



THE UNIVERSITY OF
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Pearcey
FOUNDATION

The Past and Future of Australian Innovations in Information and Communication Technology (ICT)

Oral History Interview

16

Geoff Huston

Interviewed by:

Graeme Philipson, Sebastian Boell, Kai Riemer

Interviewed on:

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Project Summary

This interview is part of a series of oral history interviews undertaken by the Pearcey Foundation and the University of Sydney as part of the project ‘The Past and Future of Australian Innovations in Information and Communication Technology (ICT)’. The series interviewed recipients admitted into the Pearcey Hall of Fame from 2003 to 2020. The hall of fame recognizes outstanding life-time contribution to ICT in Australia in business, research and government. Each oral history captures a short biography of individuals who made an outstanding contribution to ICT in Australia. They also collect insights on aspects that had a lasting effect on ICT innovations in Australia, positive as well as negative from approximately the 1960s to the 2010s. Interviews lasted about 60-90 minutes and were conducted by Sebastian Boell, Graeme Philipson, Peter Thorne, Kai Riemer, Sandra Peter and Belinda Wang. The complete set of interviews in this series is archived by the Pearcey Foundation.

Key Points Covered in this Oral History

1. The building of the Australian national university of network AARNet was the very first service network, which then triggered the Telstra Internet infrastructure construction.
2. Cloud services and data centres construct the new ‘Internet’, however, it related to data security issues (the issue is not from the critical comms infrastructure) where we should leverage the coding functions on regulatory mechanisms.
3. The bureaucratic culture in big corporate (Telstra) and politics are major throwbacks that hindered the innovations in Australia (e.g. Political battle count for NBN’s problem)

Biography

Geoff Huston AM

Founder of AARNet
Former Chief Internet Scientist of Telstra
Pearcey Hall of Fame in 2015
Internet Hall of Fame in 2012



Australian Internet pioneer, Researcher, Author

Geoffrey Ian Huston was born in Canberra in 1956. He attended Canberra Grammar School and studied pure mathematics at the Australian National University, where he received an Honours and Master's degrees in Computer Science, focusing on network protocols and network security.

After graduating he became Computer Systems Manager at the ANU's Computer Centre. In 1982 he married Michele Cardow, who he had met while they were both still in school. They had three children. In 1989 he was the Centre's Network Manager when he successfully applied for the job of Network Technical Manager with the new Australian Academic and Research Network (AARNet).

AARNet was set up to bring the Internet to Australia's academic institutions and was Australia's first Internet Service Provider. Huston's job was to design and implement the network. When he started, he was the organisation's only full-time employee.

The job was as much about diplomacy and marketing as it was technical. Huston spent an enormous amount of time in the early years pleading for money from academia and government to expand the network. It was a constant battle. Colleagues credit the tireless and articulate Huston with being the driving force behind the introduction of the Internet to Australia.

AARNET grew beyond its academic origins and was acquired by Telstra in 1995. Huston became the carrier's Chief Internet Scientist for the next ten years. He played a leading role in the construction and development of Telstra's Internet service offerings, both in Australia and as part of Telstra's global operations.

Huston was, and remains, a very active member of the International Internet community. He was a member of the Internet Architecture Board from 1999 until 2005 and served as its Executive Director from 2001 to 2005. He was also an active member of the Internet Engineering Task Force, where he chaired a number of Working Groups. He served on the Board of Trustees of the Internet Society from 1992 until 2001 and served as its Chair for a term in 1998-1999. He served on the Board of the Public Internet Registry and chaired the Internet Engineering and Planning Group from 1992 until 2005.

In 2005 he became Chief Scientist at the Brisbane based Asia Pacific Network Information Centre (APNIC), the Internet Address Registry for the Asia-Pacific region. At APNIC he

undertakes research on topics associated with Internet infrastructure, IP technologies, and address distribution policies. He serves on the organisation's Executive Council.

He is the author of three books focused on ISPs: Internet Performance Survival Guide; Quality of Service: Delivering QoS on the Internet and in Corporate Networks; and ISP Survival Guide. He has also written numerous papers on the Internet and spoken at many events, in Australia and around the world.

Geoff Huston was made a Member of the General Division of the Order of Australia (AM) in 2020 for 'significant service to science, and for pioneering roles with the Internet'. He was inducted into the Internet Hall of Fame in 2012 and the Pearcey Hall of Fame in 2015.

Interview Transcript

Date of interview: Monday 16 November 2020

Can we start out with a brief summary of your career? Your early education, what educational institutions did you attend? And how did you become what you are today?

I was born in Brisbane, but I was raised in Canberra, I'm the son of a public servant. I attended high school here in Canberra, at the local boys' grammar school. I then went on to the Australian National University where I studied Science and tried to do pure Maths and decided that was all too hard. So, I made it oddly enough in Computer Science. I graduated with honours from an undergraduate degree, a Bachelor of Science. I then took up a position in the Public Service for about six months and decided that that wasn't for me. So, I became a tutor in the Department of Computer Science for a couple of years at the Australian National University, and from there, I jumped across into the General Services area and joined the Computer Centre. I stayed with the Computer Centre for almost 10 years.

What years are we talking about it, Geoff?

From 1983 to 1988 I worked in systems programming predominantly on Digital [DEC] machines. I had a brief stint in '88 as an employee of Digital that lasted for all of eight weeks, I decided the private enterprise wasn't my bag.

So the government's not your bag and private enterprise isn't?

Yeah, right. So, I ducked back in the university system where, by then, networking was taking off. In '89, I accepted a secondment across to the peak body of the Australian universities, which at the time was called the Australian Vice-Chancellors committee. Today, it's called I think, Universities Australia. And my job was to set up a national academic and research network, in the same vein, as the, by then recently set up, National Science Foundation at work in the United States, which I then proceeded to do. And over the next six years, devoted a huge amount of time and effort actually building what was developing what was not only a national, academic and research infrastructure, but the only national computer network that actually worked in Australia. It still exists today. AARNet. Yeah, but at the time, because there was nothing else around once we'd solved the issues for the universities. We were beating back just so many others who wanted to join that the obvious answer was to stop beating them back and take their money, which we then did. This then sort of turned us into a massively rapidly growing service network, which certainly stressed the decision-making fabric and the investment fabric of the dear old universities.

We were very fortunate that Glenda Korporaal wrote a wonderful history of AARNet.

In which you figure very prominently.

She got into a fair bit of this. I think the bits that she may not have touched on were that we grew extremely quickly. And the Vice Chancellors at the time were just totally shocked at the amount of decision making that was coming their way. There was the need to make large scale investments rather than just simply do it as a cash flow business. And so, by 1994, it was pretty clear that this couldn't continue. They did not want to commercialize this. That was kind of not their remit to explicitly float us as a common University enterprise: this kind of service platform. So, they took the easy way out, which was to sell the entire system and its customer base across to Telstra. This was effected in mid '95. I was then moved over into Telstra as part of that sale. I spent the next 10 years working for Telstra.

Little did they know that I was there to take them over, which I don't think they appreciated in '95. But it's certainly obvious by the year 2000, that there was no other business in Australia, other than the data business, and there was no other way of doing it other than the internet. There was a whole bunch of opposition from within Telstra to this. I spearheaded their core infrastructure group. I didn't do retail. And I led the rollout design and expansion of the network for many years. Telstra data network was called Telstra Internet and all the other retail platforms including mobiles, the Big Pond thing, the modem networks, and so on were basically customers of this core network. The core network started off as an Australian network. And then we then moved it across and built out facilities in the United States and in Europe and in Asia.

And before I forget, I should take note, you said there was opposition within Telstra to this, what was it?

It's very hard for a very large company to redeploy resources, capital and focus, from existing products, because they're making money. And when you make the case that they are sunset products are not going to make money next year, that doesn't make your case any easier. In essence, what was going on was a huge battle for the available funds to build out infrastructure between X25 based platforms, ATM based platforms, even the remainder of the Ericsson switch-based platforms, and this thing called the Internet. Now, we were cheap, we were dirt cheap. But even so it was a struggle.

And in the background, you had the continuing privatization of bits of, and eventually all of, Telstra.

That's correct. By then, we had largely privatized, and there was certainly this mantra of shareholder value. But Telstra at the time was still the old, bloated, government monopoly that it always was. It was quite a mind-boggling experience to appreciate that most of the issues inside the company were internal, rather than customer focused.

Thanks, Geoff you're talking about Telstra, right?

If you kind of think of Telstra is one unit, you'd be so wrong. At the time there were four or five separate divisions within Telstra, and they were like medieval fiefdoms. We had been purchased by business and government, which was a group that operated almost in competition, to wholesale, to engineering, to retail and to Central admin. So, bringing the internet into business and government was seen as an overtly hostile move, particularly by engineering. We started having these massive issues around access.

By the time the network had been sold to Telstra, we were in desperate trouble. We had way too much traffic and not enough bandwidth, by you know, a couple of orders of magnitude. And in the end, I was resorting to try and do engineering on the front page of the Financial Review. Basically, talking about the fact that Telstra was a hapless bunch of lunatics who didn't have a clue about data and getting that reported. So, forcing the company to try and get rid of the problem by basically opening up their books on available capacity.

Of course, this is the mid 90s or late 90s. This is 1996 and the peak of the acceleration of the internet boom,

No, the peak was actually a bit later. And this was just really trying to ride the tiger, predominantly at the university use and the emerging dial up modem use. But the universities were by and large significant ones. But the company was a phone company, you know, 64 kilobit calls, all that kind of good stuff, and our demands where, we needed upwards of 100 Megs of capacity down the East coast. And we needed about 16 to 20 Meg's of capacity across the Pacific.

Now, Telstra didn't do it like that. They liked planning 10 years in advance. They liked neatly ordered books. They'd like to sort of take the margins of oversupply on polyphony, and sort of carefully dole it out to the data folk. And I was sitting there going, "I just need not just E1", (which are two megabit units). "I need E3 and I need them now, and I need CR622 meg's and preferably 150, how can you do that?" They looked at each other and go the fibre folk don't release that to product. I am the sort of going: This is ridiculous, you know, you're sitting on top of demand. And so, we fought for about five years on this whole thing about the phone company doesn't do it this way. And it wasn't actually until Ziggy Switkowski became CEO of Telstra, which, oddly enough, internally was a fight at the Board level over the future of the internet within the company, which had pretty far-reaching implications. Because it was only with Ziggy all of a sudden, the Internet got hauled into engineering, but as soon as it got hauled into engineering, all of these issues about access to infrastructure build out magically disappeared. And instantly, we had direct access onto the underlying fibre network, and try it as quickly as possible to take it over.

When did he become CEO?

Oh, God, I can find out. I'm gonna guess around '99 or 2000 after Frank Blunt. It was basically a phone guy or a data guy and in the end the Board picked the data guy. Because I think the Board had enough understanding to realize that the only goose laying golden eggs at the time was mobile telephony, and that was fast becoming a commodity. They either got on the data bandwagon, or they died then and there. It was certainly traumatic times whenever you fight these fights over resource allocations. For every time you win, someone else lost. And we had huge issues with basically the ATM platform. The phone guys were totally wrapped up in a common ATM substrata and a single sort of platform for all of networking. We didn't want any part of that. We just wanted raw data, raw fibre, and to slap routers on it and use routing protocols as being the Resource Management Protocol and to forget about all the rest of this crap that they used to have in their fibre network.

Geoff, could we get back to the early years of AARNET and the extent to which AARNET that was instrumental in ushering Australia into the internet era?

Okay, so it certainly was extremely instrumental. Up until then, things were phenomenally expensive. Leasing permanent circuitry to anywhere apart from Australia was a major piece of investment.

I think it was Melbourne Uni or some of Robert Elz setting up the first internet connection into Australia.

Well, yes and no. What actually happened is the computer scientists picked up a store forward messaging system, which was originally called UUCP. And over at the University of Sydney, Bob Kummerfeld and Piers Lauder changed that into a multi-virtual circuit messaging protocol that we called ACSNET, about 1985 ish. I got involved because I ported some stuff over to Vax VMS from Unix, because there was a lot of folks that still had VAX rather than Unix boxes. Anyway, there was this emerging messaging network based around ACSNET and Digital Equipment as part of its support for university education. This was part of their sales system, underwrote telephone calls between the ACSNET, which Robert Elz had run out of the University of Melbourne and calls to Rick Adams machine at SEISMO¹, the US Geological Survey; Piet Beertema system in Amsterdam, and there was one other but I forgot. So Robert was doing this on phone calls on Digital's coin. Unfortunately, Digital pulled out at some point. It got too expensive or something. The phone calls never hung up. And so, Robert, then with the cooperation of Bob Kummerfeld set up an accounting system, and by '88, they were billing back universities based on kilobytes and all that kind of stuff. But it was still all telephone calls.

Yeah. With modems.

Yeah. In 1988 Digital's major thrust, (which they thought the universities wanted), was to introduce the "Coloured Book" protocols into the Australian university system, based on a UK effort that was underway at the time, which fell through. This was meant to be built on top of the Telstra or at that time Telecom AUSPAC offering X25. But quite frankly, although sorry, Computer Centre directors were sort of 'Oh yes free VAXes", everyone else in the community was aghast because if there's one thing that we knew about "Coloured Book" is that the Americans didn't run it. There was nothing over in the UK that was even vaguely interesting. And even DEC's efforts to do OSI based networking, (DECnet phase five) was a shamble. There was a requirement from the US Federal Networking Council in '88 to provide support to US researchers, who were on various forms of research exercises in Singapore, New Zealand, Australia, and Japan. I think was the first set. And the federal networking council funded NASA to set up a program to network across the western Pacific Rim. They awarded it to a researcher at the University of Hawaii, who then convened a couple of meetings: we called it PATCOM.

The idea was we use NASA's money. And we funded permanent satellite links. From the NSFNET, from the University of Hawaii, across into New Zealand, Australia, Singapore, Korea, Taiwan, and Japan. The deal was they'd pay for one link, but to make it work, each of the countries had to build their own infrastructure. So each of us had to set up sort of a, an Internet internally to articulate what was basically an Internet based service. Trevor Hales of CSIRO visited the first meeting in 1988 and said "Yahoo". But it was kind of difficult to get things going. At the end of that year, we held another conference of network managers, and

¹ ([Centre for Seismic Studies in Northern Virginia](#)),ed

managed to figure out that it was cheaper than we thought and it was actually possible to do this internally with relatively inexpensive leased lines.

And if we did it quite right, using Cisco, quite new kid on the block. But that kind of hybrid router-based switch, we could do this very inexpensively. And so out of that proposal was sort of put forward back to the Vice-Chancellors going: "This is one way of solving your outstanding problem without years of delay, it gets the computer centre directors off your back, and, you know, brings us a service that all of us actually want".

Was there a lot of pent up demand? A lot of inquiries from non-computer science, non techie type people that have heard about this thing called the Internet thing and thought that Australia can benefit from this?

Well, our best friends were the librarians who were spending a fortune. They were hearing their colleagues in the US getting stuff online, and for a lot less than the phenomenal cost of the library systems. The libraries at the time, were upwards of I think 20% of the recurrent operating expenditure of universities and when the librarians said they wanted something, they got it. And so almost from the start, they were very much on board, supporting the efforts of the technologists to basically hook into the US NSF net. It was as simple as that. They didn't really care about protocols, they cared about the connectivity to the other library systems. And that was what was on offer. So, they were the first and most vocal supporters of the effort.

Yeah, so going forward now in time, after you left Telstra in the in the 2000's what have you been doing since then?

I've only ever done one thing and that's I'm the Chief Scientist at a mob called APNIC. We do Internet addresses. And my job is basically measuring various aspects of the internet. Its use of addresses its infrastructure, its performance.

So you are 64 or so now, thoughts of retirement?

No, I enjoy it. As long as work is enjoyable, it's not work.

And that's true. I'm 2 years older than you. And I feel exactly the same way.

Right. So as long as I'm enjoying it, I'll keep on doing it. It's always absolutely fascinating. Part of the reason I think that drives me, it certainly drives many others I'm sure too, is that when you scratch the Internet, what you find is a bunch of ad hoc trade-offs, that no one quite understands why. And investigating the rationale behind those trade-offs, and looking at alternatives and trying to understand where does the sweet spot lie, in terms of performance engineering, is always just totally intellectually fascinating. You know, if you really get down to it, we don't understand packet networks. Never did, maybe we never will. But we certainly don't understand packet networks, yet the entire world lives on packet networks.

So, you know, my current areas are around obviously routing security because, you know, and then it forks off in many areas. The whole issue of web-based security and what security really is, and why it fails. The issues around address usage. And I don't know, the complete refusal of the internet to follow a script: that we're going to run out of 32-bit addresses, we obviously needed 128 bit addresses. 10 years later, we still haven't really run out of 32-bit addresses. And oddly enough, the protocol transition has proved to be insurmountably difficult. The question as to why, is fascinating. The interplay between the various sort of

economic and technology forces is fascinating. And more recently, now the rise of the content distribution network and the death of the Internet as we know it, which is, again, changing everything,

Can you expand a bit on that please?

Almost all of the traffic that people get these days comes from a local data centre. Almost nothing comes from anywhere else, because you had to know, because it would be deathly slow. So all the web content is in cloud services like CloudFlare, Akamai, Google, whatever. Even your email. All those services are hosted, very, very close to you these days. And the long-haul infrastructure, that used to be part of the public Internet is now basically not used anymore. These are private networks that feed each other. So for the last 10 years, the only folks that building submarine cable in terms of the money, have been Google, Microsoft, Amazon, and a couple of others. Telcos have been largely written out of that script. Your packets actually don't travel around the world anymore. The only thing your packets do is travel to the closest data centre and back.

Bevan Slattery is building massive cables from Asia, from Australia to the rest of Asia.

If Google wasn't an investor, he'd be dead in the water. Yeah. Literally, he'd be dead in the water. And he's only living on the margins of Google's interest.

And that whole infrastructure, fibre infrastructure is closely tied in with the growth in data centres.

Well, that's the whole thing and data centres are now the new internet. The largest cable system in terms of capacity in the world Spain to America is basically a 100% Google cable. And this has real implications in what we thought networking was. Because in some ways, this globally connected uniquely address thing that was the internet largely died about 10 years ago. And in its stead is a whole bunch of private networks that feed data centres, and last mile access networks that feed off them. It's really hard to actually send traffic from a user to another user. We just don't do that anymore. Applications don't do that anymore. If you have web content, putting it in Cloudshare doesn't cost you anything. This is a phenomenal shift up the value chain as well. As well as that, applications are busy shutting networks out. These days, what you find with encryption is not just a case of stopping idle eyes from looking at your packets, it's stopping networks from looking at application behaviour. And so really if Google says, who's my enemy? Well, my enemy is actually Telstra, AT&T, you know, Verizon, and all the rest of the carriage folk. And so, applications are basically arming themselves, and asserting more and more control, and the latest protocols like QUIC, that actually armour plate, from application to data centre, totally, and resist all attempts by networkers or anyone else to actually look inside as part of the new architecture of networking,

Because of data security and things like zero trust architecture?

No, it's because Google have spent a lot of money finding out what I'm going to buy, they're not going to share it with anyone. The real issue here is actually an issue called surveillance capitalism, more than anything else. Personal profiles are worth their weight more than gold. It's all your future purchases. And anyone who builds and creates a system that extracts that does not want the users' traffic to be divulged to anyone else. That's why they armour plate up the application traffic.

Can we switch the emphasis a bit to innovation, one of our key questions we ask people is what's the most innovative thing you've done in your career or being involved with either a product or technology and what made it innovative?

Ah, unidirectional, BTP. There was a window of opportunity or a problem flying around that in the mid to late 90s '95 to 2000. The cable systems were not being constructed as rapidly as the demand for bandwidth, so we had a lot more traffic than we actually had capacity to shift. We needed alternative ways of doing it that wasn't on cable.

You mean Telstra or other carriers?

It wasn't just Telstra. Almost every carrier got caught flat-footed. They were thinking about the growth in polyphony, the growth in the Internet was just beyond it all. We turned back to the satellite systems and started to reuse them, even though they were slow. But we actually found this oddity that while cable systems are bi-directional satellite systems are unidirectional. You actually buy a one-way circuit from A to B and the circuit from B back to A as a separate circuit.

Our real problem was importing data, not exporting it. And what we wanted to do was to buy a bunch of 45 Meg unidirectional circuits, from the US West Coast to Australia over satellite. There was a lot of capacity, but we didn't want to pay for the reverse. To make that happen you've actually got to think about how you engineer the two-way loop of data control. I send you data, you have to send me an ACK, you don't send me an ACK, how do I know you've got the data. And so somehow, we needed to use the cable systems for the reverse flow, but actually deploy a number of satellite-based circuits to fuel the demand for inflow into Australia.

And the reverse was simply ACK. So you didn't need much bandwidth.

Huge data packet, tiny ACK. The ratio is something like 10,000 to one. I managed to find a way of doing this using the routing protocol, and a big fat loop that actually went from the earth stations, which at the time were in behind Vancouver, across the satellite into Sydney. And then the reverse was actually back through the cable systems up onto the West Coast and up to Canada. With enough jiggling around of the BGP protocol, you could actually make it work so that if you ever had a satellite lost, the system would know it was lost, even though it's unidirectional. But while it was working, it was able to fill the pipe. I think it says a lot about the fundamental design of the protocols that the Internet was built with phenomenal elasticity. You know, my early work with DECNet, everything interlocked with everything else. And it was impossible to cleave out a component and play with it. With the Internet, everything was decoupled. Routing was different from forwarding, even the TCP Control Protocol, you could use anything, and the rest of the Internet won't care. It was only possible to take the routing protocol and repurpose it to use unidirectional lines. I was quite pleased with it. It solved the problem for about four years and then Sprint International sold it into Africa for the next 10 years.

So you commercialize the product?

No, we just published it. Yeah. It solved the problem of the sort of gap between bidirectional fibre based infrastructure Earth infrastructure, and the delays in getting enough.

And at the time, did it become a product as such?

I published it to the world, it was Sprint that made it a product. But, you know, at the time, we thought we were doing things for the good of everybody. Yeah, it wasn't, it wasn't a personal get-rich-quick scheme.

So you think that this was a major advance at the time?

I solved a problem. It solved our problem for about three years. There was no other way we were going to solve it. So yes, it solved a problem.

Is that widely recognized as a major Australian innovation internationally?

No, it's an esoteric piece of engineering that solved that particular problem at the time. As you are asking what did I do? That's what I did. Yeah.

Who commercialized it?

Bob Collet of Teleglobe Bob Collet from Sprint.

Where are they based?

Well, they got bought, and bought and bought, bits of Teleglobe, which was the Canadian version of ATC ended up in TATA. Sprint, God knows where Sprint ended up.

It was an innovation coming out of Australia that was then commercialized overseas?

Look, it was a cute hack. And, and, you know, it was published as a cute hack. Because we had to work with Sprint to make it work at the time, Sprint then they just took it on and did the same hack elsewhere. And at the time, as I said, it was an effective hack that just got over a problem with the lag of terrestrial infrastructure, and the oversupply of satellite infrastructure. Part of the issue about satellites, I don't know how much you are aware of the way they work, is that you launch the spacecraft and it actually has beams, spot beams to the various parts of the world. Now, when you first launch it your business case is, major centre to major centre. But as soon as those centres get fibre, they are no longer a customer of the satellite. So the satellite now has this extraordinary amount of capacity. It has to seek more and more module markets, because it's still got capacity. And the issue is, then it needs to soak up these residual markets because the major markets have been serviced by fibre. The problem was that the technology model used by satellites was actually based on two major customers: telephony, bi-directional, and television, one up multi down. And what I wanted and what a number of countries wanted, was a bunch of data - unidirectional, to complement fibre. And it was this really stopgaps while the fibre guys managed to lay more fibre eventually.

Do satellites have a major role in data communications nowadays?

Not the geostationaries anymore. It's too slow, too high. Yeah. But watch out a lot for the LEOS.

Low Earth Orbit.

Yeah, the Low Earth Orbiting Systems are going to make a lot of the existing terrestrial folk extremely nervous.

And there's been a few people trying LEOS over the years. There's been some spectacular failures. Who's ahead at the moment?

If SpaceX, if Elon gets it up, it will be a chilling story. The Iridium story is an education here. Well, well it failed. Because of the resistance from the terrestrial providers like Telstra, that refused to give them license to operate in their country because they saw these Low Earth Orbiters that had made all their money in America, whenever the spacecraft was over Australia near, no price was too low. Because, you know, all the money, all the original money had been soaked up in America. So, yes, Telstra was very nervous. And I think today, when we look at 5G and so on, we're going to have a real problem terrestrially. But upwards is actually astonishingly clear. Yes, there's a few clouds here and there. But if you have 11, spacecraft visible from horizon to horizon, as they fly overhead, you can do a phenomenal job. And, you know, in some ways, the LEO story, if you can launch them cheap enough and keep them up long enough, is seductively cool.

So how far away are we from this happening to us?

That's a good question. They're launching right now. And they're certainly putting up the spacecraft. They're doing the cross-satellite linkage. And the folks who are most interested in it right now, the day traders, you know, the millisecond traders, because obviously, it's as fast as hell and we can't do this any other way. But the soaker money is actually going to be in direct one on one competition with so called 5G. And it's, it's highly likely that that competition will become quite fierce, as long as launch costs stay as low as they are. Elon, because of the reusable spacecraft, has got a phenomenally low launch cost. Easy.

Switching the focus, in hindsight, what sorts of things could have helped you in your career? What sort of factors might have helped or hindered you? Or have helped or hindered you? External factors? Government support? The Australian psyche? The financial background? What would you say are the key driving forces or hindrances to your career and technology and innovation generally? Big question.

Okay. It always struck me that the bureaucracy, particularly associated with the university sector, it was called the Department of Science or something, was difficult. When trying to say here is a truly innovative and advanced piece of technology, the universities can't build this on their own, they need your help, the answer was pretty stony silence.

And that silence from government, business community, bureaucrats?

They seem hell bent on recreating the halcyon days of the 1950s. Yes, it was impossible to sort of get them out of their rut of the way they thought. I found the university system incredibly supportive of this kind of innovation. They were willing to take risks. There were some risks but I don't think it was that much of a risk. They looked at us and saw this thing going gangbusters. And it was kind of: we really need to be there. But trying to convince the funding structures in the Australian system was incredibly difficult. Unlike the US, the centralized funding model is broken. The model of funding for research in the US is incredibly effective. And I suspect that things like Silicon Valley, are actually a product of that environment. They weren't a one-off sort of outcome of the transistor. There is a hell of a lot more willingness to take risks in research. Whereas the Australian system is hell bent on funding the folk who already have a track record, which is the same as saying they're hell bent on funding yesterday. And they just refuse to really give innovative high-risk prospects a look-see, and this just continues.

Has it improved?

I don't think so. Not in the slightest

I remember the difficulties in making a case for the internet, we could never have done it had the US not led the charge with the NSF net. The NSF net did it because they're willing to take a much bigger risk. They're willing to take their entire national infrastructure and give it a try. We would never ever, have done that, had they not gone there first. Well, I'm glad we did it. And I'm glad we did it as quickly as we did, I think that was actually very worthwhile. It was disappointing that we actually needed an exemplar and that we're unable to do it on our own. The other part of this was Telstra. No utility sector in this country has any vision. They weren't just pedestrian, they were pre-historic. And I even sense today that the efforts to try and recast the company's fortunes strike me as a 1980s solution. It's just decades behind what's needed for communications infrastructure. They refuse to accept the fact that comms is like sewerage. It's a utility. And the kerfuffle over the NBN, it needn't have been like that. But somehow, we managed to spend a lot of money and still not do it right.

There are a few things, politicians should never build infrastructure, point A. Point B, you can't get a 20% return on capital, when you put fibre in the ground, think 1%. And be grateful. You know, this is like water and sewage, you just need it. You really need it. But it's not going to pay you rich money. What happens is everything else layers on top of it. And that's what makes money. And the inability to see that and the whole idea that since mobile's made so much money, everything has to be like mobiles. It's the kind of backward and imaginative prehistoric thinking that holds us back every time. Why can I get 100Mbit to my house for 10 bucks a month?

Yeah, yeah. Why can't we?

Sounds cheap. I always found Telstra to be a classic example of the way you'd buy a Hyundai Excel. They would buy a Rolls Royce, ship it to your house, and then strip out everything and leave you with the chassis and the wheels and say "Here you are, here's your Excel". They bring fibre to your doorstep and then spend a fortune making it go slow. And the whole answer was you didn't need to make it go slow. You've rolled out the fibre, let's just use it. But the mentality was just completely backward. And as I said, quite frankly, that was that was the major throwback that the folks who run these companies and their boards are just totally inept and incompetent, and not up to the job.

It's not an Australian characteristic or a human characteristic.

I'm only familiar with Australia. I have seen more adventure in the US and much more risk taking. Even in their major corporates, I've seen a much greater willingness to engage. The only counterpart that I ever found in the US was stodgy old AT&T. But everyone else was kind of there inside our meetings, talking our language, you know, trying to innovate even more than we were.

And AT&T had Bell Labs.

Well, they did and Bell Labs was great. But that wasn't AT&T: the company. You know, most of what we're living with is a Bell Labs by product. But a bit like Xerox invented so much good stuff, but they are still a photocopier company, AT&T had Bell Labs and spent all their time trying to basically deny that they existed.

Can I just come back to the NBN rollout? A couple of questions. I wrote a couple of op eds at the time when the Liberal government reverted the decision to roll out fibre to the premise. And there were two things that struck me. The first one was the short sightedness of rolling out infrastructure that at the time wasn't fit for purpose. I want to challenge you on one thing, in order to roll out first class infrastructure across the board, wouldn't it be up to governments at least to subsidize that because businesses would cherry pick the high value connections and then basically stop. And the other question was, it seemed to me completely ludicrous at the time to do a cost benefit analysis by going to customers and ask them what they wanted or what they needed. Right when we were building for the next 20 years. Can you comment on those?

So my house has potable drinking water? And every house, bar a few thousand, has the same and we paid for that? How do we do that? It wasn't the national program, but it was a program, predominantly in the states, of infrastructure investment. And they used investment bonds because it doesn't make zillions of a percent per year. But everyone wanted it. Now my house has electricity, there are wires running all through the suburb, again, who funded that? I house is connected to gas who funded that. And by the way, I've got a sewerage line. Now, I would argue that all of those four cost more to service my house than a lousy pair of fibre lines. So why is one considered to be this vast political problem, and the others were just seamlessly solved. And I for one, kind of think that part of the issue was: the monster that was Telstra. And because they squatted across this, and literally spent a massive sum of money preventing us from treating infrastructure, like any other utility, it's just fibre let's get it over with. It became the monstrous political battle.

So they treated it as a product, right? Not as an infrastructure.

No, they treated it as their death. And so that's why they fought tooth and nail to stop it everywhere they could.

The NBN itself?

Yes. This was the legacy of Sol Trujillo here. And again, if you go back even further, this is the Australian attitude that Australian CEOs are a bunch of, well, you know what I mean? And that we need an international CEO to really do something. And so while they had perfectly competent CEOs in the telecoms business, when they were trying to grapple with the Internet, they went and got this Sol Trujillo person, because he was American, and a bit like the way Bob Joss raped Westpac. Sol Trujillo raped the entire comms environment. It takes a special skill to piss off the left, and the right, and the bureaucracy all at once. And Sol managed all three. So by the time he left, everyone said to each other, Liberal, Labor and the bureaucracy, Telstra has to die. So when in 2007, they were looking for 2008, large government programs that were going to basically spend their way out of this problem of the great financial calamity. Killing Telstra was high on the list because they got infrastructure, and they killed this monster that was the Telstra that piss them off completely. Now politicizing that then created the problem for Turnbull that he had to do something different than fibre. But different than different than fibre, like, really, you know! And so up came this is absolute pig's breakfast of a network. That's neither one thing nor the other, that still uses high speed electronics sitting in cabinets out on curb side, and crappy copper for the last 200 yards, just to make sure that the network doesn't go fast. Whereas all my mates in New Zealand can get 10 Gig for 60 bucks a month on demand. Yeah. So you know. So

I'm using Optus, 4g, wireless broadband.

The whole idea is, we're all trying to get into the one Ferrari, but there's only one seat. So you can go fast, or I can go fast. But there's only one seat, we can't both do it together. The whole way, why 4G and 5G go like the clappers is that you take over the entire base station, and the lot, and it's kind of: well, that's really good for infrastructure, isn't it? The answer is well, no, it's not. It's complete crap.

I can go here A little bit about your impression about other people that make things because it's all teamwork and team efforts to make things a success. So when you are hiring others, what skill sets are important to you? What qualities are you looking for in people and how would you identify them?

Oh, I'm special. I find it very difficult. And certainly after Telstra, I never wanted to build a large team ever again. They were a source of deep disappointment to me. I have always worked in teams of at most about four people. And I want capability, imagination and personal responsibility: so that I'm not doing it, they're doing it. And we have a debate rather than I tell them what to do. I find that rarely, very rarely in people. But I think I'm way too demanding.

How would you describe that characteristic? What would you call it?

OCD? Yeah, I'm a coder. And I want coders who are also phenomenal coders, but also have cross disciplinary skill. In other words, not only can they code it but they understand why they're coding it and what it's good for. I want folks who can challenge me and challenge the rest of the world at the same time. And, you know, those are few and far between, but occasionally, when you meet folks who are really, really good like that, it's electric. There are only two of us in AARNET. There's only me and Pete and I would class Peter Alford in that kind of category. We both pushed each other extraordinarily hard. And I'm not sure there was anyone else in the country who was apt to be so. I find it very difficult to develop folk, I tend to look for folks who are already exceptionally capable, in all kinds of ways, but exceptionally capable, and match them and work with them if I can.

And have you found such people as sufficient and large number of them?

Well, the Internet's always had quite a number of them that are awe-inspiring. I have always enjoyed working with Vint Cerf, that guy is a sideways thinker, like you'd never believe. And he is constantly challenging. But yeah, there were very few such people in this area. And I don't know how they made, but I certainly am on the lookout for them. Because those are the folks that interest me. And, you know, those are the folks I enjoy working with.

Thank you.

I do a lot of work with Google in measurement. And Vinthas been a strong proponent of my work inside Google. And I think largely instrumental in the fact that, you know, it still happens.

And what sort of work you're doing with Google have you done? How do you measure the internet?

Yeah, how do you measure the internet? Exactly. And in actual fact, most of the measurements that we see are all bullshit. About the only way you measure the internet is to literally get millions of people every single day all over the net, to do what people do. And so somehow, you've got to get folk, resolving DNS names, trying to get to places and measure

their experience. Now, folks don't like to run the kind of software we've tried in the past, and no one runs it. But I came across this system, where you can use ads and paste the script in them. And it's not a difficult script. It's clever, but it's not difficult. And the script basically goes and get some URLs, and then reports back. And I use Google to spread this script around the world, about 10 million a day. It's a hefty amount. Say if I want to measure V6, and I do, then I make sure the only way you can get this thing that it is trying to get is if you have V6. If you don't have V6 you will report failure. I want to see if you've got both protocols V4 and V6, which one do you prefer? Well, I set up something with both and see which one people choose. But it's sort of weirder than that. There's a new security protocol for the DNS. God knows if users need it, called DNS sec. So I set up something that is signed with DNS sec –badly-. You shouldn't be able to get this URL because security says don't go there. And I measure how many people get there. It's kind of whoops, you're not doing things right. And so, I can tell you, for example, that Optus have deployed DNS security for their customers in their network and Telstra have not. I can do the same for every single network all over the world. So Google supports me with that, they fund sort of half of the ads, which is really good, because ads aren't cheap. They are relatively cheap, but not free.

That was my next question. Have you commercialized this and your work? Are you a consultant to or a consultant for Google?

No. I've never been in this for the money. I don't know why, maybe it is my university background. But it's something we all need to know. That's why I do it. These are the few measurements because most of the measurements that folk do are private. Google disclose nothing, Microsoft disclose nothing. Amazon disclose nothing. So when you say how's the internet today? The answer is, well, Google might know. But I don't know. Google say they've got Google Analytics, and that they're helping people analyze their web traffic. But that doesn't talk about the internet, that just talks about you. When you want to actually understand performance, understand reliability, understand security, understand all kinds of things, you actually need open measurements about all of the internet. And humbly, I think that that's what I do these days. Because my stuff, the answers are always published, there's no, “this is a super secret”. It's not. And it's trying to actually understand how the internet is working, and what things aren't working and why.

And is there a demand from Google and others for that sort of information?

I publish it, I don't sell it. So it's there for anyone to see. I know, Google is certainly interested in aspects of this. For example, did you know that one quarter of the world's users send their queries to Google's public DNS resolvers. Now, if you think about the fact that the DNS knows more about you than you know about anything else, because everything you do starts with a query to the DNS, whether it's an ad, a URL, email, everything starts with the DNS. And if one quarter of the world's users sent their queries to Google's DNS, they don't need any other intelligence. They know the internet more intimately, and they know you more intimately than you know yourself. I'm not sure anyone else had mentioned that. But I'm pretty sure no one else had mentioned that, because it's a tricky measurement. But it's an illustrative measurement of just exactly how far Google has got in terms of reach across the entire network. Kind of scary.

Now, I've broached the subject a little earlier, but specifically, is there any, (you are rightly critical of Australian bureaucracy) politicians, are there any positives about the Australian psyche, or the Australian makeup that has helped us over the years as a nation?

I think the whole the Internet has been like, you know, delivering water to the desert. I think there's a huge amount of cultural cringe. There is a huge amount if it's invented somewhere else, it must be better than what we're doing. And I think a poor appreciation of our own skill sets,

You think that's important? Or is that still the case?

I think the Internet has dragged us into the middle of the world. I think it's glaringly obvious where our strengths and where our weaknesses lie with others. And we no longer automatically assume a cultural cringe. We can compare and contrast ourselves to other economies. Geez, this last election, other political systems, and understand where we have strengths and where we don't, but do so without the automatic assumption, that we're an isolated group of folks in the wrong end of the Pacific, that are constantly isolated. I don't think we feel isolation in any sense. You know, and I think that's astonishingly good. I think the international consultant that tells us what to do is hopefully a thing of the past. Yeah, yeah. I think even that cringe that employed Sol Truhillo, and Bob Joss, I would hope is a thing of the past.

I've seen it in my career as well. I'm in a slightly different perspective than yours and technology journalists and market analyst, but it's certainly improved.

And I think that assertion of understanding our strengths and weaknesses without an automatic assumption of weakness has been a cultural shift within a generation I think the Internet has largely bought that about by simply exposing the rest of the world, rather than seeing it through the eyes of television.

Yeah, yeah. Sebastian, Kai, do you guys have any more questions?

I think we can move on to the question of the highlight. But maybe you want to ask that Graeme. Well, highlights in your career and disappointments?

I think the biggest highlight was spending two weeks travelling in 1990. Peter Alford, and I jetting around the 48 university campuses, and literally wiring up an entire national network inside two weeks. And we had done enough spadework that we're relatively confident that when we did it, it would just work and it just worked. That was an astonishing highlight. I found the sale to Telstra to be, at the time, very disappointing. But I realized, I suppose in retrospect, that the university system was never going to build a national internet. And it had to be Telstra. And that was the only way of doing it. So what was I suppose a disappointment in mid 95, was that the university system just couldn't keep the balls in the air. After the initial shock of joining Telstra, I took on a mission to try and beat some sense into them. And again, by about the year, it took a while. 2002 we were kind of there. But oddly enough, I mean, the price of success is no one listens anymore. Yes. Great, because you got nothing new to say because they all know it. And what I found in Telstra was, by the time everyone had picked it up, it was sort of well, I wasn't anything special. But you know, in some ways, that's okay. Because if you had something new to say, eight years later, you've obviously failed for the last eight years.

Do you feel you've got the recognition you deserved? Your career?

Um, I was never after it? Yeah. No, honestly. I've never been after it. This is, you know, I live in Canberra. I live in an isolated country town. This is not a recognition issue. It never was. For me, it was, it was a case of doing something because I really love doing it. And being passionate about it, because I'm really passionate about it.

Yeah, I can tell that.

Right, but it's not. It's not what others think of me. I'm sure they're very many opinions of me. And that's okay. It's not recognition.

I think you are reasonably regarded Geoff. Okay, you said you were disappointed when you moved to Telstra, but ended up staying there 10 years, I suppose you couldn't really do much else with your skill set.

Look, I dallied with Cisco, I dallied with a few of them. But, you know, I'm not a sales guy. I'm not a marketing guy. I'm a geek. And if the universities were building the internet, Telstra was and I spent, you know, the first eight years of that time, basically geeking it out and fighting geek fights, and thoroughly enjoying, I suppose, the cut and thrust of technology. The period in APNIC has been weird, because I'm not building much. But on the other hand, I'm operating, probably the largest measurement system on the planet. And you know, I'm enjoying doing that. And it's, it's challenging. And I suppose underneath all this is this attitude: that the telephone companies used to promote the idea that technology was a book, it was like a Bible. It all been written before. And you just had to follow the instructions. I was always impressed when I first started going to the internet meetings that a whole bunch of folks that I looked up to, were willing to say, we don't know. It's just a conversation. You know, the stuff we do, we might change in a year's time, we certainly haven't got it right. We're just throwing a dart at the board and we might throw another. And I've enjoyed the fact that technology is a conversation, and that it's amenable, and anyone can join that conversation. It strikes me as really cool. I was always astonished that the Americans way back in the early 90s were willing to invite others including, you know, opinionated Australians to the table and listen to them. Now this never happens. You colonials go away. So that's the way we were treated with OSI and those sorts of efforts. But the Americans were much more open and welcoming and willing to sit down and listen to you and debate it through. I found that to be refreshing and I still do. So yes. Technology is a conversation rather than a, you know, something that's preordained. Yeah.

Sure. Geoff. If the government came to you and offered you an advisory position, with an open ended, sort of brief to say, look Geoff, what can we do to sort out the digital infrastructure? We want Australia to become a major Innovation hub? What would you advise them_ to start?

There's the short term and the long term, I'd start putting a few chairs of comms in universities, because we don't teach any of this shit. And I think that's a crying shame. And so no matter what you do, tactically, you're going to be left in five years' time going, where do we go from here, there's no core of intelligence about how these systems architecturally work, to understand where to go next.

So these are engineering type chairs?

In technology, whether it's engineering, I really don't care. But in some ways, we don't teach networking in any university worth a damn, and haven't done for 30 years. And it's kind of a

crying shame, that we've never really pushed this area. This is stuff that is useful, almost necessary to understand. And I see other places all over the world with phenomenal infrastructure and investment in this area. The French are right into it these days, the Poles, the Czechs. That's the first thing I would certainly be interested in trying to create a bit of infrastructure, but I'm wondering whether it's the infrastructure, or the venture funding to see good ideas, because we only back winners in this country. And the winners are generally conservative rather than adventurous. And so I look at other places, Skype, for example, and the way it came up was accidental. And some of the most astonishing, I suppose, blindsiding, revolutionary technologies, are so blindsiding because they're unexpected, and they're unexpected, because no one was ever willing to fund them as a conventional exercise. I'm not sure if I would build more Macquarie data centres. Boring! Or I would actually create venture capital funds, and actually head them up with folks who graduated in the last five years, who are willing to take absolutely crazy ideas. And because it's a venture, 95% of them might die. But all you need is a couple and you've created a different kind of culture. I see other countries going down this path in various degrees of success. But that would be certainly the way I would look at how we could create a more positive culture that embraces where we're inevitably heading, you know, and comes to grips with it more quickly, and more productively, rather than just being treated as a nation of 27 million consumers. Which is the danger.

We're about out of time. Geoff, do you have any more comments, observations along the lines of what we've been talking about?

I don't think we ever understood what we were doing. And I'm not even sure we do now.

We being?

The technology fraternity. And, in the same way that we trusted Telstra to always produce an accurate bill every month, we kind of believe innately that Google and Akamai know what they're doing. The dismal reality is, of course, way more prosaic than that. And I'm not sure we are fully aware of the need to be skeptical, and in some ways, slightly less accepting than what we are. Anyone who looked at the Boeing 737 MAX 8 saga would have to realize that building complex software systems doesn't necessarily always give you the right answer. And as we, increasingly, just push networking, programming and comms across our world, I think we're becoming way too uncritical about the way it's being pushed. And less, I suppose, curious about how it's put together and understanding the robustness of the processes that got us there. I suspect the next 20 years is going to be horrible. Predominantly because all this crappy software is going to destroy a lot of our infrastructure before we get it right. And, you know, I suppose my messages in some ways ...

In what sense destroy Geoff?

The largest attack that was ever launched on this planet launched a couple of years ago, used absolutely shitty software in baby webcam monitors, to launch a Terabit attack on critical infrastructure. It wasn't the critical infrastructure was the problem. It was the fact that folk bought \$100, baby cams that work just fine as a baby cam. But they were connected with a public internet access with a known root user password that used a thing called BusyBox that anyone could reprogram. We sold millions of these units a day. And so we're populating our world with shit. Just absolute unprotected shit, and the mechanisms and intelligence to understand what's going wrong and why just aren't there. I don't understand, I don't think anyone knows yet how we try and curb that problem. But by God, we've got to. You can go a

bit further and look at the security infrastructure. What makes your bank your bank? Because I can tell you right now, you're banking with the Commonwealth Bank, you're not? You're banking with the Bank of Akamai? How do you know it's Commonwealth Bank behind that Akamai IP address- behind the Akamai engine? And the answer is scarily bad. You don't. You just hope. We've got to do a better job. But at the same time, we've got to be, I suppose aware that better jobs need to be done. And part of it is we have this sort of awe of technology: Oh it's difficult, it must work. These boffins are in charge of it, they must know what they're doing. I think we need to be a little bit more skeptical about those kinds of claims and actually be willing to challenge them and demand more.

Okay, where would you even start? Education? Regulation?

Isn't that a great question? No, I'm serious. No, no,

I'm with you.

These are the questions of our time. Because another bright, shiny new Australian Cyber Defence Centre is a waste of 350 million bucks. That's just burning money in a bonfire out the back. But if I could spend that money in doing better codes, in actually thinking about what regulatory mechanisms might impact the market, understanding the economics of technology, we might actually be able to have a better idea of how to exercise control functions that lift quality automatically. Because if we don't do something like that, all the Cyber Defence Centres in the world are just simply watching and documenting the disaster. They're not averting it. They don't have a chance in hell.

That's a wonderful point to end on.

No problem.

Thanks so much. Thanks, bye.

End