Low Earth Orbit Satellite Working Group—2023 Chair's Report

February 2024

On 21 October 2022, as Minister for Communications, you established the Low Earth Orbit Satellite (LEOSat) Working Group (Working Group). Its terms of reference are at **Attachment A**, and its aim was to 'help inform Government about how this emerging capability might play a role in future telecommunications policy'. The Working Group was also asked to help to make sure Australia is able to capture the benefits of this technology as early as possible. The Working Group consists of industry, government and First Nations representatives, and other organisations are invited to meetings as required.

Four meetings of the Working Group were held in 2023, and this report consists of my reflections as Chair of the discussions and contains recommendations for your consideration, including the future of the Working Group. Members of the Working Group have been consulted in its preparation.

LEOSat constellations are distinct from satellites in other orbits in that they are significantly closer to the Earth, allowing for lower latency transmissions and less signal propagation loss. These factors have allowed consumers to access broadband services which are more comparable on many key metrics to services supplied over fibre optic and other fixed networks. Owing to the global nature of most LEOSat constellations, coverage can be ubiquitous.

There is significant innovation occurring in the field of LEOSats. Rapid developments in the market are bringing choice and a step change in broadband capability to businesses and households in regional and rural Australia. In addition, the capability for satellites to connect directly to mobile handsets (direct-to-device or D2D capability) is developing.

Developments in mobile standards, such as 3GPP releases 17 and 18, supporting Non-Terrestrial mobile Networks (NTN) also have positive implications for regional, rural and remote communications in Australia. Devices are already available in Australia supporting basic messaging services but further enhancement of LEO-enabled networks is likely to support greater capabilities, such as voice, data and video, in coming years.

Richard Windeyer
Chair, LEOSat Working Group

Overview and recommendations

I am pleased to report that these meetings have seen representatives from an emerging and competitive sector come together in a positive spirit to consider how to deliver a better telecommunications outcome for the Australian public. Members of this Working Group continue to be willing to engage with government to help to design and deliver future programs and initiatives where appropriate. A summary of the types of services offered by Working Group Members is at **Attachment B**.

Below are the recommendations of the Working Group, followed by a summary of the discussions from each of the four Working Group meetings to expand on the recommendations, and the expert advice received. Each discussion summary is presented in the context of that meeting. If at times statements captured appear to be contrary to similar statements at earlier meetings, it is important to remember the context and evolving nature of the conversation across the Working Group meetings.

The Working Group has held four meetings discussing the issues noted below, and there is clearly further work to be done as we consider the opportunities and challenges of this emerging technology. I recommend that the Working Group continue into 2024 with a re-evaluation at the end of the year. While the Working Group may not have the same regular cadence of meetings as it did in 2023, it would be useful to have the Working Group on hand as a sounding board to provide input and consider issues as they arise. This could be in the format of ad-hoc meetings or consideration of items out of session.

Recommendations

1. Digital inclusion and Closing the Gap Target 17

Recommendation 1.1: Trial LEOSats in First Nations communities.

Recommendation 1.2: Identify and remove barriers to providing prepaid satellite internet services to consumers.

2. Universal services

Recommendation 2.1: Consider the role of LEOSats when reviewing the universal service framework.

3. Direct-to-device

Recommendation 3.1: Monitor developments in the D2D market for regulatory and policy implications.

4. Resilience and redundancy in emergencies

Recommendation 4.1: Ensure suitability of regulatory settings to support use of LEOSats in emergency communications.

5. Business and economic benefit

Recommendation 5.1: Monitor industry developments to ensure regulatory and policy settings are fit for purpose for the adoption of new technologies.

Discussion themes

1. The potential role of LEOSats in Digital Inclusion and Closing the Gap Target 17

A lack of digital inclusion, in particular access to online support for health, housing, education and other essential services, is considered a key barrier for First Nations people to be able make informed decisions for themselves and their families. Having access to information and enabling services through connectivity will assist First Nations people in achieving equal levels of digital inclusion and assist the Australian Government in achieving Closing the Gap outcomes. LEOSats have the potential to address digital inclusion priorities through the provision of high-quality internet services.

Expert presentations

- First Nations Digital Inclusion Advisory Group (FNDIAG)

Issues identified by the Working Group

Connectivity initiatives

The FNDIAG presented a proposal for a trial of LEOSat services for regional First Nations communities. Industry was supportive of this proposal and expressed interest in participating. Participants that are not yet established in the Australian market noted that waiting until they can participate may lead to better outcomes and better capture a picture of a more mature LEOSat connectivity market. The FNDIAG Initial Report has more detail on this proposal.[1]

Reflecting on a comment that terrestrial technologies such as WiFi 6 and 7 as well as mobile networks can be used to reticulate connectivity in regional hubs and remote towns, a participant noted that for some Australian communities, reticulating mobile signals via satellite backhaul generally has better performance compared to reticulating WiFi signals via satellite backhaul, due to the different characteristics of the two technologies (WiFi vs mobile). WiFi generally has a smaller coverage footprint than mobile. This is based on analysis the participant had done for remote Australian populations with the NT government. The greater dispersion of Australian remote populations (vs other examples such as Mexico and Brazil where they are quite densely grouped) lent itself more towards a mobile solution vs a WiFi solution (both via satellite backhaul) due to the coverage footprint differences

Participants noted the process of scoping and determining how a community service trial will work may be complex and there may be many moving parts which will need to be considered. A participant noted there will be questions as to the service integrator, how to go to market and how to engage with the average customer.

Providers also noted they are global entities that undertake work to address digital inclusion in a range of countries and expressed interest in participating in Australian programs.

Ecosystem of technologies

The Communications Alliance provided an outline of the ecosystem of technologies with the capacity to address Closing the Gap Target 17 and more generally, to close the digital divide, noting that the overall aim is to provide people (particularly from First Nations) living in regional, rural and remote communities with access to similar connectivity as their urban counterparts. Communications Alliance noted the capacity to achieve this outcome exists and is expected to improve.

The presentation covered geostationary (GEO) and non-geostationary mobile and fixed satellite services including 3GPP and proprietary narrow band services, non-terrestrial mobile networks and broadband internet services. Communications Alliance explained these technologies can work together with terrestrial technologies such as WiFi and terrestrial mobile networks. The presenter also noted that

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[1] [First Nations Digital Inclusion Advisory Group Initial Report.](#)

across different geographies, population densities and use cases, these technologies form a greater ecosystem and complement one another. Communications Alliance advised that the main focus should be on how to deliver services to users wherever they are across Australia, rather than on particular technologies. The presenter also noted that some technologies that may have been discounted in recent years, have also seen technological enhancements and remain valuable options to address certain needs. See **Attachment C** on technology options.

Challenges that LEOs can address and benefits over traditional non-terrestrial services

LEOSats enjoy several key technical advantages over other technologies which allow them to address challenges in the Australian regional telecommunications market. They are closer to the Earth's surface and can therefore maintain connections using less powerful ground equipment, they also introduce relatively less end to end latency when compared to GEOs and medium earth orbiting satellites (MEOs), making several use cases more viable. Additionally, because individual LEOSats service smaller areas and there are many of them, the throughput available to each user can be significantly higher and the network less likely to suffer from congestion compared to a GEO communications satellite. LEOSat global network capacity can also be increased by adding additional satellites. In contrast, newer GEO satellites can dynamically reassign their capacity, but remain limited in terms of total output.

Reliance on software-controlled electronically steered phased-array antennae instead of more traditional manually configured parabolic dishes has also meant that installation, reconfiguration and translocation of LEOSat ground terminals is substantially more convenient for consumers. A LEOSat connection can be established quickly as the relatively lightweight equipment can be delivered to a location with a power supply and reasonably unobstructed view of the sky. It is now largely possible to maintain a broadband internet connection from a moving vehicle with a roof-mounted dish, almost anywhere in Australia provided an uninterrupted view of the sky is maintained. It should be noted that the component cost of a phased array antenna tends to be higher than that of a parabolic dish, this may impact their suitability in some applications.

LEOSats can address deployment scenarios beyond the fixed line and potentially also the fixed wireless network footprint where these properties are advantageous, this includes:

- consumer or business connectivity where latency or congestion are a concern
- customers in regions where in-person technical support is problematic
- customers who need to be able to relocate their terminal (such as to different locations on the same property or between several properties) and
- customers who need transportable broadband connectivity, such as police or travellers in regional areas.

Economic barriers to adoption of LEO services

Working Group members identified affordability and availability as potential barriers to disadvantaged consumers accessing LEOSat services. In part, these barriers may be addressed through the continuing densification of existing networks and the entry of new participants into the market. Competition with existing connectivity technologies such as NBN Co Sky Muster, the expansion of fixed wireless broadband networks and mobile network fixed wireless should create downward pressure on prices. It is possible however that in the short-to-medium term, and potentially the long term, disadvantaged consumers (particularly First Nations communities) may find LEOSat connectivity unaffordable.

The initial deployment cost of terrestrial infrastructure and the cost to establish mobile network towers in remote locations may reduce somewhat due to the emergence of LEOSat mobile backhaul. This may alleviate affordability and availability for remote consumers as mobile and fixed wireless plans tend to be significantly more affordable than current LEOSat broadband plans. However, the emergence of LEOSat capability may also chill investment in regional mobile tower infrastructure.

It is possible that some markets will continue to remain too thin for such deployments to be commercially viable and in this instance government programs such as the Mobile Black Spot Program (MBSP) and Regional Connectivity Program (RCP) will continue to play an important role. The Working Group noted the importance of ensuring these programs contemplate LEOSat technologies within the range of technology options to ensure a solution is fit for purpose. One participant noted that it has not put forward any LEO proposals in recent rounds of the Regional Connectivity Program because of the minimum operational period of 7 years (10 years in the Mobile Black Spot Program). LEO services are typically sold on a maximum contract term of just 3 years, making this minimum operational period prohibitive to LEO proposals. Historically, proposals funded under the RCP are high capital expenditure (CAPEX), low operational expenditure (OPEX) (i.e. mobile and fixed wireless towers), however LEO installations are likely to be low CAPEX, high OPEX investments (the antennas are cheap -the monthly access fees are more expensive). The participant noted that 'a few small changes to the RCP guidelines could make a big difference to promoting LEO proposals'.

Rain-fade

Propagation loss during rain events, known as rain-fade, can be an issue for some satellites, although industry advised the Working Group it is expected to be less of a factor for LEO. The propagation distance is less (and hence the signal is stronger) and with LEOSat capabilites there are often multiple satellite options in different parts of the sky at any point in time, providing some redundancy around such fade issues. Consumer groups are however concerned that there is limited data on the extent to which LEOs are impacted by rain-fade, and that this needs to be better understood. It was noted that terrestrial services are not immune from disruption due to rain-related flooding events. They argued that acceptable reliability should be established through trials before LEOSats are considered an appropriate replacement for existing technologies, particularly those used for delivering universal voice services. Industry noted that the science of rain-fade is well understood and can be accounted for in the selection of service operating frequency, design of systems and equipment. They noted there are many variables relevant to the issue, including location of services (including type of rainfall experienced), design of networks, spectrum being accessed and equipment being utilised but that ultimately, they are confident of the capability of services, even in heavy rainfall areas.

An idea raised during discussions was whether it would be appropriate to subsidise the cost of more powerful antenna in particularly affected regions, and to provide guidance to consumers in these regions about the limitations of the technology.

The technology mix in areas of disadvantage

The Working Group noted that disadvantaged Australians, particularly in First Nations communities, often rely on WiFi hotspots (such as those hosted by local councils) and pre-paid mobile phone plans for connectivity, rather than fixed residential connections or post-paid mobile phone plans that are more typical in the general population. This is likely due to income uncertainty but can lead to these communities or individuals having to pay a premium for connectivity. Such individuals would likely not benefit from a connectivity program that assumes beneficiaries subscribe to ongoing plans, have fixed connections or an ongoing relationship with their connectivity provider. They may also not benefit from a proliferation of LEOSat broadband plans as they may remain too expensive despite competition with terrestrial based connectivity options, and not align with their connectivity needs. Aggregating demand and providing connectivity through subsidised gateways such as WiFi hotspots or 4G and 5G private networks is one mooted solution to this issue.

Diversity of communities and connectivity needs

It is a challenge to determine what solutions are needed for particular communities owing to the diversity of communities and the mix of needs. The Working Group identified community size and density, cultural issues, and community location as factors which contribute to this challenge and affect the type of solutions which are suitable and viable. The location of a community in terms of region and remoteness

will affect which type of technology is technically viable in terms of its physical strengths and weaknesses (e.g. rain-fade, power requirements) and deployment practicality (e.g. highly technical with maintenance required or turnkey and reliable) will impose restrictions on where the solution can be deployed. These factors may not be obvious to an outsider and the Working Group identified a need for quality consultation with communities and advised against a one size fits all solution. This issue is explored in **Attachment C**.

Connectivity literacy

Connectivity literacy can be defined as the understanding of connectivity options and how to engage with them. People with poor connectivity literacy may struggle to make informed choices as to which solutions will most efficiently address their needs.

Having low connectivity literacy can result in people persisting with overly expensive, poor, or no connectivity despite reasonable options existing. Additionally, improvements in connectivity options can have little or no effect where consumers are either unaware of the option and or are not enabled to learn about them. It is therefore important to educate people with poor connectivity literacy about their connectivity options and to make this information more accessible to relevant cohorts, such as by making it more available in non-digital media.

Technology mix

Members of the Working Group noted there may be a role for GEO and MEO based technologies in improving connectivity outcomes. While LEOSat technology has garnered the most attention recently, technology continues to improve in other orbits and different orbits can complement one another. One participant noted that operators are working on solutions that use GEO/MEO satellites in conjunction with LEO satellites, providing the example of the 'SES Cruise mPOWERED + Starlink' offering.[2] Each orbit has its own benefits and weaknesses, with the most prominently discussed strengths of LEOSats being relatively low latency and high throughput. Despite these advantages there are applications where latency is of little importance, and GEO/MEO satellites with significantly higher throughput are now being deployed.

Recommendation

1.1 Trial LEOSats in First Nations communities

The Government should consider LEOSats as a potential communications solution for First Nations communities. Noting the work and recommendations of the FNDIAG:

- A trial of LEOSat broadband connectivity may be appropriate, including non-LEO satellite solutions that may include aggregating demand and providing connectivity through subsidised gateways such as WiFi hotspots or 4G and 5G private networks.
- Close consultation with First Nations communities would be required.
- Consideration could be given to the power requirements of antennae, given potential rain fade and other issues.

1.2 Identify and remove barriers to providing prepaid satellite internet services to consumers

The Government and communications market participants, including service providers, retailers and satellite/LEOSat operators, should consider how prepaid internet services can be offered to consumers.

Barriers to offering pre-paid services should be identified and recommendations provided to DITRDCA.

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[2] The SES Cruise mPOWERED + Starlink offering is a manages service that integrates the SES Medium Earth Orbit and Starlink LEO constellations to provide up to 3Gbps per ship to cruise ships.

2. The potential role of LEOSats in delivering universal telecommunications services

Much of the current focus on the use of LEOSats emphasises the improvements this could bring to regional, rural and remote areas by providing access to low latency fixed broadband internet services, and potentially also supporting fixed voice services.

To date, the rollout of terrestrial mobile services has been subject to commercial decisions of mobile carriers, but with targeted government co-investment to encourage further deployment into less densely populated areas that are otherwise uncommercial. While mobile services are available to around 99.5% of the population, terrestrial mobile services cannot be accessed in all cases, as they provide coverage to around a third of the Australian landmass. However, there is the potential for LEOSat services in coming years to deliver connectivity that is sufficient to support direct-to-device functionality and allow customers to send messages, make voice calls or access data using existing or newer smartphones. The promise of LEOs is that they could ultimately help support higher quality fixed and mobile telecommunications services in more remote areas that have traditionally been extremely high cost to serve.

Additional invitees

- Australian Communications Consumer Advocacy Network (ACCAN)
- Better Internet for Regional and Remote Australians (BIRRR)
- National Farmers' Federation (NFF)

Expert presentations

- Department of Infrastructure, Transport, Regional Development and Communications, Universal Services Branch

Issues Identified by the Working Group

Balancing an outcome-based approach with technology trade offs

There was discussion around focusing on outcomes for consumers, rather than prescribing technology or metrics. Members of the Working Group noted there may be some trade-offs associated with using LEOSats to provide universal service to regional, rural, and remote Australians due to the different technological benefits and limitations, but there was scope that overall service could be improved. In particular, a participant noted the availability metric for LEOSat services may be slightly lower than copper (mostly due to rain fade) but that all other metrics would be improved and the difference in availability would be negligible.

A conflicting view expressed was reticence to sacrifice service availability or reliability as service continuity could be critical at any moment and that these times are likely to overlap with service interruptions in the event of adverse environmental conditions.

It was also noted that the improved service quality associated with LEOSats had supported consumers to take advantage of digital technologies that rely on connectivity, such as smart farming systems and that these consumers had a clear preference for LEOSat technology over legacy copper.

There is a balance to be achieved between these priorities, however, this is beyond the remit of the Working Group and is being further considered through consultation on a modernised universal service framework, and associated trials of alternative networks.

Challenge of rain fade

Rain fade (discussed above) was also raised by consumer groups in the context of universal services.

NBN Unlimited trial

The expansion of the NBN Co fixed wireless footprint through radio equipment upgrades and the entry of Starlink into the regional connectivity market is relieving capacity on the Sky Muster satellites, allowing NBN Co (at the time of the meeting in late July 2023) to trial unmetered connections for a large cohort of NBN Sky Muster Plus customers. Consumer groups also noted that the NBN unlimited trial was producing positive results, referring to the lived experience of their membership. The trial was subsequently expanded to a larger trial cohort and then to all Sky Muster plus plans.

Framing the issues around regional connectivity

The Working Group discussed the risk of having negative impacts on connectivity perceptions due to underplaying the quality of available connectivity options in regional, rural and remote Australia. Participants advised that communications around regional connectivity should be framed carefully to focus on realising opportunities for improvement, rather than on problems. Otherwise regional communities may be unintentionally portrayed as being less-desirable places to live and work than they actually are. Participants noted that connectivity options are reasonably available throughout Australia, including relatively fast connections for customers in more remote locations provided they are willing and able to pay a premium for access.

Recommendation

2.1 Consider the role of LEOSats when reviewing the universal service framework

As the Government considers a modern universal service framework, consideration should be given to the future role of LEOSats. The inclusion of LEOSats should only follow extensive testing of their suitability.

3. The potential role of LEOSats in delivering direct-to-device connectivity

Direct-to-device (D2D) capability continues to develop. The Working Group heard about commercial offerings and some of the technical challenges.

Expert presentations

- Lynk Global

Issues identified by the Working Group

Unique enabler

The opportunities for LEOSat systems to advance the development of connectivity and connectivity-dependent solutions in regional, rural and remote Australia may be unlikely to match terrestrial networks on a network-wide basis, they may offer sufficient latency and bandwidth to a more limited set of customers.

Regulatory

The Australian Communications and Media Authority (ACMA) noted that there are some issues associated with using terrestrial spectrum to send signals from space. The ACMA also noted that there would be various telecommunications obligations for providers to consider. The ACMA directed participants to look at the upcoming Five-Year Spectrum Outlook (FYSO) (which was in the clearance process at the time), which discusses LEOSat D2D networks. [3]

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[3] ACMA Five-year spectrum outlook 2023–28 pages 20-23

Complementary networks

Mobile network operators advised the Working Group that LEOSat NTNs will provide a complementary service to their terrestrial networks. D2D NTNs are unlikely to match terrestrial networks on latency or bandwidth on a network-wide basis, although they may offer comparable latency and bandwidth to a more limited set of customers. D2D NTNs will be useful for deploying into areas where the terrestrial network would be absent or inadequate for reasons such as economic viability, planning restrictions or customer preference (including where a customer desires features that are unavailable from a terrestrial network, such as ubiquitous coverage).

While D2D NTNs may be envisaged to be filling blackspots by providing a ubiquitous minimum viable network rather than avoiding deployment of regional infrastructure, NTNs will allow smartphones and IoT devices to connect seamlessly with terrestrial mobile networks and or with NTN based satellite networks when out of range of terrestrial connectivity. Because NTNs may have less total bandwidth in a geographic area than terrestrial mobile networks, there will still be an impetus to deploy terrestrial infrastructure to fill in areas where there is need for faster speeds.

Consumer expectations

Mobile Network Operators (MNOs) noted the importance of managing customer expectations as to LEOSat NTN capabilities, especially due to the possibility of customers conflating LEOSat broadband internet supported by dedicated modems and antenna, with LEOSat mobile networks supported by handset modems and antenna - which are significantly less capable.

Social licence

An MNO noted that an important aspect of deploying D2D would be securing social licence and that environmental and cultural sustainability should be a consideration. For example, emissions associated with launching LEOSats as well as the visibility of LEOSats and the impact on the night sky. Of particular note, the cultural significance of the Dark Emu constellation to Aboriginal Australians and the risk that this could be obscured by the light reflected by ever increasing numbers of LEOSats remains a consideration.

Spectrum choice

It was also noted that there are two available approaches with regard to spectrum, using MNO-held terrestrial spectrum or using Mobile Satellite Services (MSS) spectrum, and that each have their own pros and cons. The approach to spectrum has subsequently also been discussed in the ACMA Five Year Spectrum Outlook 2023–28.

Spectrum choice: terrestrial spectrum

Utilising terrestrial spectrum takes advantage of spectrum already held by MNOs who may then lease it to LEOSat NTN operators. The advantage is that new phone standards are not needed, this system can operate over old 3GPP standards such as 4G and most existing consumer handsets are likely to be capable of connecting.

There is speculation over whether low end devices will be capable of connecting although there are some indications that they will be able to, at least for less advanced services such as messaging and voice.

There was discussion within the Working Group that using this spectrum may lead to interference issues at the edge of terrestrial networks where a user would transfer from terrestrial to non-terrestrial networks. However, a LEOSat operator noted that after 30 trials with MNOs using terrestrial spectrum it

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Of note: ACMA is currently conducting consultation which is asking industry views on whether the current spectrum management framework fit-for-purpose to manage these new satellite services, and whether there any other commercial, regulatory or public-benefit implications ACMA should take into account

had not received feedback that interference had been an issue. It was noted by another participant that a potential solution to interference could be for an MNO to dedicate some of its spectrum to support its LEOSat extended network rather than having it be shared between terrestrial and LEOSat base stations.

One participant suggested nationwide spectrum licences for D2D as a solution to interference. A contrary view was that regional spectrum licences can be quite large already, often larger than entire countries in other parts of the world. Nationwide spectrum allocation has been suggested as part of the Federal Communications Commission (FCC) consultation into D2D supplemental coverage from space. It was noted that the spectrum system in the United States is somewhat distinct from Australia and the policy may not be directly applicable.[4]

Spectrum choice: MSS spectrum

This approach uses MSS Spectrum which has less chance of interfering with terrestrial networks while maintaining good propagation characteristics. A potential roadblock is the need to update consumer handsets for this to work. There is a risk that lower end device manufacturers will take a long time to implement necessary standards and that some users will be excluded because they do not upgrade their devices regularly.

It was noted that the S and L MSS bands have been identified by the International Telecommunication Union (ITU) for the satellite component of international mobile telecommunication (IMT) – and that these bands can operate alongside terrestrial mobile signals with less interference concerns.

Competition

One MNO noted that they expect to see consolidation in the LEOSat market and policies to support competition and ensure good value for customers may be needed if a dominant participant emerges. It is notable that while Starlink currently dominates media coverage of the D2D field, there are multiple parties entering the broadband internet and D2D market.

D2D performance, congestion

Multiple participants noted that despite the lower capacity likely available through LEOSat mobile networks, they will have a significant impact. They also noted that even if there are limitations, having even limited D2D connectivity would be better than nothing. The emergence of easily accessible ubiquitous coverage in regional, rural and remote Australia is expected to be transformational, despite limitations.

Working Group members noted that it might be appropriate to throttle some usage in order to support overall connectivity (for example, reducing access to data in order to protect access to voice and SMS) and that emergency services traffic could be prioritised. It was noted by another participant that 3GPP 5G releases will support network slicing in this way.

Recommendation

3.1 Monitor developments in the D2D market for regulatory and policy implications

The LEOSat D2D capability is growing quickly, with a commercial deal already established in the Australian market. Current regulatory settings appear to capture the most likely LEOSat service delivery setups and the usual telecommunications regulatory settings around competition and access apply to LEOSats. There are some edge scenarios that should be examined closely. Developments in the market should be

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[4] See Federal Communications Commission, Notice of Proposed Rulemaking, Supplemental Coverage from Space, FCC 22.23, p.70, para., 4., available at, https://www.fcc.gov/document/fcc-proposes-framework-facilitate-supplemental-coverage-space-0

monitored to ensure that regulatory and policy settings continue to be fit for purpose and enable this market to develop.

4. The potential role of LEOSats in enhancing resilience, redundancy and services in emergencies

During emergencies access to communications services are critical for people to receive information and for public safety agencies to be able to communicate effectivity. In emergencies terrestrial networks can face disruptions both from the loss of power, the destruction of equipment and backhaul links as well as congestion. Satellite services have been shown to have the potential to fill gaps and aid in emergencies and their aftermath in domestic and international scenarios. LEOSats could have significant potential to help in times of emergency.

Expert presentations

- Department of Infrastructure, Transport, Regional Development and Communications, Security and Resiliency Branch

Issues identified by the Working Group

Roaming

Noting the Parliamentary Communications Committee Inquiry into Mobile Infrastructure Sharing, and the Australian Competition and Consumer Commission's (ACCC) consultation on temporary emergency roaming (informing the recently released report[5]), a carrier noted that LEOSat technology would be appropriate to facilitate roaming in an emergency scenario. It noted that sharing terrestrial networks in these circumstances can be cumbersome and expensive and that using a non-terrestrial network, which is built from the ground up to support roaming, would make more sense from their perspective. LEO D2D operators indicated that their services would be suitable for this purpose.

Congestion

Industry noted that while it will be technically possible to provide emergency access to everyone within an emergency area when terrestrial networks go down, that a LEO D2D network will likely become congested under these conditions. One operator noted that in this kind of scenario it would likely throttle individual connections to text messages only (or similar) to ensure reliable access to everyone. Additionally, it may be possible to prioritise certain services, such as for emergency personnel.

Broadcast alerts

It was noted that for broadcast alerts, LEOSat-augmented networks will be able to reach any mobile phone in any location irrespective of terrestrial network with an emergency broadcast alert provided there is satellite line of sight. This would include people beyond the terrestrial network edge, and also the people within the terrestrial network who suddenly experience an outage.

A LEOSat D2D operator noted that it is also enabling MNOs to message their subscribers to inform them about unexpected events such as a local terrestrial network outage.

Rain and smoke fade – implications in emergency scenarios

It was noted that where the Ultra High Frequency bands are used (700, 800, 900 MHz), propagation through rain and smoke is not an issue. It was also noted that it is not so much the satellite technology but the spectrum used and gateway locations (e.g. one static gateway versus many distributed) that affect rain-fade and smoke-fade vulnerability, with frequencies above 5 GHz being the most susceptible and lower frequencies being less affected. Although no real-world testing was referred to, it is was

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[5] ACCC Regional Mobile Infrastructure Inquiry Final Report

suggested that LEOSat D2D networks would be fairly resilient to adverse atmospheric conditions in an emergency scenario and would provide a reliable backup where a terrestrial network goes down.

Recommendations

4.1 Ensure suitability of regulatory settings to support use of LEOSats in emergency communications

Resilience is a broad topic and LEOSats clearly have a role in assisting in emergency situations, and the Government should consider this capability in this space. LEOSats are also becoming increasingly relevant to the emergency calling space, with Apple for example providing an emergency SOS service through its concierge triaged service. The Government should consider whether regulatory settings are fit for purpose to encourage greater use of LEOSats for emergency communication purposes.

5. Economic benefits from greater use of LEOSats, including in facilitating the Internet of Things (IoT)

While there is a significant focus on the emerging role of LEOSats in providing broadband and mobile handset access, the utility of LEOSats is broader. There are a number of more established IoT connectivity solutions such as long range wireless communications (LoRa) that are supported by LEOSats. The 'internet of things' refers to connected devices and the networks that connect them to the cloud, this could be for collection of data through remote sensors, remote control, tracking and more. The characteristics of these services can be quite different to those offering consumer broadband connectivity and typically provide specialised services to enterprise clients. LEOSats can enable IoT connectivity outside the reach of terrestrial networks from which economic and productivity benefits can be derived.

Additional invitees

- Internet of Things Alliance Australia

Expert presentations

- Internet of Things Alliance Australia
- Myriota

Issues identified by the Working Group

Market developments

Myriota presented on the potential economic benefits, including sustainability uplift, of LEOSats supporting IoT networks in Australia. Myriota noted that while the market size for satellite IoT has been relatively small, there is expected to be strong growth in the next decade, from about 5 million devices currently to 60 million in 2032.

Myriota's solution uses an Australian-developed proprietary standard but it anticipates that the development of 5G low-power and low-data standards will lead to expansion of the market.

Narrowband versus broadband Services

Myriota noted that narrowband services are complementary to broadband services, with the latter focusing on connecting people and narrowband focusing on connecting things in order to provide insights and facilitate management activities. Myriota advised that the need to efficiently collect data and control equipment related to resources and materials, which are distributed widely and well beyond population centres, has existed for some time in Australia. This issue can be resolved through narrowband services.

Opening new use cases

Myriota noted that there are many IoT use cases in Australia which have become economically viable because of the low-power and low-data requirements of IoT networks. They allow inexpensive devices to operate remotely for years on small batteries without needing to be replaced. Examples include: asset tracking, water resource tracking and use management, minerals exploration and mining, agriculture, ground truthing/surveying, fire prediction and management, and environmental tracking. Businesses are able to do things they already do (such as meter reading) more efficiently, and will be enabled to do things they couldn't previously do, allowing business to positively transform their practices.

By way of example, Myriota noted that they are participating in telemetry trials in the Murray Darling Basin which are looking at how resources are managed so that the right amount of water is being extracted. This process helps water users to avoid fines while protecting other water users and the environment. Previously, water usage would need to be checked each year by an officer/ team of workers who would often travel large distances to check these resources manually. If overuse were detected this would often lead to fines. Now usage can be monitored on an ongoing basis and adjusted appropriately before over-use occurs.

The Internet of Things in Australia

The Internet of Things Alliance Australia (IoTAA) presented on IoT and LEOSats in Australia. IoTAA noted that that their vision is for a 'Data Smart Australia', and it has expanded its focus recently to include Net Zero, the circular economy, and building community trust in IoT through good practices in addition to productivity.

Bandwidth demand versus distribution: choosing appropriate services

IoTAA noted that in terms of use cases you can plot a spread of use cases with distribution of devices on one axis and bandwidth requirement on the other. For industrial IoT, where there is a confluence of wide area and low-bandwidth monitoring, narrowband LEOSats best fit this niche; whereas for high bandwidth applications and high network deployment costs broadband LEOSats fits best. IoTAA noted that for IoT there are many use cases which are viable because narrowband services can support a high quantity of data points at a low cost per unit and that this data can be extremely valuable. An example is being able to monitor the status of power lines and knowing whether a power line pole is damaged. This process may not require a lot of data but may prevent millions of dollars in fines. IoTAA also explained that what is on the 'end' of the connection is important. It noted the importance of standards in terms of device availability and interoperability but also accessibility to users in terms of how easy it is to take up services, how they are billed, whether power-efficient devices are provided, etc.

The importance of competitive markets

IoTAA outlined the importance of robust competitive markets, where multiple options are available to address a particular business need or provide redundancy and noted that terrestrial and satellite services should therefore be considered as complementary (even if they overlap). IoTAA noted that the availability of devices became an issue during the COVID-19 pandemic. Some devices disappeared without suitable alternatives being available because they were proprietary and the supplier's supply chain could not cope with demand. IoTAA noted that if there are no enforceable standards then affordability and availability can be a challenge. Resilience and security were also identified as being important factors in IoT networks.

Mapping the multiplier effect of digital technology

IoTAA also noted that the 2023 Productivity Commission Report had commented on the multiplier effect of digital technology on productivity and that there is a knowledge gap around comparative analysis of this multiplier effect in metropolitan versus regional, rural and remote Australia for IoT. IoTAA suggested looking at this area as a potential opportunity for industry and government.

Technology readiness: time for practical action

Participants noted that there has been much theoretical discussion about what could be done in this space and that the technology has progressed to the point where it is technically feasible to put solutions into place. They further noted that it would be appropriate to start practical trials to reinforce proof of concept. It was further argued that entities like Starlink have benefited greatly from US government support without a high level of confidence in the ability to solve a problem at the outset, providing a benefit to lead in the international market. Some members noted that Australia has an opportunity to propel its burgeoning space and IoT industry in a similar manner. Participants expressed interest in helping the department and Government develop this opportunity.

Building on discussions around the merit of trials, there was discussion around what economic multipliers could be identified to help justify government action in this field. A participant suggested that an alternative approach could be to use trials to identify and demonstrate real world benefits and that further research to identify theoretical economic multipliers might not be warranted.

Opportunities to help green the economy

Participants noted Fleet Space's work in lithium exploration and the opportunity to lead globally by developing and implementing carbon offset credit quality verification methodologies. Participants also noted the implications for land stewardship and First Nations outcomes, with the examples of enhancing the capabilities of Indigenous rangers and providing connectivity for use cases at remote outstations which are not always occupied.

A participant noted that there is a gap in mandated financial environmental disclosures in the context of carbon credit quality and that IoT could help close this gap. The participant explained that Treasury has acknowledged that quantitative data, being more valuable, is difficult to collect in this field and that as a result mostly qualitative data is collected. Participants noted that because of the greater and more affordable data collecting capacity enabled by IoT, quantitative data can now be collected more easily. Participants also noted that this data can serve dual purposes, such as supporting various business needs in addition to regulatory compliance.

Standards

The conversation also covered the role of standards for devices and data in the market. Participants noted that interoperability of data is an issue where there is a 'yawning gap'. There is no lack of data collecting ability but there is a lack of common data taxonomy and trust for that data to be shared and used. The issue is exacerbated because data sharing tends to be along business lines rather than being open.

Members of the Working Group however cautioned against setting standards too aggressively as this could have a stifling effect on innovation. A participant noted that standards tend to follow innovation and that you need to find the right point of commonality to set. There needs to be enough leeway for business to innovate and there is a balance point where the implementation of a standard is most beneficial in realising benefits, building availability, accessibility, and resilience. The participant noted that it is currently innovating in an area that is yet to be standardised, and that standardisation is on the horizon, but that if standardisation occurred now its innovation would be diminished.

Participants also noted that large companies can sometimes stifle a field by holding up standardisation processes in order to delay competitors from progressing in a market.

A participant also noted that LoRa has adopted a standard for IOT in the MSS bands in the 2 GHz (1980-2010 MHz and 2170-2200 MHz band and this is being successfully implemented in Europe and elsewhere.

Recommendations

5.1 Monitor industry developments to ensure regulatory and policy settings are fit for purpose

Recognition of the benefits of IoT solutions continue to grow, and the IoT is connected through a range of solutions including LEOSats. There isn't a clear need for government intervention at this stage, but the Government should continue to monitor the industry and work with organisations such as IoTAA to ensure regulatory and policy settings are fit for purpose and whether there could be a role for demonstrations or incentivisation.

Attachment A – Terms of Reference

Australian Government

Department of Infrastructure, Transport, Regional Development, Communications and the Arts

Terms of Reference
Low Earth Orbit Satellite Working Group

17 April 2023

Objective

The proliferation of innovative Low Earth Orbit Satellite (**LEOSat** or **LEOs**) technology has presented new applications in delivering Australian communications. These developments have led to a growing number of companies deploying LEOSats in Australia with a range of use cases. It is timely to establish a Low Earth Orbit Satellite Working Group (Working Group) to help inform Government about how this emerging capability might play a role in future telecommunications policy.

Terms of reference

The Working Group will examine LEOSat technologies, and the developing market with the aim of:

- building an understanding of the technology and its capabilities;
- identifying where LEOSat technologies may deliver positive outcomes for consumers, particularly in relation to Closing the Gap Target 17;
- identifying policy or regulatory issues; and
- supporting well-informed decision-making by Government.

The Working Group will also take account of the existing and emerging capabilities of LEO satellite operators, other Non-Geostationary Orbit (NGSO) operators - such as Medium Earth Orbit (MEO) satellite - and GEO satellite operators, to deliver integrated communications solutions that are not necessarily orbit or satellite operator-specific.

Expected areas of focus

LEOSats have the potential to support Australians' access to higher quality telecommunications services, especially in regional, rural and remote areas. The Working Group will have a broad interest in LEOSat operations, examining the potential for LEOSats to:

- help close the digital inclusion gap, particularly in relation to First Nations people consistent with Closing the Gap Target 17, including potential pilot programs;
- support delivery of universal telecommunications services, including mobile coverage, in rural, regional and remote Australia;
- deliver economic benefits by enabling business innovation, including uplift of industrial sustainability, particularly through use cases outside providing broadband data services, through facilitating the Internet of Things;
- support greater resilience and redundancy of communications networks in emergency circumstances.

In this context, the Working Group will consider:

- existing and emerging products, including their technical capability and features, accessibility, affordability, consumer support, commercial sustainability, and readiness for market;
- competition and the role of LEOSats relative to other satellite technologies, including as a useful complement and with the potential for the development of integrated multi-orbit solutions;
- use cases, including by households, businesses and communities; Internet of Things; emergency telecommunications; broadband for high mobility locations and transportation; and 5G non-terrestrial networks (i.e. satellite 'direct-to-device' communication);
- issues focused on broader Government priorities, including emissions reduction; and
- the role of government, including regulatory/policy certainty for industry in areas such as spectrum, consumer protection, data protection and national sovereignty issues.

Out of scope

There are a range of established forums in place to consider the regulatory framework that LEOs operate in. The Working Group is not seeking to replace them. In particular, the Working Group will not examine issues under consideration by the World Radiocommunications Conferences (**WRC**) or within the remit of the Australian Space Agency, including space sustainability. The representative(s) of the Australian Space Agency on the Working Group will act as conduit into that organisation.

Where an issue is not already subject to another forum, the Working Group may discuss that issue in the context of introducing it to the appropriate forum.

Membership

Membership for the inaugural meeting is outlined at Appendix A, with members to meet their owns costs of participation. Ongoing membership will be considered at and following this meeting.

The Minister for Communications (the **Minister**) may invite other entities to join the Working Group at any time, including at the suggestion of existing Working Group members.

Governance

Chair

The Working Group is chaired by Richard Windeyer - Deputy Secretary, Communications and Media Group of the Department of Infrastructure, Transport, Regional Development, Communications and Arts (the **Department**).

Sponsorship

The Minister is responsible for settling these terms of reference, including membership.

Operation of meetings

The Working Group is not a decision-making body. Where appropriate, recommendations and/or suggested actions can be presented through the Department for the Minister to consider. The Working Group will aim to provide the advice to the Minister on the identified themes by the end of 2023.

In undertaking its work, the Working Group may engage with other Government agencies, relevant industry sectors, technical experts, consumer groups, end users, Australian communities and governments.

The Working Group will consider issues of information sharing between participants. Working Group members acknowledge they may have competing interests in some areas and will give due regard to this their dealings with other members. Discussions will not be considered confidential.

Minutes will be prepared to each meeting and will be circulated to all members.

Secretariat

The Digital Inclusion and Sustainable Communications Branch of the Department will provide secretariat services.

Meetings

Inaugural meeting

The Working Group held its initial meeting on 10 February 2023 virtually.

This meeting was in the form of a roundtable with broad ranging discussion to identifying issues of interest.

Ongoing

The working group is expected to meet in May, August and November 2023, with future meetings to consider the themes identified in the first meeting and potentially include new participants depending on meeting topic. The final meeting will also consider the future of the group and seek to revise the terms of reference.

Appendix A

Membership

Sector	Organisation
Government	• Department of Infrastructure, Transport, Regional Development, Communications and the Arts • Australian Communications and Media Authority • Australian Space Agency
First Nations	• Ms Dot West OAM • Dr Lyndon Ormond-Parker
Industry	• Amazon project Kuiper • Commpete • Communications Alliance • Echostar Global • Fleet Space • Inmarsat • Intelsat • IPSTAR • Lynk Global • Myriota • NBN Co • Omnispace • One Web • Optus • Pivotel • SES/O3b • Speedcast • Starlink • Telesat • Telstra • TPG • Viasat • Vocus

Attachment B: Satellite services

	Narrowband/ Wideband Proprietary	Narrowband/ Wideband Standardised (3GPP 4G, LTE, 5G, LoRa)	Broadband (proprietary) High Throughput Satellite	Broadband (proprietary) Very High throughput Satellite
Geostationary Orbit	e.g., Thurya, Inmarsat: ELERA, Wideband Global SATCOM (Defence)	e.g., Inmarsat ELERA	e.g., Sky Muster 1 and 2, Various Intelsat, Inmarsat GX, ViaSat 1, 2, Optus D series/Optus-10	e.g., ViaSat 3 (APAC), Optus Optus-11, Inmarsat GX6A
NGSO **Medium Earth Orbit**			e.g., SES O3B	e.g., SES O3B mPOWER
NGSO **Low Earth Orbit**	e.g., Myriota, Iridium, GlobalStar	e.g., Space X Starlink, Lynk Global, AST Space Mobile, Omnispace, EchoStar, Fleet Space		e.g., Space X Starlink, OneWeb, Amazon Project Kuiper, Telesat Lightspeed

Attachment C: Connectivity solutions for disadvantaged communities and associated costs and drawbacks

Population distribution	Technical solution	Cost	Drawbacks
Regional/ Urban	WiFi hotspot attached to existing public infrastructure	Low	Introduces security challenges. Relies on public infrastructure with existing connectivity. Can introduce social issues.
Small remote population hub	WiFi hotspot connected via LEOSat	Low / medium	Introduces security challenges. Could be vulnerable to congestion if the population is too high (so multiple downlinks will be needed).
Medium remote population hub	WiFi Mesh connected via LEOSat downlink	Medium	Introduces security challenges. Single point of failure for the entire mesh if there is a single downlink. Additional costs for multiple downlinks if congestion arises.
Medium remote population hub	WiFi Mesh connected via multiple LEOSat downlinks	Medium/ high	Introduces security challenges. May become harder to protect infrastructure.
Medium dispersed remote population	4G or 5G standalone mobile network backhauled with LEOSat	Medium / high	Managing access regime could be challenging or introduce secondary issues. May require a complex managed service relationship with an operator (may not be ideal for extremely remote communities).
Highly dispersed remote population	Multiple dispersed LEOSat downlinks	High	Harder to protect infrastructure as individual households would be responsible for equipment. The administrative burden may also be unacceptably high because this solution does not aggregate demand into a simple access point (such as a WiFi log in page).
Tropical and sub-tropical locations	All satellite enabled solutions	Higher	As satellite downlinks are susceptible to signal loss during heavy rain, larger antenna may be required to deliver similar service, this introduces additional cost.
All population types	Expand commercial terrestrial mobile network	Variable	The emergence of LEOSat backhaul for mobile networks may lead to an expansion of the mobile networks. Even when enabled through Mobile Black Spot Program or similar, this option depends on the site being at least somewhat commercially viable. Some sites may never be commercially viable.

Glossary

Reference	Description
3GPP	The Third Generation Partnership Project – formed to standardise 3G cellular network standards but has also set all subsequent cellular network standards
ACCAN	Australian Communications Consumer Advocacy Network
ACCC	Australian Competition and Consumer Commission
ACMA	Australian Communications and Media Authority
BIRRR	Better Internet for Regional and Remote Australians
D2D	Direct-to-device
FCC	Federal Communications Commission (US)
FNDIAG	First Nations Digital Inclusion Advisory Group
FYSO	Five-Year Spectrum Outlook (ACMA)
GSO/GEO	Geostationary orbit
IMT	International Mobile Telecommunications
IoT	Internet of Things
IoTAA	Internet of Things Alliance Australia
ITU	International Telecommunication Union
LEOSat(s)	Low Earth Orbit Satellite(s)
LoRa LoRaWAN	Low power, low data, long range wireless communication standard
MBSP	Mobile Black Spot Program
MEO	Medium Earth Orbit
MNO	Mobile Network Operator
MSS	Mobile satellite services – this typically refers to portable satellite communications solutions that use spectrum bands assigned for this use.
NFF	National Farmers' Federation
NGSO	Non-geostationary orbit (e.g., LEO, MEO, elliptical)
NTN	Non-Terrestrial Network
RCP	Regional Connectivity Program
S and L band	Satellite frequency bands. L-band (1-2 GHz) is used by Earth Observation satellites, Global Positioning System (GPS) carriers and satellite communications providers such as Iridium and Inmarsat. S-band (2-4 GHz) is predominantly used for radar and some satellite communications such as those with the International Space Station.
WiFi	Wireless Fidelity – a wireless communications standard for local networking
WiFi 6 / WiFi 7	WiFi 6 is the current most advanced general use wireless local network standard, WiFi 7 is in development