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Broadband bottleneck: History Revisited
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Abstract
The vexed issues currently surrounding broadband policy in Australia remind us that the public sector has a great track record in building valuable telecommunications infrastructure. One lesson from the past 150 years is the constructive role played by the public sector by providing the vision and seeding capital for the creation of three major communications platforms: Australia’s overland telegraph in the 1870s, communications satellites funded by the National Aeronautics and Space Administration (NASA) from the 1950s, and the early internet, funded by the US government from the 1960s to the 1990s. But times have changed and new policy models have emerged. Australia’s telecommunications public policy decisions during the past decade have locked us into having few choices for broadband. The sad irony to date is that the introduction of the open competition model in July 1997, its associated regulatory framework and the full privatisation of Telstra have actually made us less efficient in investment and impeded the development of the broadband networks we need. We might just benefit from revisiting some lessons from history.

While most of Australia’s trading competitors have embarked upon building high-speed broadband networks during the last decade, we have been unable to follow their lead.

The reasons behind Australia’s broadband bottleneck, which has followed on from the introduction of open competition in 1997 and the subsequent full privatisation of Australia’s dominant carrier, Telstra, are complex and only partially examined here. Rather, the thrust of the article is to revisit some of the lessons of history and argue that the vision and capitalisation for the initial construction of the major new communications platforms throughout the past 150 years largely emerged from some remarkable individuals, and the unheralded role of effective public policy decisions in their creation.

First, a quick reminder of the recent past procrastinations with broadband. The much-awaited Telstra Strategic Review, announced by newly appointed Telstra chief executive Sol Trujillo on 15 November 2005, suggested that future fixed-line business growth might be limited, that mobile communications were likely to continue to be an intensely competitive space, and that the future principal growth in telecommunications was with integrated IP-based value-added services.

In the accompanying Telstra Technology Briefing, the new Chief of Operations, Greg Winn, outlined the corporation’s technological vision for broadband: The sort of things that will be available are things like high speed internet, voice over IP … the possibility of TV delivery over IP, telecommuting, video
conferencing and video delivery of services in general … There’s really two dimensions key to access. What we are aiming to do is deliver a capability which is fast so speed is important. The second part of access is really about capacity. As more and more customers use more and more of these sorts of products they start to demand more and more of the infrastructure and the dimension of their actual core network and the access network … So what are we transforming access to? Well first of all we are transferring it to a high speed broadband capability. (Gration, 2005)

However, the announcement nine months later, in August 2006, of the discontinuation of negotiations between Telstra and the Australian Competition and Consumer Commission (ACCC) about Telstra’s proposed investment in a fibre-to-the-node broadband network appeared to contradict this vision statement. The corporation announced that, ‘until Telstra’s actual costs are recognised, and the ACCC’s regulatory practices change, Telstra will not invest in a fibre to-the-node broadband network’. The new management team at Telstra defended its decision on the grounds that the corporation could not achieve adequate guarantees of regulatory certainty to justify such substantial investment (Gration, 2006). And from this time of the promise of ‘transformation’ by its new management, Telstra steadfastly refused to embark upon new investment in a fibre to-the-node broadband network until government tenders were called in mid-2008. Its competitors, notably Optus, were also part of the major broadband infrastructure ‘investment strike’ that had come since open competition was introduced. This was not comparable with the way most of Australia’s trading partners were acting with new broadband rollouts in their countries.

So let us now turn to seek some possible lessons from Australia’s proud telecommunications history of achievement, and also examine some related overseas infrastructure accomplishments. Three historical case studies have been chosen: first, Charles Todd, the South Australian government and the overland telegraph in the 1860s; second, communication satellites and the National Aeronautics and Space Administration (NASA) in the United States from the 1950s; and third, the origins of the internet in the United States in the 1960s.

Charles Todd, the South Australian government and the overland Telegraph

Charles Todd (1826–1910) was born in Islington, and became assistant astronomer at the University Observatory in Cambridge in 1849. He and his wife Alice came to Australia in May 1855, where Todd took up the position of Government Astronomer and Superintendent of Telegraphs for South Australia (Thomson, 1999: 1–10). Even before arriving, he was possessed by the notion of an overland telegraph in Australia. At his wedding, he said ‘one day he would like to see a telegraphic string stretching around the world, like the necklace of pearls around Alice’s throat’ (1999: 10).

Entrepreneurial international telegraph companies proliferated in the 1850s. They had mixed fortunes: some grew, others went broke or were bought out, and some split up with changed names. In 1855, two British entrepreneurs, Brett and
Carmichael, who had built the Channel cable, suggested to colonial governments the benefits of linking into a variety of proposed overseas cable lines. However, it wasn’t until 1858 that the American promoter Lionel Gisborne approached the British Secretary of State for the Colonies with a scheme to connect the Australian colonies with a proposed Dutch cable from Batavia to Singapore and Port Essington in Northern Australia (Moyal, 1984: 36–37). Though the overseas cables were privately owned, the construction of the Australia’s overland telegraph was not accomplished by a private sector company with private capital, but by public sector planning and public capital.

In 1858, nobody had crossed the continent: the inland deserts were completely uncharted and there was still talk of an inland sea. Todd thought that it was impracticable at this stage to launch into an overland telegraph (Moyal, 1984: 36). Different interests favoured different routes, and there was much competitive rivalry between the colonies. Victoria liked the route from Ceylon to Western Australia via the Cocos Islands, but New South Wales preferred Gisborne’s route, linking up overseas from Port Essington in northern Australia to Moreton Bay on the east coast. Understandably, there were many sources of uncertainty. One was the evident fragility of the cables that were laid. Between the United Kingdom and Europe in the early 1850s, and between India and Ceylon in the late 1850s, there were frequent interruptions because of damage to the cables (Livingston, 1996: 48). Technology clearly had some way to go before the service could become reliable.

The Governor of South Australia, Sir Richard MacDonnell, swiftly grasped the political advantages of hosting a telegraph route and favoured a Timor–Adelaide route. He consulted Todd about the proposed scheme, but at this stage Todd preferred Gisborne’s alternative.

In 1860, at the South Australian government’s request, Todd drew up an estimate of costs associated with an overland line from Port Augusta in South Australia to King George’s Sound, near Albany in Western Australia. While he did not dismiss the King George’s Sound option, he reported that he was ‘more than ever disposed’ to believe that ‘we shall yet connect ourselves with India by an overland line to the northern coast, and thence, by a comparatively short submarine section to Java’ (Moyal, 1984: 38). In 1859, the South Australian government offered £2000 to the first person to cross the continent and reach the north or northwest coast. John McDouall Stuart had taken up the challenge. It took him three attempts and much illness and hardship to reach the northwest coast at the Mary River in 1862 (Moyal, 1984: 38–39; Morris, 1976). The party arrived back in Adelaide in December 1863. During a public holiday in Adelaide the following January to celebrate his achievement, ‘crowds lined the streets amid banners strung from buildings’ (Morris, 1976).

In the preface to his published journals, Stuart attested to the feasibility of a telegraph line through the interior. Todd also now became more positive about an overland route, despite the evident difficulties of establishing and maintaining it (Moyal, 1984: 39). The South Australian government, with Todd’s unequivocal commitment, entered into negotiations with the British Australian Telegraph Company (BAT), promising first that it would finance the construction of the
overland line, and second that it would have the line ready for traffic by 1 January 1872 or pay penalties at the rate of £70 per day. The Port Augusta to Port Darwin Telegraph Bill, empowering the construction of the line, was introduced on 8 June 1870 (Moyal, 1984: 41–42; Thomson, 1999: 50–53).

Todd set down all the instructions himself, guiding each aspect of the expedition: care of horses, oversight of the men, care of the tools and instruments, how to plot the route, even where to find water. The line was eventually finished in August 1872, eight months overdue. According to the original agreement with BAT, this should have meant the payment of a large sum (nearly £17 000 — or £70 each day from 1 January 1872) as a penalty. But the overseas cable line laid by BAT in November 1871 failed in June 1872 and was not restored until October, well after the overland telegraph line was completed. The issue of penalty payments lapsed (Moyal, 1984: 51–53).

Whose vision and whose benefit?

The great attribute of the project was that news could then reach Australia from Great Britain within a few hours, rather than taking three months by sea. Key beneficiaries in Australia were colonial governments, the metropolitan press, and commercial interests (Livingston, 1996: 51; Inglis, 1980). Governments were heavy users: in Victoria, government telegraphs accounted for between a quarter and half of all telegrams in the first decade of the service (1854–64). The press also used the service extensively: overseas newspapers had been delivered at Adelaide and there was considerable rivalry between agents to telegraph the contents to the eastern colonies from the telegraph station at Port Adelaide (Livingston, 1996: 51).

There is no doubt that Todd himself had a vision of international telegraphic communications, even before he came to Australia. The South Australian Governor, MacDonnell, seems also to have had a real and substantial influence over the decision to go with the north–south line. But it was, of course, the government that enabled the vision to be realised, as the parliamentary extracts make clear. Economic rationalism was not a term in vogue in Australia in the 1850s, but had it been, someone would no doubt have pointed out that Todd estimated the full cost at establishing the overland telegraph at £120 000 (Moyal, 1984: 41). This amount eventually blew out to £479 174 — a figure arrived at in 1884 (Moyal, 1984: 55). It is interesting to compare the amount set aside for the telegraph with some other items of expenditure for the South Australian government at that time: the civil list (£15 800), charitable institutions (£55 444.18.10), telegraphs (£12 275.14.11), railways and tramways (£104 525,10.4), roads and bridges (£27 820.8.10). These documents suggest that total government estimated expenditure for 1870 was £736 160.5.0. Hence the eventual overall expenditure of the overland telegraph infrastructure was then as much as 60 per cent of the total cost of one year of the state government’s budget. Contrast this today with the current fibre-to-the-node $4.7 billion broadband proposal that would cost the Commonwealth government, in 2007 data, about four months’ revenue — not of its overall annual income, but merely its surplus!
Communication satellites and the National Aeronautics and Space Administration (NASA)

The United States has a long, proud history of being the most highly privatised media, information technology and communications sector in the world: the gigantic American Telephone and Telegraph company (AT&T) dominated the telecommunications industry for most of the twentieth century. However, the remarkable innovation of communications satellites does not owe its origins to the private sector, but rather to strategic initiatives taken by the American government during the 1950s.

As early as 1945, Arthur C. Clarke (then an RAF electronics officer) had proposed in an article in *Wireless World* the use of manned satellites in 24-hour orbits to distribute television programs. In 1954, John R. Pierce of AT&T's Bell Telephone Laboratories anticipated that a communications satellite could carry as many as 1000 simultaneous telephone calls (Pierce, 1968: 108). The trans-Atlantic cable at the time could carry 36 simultaneous telephone calls (Whalen, n.d.(a)). The successful launch of Sputnik by the Soviet Union in October 1957 (Whalen, n.d.(c)) precipitated a crisis in the United States. Forced to realise it was not pre-eminent in this sphere, it launched a powerful program intended to make good this deficiency. NASA's account explains what followed:

The Sputnik launch changed everything. As a technical achievement, Sputnik caught the world’s attention and the American public off-guard … The Sputnik launch also led directly to the creation of … NASA. In July 1958, Congress passed the *National Aeronautics and Space Act* (commonly called the *Space Act*), which created NASA as of October 1, 1958 … (Whalen, n.d.)

So the immediate response from the US government — including the establishment of NASA and all that flowed from that — had more to do with political and public imperatives than scientific considerations, and certainly more than commercial imperatives.

The initial focus of the NASA program was space exploration rather than communications development, but the two were obviously linked. Kennedy mentioned communications satellites in his famous Man on the Moon speech. Even today, satellite communications constitute the only truly commercially successful space technology (Whalen, 1997). In the early days of communications satellites, NASA saw the space shuttle program itself as a way of developing the communications satellites market, because of the growing numbers of satellites being launched or planned. First the satellites had to be launched. Then, because of the shuttle’s capacity to mount manned flights, it could repair or perhaps even retrieve satellites. All these functions were considered by NASA, which offered ways for the space program to actually generate funds instead of simply absorbing them (Bromberg, 1999: 109–11). Oddly though, because NASA had been established through legislation as an R&D organisation, not a commercial operation, it was unable easily to capitalise on its assets in this way. Bromberg says:

NASA representatives … had no expense accounts for taking potential
customers to dinner. They had no authority to meet demands that foreign
governments were making for offsets. NASA scrambled for ad hoc
arrangements to get around such drawbacks. (Bromberg, 1999: 112)

Perhaps this was because the communications satellites had been a kind of
byproduct of a much larger program, although it was certainly recognised early on
that they would be enormously important in many ways. But Bromberg does seem
to imply that the government was hardly alert to the extent or depth of commercial
opportunities arising from the NASA program. Whalen points out:

Thus far in the 1990s, the average number of communications satellites
launched annually has been twenty, at an average cost of more than
$50 million for the satellite and another $50 million (or more) for the
launch vehicle. The average spent annually on communications satellites
is in excess of $2 billion. (Whalen, 1997)

This would certainly seem to bear out Bromberg’s argument that NASA, a
public agency, ‘has influenced the formation and sustenance of new industry’
(Bromberg, 1999: 4). The Communications Satellite Act of 1962 established
Comsat (the private Communication Satellite Corporation), which was responsible
for the US part of an international satellite system. This was followed in 1965 by
Intelsat (the International Telecommunications Satellite Consortium) (Cohen and
Noll, 1991: 151). Although Comsat was a private company, it was under strict
government control (Gavaghan, 1998: 194).

**Whose vision and what did this cost?**

Cohen and Noll (1991) claim that the space program, begun with such passion
and commitment — political, moral and economic — really had no clearly
planned purpose beyond the Apollo mission. This objective — to get a man on
the moon — was achieved in July 1969 when Neil Armstrong took his ‘small
step’ on to the moon’s surface for all to see back on Earth via a communications
satellite. Who could have imagined then the subsequent communications spinoffs
enabling McLuhan’s global village, Ted Turner’s 24-hour news channel broadcast
from America to 180 countries, Rupert Murdoch’s Sky Channel for Europe and
Star Television for East and South East Asia, or the BBC going global with its
television news?

During the 1970s, NASA increasingly made its launch service available to other
countries and organisations. During the period 1969–78, it successfully orbited 96
payloads, mainly weather and communications satellites, for other organisations,
including the US Navy, Western Union, France, the Netherlands, the European
Space Agency and Intelsat (Ezell, 1988).

The Applications Technology Program was the part of NASA that ‘pioneered
advances in satellite technology, laying the groundwork for applications in television
transmission, satellite tracking and data relay, communications with ships and
aircraft, and direct broadcast satellites’. According to Cohen and Noll, ‘despite
widespread acclaim, the program was cancelled in 1973’ for basically political
A classic assessment of the history of a wide range of government-supported R&D commercialisation programs concluded that ‘on the basis of retrospective benefit-cost analysis only one program — NASA’s activities in developing communications satellites — achieved its objectives and can be regarded as worth the effort’ (Cohen and Noll, 1991: 365).

**Origins of the internet**

The origins of the internet do not reside with great entrepreneurs located within major corporations prepared to risk huge capital investments in technological innovation in order to gain market competitiveness. Rather, the beginnings of the internet came largely from brilliant people working for a US government agency and their links with academics in the discipline of computer science within a few American universities. Without such outstanding innovation within the public sector, the world may never have had an internet as we know it today. And acknowledgment must be made of other non-government individuals, especially Tim Burners Lee, who worked at the CERN physics laboratory in Geneva, and who invented the software platform he called the World Wide Web. His web was not self-patented, and this remarkable communications platform has always remained in the public domain.

In 1957, the US government established the Advanced Research Projects Agency (ARPA) within the Department of Defense (DOD) to ‘direct or perform such advanced projects in the field of research and development as the Secretary of Defense shall, from time to time, designate by project or by category’ (Federal Communications Division, 2007). ARPA, together with the National Aeronautics and Space Administration (NASA), was created in response to the then Soviet Union launching the Sputnik satellite, in an attempt to regain technological superiority for the United States.

Internet historians give great credit to the foresight of the first two directors of ARPA’s Information and Processing Techniques Office (IPRO). They were Joseph Licklider, recruited from MIT in 1962, followed by another academic, Bob Taylor, who headed the IPRO from 1964. Licklider, an MIT professor, was fascinated by psychoacoustics, the study of how the human ear and brain convert air vibrations into the perception of sound.

Licklider shifted the orientation of computer and network research away from machine information processing and storage into behavioural factors, especially interactions with the users. In so doing, he put his indelible stamp on the IPRO projects. In 1960 he wrote:

> It seems reasonable to envision, for a time 10 or 15 years hence, a ‘thinking center’ that will incorporate the functions of present-day libraries together with anticipated advances in information storage and retrieval. The picture readily enlarges itself into a network of such centers, connected to one another by wide-band communication lines and to
individual users by leased-wire services. In such a system, the speed of the computers would be balanced, and the cost of the gigantic memories and the sophisticated programs would be divided by the number of users. (Licklider, 1960: 4–5)

One biographer of Licklider wrote:

In response to this revelation, in 1957 Licklider spent a day measuring the amount of time it took him to perform the individual tasks of collecting, sorting, and analyzing information, and then measured the time it took him to make decisions based on the data once it was collected. He discovered that the preparatory work took about 85% of the time, and that the decision could then be made almost immediately once the background data was available. This exercise had a powerful effect, and convinced him that one of the most useful long term contributions of computer technology would be to provide automated, extremely fast support systems for human decision making. (Whalen, n.d.(b))

As IPRO director, Licklider’s mantra was to support and fund projects that facilitated interactive computing for large numbers of users. When Taylor followed Licklider, he said that he became ‘heartily subscribed’ to the same version of interactive computing.

From his office in the Pentagon, Taylor had teletype terminals to each of three ARPA-resourced time-sharing computer systems — at the Massachusetts Institute of Technology (MIT), at the Systems Development Corporation (SDC) at Santa Monica, and at the University of California at Berkeley. Taylor wrote:

Three different terminals. I had them because I could go up to any one of them and log in and then be connected to the community of people in each one of those places … Once you saw there were three different terminals to these three distinct places the obvious question that would come to anyone’s mind [was] why don’t we just have a network such that we have one terminal and we can go anywhere we want? (Taylor, 1994)

Whose vision and what did this cost?

So what might the foundational costs of the internet have been? Following the creation of ARPA in 1962, the Department of Defense issued a modest US$19 800 contract on 6 December 1967, for a four-month study of the ‘design and specification of a computer network’ based on the principles that had emerged under the leadership of Licklider and Taylor. This was an astonishingly small amount considering that in those days a computer cost between US$500 000 and $3 million. A subsequent ‘cost-effective’ follow-up in 1968 was the awarding of a contract with the purpose of designing, constructing, installing, testing and maintaining four interfacing message processors (IMPS) for US$563 000. The four computers to be linked were located at the Stanford Research Institute (SRI), the University of California — Santa Barbara (UCSB), the University of California
— Los Angeles (UCLA), and the University of Utah. Subsequently, on 15 October 1969, the IMPS installed on the computers at SRI and at UCLA connected for the first time, giving new meaning to the words ‘log in’. This contract promised that the outcome would be ‘a unique prototype of futures communications systems’ — and it was. Thus ARPANET (Advanced Research Projects Agency Network) was born; from it, the internet as we know it today subsequently emerged. The key factors in creating the initial phase of the internet were not only the resources made available for research during the Cold War by the DOD, and the great applied research and management leadership by Licklider and Taylor, but also the positive contribution of many scientific and computing academics. The user-centred development philosophy that came from the top of APRA found synergy with the academic desire for decentralisation of organisational authority; their acceptance of the need to share ideas, and the desire to build new telecommunications networks that provided greater openness and access to information carried on the networks. All were centred within the public domain.

Fortunately, several early pioneers of the internet remain alive today to see the extraordinary range of new economic and social practices and benefits emerging from ‘their’ platform as it is progressively becoming globally accessible.

Conclusion

Two broad conclusions can be drawn. First, a lesson from 150 years of telecommunications history that appears not to be widely acknowledged is the critical role played by the public sector. It was the public sector that provided the organisational framework and the seeding funding for the creation of each of these three major communications platforms — Australia’s overland telegraph, NASA’s communications satellites, and the beginnings of the internet. There can be little doubt about the amazing long-term successful cost-benefit analysis in all three cases. Moreover, had the formulative development factors outlined in this article — different though they were in each case — not existed within the public sector, together with the brilliant individuals who could implement the vision, these platforms and their successors might not exist today.

Second, a long bow could be drawn to assert that if the centrality of the public sector as investment incubator had been preserved, the broadband networks needed today would have been built by now or would be well advanced. But history also shows how difficult it is to unscramble telecommunications policy omelettes. For the past 20 years or so, there has been widespread international acceptance of the paradigm that the ‘best government is the least’ and the related telecommunications policy presumption that a more privatised, deregulated and liberalised policy model will always now be best. Yet, in the context of the major investment needed in broadband, so widely agreed to be vital to the future of Australia, we have a dysfunctional contemporary telecommunications policy model.

However, things appear to be on the move. During the national election campaign in 2007, the Australian Labor Party offered to provide substantial government capital towards the construction of a national broadband network.
Australia’s new Rudd government has committed $4.7 billion to ‘facilitate the roll out of a new open access, high speed, fibre based broadband network, providing downlink speeds of at least 12 megabits per second to 98% of Australian homes and businesses’ (Conroy, 2008).

So this appears to be history revisited. Of all of the areas of R&D government investments in industry projects, the field of communications appears to be the leader in terms of long-term cost effectiveness and national strategic value. If there had been no overland telegraph, or no communications satellite, or no internet developed initially in the public sector during the last century, there might never have been a Telstra to privatise in the new century to facilitate the largest single investment in broadband infrastructure in Australia’s history. And it appears that public policy and major public investment will be vital in the future if Australia is to build the broadband network it needs.

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