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"The telco revolution in the sky: How LEO satellites are changing the game"

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Introduction

Good morning everyone and thank you to Tech In Gov for inviting me to speak today. I'm here to speak on the topic of "The telco revolution in the sky: How LEO satellites are changing the game."

For those of you who are unfamiliar with the term, LEO stands for 'Low Earth Orbit', because these satellites are dramatically closer to the earth than traditional satellites.

I'll break my presentation down into three parts. First, I want to tell you about Vocus and the role that we play in the LEO ecosystem. We don't launch satellites, but it's our fibre network on the ground that connects them to the rest of the world. Second, I'll tell you what LEOs are, and why they're so revolutionary compared to the satellites that are commonly used today.

And finally, I'll speak about the applications for LEO in Government, and why this technology has the ability to change the way we deliver Government services – and will force a policy re-think when it comes to regional communications.

So first of all, you're probably wondering why a speaker from Vocus – a fibre network operator – is here speaking about satellites, when we don't own any.

I'll get to the specifics on how LEOs work in the second part of my speech, but fundamentally, the breakthrough speeds offered by LEO satellites are interconnected with the rest of the world by a highcapacity fibre network on the ground. And that's where Vocus comes in.

The Vocus network

Vocus owns and operates Australia's second-largest fibre infrastructure network: 25,000km of high-capacity, low-latency, and highly secure fibre connecting all mainland capitals. This network also has extensive regional reach, with inland routes along the east coast and fibre in remote areas between Adelaide, Darwin, Brisbane, Perth and Port Hedland.

And Vocus is currently undertaking the largest expansion and upgrade program of our fibre network in the company's history, worth close to a billion dollars in new investment. These investments are being driven by market trends, all of which require vastly more capacity than is available today. The emergence of new technologies like Low Earth Orbit satellites is one of these key trends driving our investment strategy.

Another is trend towards regionalisation and the 'edge', with demand for connectivity with our trading partners to the north – particularly Darwin, our only capital north of the Tropic of Capricorn.

Extending our reach – Project Highclere

The first network expansion project we're deploying is Project Highclere: the final link to complete the \$500 million Darwin-JakartaSingapore Cable system between Darwin, Port Hedland, and SouthEast Asia. This will establish a new 1,000-kilometre submarine connection from the Port Hedland to a branching unit on the Australia Singapore Cable in the Indian Ocean, creating a direct path from Darwin to Jakarta and Singapore.

- It will make both Port Hedland and Darwin as new landing points for international data.
- It will provide additional redundancy by creating another ring in our network in Australia's North-West.

Project Horizon

Closely connected to Project Highclere is Project Horizon: a new 2,000km fibre route from Perth to Port Hedland, where it will interconnect with the Darwin-Jakarta-Singapore Cable system. This will create a fibre loop in Australia's West, as well as completing a figure-8 of fibre rings across Australia's east and west. With design capacity of 38 Terabits per fibre pair, it will be the first competitive fibre backbone connection through Australia's mining region with direct low-latency connections onto south-east Asia from both Perth and Port Hedland.

This is a project which has been in planning since 2018, and it is on track to be completed in the same timeframe as Project Highclere in 2023.

Timor Leste and Kupang

As well as extending the North-West Cable System to connect to the Australia Singapore Cable, we're also planning extensions to the North West Cable System to Timor Leste and Kupang in Indonesia. High-level design work for both projects has been completed, and we are engaged in discussions with Government and industry stakeholders in Timor Leste and Indonesia.

When combined with Project Highclere, these extensions will mean Darwin will have direct submarine connections Timor Leste, Kupang, Jakarta, and Singapore. The North-West Cable System has multiple fibre pairs available, meaning these new tails can be delivered at incremental cost.

East Coast Cable System

We're also responding to market demand for capacity and redundancy on the east coast. To complement our existing coastal and inland fibre routes between Brisbane, Sydney, and Melbourne, Vocus has commenced planning to construct the 'East Coast Cable System' – a new submarine cable system connecting these three capitals.

Together, these five major network extensions will be backed by a substantial capacity uplift on our existing fibre network.

Upgrading our capacity

Our 25,000km of fibre can be upgraded to provide 50 times more capacity than currently provisioned, at incremental cost. We've already we added 25 times more capacity between Adelaide, Darwin, and Brisbane the 'Terabit Territory' project the Northern Territory Government.

Starting this year, we'll be adding:

- 20-times more capacity on our Sydney to Brisbane regional fibre,
- 5-times more capacity on our Sydney-Melbourne-Adelaide intercapital routes,
- And an additional 4 Terabits of capacity on the Australia Singapore Cable.

The following year we'll have delivered 8-times more capacity from Perth to Geraldton and 13-times more capacity on our Sydney to Melbourne regional fibre – as well as completing projects Horizon and Highclere.

And after that, we'll:

- double the capacity on our Adelaide to Perth fibre,
- quadruple capacity on Sydney to Brisbane intercapital fibre,
- add 13-times more capacity on our Melbourne to Adelaide regional fibre,
- and significantly uplifted our Sydney to Melbourne Coastal regional fibre.
- Our metro fibre will be upgraded in all capital cities.
- 400 Gig services will be the new standard across our national fibre backbone, and 100 Gig will be the new standard on our regional routes.

All up, we will add more capacity to our network in the next few years than at any other point in our history. So with that overview of our network and our expansion plans, I'll move on to my second point – what are LEOs, and what has led to the emergence of this new technology?

LEOs

There's a famous quote by science fiction writer and futurist Arthur C Clarke that says: "Every revolutionary idea seems to evoke three stages of reaction..."

- (1) It's completely impossible.
- (2) It's possible, but it's not worth doing.
- (3) I said it was a good idea all along.

The technology behind LEOs has moved rapidly from stage 1 to stage 3 over the past few years, and what was considered science fiction ten years ago is now entering the competitive commercial market today.

Networks are being deployed by companies like Elon Musk's SpaceX, Amazon's Project Kuiper, OneWeb, and TeleSat.

There have been three developments in new technologies that have been pivotal to the commercialisation of LEOs. Multi-use rockets, the phased array antenna and multi-satellite payloads have been the key to viability. While traditional satellites were typically launched on a single-use rocket and as a single payload, or in some cases with a couple of other payloads, SpaceX has pioneered the use of reusable rockets with the capacity to carry much greater payloads.

The flat panel phased array antenna, allowing for selectable, steerable beams back down to earth – like

the difference between an LCD TV and a slide projector – one can change its image dynamically the other is pre-fixed.

In January last year, a single SpaceX Falcon 9 rocket delivered 143 payloads – a world record. To date, SpaceX has performed 156 launches with 95 rockets reflown. Due to their orbit being much closer to the earth than traditional GEO satellites, a LEO constellation requires far more satellites in orbit to provide the same coverage of the earth's surface. So the ability to launch multiple payloads per rocket is a necessity.

LEO vs GEO

A LEO typically sits between 300 to 600km above the earth's surface, compared to GEOs which are as high as 35,000 kilometres above the earth. To illustrate this – NBN is able to provide coverage to all of Australia and Australia's external territories using its two Sky Muster GEO satellites. LEO operators will require hundreds of satellites to provide that same level of coverage.

LEO Coverage

Starlink, the broadband brand of SpaceX, plans to launch a constellation of around 12,000 LEOs to provide global coverage, and it has over 2,200 already in operation today. Other operators like OneWeb plan to have 648 satellites in orbit, with 428 already in orbit today. OneWeb launched 34 new LEOs in a single payload in February this year, making its network now two thirds complete. I cannot overstate just how rapidly this technology is developing.

Last year the first Australian trial customers of Starlink received their satellite dishes and connected live services. Starlink calls the live trial service a "Better Than Nothing Beta". But the tongue-in-cheek name for the beta test really undersells how revolutionary this service is.

Media articles have reported Australian users receiving download speeds of more than 340Mbps, with upload speeds above 40Mbps. Starlink itself has marketed the trial service as providing download speeds of 50Mbps to 150Mbps, which is again underselling the experience when real-world conditions appear to show the service delivering at the top end of that range – even more than double the top end of the range.

Compare this to the NBN Sky Muster Satellites – which were considered world-leading when they commenced operation just 7 years ago – that offer peak speeds of 50Mbps.

Another technological breakthrough offered by LEOs is latency – that is, the time it takes for data to travel from the ground to the satellite and back again.

Since LEOs are only around 500km above the earth compared to 35,000km for GEOs, the time taken to send and receive data is dramatically reduced. Starlink says the typical latency on its LEOs is 20ms to 40ms, which is comparable to terrestrial broadband technologies and a giant leap from the 600ms latencies typically seen on GEO satellites. The huge increase in the use of cloud services over the past few years has made latency a critical factor for many users, as these services simply don't work as they're meant to when connected with the high latencies of GEO satellites.

These low latencies are dependent on the deployment of extensive ground infrastructure with high-capacity fibre backhaul, so processing and storage can occur as close to the edge of the network as possible. This means having ground stations in regional areas close to where the end-users are located, to minimise round-trip time. This convergence gives traction to Edge compute and Edge Data Centres,

illustrating why Vocus, a fibre company, is taking such a strong interest in LEO Satellites.

Vocus' extensive regional fibre network is key asset which we intend to expand and upgrade the capacity of. But Vocus' extensive regional network is more than just fibre. Our 25,000 km of terrestrial fibre around Australia is supported by a network of Edge Facilities dotted every 100km along our fibre used to retransmit our fibre signals. These Edge Facilities are ideally suited to support satellite ground stations all over the country.

LEO Ground Stations

Satellites connect back to earth via ground stations, and these ground stations are connected with high-capacity fibre to the internet. Historically, these ground stations were based around huge, mechanically-controlled dishes to send and receive signals – if you've ever seen that classic Australian movie 'The Dish' you'll know what I'm talking about. Given the wide geographic reach of GEO satellites, NBN's two Sky Muster satellites require only ten ground stations across Australia. But the arrival of LEOs has also changed the nature of ground station technology.

Given LEOs have a smaller field of view from their position closer to the earth, they require a far denser network of ground stations. Today, Vocus has deployed 16 ground stations for our LEO partners – more than any other operator in Australia – and this network is expected to densify as demand grows. But the technology utilised in these ground stations is not like anything you would have seen in 'The Dish'.

LEO ground stations are far smaller than GEO dishes, and take up a space around the size of a large suburban backyard.

LEO ground stations are a bit like mobile base stations – the more users you have on your network, the more ground stations you need to deliver sufficient capacity and maintain high service standards. And we're just beginning to see how ground station technology will develop as LEO networks are deployed.

Vocus has entered a partnership which we believe has the potential to dramatically improve the speeds, logistics and economics of LEO deployments in Australia. Vocus is a founding partner and shareholder in Quasar Satellite Technologies, a revolutionary new satellite ground station service company based in Australia.

Quasar's technology promises to disrupt the satellite ground station market by delivering "ground stations as a service". They'll enable this using their electronically steered phased array technology. This technology emulates the behaviour of a traditional parabolic antenna, but no longer requires the antenna to mechanically track satellites across the sky. As a result, Quasar's technology is able to connect to hundreds of satellites at once, managing connections through time slots for uplink and downlink activity.

Quasar could allow new LEO satellite fleets to launch far more quickly and cost-effectively as they wouldn't require multiple deployments of ground infrastructure. Rather, several operators could connect to Quasar's ground stations as a service, and focus their energy on launching their space infrastructure instead. And the market is not only for satellite operators – users such as Government, Defence, and telcos themselves could avoid requirements to build their own ground stations and instead utilise a commercial Quasar service. Quasar has the backing of Main Sequence, the CSIRO-founded venture capital fund that invests in high-growth tech start-ups based out of research.

We're very excited about the possibilities. And one thing which excites me about our work with Quasar is that it's an Australian company, backed by Australian funding, developing a sovereign Australian

capability in the modern-day space race. And sovereignty is a factor which Vocus increasingly sees as a competitive advantage in a market where security is critical to success.

So hopefully you've now got a good idea of why LEOs are taking off – both literally and figuratively – and what this revolutionary technology is capable of delivering. And this brings me to my final point – LEOs are not just a consumer technology but will change the way we deliver connectivity to Government.

The Vocus Network

Most of the attention on LEOs has so far centred around the consumer benefits. Today, people living in eligible areas of Australia can order a rooftop dish for \$924 plus \$115 shipping, with a monthly connection fee of \$139 for unlimited data. Considering that Satellite services typically have very low data caps, and an unlimited 100Mbps fixed line NBN connection typically retails from between \$90 to \$110 per month, that's pretty competitive. But home broadband in regional areas without fixed line is just the beginning.

The applications for Government and Enterprise users will change the way networks are delivered. Think about Defence applications for a moment. We've seen how in Ukraine, when Russian forces targeted fixed line and mobile networks, Starlink was able to rapidly activate services to keep the

Ukrainian defence force connected. Starlink was switched-on in Ukraine in February, and already 10,000 terminals are in active daily use. These small dishes are able to get online in a matter of minutes and do not require any physical connection to terrestrial infrastructure – making them extremely difficult for Russian forces to disrupt.

They're also highly portable, allowing Defence forces to move locations and stay connected. They're being used to control drones, to allow for communications between military units, and to keep hospitals online when all other methods of connectivity have been destroyed. We've also seen how LEO connectivity can be rapidly deployed in natural disasters.

When Tonga was hit by a volcanic eruption and tsunami earlier this year, its only submarine cable was damaged – leaving the country reliant on slow, low-capacity satellite connectivity until the cable could be repaired. Despite not having any ground station infrastructure established to cover Tonga, Starlink rapidly established a ground station in Fiji –which was able to provide LEO coverage to Tonga. And all of this happened within a matter of weeks.

It's not hard to imagine how Australia could utilise this technology to maintain connectivity during bushfires, floods and other natural disasters that take mobile and fixed-line networks offline.

Beyond defence and resilience applications, LEOs will enable a complete re-think of broadband service delivery to regional and remote Australia.

Today, Australians in regional and remote areas are connected via a variety of expensive and overlapping subsidy programs, including NBN's loss-making fixed wireless and satellite networks, the Universal Service Obligation, the Regional Broadband Scheme, Mobile Black Spot Program, and Regional Connectivity Program. Combined, these programs cost north of a billion dollars every year – and LEOs could easily replace them all with a better technology.

The Canadian federal government has signed a C\$600 million, tenyear deal with LEO operator Telesat as part of its Universal Broadband Fund. The agreement will provide unlimited data at speeds of 50Mbps across rural and remote areas, with a particular focus on improving

connectivity in indigenous communities – three quarters of which aren't connected today

Canada's broad geography and low populations densities make it a market with plenty of similarities to Australia. For perspective, that ten-year agreement costs less than a single year of Regional Broadband Scheme funding here. So there's just a taste of the kind of applications LEOs can bring to

Australia, and which will be available in the very near future.

I'll conclude with a brief re-cap.

First, Vocus is currently undertaking the largest network expansion and upgrade program in our company's history, with close to a billion dollars' worth of investment over five years.

Second, LEO satellite networks are being deployed today will revolutionise connectivity and offer fixed-line speeds and latencies even in the most remote locations.

And finally, LEOs will enable entirely new ways of delivering Government services, with applications for Defence, resilience, remote users, and much more.

Thank you, and I hope you enjoy the rest of the conference.