco businesses, ie Telstra shop front, are hours away). Right from the get-go, the process of 'getting connected' is inherently more difficult and expensive to undertake as a consumer in remote and regional Australia.

Accessible, affordable information and/or education, available in various formats, is required. As well as the provision of services which are 'fit for purpose' for remote and regional Australia to be sufficiently connected.

Appendix B – Decision Tree by Premise

CRCNA

Northern Australia Communications Analysis

APPENDIX B – DECISION TREE

Report No: CRC-0001/2003381
Rev: FINAL
14 April 2020

BACKGROUND INFORMATION

CRCNA's Northern Australia Communications Analysis project is a collaborative project between QUT, JCU, CDU, CfAT, RDANT and Premise. The second objective for Premise in this project is to develop a decision tree to assist producers in Northern Australia (WA, NT and QLD – anywhere above the Tropic of Capricorn) to assess their digital connectivity capability for themselves to identify potential AgTech solutions for their situation.

Through discussions with this project's collaborative team, it was decided that this document needs to be:

- presented in a format that can be quickly and easily perused and understood;

- easy to distribute – either a small file that can be emailed or downloaded (a 'lite' document with no moving graphics) for digital distribution, or printed and made available as a hard copy; and

- able to be easily updated with suppliers removed and added as required.

To achieve these objectives, this document only contains information pertaining to: network types, likely availability of those networks for landholders depending on their location, and AgTech suppliers categorised by connectivity availability.

To manage the size of this document, investigations were limited to supply options for water level monitoring, weather monitoring, irrigation options, security monitoring, sensor connection across a property, stock and staff movements, and walk over weighbridges.

Information relating to telecommunication companies is not included. Further information is available in many other great resources. If further technical information is desired, the recommended reading includes:

- The Better internet for Rural, Regional and Remote Australia (BIRRR) website: https://birrraus.com/;

- Agri 4.0 Connectivity at Our Fingertips (KPMG, 2019): https://assets.kpmg/content/dam/kpmg/au/pdf/2019/agri-4-0-connectivity-digital-innovation-australian-farming.pdf;

- Australian Government 2018 Regional Telecommunications Review, "Getting it Right Out There", (2018): https://www.communications.gov.au/publications/2018-regional-telecommunications-review-getting-it-right-out-there; and

- Food Agility CRC's AgTech Finder: https://agtechfinder.com/.

The decision tree is attached below and can be distributed at CRCNA's discretion.

The decision tree tool has two pages. The first page lists digital connectivity options and indicates how likely they are to be available, using a series of easy-to-understand icons, to landowners based on their location. This information is indicative only and users' should check options for their own areas/properties. The second page includes flow charts, utilising landowner 'wants' and connectivity requirements to identify potential AgTech options. The information garnered from Page 1; identification of digital connectivity availability for a location, is used to discern the AgTech options by their connectivity requirements, on Page 2.

Digital Connectivity Availability

Data Transfer Network Type	Likely Availability	Property close to or in town	Property beyond 20-50km from a small to medium town but not extremely remote	Remote property
Mobile Data transferred via the mobile phone network. This can be 3G, 4G or 5G. 4G is required for internet connection but 3G can be used for low volume data transfer.	5G is the new generation of mobile network and only available in selected cities and regional centres. 4G will be available in areas in or surrounding towns and cities. 3G coverage is likely available for many regional areas but not remote areas. This will also depend on the carrier (e.g. Telstra, Optus, Vodaphone,etc). A smartphone will indicate the mobile network (3G or 4G) that is available in your location.	🙂 (green)	😐 (yellow)	🙁 (red)
Low Powered Wide Area Network (LPWan) Data transferred via the mobile phone network. A long range (5-50km) and low frequency technology that can connect low powered and low data sensors (e.g. soil moisture probes and weather stations) to a central base station. Narrow Band IoT (NB-IOT), Lora and Sigfox are all LPWan technologies.	This can be set up on any property (unlicensed) but is available through licensed providers in some areas (e.g. Telstra, Optus, Vodaphone, etc). Contact the preferred licensed provider for details of their coverage. This coverage utilises existing mobile network infrastructure but has a longer range from the transmitter.	🙂 (green)	🙂 (green)	🙂 (green)
Fixed Wireless A direct point to point 4G signal similar to the mobile phone network but provided directly to your property receiver. This can connect houses to the NBN network up to 15 km from the transmission tower. Wi-Fi is usually available if you have Fixed Wireless.	NBN via a fixed wireless connection is likely available to properties in small towns or on the outskirts of major cities/towns. This technology is intended to provide NBN to houses within small towns. It is unlikely to be available to properties beyond the outskirts of towns. However, private relay points can be set up to extend connectivity.	🙂 (green)	🙁 (red)	🙁 (red)
Satellite Data is sent from a gateway transmitter to an orbiting satellite which relays the signal to a satellite dish installed on the property. Speeds (up to 25Mbps) are generally slower than cable and fixed wireless.	Satellite internet is available in most remote areas. Technically, if a property has access to any other NBN technology (fixed line or fixed wireless) then it is not eligible for satellite, as it is reserved for remote areas.	🙁 (red)	😐 (yellow)	🙂 (green)

> Premise

AgTech Options

Monitor water levels in troughs, tanks and dams.

What do I want to do?	What connectivity does this require?	Who can supply this?
Monitor water levels in troughs, tanks and dams.	Mobile	Observant / Unidata / Farmbot / WildEye / Goanna Ag / uSEE
	LPWan	IoTag / mOOvement / Goanna Ag / Farmbot
	UHF	Station Innovation
	Satellite	Farmbot / Station Innovation / Goanna Ag / Unidata / uSEE

Remotely monitor weather from around my property.

What do I want to do?	What connectivity does this require?	Who can supply this?
Remotely monitor weather from around my property.	Mobile	Observant / Unidata / Farmbot / WildEye / Goanna Ag / Station Innovation / Pacific Data Systems / Davis
	LPWan	Goanna Ag / Farmbot / Powertec
	UHF	Station Innovation
	Satellite	Farmbot / Station Innovation / Goanna Ag / Unidata / Pacific Data Systems

Remotely monitor and control my irrigation network.

What do I want to do?	What connectivity does this require?	Who can supply this?
Remotely monitor and control my irrigation network including soil moisture probes, water pumps, valves, sprinklers, tanks, etc.	Mobile	Observant / NetBeat / Goanna Ag / Rubicon / Edaphic Scientific
	LPWan	IoTag / mOOvement / Farmbot / Taggle / Edaphic Scientific / Goanna Ag
	Satellite	Station innovation / Goanna Ag

Monitor remote locations using real time video or regular photos.

What do I want to do?	What connectivity does this require?	Who can supply this?
Monitor remote locations using real time video or regular photos. This could be for security or infrastructure (water tanks/troughs).	Mobile	Station Innovation / Outdoor Cameras Australia / Observant / uSEE
	Satellite	uSEE

I want to connect to a range of sensors or extend internet connectivity.

What do I want to do?	What connectivity does this require?	Who can supply this?
I want to connect to a range of sensors across my property or extend internet connectivity across the property.	Mobile	Telstra / Powertec / Origo.farm / Activ8me Business Hub
	LPWan	Fleet / MarchNet / Observant / Powertec
	Wi-Fi	MarchNet / Powertec / Zetifl / Origo.farm / Activ8me Business Hub
	Satellite	Fleet / Origo.farm

I want to track stock movements.

What do I want to do?	What connectivity does this require?	Who can supply this?
I want to track stock movements across the property in real time and implement virtual fencing to control their movements.	Mobile	OneX
	LPWan	IoTag / mOOvement / Actility
	Satellite	Ceres Tag

I want to track staff locations.

What do I want to do?	What connectivity does this require?	Who can supply this?
I want to track staff locations to manage WH&S requirements.	Mobile	Station Innovation
	LPWan	IoT Store
	Satellite	SPOT / Station Innovation / UFind

I want to remotely monitor cattle weights.

What do I want to do?	What connectivity does this require?	Who can supply this?
I want to remotely monitor cattle weights using a walk over weighbridge.	Satellite	Tru-Test / eTrend Precision Pastoral

CRCNA — DEVELOPING NORTHERN AUSTRALIA

Appendix C – Consortium organisations and team members

Lead institution

The **QUT Digital Media Research Centre** (DMRC; research.qut.edu.au/dmrc) conducts world-leading research for a creative, inclusive and fair digital media environment. The DRMC's research programs address the challenges of creativity and innovation, inclusion and diversity, and trust and fairness in the constantly changing digital media landscape. The team of DMRC researchers involved with the CRCNA project are Dr Amber Marshall (Project Manager), Assoc. Prof. Michael Dezuanni (Project Leader), Prof. Jean Burgess, Prof. Marcus Foth and Assoc. Prof. Peta Mitchell.

Partner institutions

The **Cairns Institute at James Cook University** conducts research that addresses critical points of social and environmental transformation in the tropics. A key research theme is sustainable development of Northern Australia through long-term partnerships with communities, institutions and governments throughout the tropics. Our JCU team members are Prof Hurriyet Babacan and Ms Jennifer McHugh.

The **Northern Institute at Charles Darwin University** is a hub for research expertise, leadership and impact for stakeholders. It is recognised nationally and internationally as a leader in the fields of: Contemporary Indigenous Knowledge & Governance, Demography & Growth Planning, Evaluation & Knowledge Impact; and Regional, Economic & Workforce Development. We collaborated with Institute Director Prof Ruth Wallace on this project.

The **Centre for Appropriate Technology** exists to support people in regional and remote Australia in the choices they make in order to maintain their relationship with country. This is achieved by providing solutions to infrastructure challenges that people face in maintaining their relationship with country, primarily: reliable power, water supply, digital connectivity, built infrastructure, training and skills development. We collaborated with CEO Steve Rogers on this project.

Regional Development Australia Northern Territory is a local not-for-profit concerned with supporting the sustainable development of the Northern Territory. RDANT works to identify and facilitate diverse projects that contribute towards this broad objective through partnerships across three tiers of government, industry, and other not-for-profits. We collaborated with Ms Robin Gregory, Project Officer Central Australia.

Premise is a multi-disciplinary consultancy that provides tailored solutions across a number of sectors, including Urban Development, Transport, Water and Waste Water, Agriculture, Health & Education, and Energy & Resources. Their agricultural and environmental scientists and engineers provide specialist insight relating to environmental assessment and monitoring, compliance, intensive livestock industries, irrigation, land management and precision agriculture. Our Premise team members are Dr Kimberley Wockner and Mr Tim Neale.

Prof. Fran Crawford, based in Western Australia and an Adjunct Professor of Rural and Regional Social Work at the University of New England (UNE) was also a contributing team member.

Appendix D – Northern Australia geographic and demographic information

As shown in Figure 20, Northern Australia covers 40% of Australia's landmass but houses only around 6% of Australia's population. From a labour force perspective, the three employing industries in Northern Australia are health care and social assistance, retain trade and public administration (Dale *et al*, 2020). The diverse and geographically disperse industries and occupations in Northern Australia means the scope for the present research is wide and complex, which is summarised in the following demographic and economic snapshot of each of the three states in Northern Australia (Table 23).
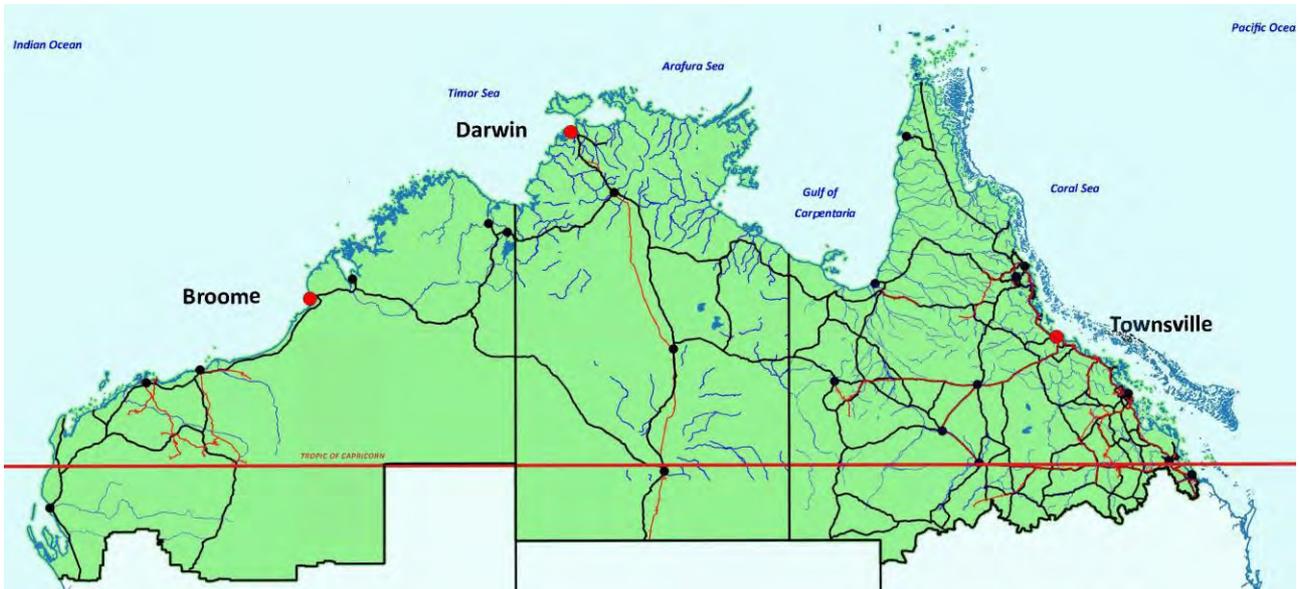
Figure 23: Map of Northern Australia as defined in the CRCNA's Commonwealth Funding Agreement (CRCNA, n.d.).

North Queensland and Far North Queensland's population is approximately 1 million (Queensland Government, 2019a), which is about 20% of Queensland's population. Key industries across these regions include agriculture and horticulture, food and agribusiness, aviation education, tourism, mining, resources and construction. All of the State's 18 discrete Indigenous communities are located in the North, mostly in the Cape and Torres Strait but as far south as Rockhampton. According to the Queensland Chief Scientist (Queensland Government 2019b), the challenges for Northern parts of Queensland include balancing agricultural interests with tourism and conservation (particularly in relation to the Great Barrier Reef), supply chain efficiencies in food production, digital disruptions (robots, big data), extreme weather resilience, and STEM education.

Northern Territory. At the 2016 Census NT's population was 228,833, with 25% of them being Indigenous people. 60% of the population live in Darwin and the majority of services are located and controlled from there, The Territory includes the both tropical Top End and the Central Australian arid zone. The largest industries by output in the NT are Public Administration and Safety, and Manufacturing, Mining, Healthcare and Construction. In its Economic Development Framework, the Northern Territory Government (2019) has identified growth sectors to be: Agribusiness, Tourism; Energy and minerals; International education and training; and Defence and defence support initiatives.

Northern Western Australia. There are two distinct regions in NWA – the Pilbara (population approx. 61,500) and the Kimberley (population approx. 36,000) which combined is approx. 3.75% of WA population. The Pilbara is the richest mining region in the nation with 82% of the value of

regional exports being generated from mining, with over 36% of the population living in Karratha. The population of the Kimberley region represents 1.4% of WA residents, and is approximately 45% Indigenous (WA Government, 2018). Ninety-seven percent of the Kimberley region is classified as very remote. The remaining 3% (Broome and Kununurra) is remote.

These areas share many challenges for social and economic development including: sparse and, in some cases, declining population; high distribution of financial and human resources; difficulty attracting large investment other than in key industries; harsh climate and remoteness from other Australian capitals; rising cost and complexity of public administration and service delivery; and boom and bust economic cycles. Despite these commonalities, each of the states/territories, and the regions within them, also have diverse challenges.

	Approx. population	Composite regions	Largest output industries	Largest employing industries
Northern Queensland	1,000,000	1. Cairns and Far North Queensland 2. Townsville and North Queensland 3. MacKay and Whitsundays 4. Central Queensland, (including Rockhampton and Gladstone) 5. Central West (including Mt Isa)	• Mining • Manufacturing Construction	• Health Care & Social Assistance • Retail Trade • Education & Training
Northern Territory	250,000	1. Top End (Darwin as service centre 2. Central Australia (Alice Springs as major service centre)	• Mining • Construction • Public Administration & Safety	• Public Administration & Safety • Health Care & Social Assistance • Education & Training
Northern WA	100,000	1. Pilbara (Karratha as service centre) 2. Kimberley (Kununurra and Broome as service centres)	• Mining • Construction • Rental, Hiring & Real Estate	• Mining • Construction • Accommodation & Food

Figure 24: Snapshot of Northern Australia (Source: Remplan Economic Profiles (https://app.remplan)).

Appendix E – Review of regional development policy relevant to digital inclusion.

Policy document	Summary	Implications for Northern Australia
***Regional Telecommunications Review* (2018) by Regional Telecommunications Independent Review Committee, Australian Government, Dept of Regional Services, Sport, Local Government and Decentralisation.**	Key findings: • The higher proportion of low-income households in regional and remote Australia makes digital affordability a key barrier to digital inclusion; • Governments and industry must reduce barriers to people engaging with essential services online, including un-metering data for access to government sites; and • There is a crisis of confidence when it comes to using and understanding digital technology, namely people often lack the knowledge or experience of how to use different technology, what it can be used for, and how to troubleshoot issues. Relevant recommendations • Developing an online technology 'hub' to provide independent and factual information to help support people to build up the skills to solve telecommunications issues; • Deploying technical advisers on a short-term basis across regional, rural and remote Australia to provide on-the-ground support to help people get connected and stay connected, using technologies that are suitable to their individual needs; and • Encouraging the agriculture sector to provide industry-specific advice about the Internet of Things and other digital applications that will drive productivity gains in the sector.	• The large majority of Northern Australia is comprised of rural and remote areas, whose residents experience comparatively less reliable and affordable telecommunications and internet services (several telcos and NBN fixed line services). Consumers who live on the fringes of urban areas are under-serviced. • The 'crisis of confidence' in using and understanding digital technology is far less pronounced in Northern Australia's regional cities such as Cairns and Townsville. As some of the first sites in Australia to receive NBN, these cities foster innovation and entrepreneurialism (e.g. in 2015, the start-up density in Cairns was greater than the Gold Coast). • Establishing a technology hub and short-term service providers in Northern Australia may fill a critical skills shortage on the short term but will not build capacity for the long term.

Regions at the Ready (2018) by Australian Government, House of Representatives Select Committee on Regional Development and Decentralisation.	**Principles (3 of 12) proposed for building and sustaining regional Australia** • **Regional Australia requires a long term, flexible strategy and commitment to meet the needs of a modern, globally connected and changing environment.** • **All Australians should have access to reasonable services including health, education, transport and connectivity.** • **• The Commonwealth Government has an obligation to create conditions for the private sector to thrive and to invest in regional Australia, including the provision of enabling infrastructure.**	• **In relation to digital inclusion in Northern Australia , this means future-proofing industry by pre-empting the digital infrastructure that will be required into the future (which NBN Sky Muster satellite will not deliver), enabling economic diversification (beyond mining and agriculture), and upskilling people in the regions to be ready for digital jobs** • **If Australia plans to be a top 3 nation for digital government by 2025 (REF), a cohesive plan for onboarding and supporting Northern Australia residents to access and use digital services is needed, particularly in remote and Indigenous communities.** • **• To date, there is no plan for bolstering competition in Northern Australia telecommunications market.**
Australia's Tech Future (2018a) by Australian Government, Dept of Industry, Innovation & Science.	Australia can maximise opportunities of technological change in four categories: people, services, digital assets, and the enabling environment. In relation to digital inclusion, areas of particular interest include: • A strong emphasis on digital skills development so that individuals and businesses can thrive into the future; • A commitment to inclusion of all Australians in the digital economy, including disadvantaged and underrepresented groups; • A vision for Australians to have world-class digital infrastructure in their personal and working lives; and • • Encouragement of Australians, businesses and governments to use high-quality, well-managed data to help deliver economic and social benefits	• Some wealthier cities and towns in Northern Australia are investing in economic diversification and 'growing their own' skilled workforce. For example, The Pilbara Universities Centre in Karratha and Port Hedland continues to gain momentum a catalyst for innovation and skills development in the region. • Owing to a lack of fundamental digital connectivity infrastructure, and a lack of vision to build it, Northern Australia governments and businesses are self-funding 'piecemeal' solutions for their local purposes.
Australian Infrastructure Audit (2019a) by Australian Government, Infrastructure Australia.	The 2019Audit includes a chapter on Telecommunications and a specific section on social inclusion and affordability for telecommunications services. Chapter 8 cites four key telecommunications challenges: • Innovation enabling productivity • Challenges for mobile service provision • Innovation enabling productivity • Maximising the benefits for nbn investment	The document itself alludes to ways that existing telecommunications infrastructure is assisting Northern Australia's economic social progress, and areas for improvement: • Significant investment is occurring in the telecommunications sector, responding to growth in demand for data-driven services and new uses for telecommunications. • Generally, consumers are positive about quality and access to networks but are concerned about paying more.

	• Accessibility and connectivity for users	• There are opportunities to improve the telecommunications services for the digitally disadvantaged, and for rural and remote • communities and businesses. • The specific needs of rural and remote users are often overlooked in upgrades to national telecommunications infrastructure.
***Telecommunication Reform Package** (2019b) Australian Government, Department of Communication.*	This package of reforms includes the following: 1. Statutory Infrastructure Provider (SIP) obligations ensure that all Australian premises are able to access superfast broadband services (25 Mbps or better), and make NBN Co the default 'infrastructure provider of last resort'. 2. The Regional Broadband Scheme (RBS) ensures there are long-term sustainable funding arrangements in place to provide broadband services to Australians in regional and remote areas. This will be funded by NBN (95%) and comparable non-NBN providers (5%). 3. New wholesale and retail rules will create a fair baseline and heightened competition by stipulating that, from 1 July 2018, new networks will still need to be wholesale-only.	While these are welcome reforms, their impact is largely yet to be determined in Northern Australia and other parts of regional Australia. This will become clearer with the NBN rollout is competed in 2020 and we see how market operators and consumers (individual and business) respond to the new conditions.

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www.crcna.com.au

HEAD OFFICE – TOWNSVILLE
(07) 4401 5035 | enquiry@crcna.com.au

QUEENSLAND
qldmanager@crcna.com.au

WESTERN AUSTRALIA
wamanager@crcna.com.au

NORTHERN TERRITORY
ntmanager@crcna.com.au