AJTDE

Australian Journal of Telecommunications and the Digital Economy

Volume 3, Number 3

September 2015

AJTDE Volume 3, Number 3, September 2015

Table of Contents

An Opportunity

Mark A Gregory
RMIT University

Summary: The September issue provides an interesting look at the National Broadband Network: and how it is perceived to have problems that need to be resolved; how telecommunications is having an effect on the lives of Australians, with discussion on how older Australians engage with online news; and how mobile phone use in remote Aboriginal and Torres Strait Islander communities is a balance between opportunity and affordability. Papers on future digital service delivery and metadata retention provide a balance between identifying future use and how authorities are looking our telecommunications usage.

In this issue

In this issue the *Journal* contains papers that provide discussion on how telecommunications is being used and how telecommunications and services might develop in the future.

The NBN is broken. Here's the fix provides an insider look at concerns surrounding the direction being taken with the National Broadband Network (NBN) and proposes a way forward. Possibly the solution could be a far broader review of the government's Multi-Technology Mix approach and reconciling why Australia is adopting technologies that were in vogue ten to fifteen years ago.

Digital news and silver surfers. An examination of older Australians' engagement with news online and *Balancing Opportunity and Affordability: Use of mobile phones in remote Aboriginal and Torres Strait Islander communities* provide interesting insights into how telecommunications is being used by Australians today. Telecommunications is an essential service and it is important to remember how telecommunications has a positive effect on our daily lives, but the cost of telecommunications remains a challenge for future governments to overcome.

The metadata retention regime introduced recently presents a challenge in the Internet of Things era, and *It's only the beginning: Metadata Retention laws and the Internet of Things* provides an insight into how complex the relationship between technology development and law enforcement will become without further research and broad discussion on alternate approaches.

Business and government service delivery is evolving from traditional brick, mortar and trucks to digital delivery over telecommunication systems, and *The Future of Digital Services Delivery* provides a discussion of the shift that is currently underway and why it is important to be part of the transition and to look for new and innovative ways to harness telecommunications to provide digital services.

An Opportunity

The new look Coalition government led by Malcolm Turnbull provides an opportunity for recent technology and digital security related decisions made by the government to be revisited. The question being pondered by the broader technology, engineering and science community is whether Turnbull will take this opportunity to scrap some of the government's more controversial policies, such as those affecting climate change, metadata retention and the Multi-Technology Mix NBN.

It is well understood by technologists that occasionally government decisions will be hard to reconcile, especially when Australian experts are dismissed in favour of consultants from the other side of the planet. Turnbull's challenge is to rebuild the government's relationship with the Australian science and technology communities.

Looking forward

Papers are invited for upcoming issues. The December issue includes the themes: *Economic Research, Telecommunication Legacy Issues* and *Universal Service Obligation*. The first issue for 2016 in March includes the themes: *Telecommunications and Network Security, Telecommunications Affordability* and *Block Chain Technologies (e.g. Bitcoin)*.

The December and March themes highlight the breadth of telecommunications from new technologies that are finding a place within the vast global telecommunication systems to the economics and social aspects of how telecommunications affects individuals and nations.

We actively seek your help to ensure that the *Journal* provides the readership with topics of interest that reflect the broad nature of the local and international telecommunications industry and the global digital economy. If you have a theme for an upcoming issue that you would like to recommend to the Editorial Board please let us know. And papers submitted to the *Journal* are welcome and do not need to be associated with a theme issue.

Mark A Gregory

Digital news and silver surfers

An examination of older Australians' engagement with news online

Dr Renee Barnes
University of the Sunshine Coast

Abstract: With media organisations placing increasing emphasis on online news delivery, many have argued the potential for online media to enhance democracy, by enabling increased access to the public debate and a greater ability for citizens to influence the public agenda. Within this complex paradigm of a changing media landscape, Australia's population is ageing. As a result, understanding the needs of older Australians in the presentation and distribution of digital news is vital if we are to ensure intergenerational equity in access to public debate. However, very little work has examined how older Australians engage with news online. Drawing on a survey of Australians aged 41-84, this exploratory study examines the preferences of participants in news engagement, the role of presentation and distribution of online news in engagement and perceived barriers to accessing news online and on mobile devices.

Introduction

The prevalence and impact of digital media platforms have resulted in one of the greatest changes to journalism in history. With media organisations placing increasing emphasis on online news delivery, many have argued the potential for online media to enhance democracy, by enabling increased access to the public debate and a greater ability for citizens to influence the public agenda (Gillmor 2004; Rosen 2006; Bruns 2011; Robinson & DeShano 2011). Others have argued that the assumption that digital technology will enhance deliberative democracy does not take into account issues of media agency and power (O'Donnell 2009) or the institutionalised barriers to enhanced user participation in news production, which favour professional journalism norms and traditions (Singer et al 2011). As Singer et al (2011) noted, audience participation remains largely limited to those avenues that provided the least challenge to a journalist's agency and authority, such as interpretation of the story, or the leaving of comments. However, others have argued that comments have an effect on the process and structure of public communication as they reach the same audience as mass media (because they are presented beneath journalistically

http://doi.org/10.18080/ajtde.v3n3.16

produced articles) and create conditions for deliberative interactions (Springer et al 2015). Further, studies suggest that user comments are frequently read and the online news audience placed a high value on audience members' comments (Barnes 2014; Robinson 2010).

Within this complex paradigm of a changing media landscape, Australia's population is ageing. The Australian Bureau of Statistics predicts that the median age of Australians is expected to increase from 36.8 years to 45.2 by 2056. The proportion of Australians aged over 65 years could increase from 13% to 25% of the population during the same time period (ABS 2008). As a result, understanding the needs of older Australians in the presentation and distribution of digital news is vital if we are to ensure intergenerational equity in access to public debate. This article reports on an exploratory study of older Australians. Specifically it seeks to address questions of how older Australians engage with news online and whether there are any perceived barriers for older adults accessing news online and on mobile devices.

Online news engagement and barriers for older people

Research has linked engagement with news across all platforms to temporal, situational and motivational factors. In a longitudinal study of news usage as an activity, Costera Meijer and Groot Kormelink (2014) identify 16 practices of news use: reading, watching, listening, viewing, checking, snacking, monitoring, scanning, searching, clicking, linking, sharing, liking, recommending, commenting and voting. These practices, the authors argue, relate to how individuals undertake the news activity and how it is anchored to other activities within their day. For example, the practices of reading and watching were associated with in depth or intense concentration, while viewing or listening were more about 'wallpapering' the day; a practice undertaken while completing other activities such as preparing dinner or driving. Overall, the study suggests that the audience's news use encompasses a complex spectrum of activities influenced by motivational and situational factors. This approach is similar to other studies that have examined how news usage orders and even anchors other social and cultural practices (Schrøder 2014; Domingo et al 2015). Therefore it could be argued that demographic factors, including age, will impact upon engagement with and use of news, as age will influence the social activities that are anchored to news consumption.

Specifically when considering online news media use, users can engage with online news as a 'convenience' via information distributed through platforms they are engaged with for other purposes, such as Facebook and Ninemsn (Flew et al 2011). Others seek to increasingly build their own personal repertoires of media channels to follow and access the news (Picone et al 2014; Flew et al 2011). A study of Canadian internet users found that a significant number of social media users 'value their personal network as a way to filter the news, rather than relying solely on the professional judgement of a news organisation or journalist' (Hermida et al 2012: 816). However, audiences expect online content to be free, which has made it difficult for any media producer to charge for content (Sirkkunen & Cook 2012; ACMA 2009). In terms of participation on online news websites, the majority of readers of online news sites do not leave comments or other forms of user-generated content (Barnes 2014; van Djyk 2009).

When considering age in relation to news, older adults (those aged 50 plus) tend to consume more news (Kohut 2013), but still prefer traditional media platforms such as newspapers, television and radio (Pew Research Center for the People and the Press 2012). However, older adults are increasingly accessing social media (Madden 2010). While these studies show that older adults lag behind the younger generation in terms of online news consumption, no study has focused on how older people engage with news online and what specifically prevents those who do not from doing so.

There is substantial scholarship on the equity issues related to a lack of access to digital technology. Terms such as 'digital divide' and 'digital exclusion' emphasise that existing gaps of digital technology use should be bridged, aiming for social inclusion and equal distribution of resources and life chances (Friemel 2014; van Dijk & Hacker 2003). Studies focused on this 'digital divide' tend to focus on general Internet use, with Internet access and use strongly correlated with various socio-demographic dimensions such as income, education, gender and age (Helsper 2010; Korupp & Szydlik 2005; Zickuhr & Smith 2012). Specifically researchers have noted a 'Grey Divide', which is defined as a lack of access and literacy online of the oldest members of society in comparison with their younger successors (Friemel 2014; Morris et al 2007).

Numerous studies have investigated the benefits for older people in using computers and accessing online information. Benefits can include less anxiety, higher self-efficacy, higher life satisfaction (Karavidas et al 2005) and reduced loneliness (McCausland & Falk 2012; Morris et al 2007). Specifically the Internet can enhance the lives of older people, by giving them the possibility to connect with relatives and retrieve information they are interested in (Morris et al 2007).

Studies have also focused on barriers to older adults in accessing computers and the Internet. Specifically, older people face barriers in accessing computers due to a perceived lack of benefit, lack of knowledge, fear of hardware being quickly outdated and a lack of interest or motivation (Wagner et al 2010; Selwyn 2004). Hakkarainen (2012) has described the lack of interest as a social construction of technology as the barrier, where older adults view computers as a tool that represents a danger to their lifestyle because of the time required and security issues. Barriers to Internet use reflect these broader technology and computer barriers. Peacock and Künemund (2007) found that the key reasons for not using the Internet were a lack of device, motivational indifference and deficient knowledge. However Millward (2003) argues that the fear of using the Internet is actually the fear of humiliation of not being able to. This suggests that the lack of interest is a self-made barrier, concealing a more stigmatising lack of skills (Millward 2003).

Specific design and usability issues have also been highlighted as potential barriers for older adults in accessing the Internet. Kurniawan et al (2006) found that older adult web browsers prefer personalisation instruments that most preserve the original layout (overriding the cascading style sheet with a readily available one using a standard browser). Ensuring older adults were able to access relevant information online can also be facilitated by increasing font sizes and reducing vertical page length (Becker 2004).

This project aims to further develop scholarly understanding of the 'Grey Divide', by investigating how older Australians engage with news online and the perceived barriers to accessing news online and on mobile devices. Drawing from previous studies it is apparent that older adults have specific considerations for accessing technology and the Internet. However, no study has specifically investigated how older adults engage with news online and on mobile devices. This study aims to address this gap by undertaking an exploratory study of older Australians. Specifically it will seek to address the following research questions:

> RQ1: How are older Australians engaging with online news?
>
> RQ 2: Are there any perceived barriers for older Australians in engaging with online news?

Methodology

This exploratory study focussed on the Sunshine Coast region of Queensland. This region presented an ideal case for the study of older Australians and online news delivery, with a median age higher than the Australian average (ABS) and a range of Internet quality and accessibility represented in the region. Areas in the north of the region were among the first to receive higher speed Internet access through the Government's National Broadband Network, while areas in the west and south have lower access, with many only able to access equivalent speeds through expensive satellite connections.

Data for the study was collected through a survey made available online and in hard copy in January and February 2014. The survey consisted of 17 questions that relied on a mix of open-ended, rank-ordered and closed responses to ascertain online news and information uses, preferences and perceived barriers, and demographic information about respondents. Questions probed preferences for the medium of news delivery as well as specific indications of levels of access to online news and time spent on online news websites. Interaction through comments was also canvassed, along with any perceived barriers to accessing online news sources. Demographic details such as age, sex, postcode and political persuasion were also collected.

To address RQ1, participants were asked questions around their preferred medium for news delivery (rank ordered), how they accessed online news (closed), how often they visited online news websites (seven point Likert-type scale: 1=never, 7= several times a day) and whether they interacted with news websites through commenting features (using a five point Likert-type scale: 1=never, 5= regularly, which was defined as at least each week).

To address RQ2, responses to the open-ended question: 'Please outline any barriers you feel prevent you from accessing news or more news online', were organised according to recurring themes (Strauss and Corbin 1998). Responses to the question: 'If you never or rarely access news online why is that?' (only those who responded 'never' or 'rarely' to the question of how often they accessed news online were directed to this question) were analysed in the same way.

Perceived barriers to making comments on websites were also explored through the closed question, 'If you never or rarely make a comment, why is that?' Drawing on a qualitative study examining the motivations of those who leave comments on online news websites (Barnes 2014) the following responses were provided:

(1) don't have the time or inclination,
(2) intimidated by other commenters,
(3) don't have the technical expertise and
(4) other.

Analysis of these three questions was used to address RQ2.

Participants were recruited via the Sunshine Coast University of Third Age (U3A) email list and promotional materials placed in U3A's classrooms. The study was also publicised through stories in local newspapers and radio stations.

The survey received 248 responses (234 online and 14 hard copy) with an 89.9% completion rate. The most-represented age groups were: 61-70 years (48.4%, n= 107) and 71 years or above (36.7%, n=81). Females were over-represented with 59.7% (n= 132) of responses and males at 40.3% (n= 89). As a self-selecting sample, the participants are non-representative and therefore the results are limited in their generalisability. Another key limit of the survey is an over-representation of online survey completions which has the potential to skew results to favour online sources. However, as an exploratory study, the analysis provides scope to inform further study into this understudied field.

Results

RQ1: How are older Australians engaging with news online?

Overall, the majority of participants expressed a preference for television news. This is in line with previous studies which have found that 'traditional' media platforms of print and television are preferred by those aged over 36 years of age (Pew Research Center for the People and the Press 2012). When asked specifically about accessing news online, responses were heavily weighted at either end of the spectrum (see TABLE 1), with 35.8% (n= 88) visiting news websites several times a day and 21.1%(n= 52) visiting once a day, while 9.3% (n= 23) never visited online news websites and 19.5% (n=48) rarely (defined as 1-3 times a month) visited an online news website.

TABLE 1

How often do you access news online?		
Answer Options	**Response Percent**	**Response Count**
Never	9.3%	23
Rarely	19.5%	48
Once a fortnight	2.8%	7
Once a week	3.7%	9
Several times a week	7.7%	19
Once a day	21.1%	52
Several times a day	35.8%	88
	Answered question	**246**
	Skipped question	**2**

When the data was further parsed via gender, it found that females are more likely never or rarely to visit online news websites, with 30% (n=40) of females responding 'never' or 'rarely' and 20% (n=18) of males represented in the 'never' or 'rarely' response category (See TABLE 2).

This is consistent with other studies that investigated older people and overall Internet access where females aged 55 plus were found to be less likely to go online (Friemel 2014). Of those females who never or rarely visit online news websites, their preferred medium for news and information delivery was commercial television and ABC radio.

TABLE 2

How often do you access news online?	Male		Female	
Answer Options	**Response Percent**	**Response Count**	**Response Percent**	**Response Count**
Never	8.0%	7	9.8%	13
Rarely	12.5%	11	20.5%	27
Once a fortnight	1.1%	1	3.8%	5
Once a week	2.3%	2	4.5%	6
Several times a week	9.1%	8	7.6%	10
Once a day	23.9%	21	20.5%	27
Several times a day	43.2%	38	33.3%	44
		Total: 88		**Total: 132**
			Answered question 220	
			Skipped question 26	

When the data was analysed in relation to age group, those aged 71 and above were the most likely to never or rarely access news online 37% (n= 30), while only 15% (n=4) of those aged 51-60 never or rarely accessed online news. Those aged 41-50 years were the most likely to access news online with 83% (n=5) accessing several times a day. Of those in the 51-60 age group, 67% (n=18) accessed once a day or several times a day (see TABLE 3).

TABLE 3

How often do you access news online?	41-50 years		51-60 years		71 years or above	
Answer Options	**Response Percent**	**Response Count**	**Response Percent**	**Response Count**	**Response Percent**	**Response Count**
Never	0.0%	0	7.4%	2	13.6%	11
Rarely	0.0%	0	7.4%	2	23.5%	19
Once a fortnight	0.0%	0	3.7%	1	1.2%	1
Once a week	0.0%	0	7.4%	2	3.7%	3
Several times a week	0.0%	0	7.4%	2	12.3%	10
Once a day	16.7%	1	7.4%	2	27.2%	22
Several times a day	83.3%	5	59.3%	16	18.5%	15
		Total: 6		**Total: 27**		**Total: 81**
					Answered question 220	
					Skipped question 26	

For those who were accessing online websites, the majority were doing so via a home desktop computer (65.5%, n=135). The next category was a tablet computer (27.7%, n=57), while only 5.3% (n=11) were accessing news websites via a mobile phone (see TABLE 4). When online, the majority of respondents found news stories through a news website homepage (63.3%, n= 131). Only 7.7% (n=16) used social media to source news stories.

TABLE 3

How do you most often access news websites?		
Answer Options	**Response Percent**	**Response Count**
On your home desktop computer	65.5%	135
At desktop computer that is not your own (library, friend etc.)	0.5%	1
On your mobile phone	5.3%	11
On a tablet device	27.7%	57
Other	1.0%	2
	Answered question	**206**
	Skipped question	**36**

Finally, given that interactivity is a feature of online journalism, respondents were asked how often they made comments on news stories online (see TABLE 5). The majority of respondents never made a comment (45.1%, n= 93), while only 12.1% (n= 25) often or regularly made a comment. This reflects other studies which suggest only a small portion of the overall audience makes active contributions (Barnes 2014; Van Dijck 2009). Of those who never made a comment the majority were in the 61-70 years age bracket (56.2%, n=50) and 71 and above (36%, n=32). Female respondents were also far more likely to never leave a comment (70.8%, n= 63).

TABLE 5

How often do you make comments on stories on news websites?		
Answer Options	**Response Percent**	**Response Count**
Never	45.1%	93
Rarely (1-3 times)	27.7%	57
Sometimes (3-10 times)	15.0%	31
Often (10-30 times)	3.9%	8
Regularly (at least each week)	8.3%	17
	answered question	**206**
	skipped question	**42**

*Note respondents who never visited news sites were directed away from this question.

RQ 2: Are there any perceived barriers for older Australians in engaging with online news?

Analysis of the open responses that related to perceived barriers identified the following six themes:

1. The importance of tradition and routine and convenience
2. Intimidated by or an inability to use the technology
3. Perceived quality of online news
4. Usability and design issues
5. Cost
6. Poor Internet or cellular data access

Respondents identified routine, tradition and convenience as factors that prevented them accessing news online. For example:

> *I guess old habits die hard but we do not like using the computer during the day (95)*
>
> *I do not enjoy sitting in front of a computer. I find it more relaxing to sit in my recliner lounge chair (235)*
>
> *Easier to be doing other things while listening to news (7)*

Here respondents are suggesting the importance of temporal and locational factors in the engagement with news, which reflects other studies that have examined how news usage anchors other social and cultural practices (Schrøder 2014; Domingo et al 2015). What these responses suggest is that for some older Australians news consumption is associated with particular traditions or activities such as reading in the recliner lounge chair. These routines or traditions therefore serve as a barrier to engaging with online news.

For other respondents, intimidation by or the inability to use the technology needed to access online news was the barrier. As one respondent simply noted to the question, 'If you never access news online why is that?', 'How?' (28).

Or for other respondents to the question on what barriers they thought prevented them from accessing news online:

> *I do not have a computer and cannot use one (240)*
>
> *I wouldn't know where to start. I don't use a computer (245)*

These results reflect those studies that show a general lack of online literacy for those over 55 compared with their younger counterparts (Friemel 2014).

The perceived lack of quality of online news sources was seen by respondents as another reason for not accessing news online. As these respondents noted:

> *Biased reporting. Not staying with the facts but putting ideological slants on stories' (62)*
>
> *Strong bias and sensationalist focus' (50)*

This differs from a national survey of Australians that found the Internet was the most trusted source news and information, ahead of television, newspapers and radio (ACMA 2009).

However, it was not just the content of news websites which provided a barrier to engagement with news online for respondents to the survey, but also how it was presented. Specifically for many respondents the design of news webpages and usability issues were identified as barriers. For example:

> *complicated, confusing pages with multitudes of choices and non-relevant links' (88)*
>
> *it just annoys me to have to keep scrolling to read an article (150)*
>
> *it can be overwhelming, I just don't know where to start [when first arriving at a news homepage] (32)*

This reflects studies which investigated health services online and found that older adults had more success in using systems that had made specific adjustments to design (Becker 2004).

Cost was also a barrier noted by respondents. For example, respondents to the question: Please outline any barriers you feel prevent you from accessing news or more news online, noted:

> *Requests for payment to access. As a pensioner this is not an option (22)*
>
> *The need to subscribe and pay (35)*

These responses reflect other studies, which have shown that users are reluctant to pay for online news (ACMA 2009; Sirkkunen & Cook 2012). However, respondents also noted that the cost of Internet access also played a role as a barrier to online news consumption. As this repondent noted:

> *[I] don't want to have the service cost me money because it pushes lots of irrelevant imagery at me consuming my bandwidth budget (89)*

Cost was often coupled with poor Internet access or speeds. As the above respondent further noted:

> *It is impossible to get affordable and reliable Internet in my area (89)*

Or as respondent 49 noted:

> *Terrible internet speeds where I live [Nambour], due to serious network overloading, which stops me access news while it is still current (49)*

The survey also addressed barriers to making comments online. Respondents who answered "" "rarely" to the question: "How often do you make comments on stories on news websites?" were directed to a question that asked why they never or rarely made a comment. From these responses 83.2% (n= 94) responded that they didn't have the time or the inclination, while 8% (n= 9) were intimidated by other commenters and 8.8% (n=10) didn't know how to.

Discussion and conclusion

The results of this study suggest that older Australians are still relying on 'traditional' media for their news and informational needs. The reasons for this include a lack of digital literacy as identified by authors concerned by a 'Grey Divide', as well as other exclusion issues such as access and cost. However barriers for engagement may be broader than that, with indications that the design and usability of news websites ensure these are perceived as not relevant or not applicable for older Australians. This suggests that further research is needed into the preferences and requirements of older Australians in the design of news websites. This field of research is particularly relevant considering other results of this study, which suggests that the majority of older Australians are accessing news through a desktop computer, not through mobile or smartphones. Access to news websites through mobile phones has been highlighted as the largest growth market in Australia, with mainstream news organisations investing heavily in this space (ACMA 2009). This study also suggests that older adults are finding news through news website homepages. This differs from other studies (Hermida et al 2012; Picone et al 2014) which show the increasing importance of social media in accessing the news audience online. Therefore homepage design and usability will have an impact on ensuring older adults are engaging with public debate through online news delivery. The social and cultural practices and the temporal considerations of older Australians also need to be included in any investigation of design and usability, as these are factors that influence the ways in which participants engaged with news.

This study has limitations that must be considered. As an exploratory study it focused on a case study of the Sunshine Coast region. To provide a complete picture of older Australians requires a national representative sample. However, the study does provide a useful direction for further work in this field.

Overall, the study shows a need to further investigate the needs of older Australians in the presentation and delivery of news online. This study suggests that older Australians have specific needs that in some cases are not being met by online news providers, and that this has the potential to stymie intergenerational participation in the public debate into the future.

Acknowledgements

This study was funded by an auDA Foundation grant.

References

ACMA. 2009. ‘Trust and confidence’. Report 1 in the *Australia in the digital economy*: Research report series.

Australian Bureau of Statistics (ABS). 2008. ‘Population Projections, Australia, 2006 to 2101’. [Internet]. Australian Government. Accessed 31 July 2015. Available from: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3222.0Main+Features12006%20to%202101?OpenDocument.

Barnes, R. 2014. ‘The “ecology of participation”: A study of audience engagement on alternative journalism websites’. *Digital Journalism*, 2(4), 542-557.

Becker, S. A. 2004. ‘A study of web usability for older adults seeking online health resources’. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *11*(4), 387-406.

Bowman, W; Willis, C. 2003. 'We media: how audiences are shaping the future of news and information’. *The Media Center*, Accessed 11 April 2012. Available from: http://www.hypergene.net/wemedia/weblog.php.

Bruns, A. 2011. ‘News produsage in a pro-am mediasphere: why citizen journalism matter’, in G Meikle & G Redden (eds.), *News Online: Transformations and Continuities*, Palgrave Macmillan, London, UK, 132-147.

Burns, P; Jones, S. C; Iverson, D; Caputi, P. (2012). 'Riding the wave or paddling in the shallows? Understanding older Australians' use of the internet'. *Health Promotion Journal of Australia: Official Journal of Australian Association of Health Promotion Professionals, 23*(2), 145-148.

Costera Meijer, I; Groot Kormelink, T. 2014. ‘Checking, sharing, clicking and linking’. *Digital Journalism*, (Ahead of print). DOI:10.1080/21670811.2014.937149.

Domingo, D, Marsip, P; Costera Meijer, I. 2015. ‘Tracing Digital News Networks’. *Digital Journalism*, 3 (1), 53-67.

Flew, T; Spurgeon, C; Daniel, A; Swift, A. 2011. ‘Convenience, loyalty and customising users: the behaviours and intentions of young online news users in Australia’. *Australian Journalism Review, 33*(2), 99-112.

Friemel, T. N. 2014. ‘The digital divide has grown old: Determinants of a digital divide among seniors’. *New Media & Society*. (Ahead of print) doi:1461444814538648.

Gillmor, D. 2004. *We the Media*, O’Reilly Media, Sebastopol, CA.

Hakkarainen, P. 2012. ‘No good for shovelling snow and carrying firewood’: social representations of computers and the Internet by elderly Finnish non-users'. *New Media & Society, 14*(7), 1198-1215.

Helsper, E.J. 2010. 'Gendered Internet use across generations and life stages'. *Communication Research* 37(3), 352–374.

Hermida, A; Fletcher, F; Korell, D; Logan, D. 2012. 'Share, like, recommend: Decoding the social media news consumer'. *Journalism Studies*, *13*(5-6), 815-824.

Karavidas, M; Lim, N. K; Katsikas, S. L. 2005. 'The effects of computers on older adult users'. *Computers in Human Behavior, 21*(5), 697-711.

Kohut, A. 2013. 'Pew surveys of audience habits suggest perilous future for news' Accessed 10 January 2014. Available from: http://www.poynter.org/news/mediawire/225139/pew-surveys-of-audience-habits-suggest-perilous-future-for-news/

Korupp, S.E; Szydlik, M. 2005. 'Causes and trends of the digital divide'. *European Sociological Review* 21(4), 409–422.

Kurniawan, S. H; King, A; Evans, D. G; Blenkhorn, P. L. 2006. 'Personalising web page presentation for older people'. *Interacting with Computers, 18*(3), 457-477.

Madden, M. 2010. 'Pew: older adults' use of social media nearly doubles'. Pew Research Center. Accessed 10 January 2014. Available from: http://www.pewinternet.org/files/oldmedia//Files/Reports/2010/Pew%20Internet%20-%20Older%20Adults%20and%20Social%20Media.pdf

McCausland, L; Falk, N. L. 2012. 'From dinner table to digital tablet: technology's potential for reducing loneliness in older adults'. *Journal of Psychosocial Nursing & Mental Health Services, 50*(5), 22-26

Millward, P. 2003. 'The "grey digital divide": Perception, exclusion and barriers of access to the Internet for older people'. *First Monday*, *8*(7).

Morris, A; Goodman, J; Brading, H. 2007. 'Internet use and non-use: views of older users'. *Universal Access in the Information Society, 6*(1), 43-57.

O'Donnell, P. 2009. 'Journalism, change and listening practices'. *Continuum: The Journal of Media and Cultural Studies*, 23(4), 503-517.

Peacock, S; Künemund, H. 2007. 'Senior citizens and Internet technology'. *European Journal of Ageing, 4*(4), 191-200.

Pew Research Center for the People and the Press. 2012. 'Trends in news consumption: 1991-2012: In changing news landscape, even television is vulnerable'. Accessed 10 January 2014.

Available from http://www.people-press.org/files/legacy-pdf/2012%20News%20Consumption%20Report.pdf

Picone, I; Courtois, C; Paulussen, S. 2014. 'When News is Everywhere'. *Journalism Practice*, (Ahead of print) DOI: 10.1080/17512786.2014.928464

Robinson, S. 2010. 'Traditionalists vs. convergers: textual privilege boundary work and the journalist–audience relationship in the commenting policies of online news sites'. *Convergence: The International Journal of Research into New Media Technologies,* 16(1), 125–143.

Robinson, S; DeShano, C. 2011. 'Citizen journalists and their third places'. *Journalism Studies*, 12(5): 642-657.

Rosen, J. 2006. 'The people formerly known as the audience'. *Press Think*. Accessed 10 July 2009. Available from: http://archive.pressthink.org/2006/06/27/ppl_frmr.html

Selwyn, N. 2004. 'The information aged: a qualitative study of older adults' use of information and communications technology'. *Journal of Aging Studies, 18*(4): 369-384. doi: http://dx.doi.org/10.1016/j.jaging.2004.06.008

Selwyn, N; Gorard, S; Furlong, J; Madden, L. 2003. 'Older adults' use of information and communications technology in everyday life'. *Ageing & Society, 23*(05), 561-582.

Singer, J.B; Hermida, A; Domingo, D; Heinonen, A; Paulussen, S; Quandt, T; Reich, Z; Vujnovic, M. (eds) 2011. *Participatory journalism: guarding open gates at online newspapers*, West Sussex, UK, Wiley-Blackwell.

Sirkkunen, E; Cook, C. 2012. 'Chasing sustainability on the net'. *Tampere Research Centre for Journalism, Media and Communication*. Accessed 7 April 2014. Available from: http://www.journalismfund.eu/sites/default/files/SuBMoJour Study.pdf.

Schrøder, K.C. 2014. 'News media old and new'. *Journalism Studies*, 16(1), 60-78.

Springer, N; Engelmann, I; Pfaffinger, C. 2015. 'User comments: motives and inhibitors to write and read'. *Information, Communication & Society*, (Ahead of Print) DOI: 10.1080/1369118X.2014.997268

Strauss, A; Corbin, J. 1998. *Basics of qualitative research: techniques and procedures for developing grounded theory*, 2nd edn, Sage, Thousand Oaks, California.

van Dijck, J. 2009. 'Users like you? Theorizing agency in user-generated content'. *Media Culture Society*, 31(1), 41-58.

van Dijk, J; Hacker, K. 2003. 'The digital divide as a complex and dynamic phenomenon'. *Information Society* 19(4), 315–326.

Wagner, N; Hassanein, K; Head, M. 2010. 'Computer use by older adults: a multi-disciplinary review'. *Computers in Human Behavior, 26*(5), 870-882.

Zickuhr, K; Smith, A. 2012. '*Digital differences*'. Pew Research Center. Accessed June 2014. Available at: http://pewinternet.org/Reports/2012/Digital-differences.aspx

Balancing Opportunity and Affordability:

Use of mobile phones in remote Aboriginal and Torres Strait Islander communities

Ian Watson
Queensland Remote Aboriginal Media

Abstract: This article reports on the findings of a research project that investigated the use of mobile phones and the internet in remote Aboriginal and Torres Strait Islander communities in Australia. Indigenous Australians living in remote areas have previously had little access to and use of the internet (Rennie et al 2013) and are far less likely to access the internet within the home than non-Indigenous Australians (Rennie et al 2010). The proliferation of mobile phone ownership in Indigenous communities in Australian and internationally (Brady et al 2008) is resulting in increased access to the internet via mobile devices, as well as new communication, social and economic implications for phone owners. Using qualitative methodologies, including focus groups and semi-structured interviews in four remote communities, this article explores the ways that remote community members are using mobile phones; their access to online information and social media; and the problems they experience with service provision, bills and connectivity. It reinforces the need for more research into barriers to phone and internet usage by Aboriginal and Torres Strait people in remote areas, as well as the importance of informing remote community members of their telecommunications rights.

Introduction

The challenges faced by Indigenous Australians living in remote areas in accessing and using basic telecommunications services are well documented. These challenges include "vast geographic distances, small and remote populations, the cost of deploying telecommunications infrastructure and harsh environmental conditions", coupled with the socioeconomic disadvantages faced by many people living in these communities (Australian Communications and Media Authority 2008: 5). Bandias and Vemuri (2005: 237) note that a range of Australian Government reports have "citied inadequate infrastructure, lack of service provision, the high cost of access and 'thin' markets as key impediments" to provision of telecommunications service in remote Australia. The digital divide, between those with

http://doi.org/10.18080/ajtde.v3n3.20

reliable access to new forms of information technology and those without, is widest between remote Indigenous community members and other Australians (Gunkel 2003: 499), with the Central Land Council's 2010 submission to the *Reconnecting the Customer* Inquiry noting that remote Aboriginal communities "are least serviced by telecommunications providers" (Central Land Council 2010).

At a basic level, access to mobile phone coverage has been extremely limited in many remote Indigenous communities. As of 2008, Telstra data showed 3G mobile coverage was available only to an estimated 26 per cent of remote Indigenous communities (Australian Communications and Media Association 2008: 6). Large geographic areas of Australia have consistently been unable to access reliable mobile phone services, with Rennie, Crouch, Wright and Thomas (2013: 589) noting that mobile phone (3G) coverage for Indigenous residents of central Australia was limited to about 7000 people in seven discrete locations, or only about 50% of the total population. For community members living in outstations or moving outside of community boundaries, there is generally no access at all to mobile phone coverage.

At the same time, use of mobile phones has emerged as a key communications medium for those remote Aboriginal and Torres Strait Islander community members who do live in areas where there is some form of coverage, particularly among young people (Papandrea 2010: 52). This is partly due to low levels of use of residential fixed-line services (Australian Communications and Media Authority 2008: 6), with few households in these communities having a fixed-line phone (Brady et al 2008: 390). It is also a result of the linkage between the use of mobile phone communications and traditional forms of community communication, with the aural and graphical characteristics of mobile technology aligning closely to "strengths in Indigenous oral and graphical culture" (Brady et al 2008: 384).

Access to and use of the internet has been increasing dramatically in remote Aboriginal and Torres Strait Islander communities in recent years. As Brady, Dyson and Asela note, Indigenous people around the world are becoming more and more interested in ICT (Brady et al 2008: 384). This internet access has followed an interesting pattern in remote Indigenous communities in Australia, in effect 'leap-frogging' PCs and laptops, which have experienced low levels of use in these communities (Daly 2005: 3), and moving directly to online access via hand-held devices. Internet connection in households in these communities has, like fixed-line phone services, tended to be either financially or technically unattainable. In 2006, it was estimated that Indigenous Australians were almost 70 per cent less likely than non-Indigenous Australians to have an internet connection in their home (Australian Bureau of Statistics 2007).

Much of the access to the internet by young Aboriginal and Torres Strait Islander people has been through computers at schools, with 2008 statistics showing that more than nine out of ten (91%) of Aboriginal and Torres Strait Islander children aged 5-14 years who used a computer had accessed it from a school (Australian Bureau of Statistics 2011). Internet access in remote communities has been even more problematic, with 2006 estimates showing 20% of Indigenous households in remote and very remote Australia had an internet-connection, compared with 60% of non-Indigenous households in the same statistical area (Rennie et al 2013: 583). This figure dropped as low as 2.2% for households in remote areas of central Australia.

From community to community, internet access can be highly variable in remote areas of Australia (McCallum & Papandrea 2009: 1231), with communities experiencing difference in the "types of access, bandwidth, reliability and cost" (Rennie et al 2010: 52). The issue of ICT skills and knowledge further impacts on the use of the internet in remote communities, with McCallum and Papandrea (2009: 1245) noting the lack of "prerequisite knowledge and skills for more intensive internet use". Use of the internet via PCs, therefore, has been limited in many communities to very basic fulfilment of economic needs, such as checking a bank account balance (Papandrea 2010: 54).

Arguably, the increased use of mobile phones in communities (Brady et al 2008) could provide an opportunity for direct access to the internet without reliance on computers in homes or community hubs. However, as more and more remote community members begin to use mobile phones as both their key means of communication and their key medium for accessing the internet, it is clear that equitable access to mobile services is not simply related to reliable coverage. Remote community members living in areas with reliable, or somewhat reliable, coverage are still impacted on by financial constraints and lack of access to appropriate information and support in the area of consumer rights.

A number of recent cases and research projects have highlighted examples of remote community members being sold mobile phone packages that were poorly matched to their needs and budgets (see Loban 2013; Rennie et al 2010). While use of mobile phones in remote communities has opened up new opportunities in terms of education, health, banking and social networking, they have also "facilitated access into remote Indigenous communities by unscrupulous businesses using high pressure sales tactics such as telemarketing" (Loban 2013: 6). A number of remote Indigenous communities have reported "poor customer service, extreme instances of bill shock and astronomic complaint levels" (Central Land Council 2010).

There is clear recognition internationally that access to reliable communications and the internet are fundamentally important to the well-being of communities, families and individuals. As Bandias (2010: 47) notes, "improved access to telephones, the internet and ICT services has the potential to mitigate the negative effects of the geographic and social isolation experienced by the community". This research project explores the ways remote community members are using their mobile phones and their access to online information and social media. It also explores problems community members experience with service provision, bills and connectivity, examining in detail community perspectives on barriers to phone and internet usage by Aboriginal and Torres Strait people in remote areas.

Research Methodology

The research consisted of a series of four focus groups and 14 semi-structured interviews with people living in remote Aboriginal and Torres Strait Islander communities (all of whom lived in communities with some mobile phone coverage). Each focus group comprised five to eight community members, based on recommendations from a local Indigenous research assistant as to which community members would be comfortable speaking in each other's company. The 27 focus group members included predominantly users of mobile phones (23) and the internet (23), with all those with a mobile phone using it for both texting and calling. These focus groups were informal and semi-structured, allowing participants to generate questions and concepts, express opinions, and pursue their own priorities in their terms and using their words (Kitzinger & Barbour 1999: 5).

By allowing focus groups to be flexible and fluid in nature, it was hoped that participants would be encouraged to express a wide range of attitudes, as well as developing shared values in a group setting (Waterton & Wynne 1995: 141). Group discussion was encouraged as part of the focus group process, allowing the development of collective notions shared and negotiated by members of the group (Gunter 2000: 44).

The location and number of participants in the focus groups is summarised in the table below:

Location	Date	Number of participants	Gender	Age range
Cape York, QLD	6 March 2015	5	3 male, 2 female	17-48
Cape York, QLD	6 March 2015	7	4 male, 3 female	18-52
Kimberley, WA	9 March 2015	7	4 male, 3 female	17-38
Central Desert, NT	9 March 2015	8	3 male, 5 female	18-52

The focus groups were complemented by 14 semi-structured interviews with remote community members (six in Cape York, four in the Kimberley and four in the Northern Territory). Semi-structured interviews were used "to give the interviewees the space and the authority to examine their own experiences" (Brady et al 2008: 389). As Holstein and Gubrium (2002: 120) note, this form of interviewing is an especially useful mode of inquiry as it can result in the production of meanings that address issues relating to particular research concepts. Interviewees were identified based on recommendations from a local Indigenous research assistant (Meadows et al 2007 used and recommend the widespread use of local people as research assistants). 'Chance meeting' interviews were also used wherever possible, reflecting the informal community setting of the research and the successful use of this form of interview by previous researchers in remote Indigenous settings (Meadows 2002; Watson 2013).

As with the focus groups, the interviews were fluid in nature, allowing interviewees to freely express their views about key issues relating to their use of mobile phones and the internet. This type of semi-structured interviewing allows clarification of points, extension of responses, and the ability to remind respondents of points they might not have mentioned (Gillham 2000: 14). While the interviewer attempted to facilitate without overly directing the interviewee's talk (Rapley 2004: 20), it was acknowledged that the interviewer might in some cases need to guide the interviews to ensure the key areas of the research project were addressed, recognising that "all interview statements are actions arising from an interaction between interviewer and interviewee" (Jensen 2002: 240).

All focus groups and interviews were analysed based on themes and application of codes to data (Rapley 2004: 27). As Jensen (2002: 247) notes, this use of thematic coding allows qualitative researchers to identify the occurrence of particular themes or frames in the context of communication.

Key findings:

High Levels of Use of Mobile Phones and the Internet

The outcomes of the focus groups and semi-structured interviews suggests that even in very remote communities, large numbers of Aboriginal and Torres Strait Islander people own, or have access to, a mobile phone. This was summarised by a community member in Cape York, who noted:

> We all have these phones, the mobile ones. Most people now, especially the young ones. But most people now, yes, have them.

While pre-paid mobile phone services were more common, a significant proportion of those involved in the research had signed up to post-paid contracts. Reasons why so many people in remote communities feel they need a mobile phone are related to the geographic isolation of where they live, the need to be in contact when working in remote areas, and social reasons (especially among young people). A number of community members commented on the importance of having a mobile phone to stay in touch when outside of their community, such as to “feel safe if I am driving and I get broke down” or “stay in touch if I am out working in case I need something or something goes wrong”.

A significant number of community members also indicated that having a mobile phone was seen as important as peers and family members already had them, with one community member in the Northern Territory noting that mobiles are “something everyone has, so we want one too”. The importance of having a phone for social reasons was summarised by a young person in the Kimberley:

> All my friends like to stay in touch. So they text, or they are on Facebook or something, and I don’t want to miss out. Sometimes everyone’s just sitting there with their phones looking at them, so if you don’t have one, what do you do? (laughs)

There is also evidence that the proportion of people using a mobile phone as a key (or primary) means of communication has increased significantly in the past two to three years, and continues to increase. A number of interviewees and focus group members commented on the changes that have happened in their community and networks of families and friends in terms of increased ownership and use of mobile phones, including one interviewee in the Kimberley who noted that “a few years ago, not so many people had them, but now almost everyone does”.

Community members who were part of the research project who currently do not have a phone indicated they planned to get one soon, with a focus member in Cape York noting “I will get one soon – I am looking right now at how to get one, and what I can afford.” There was also some evidence in the research of sharing of mobile phones between friends and family members, as noted by a focus group member in the Northern Territory who observed “sometimes I will give someone my phone to use, for a call or to send a message or to check something out, so I pass it to them, then they give it back to me later”.

One of the primary reasons cited by people in remote Aboriginal and Torres Strait Islander communities for wanting to have a mobile phone is a desire to stay connected to friends and family. For some community members, this was because mobile phones are now the easiest way to stay connected with people as they move around the community, as noted by an interviewee in Cape York:

> Before, you had to ask around. No one had a phone at home. No one had a mobile phone. You had to ask people: ‘Is (name of person) at the Arts Centre, or has he gone up to the road?’ Now you can just send a text or you can call them. So it makes things easier for people. It’s the same at work. Some people had walkie-talkies or whatever. But now it’s just your phone. They can call you any time.

For many community members, mobile phones are also providing an easy way to stay connected with family members and friends in nearby communities, regional or urban centres, or other parts of the country. A focus group member in the Kimberley observed that:

> People move around a lot. Or they have to go somewhere for work, or for medical stuff. The young ones might go off to school. So we can stay in touch. That might be Facebook, or just to call them. I have family in other places, so I can call them, or send them a message. You can take a photo to show them.

High Levels of Access to Online Content via Mobile Phones

Both focus groups and interviews revealed strong usage of mobile devices to access information, news and entertainment through the internet. While this use of the internet through mobile devices varies slightly from location to location (with more people in remote areas of Queensland regularly accessing content from the internet than in other locations), all focus groups resulted in evidence of widespread use of the internet. While a small number of community members reported using their mobile phones to access news and information, including weather updates and "looking at ABC or other news sites", a significant proportion of interviewees and focus group members indicated their primary use of the internet was for access to entertainment content and social media. A number of community members indicated they were using their phones regularly to "check out what's happening on Facebook" or "look at something that someone has told me about, like a video or something funny". An interviewee in the Northern Territory noted:

> We all like to be on Facebook, but some of us just like to follow YouTube or watch something. Lots of people are downloading music, and some are watching TV shows and stuff. But mainly it's that Facebook stuff, because that's how some people say connected.

When speaking about social media, most focus group members and interviews referred clearly to using 'Facebook'. There were only two references to use of other forms of social media such as Instagram, and no references to Twitter use. Further investigation of this with an interviewee in Cape York elicited the following observation:

> For most of us, it's just Facebook. Everyone is on there, so that's what we do. But some people are starting to use Instagram. A few. I don't know about Twitter. Maybe some people follow someone famous or something, but not so much. It's not what they like to do.

While health and mental health information are not key areas of online searching for remote Aboriginal and Torres Strait Islander community members, some community members referred to using the internet to investigate health and mental health signs and symptoms, and to access information on support and treatment options. While use of the internet is currently strongly focused on social media and access to entertainment content, some interviewees reported they had used the internet to look up health or mental health information online, as noted by an interviewee in Cape York:

> I have tried to find a couple of things. Mainly for health, for my kids. I'll look up and see if I can work out what is going on with them.

Importantly, many community members involved in the research indicated they would be prepared to access this kind of information in the future if content was promoted to, and tailored to, them specifically. This was summarised by an interviewee in Cape York:

> I think that kind of information is important to us, yes. And it would be useful for us. But people won't just go there to find it. They would, I think, if you had someone at the clinic tell them about it. Or a poster or something. But we don't know to go and find it on the internet, so we don't.

Problems with Reliability, Affordability and Service Provision

Despite increased access to mobile phones and the internet by remote Aboriginal and Torres Strait Islander community members, the research found that a large number of community members experience ongoing problems with unreliable access to phone networks and slow or intermittent access to the internet. These problems were most highly reported in the Northern Territory, but there is evidence in all locations of concerns about being able to access reliable phone and internet services. A focus group member in the Northern Territory observed:

> It's getting worse, I reckon. At my house, sometimes you can't get a signal. Or you want to go on Facebook, but it won't go there. It takes a long time. It used to be better.

Receiving large and/or unexpected bills was a common concern among participants in focus groups and semi-structured interviews. A number of community members commented on the experience of receiving a large bill themselves, or provided examples of family members or friends who had struggled to pay their phone bills. A focus group member in the Northern Territory observed:

> A couple of times I will get a phone bill, and it will seem like so much. Like much more than I thought it would be, and I am worried about paying it. If it arrives with another bill, I get really worried. I think that's why a lot of people pay for it, they pre-pay. Because if you get a bill and you can't pay, it's a big problem.

Many interviewees and focus group members noted that they had been shocked by the cost of using their mobile phones, either by receiving large bills or by running out of credit very quickly. Community members were unsure of why their bills are high, and/or unsure of how they can potentially minimise their call costs and data usage. As one interview in Cape York noted:

> It can be hard to work it out, why it costs so much. Because you don't know how much it will cost if you download a movie, or they tell you that you are close to going over your limit, but you don't know what happens when you do. So you just end up paying a lot, sometimes. People here like to get music, or watch videos, or call people down south. So suddenly they've spent a lot of money. It's not explained to them how.

A number of community members were also unaware of options to change their plans, and did not understand the current provisions and limits of their plans or pre-paid services. A focus group member in the Northern Territory summarised this:

> When people get their phone, they are just sort of told what will be best for them. Then when they use it, they want to use it all the time, so they end up paying too much money. And they don't know what to do to fix it. They don't know they can call up and ask for a change to their agreement or whatever. So they feel stuck.

Many remote Aboriginal and Torres Strait Islander community members did not fully understand their rights when dealing with service providers. This included some observations by focus group members and interviewees indicating that they did not think it was possible to change their phone contracts and/or services once they were set in place, as a focus group member in Cape York observed:

> I told my sister that she could change that contract. That she could ring them and tell them she wanted a better one, because she always running out of being able to get on the internet. But she said 'no, you can't change it'. A lot of people think that way. You get your phone and you sign your name and that's it. Finish.

Some community members reported dealing with service providers who were unhelpful or 'forceful' when explaining contracts to them, or outlining how to use prepaid services. This was captured in a focus group exchange in the Kimberley:

> They (the service provider) tell you it's a good deal. It's the best thing for you. They kind of force you to get a phone, and to get a certain type of calls or internet…
>
> But yeah, if you ask what you are getting, they're not helping you. They're like: 'it's what you need, so just get it'. Then you have to pay all the time, you pay too much.
>
> There's no one to tell you, in a way you'll understand, what it's all about. How much it will cost. If it will work. They just want you to buy it.

The outcomes of the focus groups and semi-structured interviews suggest a low level of awareness of support remote Indigenous community members can access to resolve problems with bills, contracts, pre-paid services or service provision in general. Some comments highlighted a cultural problem with complaining about services of any kind, with a focus group member in Cape York noting that "people up this way just don't like to complain, we won't phone up someone and tell them something is not right". An interviewee in Cape York explored this idea further:

> You can't just tell people that they can phone someone or go online if they have a problem. For a start, people aren't used to calling up places to say 'please help me with this'. They like to talk to someone they know, or someone local. Then also, they sort of don't know what to ask about. So if you could say: 'are you paying too much for your phone, for your bills?' then they might say 'oh, yeah, I am'. Then you can tell them they can get some help with that. They need to know what to say, you know what I mean?

Other focus group members and interviewees focused on what they felt to be a lack of awareness of where community members could go if they wanted to resolve a problem with their phone or internet service. A focus group member in the Kimberley noted:

> We don't know who you talk to. If your phone is broke or whatever, or you got some problem, we don't know who to talk to. We can't go to the store and sort it out.

It is evident from this research that community members would like more support and information (including translated content in community languages) that will help them to understand their rights and obligations before signing up to contracts, as well as during the contract period. A community member in Cape York suggested some "simple posters that let people know their rights, let them know who they can talk to about any problems". A focus group member in the Northern Territory suggested:

> You need some things in language, things people can listen to, because that's important for people. They won't read something, but if you can tell them, they understand. So yeah, tell them with a video or a CD or something, like radio there, tell them what questions they should ask, what they need to know.

Conclusions/Recommendations

While limited in scope in terms of the numbers of remote communities involved, feedback from community members indicates that in regions where there is some coverage, use of mobile phones is widespread and increasing. Findings in the remote communities involved in this research project align well with those of Brady et al (2008: 393), who point to a very high rate of mobile phone adoption and ownership in Indigenous Australia. This increased use of mobile phones for communication has been accompanied in the communities investigated by an increase in access to the internet via smartphones.

While previous studies have noted the use of mobile phones primarily for talking, texting and staying in touch with family and friends (see Brady et al 2008), there is clear evidence in this research project that many community members are using mobile phones to access social media and download music and movies. There is also some evidence that access to online news, as well as health and mental health information, is increasing in these remote communities. However, the desire of community members to get online and communicate primarily via their mobile devices is resulting in significant issues in terms of costs and problems with service provision. Even in communities with high levels of mobile phone ownership, issues are experienced with reliability and quality of phone and internet services.

The high, and often unexpected costs, of phone and internet usage have the potential to create ongoing problems for many remote Aboriginal and Torres Strait Islander consumers. The costs of phone contracts, pre-paid services, phone calls and data download continue to be limiting factors affecting the ability of remote community members to access reliable communications that meet their needs and wants (see also Rennie et al 2013; Papandrea 2010; Brady et al 2008). In communities where income levels are low and households are among the most disadvantaged economically in Australia, the cost of phone services can be a significant proportion of family and individual incomes. Rennie, Crouch, Wright and Thomas (2013: 591) note a 2007 study of mobile phone use in remote Northern Territory communities found that participants on Centrelink benefits were spending on average 13.5% of their income on their mobile phone, and those on CDEP were spending 8.3% of their income on their mobile phone.

Added to concerns from remote community members about the high, and often unexpected, costs of phone and internet bills and lack of reliable coverage, this research project has noted ongoing issues faced by individuals when seeking to resolve these problems. Many remote Aboriginal and Torres Strait Islander community members were confused about their phone and internet contracts and their consumer rights, and there were low levels of awareness of mechanisms for complaining or sorting out problems. It is suggested that more information needs to be provided to remote Aboriginal and Torres Strait Islander communities, in formats that are easily understood and culturally relevant, to build awareness of consumer rights and complaints mechanisms (see also Loban 2013).

Mobile phones are now playing an important and growing role in meeting the communications needs and wants of remote Indigenous community members. They provide a style of oral communication that suits more traditional forms of Indigenous communications (Brady et al 2008: 388), combining graphic and oral elements of communication that resonate strongly with cultural communication norms. They also have the potential to open up a range of new social and economic benefits for these communities and those who live there (McCallum & Papandrea 2009: 1254) and help to overcome the digital divide that has existed in these communities for long periods (Rennie et al 2010: 66). As Bandias (2010: 47) notes, improved access to telephones and the internet has "the potential to mitigate the negative effects of the geographic and social isolation experienced by the community".

Access to the internet and social media via mobile phones provides remote community members with new avenues for connection to like-minded people and communities national and globally, with Indigenous communities using new technologies in innovative and creative ways (Eardley et al 2009: 18). As an essential service for Indigenous people living in remote communities, and as a catalyst for future social connections, creative outlets and access to important news, information and services, there is a need for ongoing improvements to levels of access to reliable and affordable mobile phone and internet services. This research project suggests that this increased access must be accompanied by affordable service provision, coupled with clear and culturally-relevant information on telecommunications consumer rights.

References

Australian Bureau of Statistics. 2007. 'Household Use of Information Technology, 2006-07'. Canberra: Australian Bureau of Statistics.

Australian Bureau of Statistics. 2011. 'Australian Social Trends, June 2011'. Canberra: Australian Bureau of Statistics.

Australian Communications and Media Authority. 2008. 'Telecommunications in Remote Indigenous Communities'. [Internet]. Accessed 7 June 2015. Available from: http://www.acma.gov.au/~/media/Research%20and%20Analysis/Information/pdf/Telecommunications%20in%20Remote%20Indigenous%20Communities.pdf (link is external).

Bandias, S. 2010. 'Building indigenous social capital in an online world'. *Platform: Journal of Media and Communication*, no. 2 (ANZCA special edition): 38–51.

Bandias, S; Vemuri, S.R. 2005. 'Telecommunications infrastructure facilitating sustainable development of rural and remote communities in Northern Australia'. *Telecommunications Policy*, vol. 29: 237–249.

Brady, F; Dyson, L.E; Asela, T. 2008. 'Indigenous Adoption of Mobile Phones and Oral Culture' in Sudweeks, F; Hrachovec, H; Ess, C. (eds) Proceedings of the 6th International Conference on Cultural Attitudes Towards Technology and Communication 2008. Australia: Murdoch University.

Central Land Council. 2010. 'Submission to Reconnecting the Customer Inquiry'. [Internet]. Accessed 3 June 2015. Available from: http://acma.gov.au/webwr/_assets/main/lib311946/110_central_land_council-14-09-10-reconnecting_the_customer.pdf (link is external).

Daly, A. 2005. 'Bridging the Digital Divide: The Role of Community Online Access Centres in Indigenous Communities'. Discussion Paper 273, Centre for Aboriginal Economic Policy Research. Canberra: Australian National University.

Eardley, T; Bruce, J; Goggin, G. 2009. 'Telecommunications and Community Wellbeing: a review of the literature on access and affordability for low-income and disadvantaged groups'. Sydney: University of New South Wales Consortium Social Policy Research Centre.

Gillham, B. 2000. *The Research Interview*. New York: Continuum.

Gunkel, D. 2003. 'Second Thoughts: Toward a Critique of the Digital Divide'. New Media & Society 5(4): 499–522.

Gunter, B. 2000. *Media Research Methods: measuring audience, reactions and impact*. London: Sage.

Holstein, J.A; Gubrium, J.F. 2002. 'Active Interviewing' in Weinberg, D. (ed.) *Qualitative Research Rethods*. London: Blackwell.

Jensen, K. B. 2002. 'The Qualitative Research Process' in K. B. Jensen (ed.) *A Handbook of Media and Communication Research: Qualitative and Quantitative Methodologies*. London: Routledge.

Kitzinger, J; Barbour, R. S. 1999. *Developing Focus Group Research: Politics, theory and practice*. London: Sage.

Loban, H. 2013. 'Indigenous people, telecommunications and consumer protection'. *Indigenous Law Bulletin*. 8(6): 6–8.

McCallum, K; Papandrea, F. 2009. 'Community business: The internet in remote Australian indigenous communities'. *New Media and Society*, 11(7): 1230–1251.

Meadows, M. 2002. 'Tell me what you want and I'll give you what you need: perspectives on Indigenous media audience research', in Balnaves, M; O'Regan, T; Sternberg, J. (eds.) *Mobilising the audience*. St Lucia: University of Queensland Press.

Meadows, M; Forde, S; Ewart, J; Foxwell, K. 2007. *Community Media Matters: An audience study of the Australian community broadcasting sector*. Brisbane: Griffith University.

Papandrea, F. 2010. 'Communication services in remote indigenous communities', *Media International Australia, Incorporating Culture and Policy*, 134(134): 46–59.

Rapley, T. 2004. 'Interviews', in Seale, C; Gobo, G; Gubrium, G. F; Silverman, D. (eds.) *Qualitative Research Practice*. London: Sage.

Rennie, E; Crouch, A; Thomas, J; Taylor, P. 2010. ‘Beyond public access? Reconsidering broadband for remote indigenous communities’. *Communication, Politics and Culture*, 43(1): 48–69.

Rennie, E; Crouch, A; Wright, A; Thomas, J. 2013. ‘At home on the outstation: Barriers to home internet in remote indigenous communities’. *Telecommunications Policy*, 37(6/7): 583–593.

Waterton, C; Wynne, B. 1999. ‘Can focus groups access community views?’ in Barbour R; Kitzinger, J. (eds.) *Developing Focus Group Research*. London: Sage.

Watson, I. 2013. ‘Connecting, informing and empowering our communities: Remote Indigenous radio in the Northern Peninsula area’, *Media International Australia*, 148: 59-69.

The Future of Digital Services Delivery

Embracing co-dependency for growth of the National Digital Economy

Kevin Barrell
Technology Strategist, CTO, Alcatel-Lucent Oceania

Warren Lemmens
CTO, Alcatel-Lucent Oceania

Abstract: Australia has set a strong ambition to capture opportunities presented by the emerging digital economy. While much discussion has focussed on the significant investment being made in broadband infrastructure, it is important to recognise that a range of other factors will also impact Australia's ability to achieve its vision of a dynamic digital market. Not least will be the requirement for the highest levels of satisfaction across a complex service delivery environment encompassing retail and business consumers, today's retail and wholesale service providers, and early phase digital content providers as well as the full range of future digital application services providers.

Realising Australia's ambition for the digital economy transcends access network architecture and technology considerations, while highlighting the complex array of technology, process and systems components required to deliver digital services in the global marketplace. Successfully harnessing this diverse set of contributors is fundamental to ensuring Australia develops an effective service delivery ecosystem to underpin its digital future.

This paper makes the case for industry to turn its attention to the operational market structure and processes that will support this future environment, together with the key multi-party relationships and interdependencies that will underpin the required high levels of user experience and Australia's ultimate success.

Introduction

There is strong recognition of the significant contribution of digital services to economic performance, with broadband access as their key enabler. In Australia, the growth of e-commerce has consistently outpaced GPD growth over the last decade (ABS 2014; Deloitte 2015) while the pervasive reliance on connectivity and new digital tools in everyday

3http://doi.org/10.18080/ajtde.v3n3.22

personal and business activities reinforces their real and direct impact on economic performance.

Recent studies highlight the significant influence of telecommunications and digital services in the Australian economy. Infrastructure Australia (2015) calculates that the direct economic contribution of telecommunications services will total $42 billion annually by 2031, an increase of 101% from 2011, driven by the growing range of available services. Deloitte Access Economics (2015) estimates that the broader digital economy will grow to contribute as much as $139 billion p.a. by 2020 (7.3% of GDP).

Australia's nbn™ network is supported with this economic benefit in mind. The project envisages a national open-access wholesale platform that accelerates the availability of retail broadband services and stimulates competitive innovation in digital content, applications and services – all with positive impact to consumer participation, business productivity and government service delivery.

While provision of broadband access is considered a critical enabler for this vision, several visible trends demonstrate a broader set of challenges and opportunities that must be addressed as the telecommunications sector enters a critical period of transformation. These relate to: the proliferation of services from 'beyond the network', i.e. no longer bound to the capabilities of network-resident facilities; the business profile of emerging digital service providers – specialised, global in scale and unrestrained by existing service constructs; and virtualisation of traditionally-physical service infrastructure through the adoption of Network Functions Virtualisation (NFV) and Software Defined Networking (SDN) technologies, which are lowering barriers to entry for new entities.

In this emerging market environment, the traditional relationships between individual or business consumers and their telecommunications service providers will evolve, and in some cases be supplanted by new relationships. Further, in a world enabled by a ubiquitous open-access platform, the customer, service provider and application delivery roles become multi-party and interdependent. This implies a complex, high-stakes environment in which multiple and co-dependent parties are all demanding, and must themselves contribute to, the delivery of an assured level of user experience.

Given its significance, we can expect this emerging digital market environment to challenge many existing regulatory, investment and economic models. As a result, proactively evolving the ecosystem to address known and emerging trends will be critical to success, and to the broader growth of a national digital economy.

While this is a daunting and complex challenge with no single solution, we have identified several key aspects to inform a framework for addressing the emerging market, and stimulating Australia's digital delivery ecosystem. This paper suggests a set of enduring principles to guide effective progress in enhancing customer experience and responding to this co-dependent delivery environment:

- Transparency across multi-party actions;
- Empowerment for great customer experience;
- Automation enabling proactivity;
- Measurement driving improvement;
- Data accuracy for consistent understanding; and
- Flexible re-use for innovative service evolution

These principles, when applied to market-wide initiatives for service delivery, performance assurance and supporting systems, offer the potential to enhance innovation and sustainability across the digital services market.

A digital services future

Across the global Information and Communications Technology (ICT) industry, progression towards the year 2020 is characterised by significant and accelerating transitions. User behaviour – once dominated by email, web search and the beginnings of online commerce – is being both supplanted and enhanced by the pervasive digital technologies of cloud platforms, lower cost smart devices and ubiquitous social networks. At a macro level this transition is reinforced by governments and businesses that understand the critical economic reliance on effective telecommunications and digital services.

By 2020, digital services will be making recognisable and meaningful contribution to economic growth, and will strongly influence the evolution of today's telecommunications sector structure and role in the marketplace. Ubiquitous, open-access broadband networks will be a substantial enabling advantage for Australia. However it is important for all stakeholders to understand the evolving environment that will underpin and further stimulate a dynamic digital services market.

National Digital Economy Transformation

There is broad recognition of the increasing economic influence of telecommunications and the digital economy that it enables. This is reflected in the proliferation of digital services across industrial sectors and continued investment in telecommunications infrastructure to meet these needs.

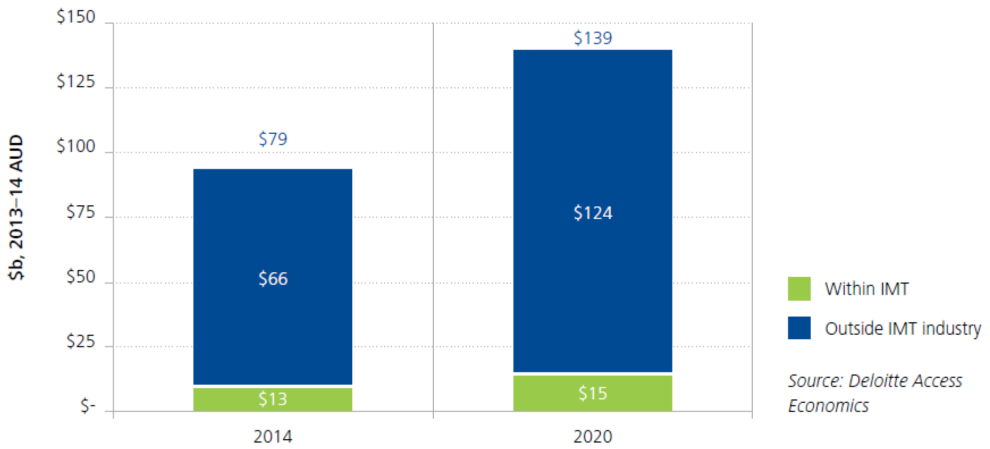
In its recent audit of national infrastructure requirements, Infrastructure Australia (2015) predicts demand for telecommunications infrastructure to grow faster than GDP for at least the period until 2031, reflecting the pervasive impact of digital technologies and demand for new services across all industry sectors as well as government service delivery. This is particularly the case for the Health Care sector to address escalating health care costs (9.6% of annual GDP in 2012-13) and in Education where digital technologies have had a significant impact on how the sector organises and delivers services.

Deloitte Access Economics (2015), in its recent report 'The Connected Continent II', highlights the significant positive impact already made by digital services, technology and commerce in Australia's economy, estimating a contribution of $79 billion (5.1%) to annual GDP in 2013-14. The growth of digital services has made a fundamental impact on consumer participation, business productivity and government service delivery. The same study further projects that the digital economy could represent $139 billion by 2020 (7.3% of GDP), based on the growth of e-commerce which has consistently outpaced GDP growth over the last decade. These forecast contribution levels also reflect the growth of the Information, Media and Technology (IMT) industry segment directly [refer Figure 1].

A critical factor underpinning this digital services participation and market growth is increasing broadband penetration. Deloitte Access Economics suggests that a 10 percentage-point increase in broadband penetration rate will most likely result in a 0.9 to 1.5 percentage point increase in annual per capita growth. However, as Infrastructure Australia notes, considerable attention should be given to ensuring that Australia maximises the potential of its connectivity investments.

Therefore it is crucial to consider the visible and emerging trends shaping the digital market and how best to establish the relationships that underpin its productive operation. Ensuring the affordability and effectiveness of broadband digital services delivery will continue to provide a substantial boost to growth across the associated digital economy.

Figure 1. Economic contribution of national digital economy



Source: Deloitte Access Economics (2015)

Competitive Digital Services Marketplace

The emerging digital economy will be characterised by massive scale development, distribution and consumption of digital services. In Australia, these services will be delivered substantially over the nbn™ network, as well as via mobile broadband.

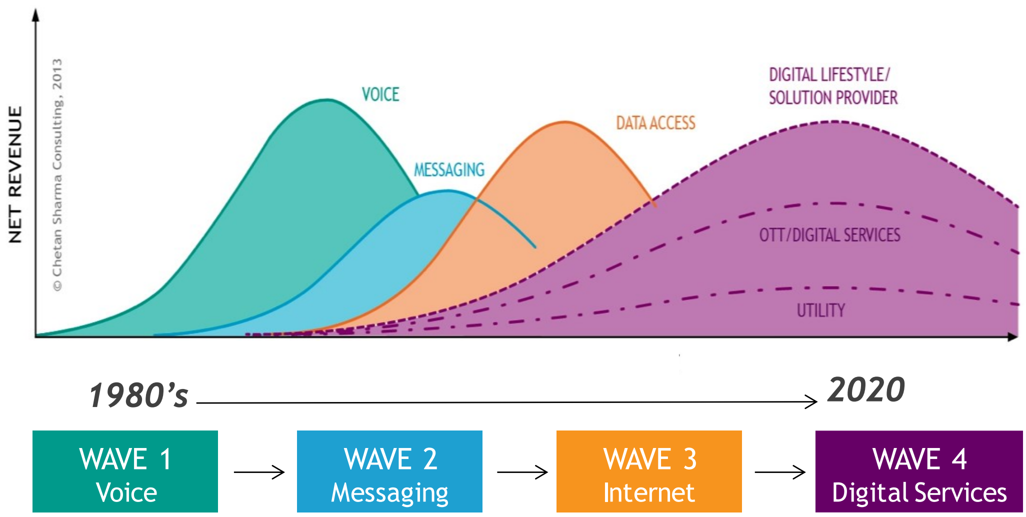
Importantly though, this era will herald a new mode of service provision, a break from past arrangements that have been characterised by the close integration of telecommunications services with their delivery networks. In fact, in the past, most communications services have been defined by the capabilities of the networks themselves. The emerging digital services environment however, will be populated with a new cadre of providers unencumbered by legacy assets and supported by a ubiquitous communications network fabric, with negligible difference between fixed and mobile broadband access platforms.

The progress through these service phases has been studied by Chetan Sharma Consulting (2012), who characterise the arrival of digital services as a 4th Wave of services evolution, see Figure 2. In coining, defining and exploring the 4th Wave, Chetan Sharma Consulting predicts that new network technology capabilities and user expectations for service consistency across platforms and devices will disrupt traditional telecommunications service-provider models. Such disruption creates threats and opportunities to which many existing telecommunications players are already having to adapt.

The 4th Wave of digital services breaks dramatically with the historical telecommunications past, with certain trends helping define how this environment is being shaped. These include:

- Service growth will be derived increasingly from services offered from 'beyond the network', i.e. no longer bound to the capabilities of network-resident facilities.
- Providers of such services are increasingly specialised and global in business operation, expanding consumer choice.
- The adoption of virtualised network services continues to render ownership of telecommunications networks or systems infrastructure less necessary for service providers to operate effectively. From both investment and competition policy viewpoints, the barriers to entry for service providers will be increasingly lower.

Figure 2 Four Waves of Services



Source: Chetan Sharma Consulting (2012)

In short, these visible trends point to a future marketplace with a large number of specialised digital service providers working through a diversity of third-party network infrastructure and systems to reach their target markets. They highlight risks of declining relevance for traditional communications service providers, even as their networks remain a critical delivery platform. It also presents opportunities for existing players to arrange themselves in a way that enhances their function and value for the emerging environment, to create and compete in a dynamic digital services market.

Device Focussed and Pervasive Virtualisation

The growing dominance of digital services, less encumbered by physical network and system assets, reflects the impact of some key areas of technology innovation:

- Device intelligence – harnessing the processing power of end-point devices has accelerated the proliferation and utility of innovative digital services. It has enabled new levels of end-user productivity and has strengthened the relationships between user and service provider.
- Service virtualisation – cloud-based service delivery has freed the service provider from the constraints of infrastructure ownership and enabled more consistent global experience.
- Massive endpoint proliferation – the emergence of the Internet of Things (IoT) also brings the requirement to respond to unparalleled quantities of data and services information drawn from many billions of sensors, probes, actuators, machines, applications and people. Thus the industry anticipates an explosion in the number of communicating devices, capable of consuming and sourcing on demand, very large amounts of media-centric, geographically-shifting and time-sensitive workloads (TM Forum 2015).

These factors deliver a positive impact on the utility and price points of digital services, and thus directly assist the acceleration of the digital services market. Yet they also place new demands on the delivery network to support these services, with dependencies, for example, on enhanced speed and latency performance, security and network-wide awareness of user service preferences to ensure a consistent user experience.

Innovation that addresses those demands is clearly visible in the complementary technologies of NFV and SDN. NFV leverages virtualisation technology from the data centre environment to implement network functions as software components running as virtual machines (VMs) over general purpose processors (servers) – thereby avoiding the historical need for dedicated and often specialised hardware. SDN addresses the highly complementary need to provide such a network software service with dynamic interconnection to other network functions (whether physical or virtual) and associated service endpoints. Although still in their early days for deployment, these new technologies are already widely viewed as essential components in reshaping the future of networking. A recent study by Arthur D. Little and Bell Labs Consulting (2015) identifies their significant impacts to network operators in the form of new relationships with consumers; new classes of competitors; the rise of new collaborations; and profound changes to operations.

Programmability of network functions allowing agile development of new services, on-demand connectivity and capacity, new performance levels underpinning service-specific Service Level Agreements (SLAs), responding dynamically with awareness of user capabilities and preferences – these are the characteristics increasingly required of the delivery networks supporting digital services and underpinning the digital economy.

Digital services delivery ecosystem

Satisfying these new demands of digital services will be increasingly reliant on the operation of a broad service delivery ecosystem. Traditional communications service delivery could often be based on a single provider's alignment of its customer, network operation and equipment views. However digital services delivery requires the coordination of multiple service-component views, e.g.: customer, device, service operation, data centre, network operation, equipment. And significantly, these views in many cases will be distributed across multiple participating providers.

The ecosystem of digital services delivery, i.e. the set of providers, networks, systems, processes and stakeholders, is therefore quite complex and challenging. In developing the early concepts of business ecosystems, Moore (1993) noted that firms operating in this environment must often co-evolve their capabilities, moving toward shared visions to align their investments and find mutually supportive roles. Extending the ecological metaphor, Moore suggests that companies need to be proactive in developing mutually beneficial ("symbiotic") relationships with customers, suppliers and even competitors.

In Australia, the broadband services market structure exerts a dominant influence on the pace of growth in the digital economy. This factor has been a driving force in the creation of Australia's NBN as a national, wholesale-only broadband platform to operate on an open access and non-discriminatory basis, in support of effective retail service competition. As such, this forms an ecosystem for service delivery and encompasses commercial and operational relationships spanning multiple market participants with each having the capacity to help or hinder an optimal operating environment.

Delivery Co-dependencies

In the emerging ecosystem, the achievable end-to-end service delivery experience results from co-dependent actions by a range of actors encompassing wholesale network infrastructure operators, retail service providers, related content, digital service or application providers, end-user devices and end-users themselves. The traditional technology-driven operations that support subscribers consuming a service provider's own products are coming to an end, and the dawn of an open collaboration model is here (Alcatel-Lucent 2015).

Contrasting with these service delivery co-dependencies, however, are the commercial supplier-customer relationships which can typically remain segmented as one-to-one within the delivery chain. In this emerging ecosystem, even without a direct relationship with the end-user, a wholesale access provider is the delivery agent for most of the physical service touch-points experienced by the end-user. This extends across installation and activation, as well as support and assurance – all of which have a significant impact on an end-user's experience.

Given the significance of the structural change facing the telecommunications sector, it is critical that industry improve the cohesion and effectiveness of these co-dependent relationships. By reducing complexity, increasing the speed of action and eliminating error, industry can substantially aid the growth of a dynamic and beneficial digital services market and national digital economy.

Australia stands at an important time of opportunity to consider how to develop the best possible co-dependent service delivery framework. The NBN initiative is now building project momentum and delivering improved access infrastructure options, however global factors such as the adoption of NFV and SDN services will also increase the pressure to preserve relevance and maximise opportunity. A rich new set of business models will be enabled, through the mix of on-demand access to connectivity, along with exposing core network functionalities to other collaborating entities. In this way, earlier open-access provisions mandated by market liberalisation regulations can evolve through a market-driven approach to enable this expanded digital services delivery ecosystem.

Legacy Practices Won't Suffice

The commercial relationships as originally established for nbn™ are focussed on separation of wholesale and retail service provision with an emphasis on broadband access:

- Wholesale access infrastructure provider to Retail Service Provider (RSP) access seeker, providing the ability to reach customer end-points for service delivery.
- RSP to end-user, providing that end-user's service relationship.

The NBN's technical capability supporting end-user relationships via multiple RSPs, has reflected the view that the end-user experience was firmly in the jurisdiction of the relationship between RSP and end-user. But successful service delivery to end-users is clearly dependent on the combined contribution of RSP and wholesale access network provider. Systems or process failure of either party, or in the coordination between them, directly impacts end-user experience.

Yet the range of digital content, applications and services and consequent end-user demand is rapidly increasing and driving a many-to-one service delivery ecosystem in which multiple entities hold a co-dependent responsibility for successful service implementation. Commercial SLAs, operational practices, supporting IT systems that were established on a model of independent service provider responsibilities can no longer be expected to effectively support the service co-dependencies resulting from a massive volume of digital services and end-users.

As evidenced by the proliferation of Net Promoter Score (NPS) metrics, customer-focussed rhetoric and corporate Key Performance Indicators (KPIs), service providers have already placed end-user experience at the heart of their market strategies. However, with the explosion of digital services and devices, in an increasingly complex and diverse service provider ecosystem, the task of managing, maintaining and improving end-user experience is becoming ever more complex.

Framed in the context of the national digital economic opportunity, this situation amplifies the importance of ensuring transparent, informed and coordinated customer experience operations across the full ecosystem of co-dependent service delivery participants.

Six guiding principles

The anticipated trends in the evolving market environment represent a challenging journey to be navigated over a relatively short period to a 2020 horizon. Technology, product capabilities, business relationships and service demands will all continue to evolve over the course of this journey, bringing the need for review and potentially ongoing adjustment.

To guide this process, we suggest a set of enduring principles to help industry respond to challenges and to ensure the required levels of enhanced user experience. These principles can be considered fundamental to delivering successful user experience and may be used to review current operational levels and capability gaps and to identify additional future solution requirements. While beneficial for today's network, systems and process environment, they can also achieve enhanced effectiveness when taking advantage of the future deployment of NFV and SDN technologies.

Transparency across multi-party actions

Service experience reflects the combined effectiveness of the multi-stakeholder delivery ecosystem. Actions taken by these stakeholders must be conducted with informed awareness of, and in collaboration with, the actions or dependencies required of others.

For service providers, transparency equates to visibility of network performance and issues, updates on problem resolution or activation status. Examples of this are service performance reporting, alerting/alarming and auto-ticketing. Meanwhile, transparency for the end-user means visibility of the performance and issue resolution with their individual service, or progress of installation/activation.

Transparency across the ecosystem is fundamental for the effectiveness of the combined relationships and to develop the trust required to support a dynamic digital services market.

Empowerment for great customer experience

With an extended, multi-party service delivery chain, there will be personnel in various layers and designations all influencing the success or otherwise of the customer experience. While policies and technology systems will guide the way these parties interact, individual personnel will also require effective empowerment to make decisions and implement changes that eliminate conflicts and reduce the time and effort required at network hand-over points.

Empowerment also extends to the individual customer, through the adoption of self-help facilities for service activation, configuration and assurance. Providing customers with effective tools and choice mechanisms engenders the feeling of being in control of their service outcome, which is one of the strongest contributors to a positive service experience.

Automation enabling proactivity

A dynamic digital services market will generate vast quantities of data transactions, with extremely high levels of assurance and reliability required. The diversity of customer service choice and delivery options demands that not only should these associated volume processes, business transactions and service/network operations become automated, but also that they be harnessed to anticipate and avoid service errors or disruptions. With the availability of analytics insights, service providers can identify trends and proactively move to prevent issues arising as well as streamline operations.

Care must be taken however to identify a minimum set of baseline automation capabilities as a threshold for industry effectiveness, avoiding the imposition of unnecessary cost barriers to market participation.

Measurement driving improvement

Across the full dimensions of business performance, customer experience and technology effectiveness, disciplined measurement is a fundamental prerequisite for enabling improvement. This well-recognised principle from continuous improvement practice is not only relevant to individual service providers or similar entities, but should be pursued on a full market ecosystem basis. By analogy, this could be considered as extending to the new digital services environment, a principle currently underlying the reporting provisions of the Telecommunications Consumer Protection Code.

Providing a collective market framework to consistently measure relevant service implementation and performance metrics, while protecting competitive business sensitivities, could provide the foundation for recognising and improving performance for the digital economy.

Data accuracy for consistent understanding

Access to a common repository and/or sources of credentialed data allows distributed customer and service delivery action to be confidently initiated. A central point of reference of this nature would eliminate the cost of duplicated, contradictory or misdirected service delivery efforts and would stimulate a diligent clean-up and verification of existing data sets. Technology solutions are emerging that can enable much of the necessary data to be auto-sourced from the deployed network and infrastructure itself. This ensures the desired consistency and reduces the dependency on resource-intensive audit processes.

Flexible re-use for innovative service evolution

The continuing evolution of a dynamic digital service marketplace will inevitably reveal unexpected roadblocks and challenges, as well as desirable opportunities for innovation in customer and market/product propositions. Maintaining flexibility to respond to these unplanned but inevitable events may be enhanced by investment to enable the configurable re-use of ecosystem platforms, processes and infrastructure components, rather than redesigning and re-deploying at each point of change.

At a technical level, new advances offer this prospect by decoupling the process or software application workflow logic defining how components are combined, from the component's behaviour implementation. Technologies such as orchestration and policy-based mechanisms are key to the flexibility required for agile creation of new applications. While these are well established in (for example) the SDN and NFV domains, they are being extended towards full ecosystem applicability by others including the TM Forum's ZOOM initiative (2014).

An industry opportunity

The future of Australia's digital economy, and also Australia's prominence in the era of digital services, relies to a large extent on our capacity to develop a rich supply of service offerings and the willingness of Australian individual and business consumers to adopt them. Global research emphasises that the factors of ease of market entry, coupled with ease of service consumption will be fundamentally important to economic success.

This future environment brings challenge and opportunity for the entire market ecosystem and perhaps most pointedly for traditional telecommunications players. While critical to the ecosystem, and potentially well placed to benefit, these carrier network operators and service providers also face significant threat from innovative new providers active across the industrial spectrum. As Arthur D. Little and Bell Labs Consulting state in their recent paper: "there are many opportunities for the expansion of value in the telecom sector, especially for carriers that purposefully embrace this transformation. But carriers that fail to internalise these changes are likely to find themselves left behind with uncompetitive and potentially untenable business and operating models" (Arthur D. Little and Bell Labs Consulting (2015)).

While telecommunications service providers are already acting to fuse their carrier networks with the cloud ecosystem, we suggest they must move swiftly to purposefully embrace the broader market transformation. Indeed, we suggest that telecommunications service providers have a crucial part to play in the development of a dynamic service delivery ecosystem to facilitate that market, being well placed to adopt and evangelise a set of service delivery principles as articulated in this paper. They must develop an intimate understanding of this emerging ecosystem and demonstrate strong leadership to build market confidence and accelerate new services to market.

Identifying practical mechanisms and initial actions through which to pursue this objective requires more wide-ranging engagement and industry discussion. Several candidate steps may be identified however, by considering some essential elements that characterise the goal of an effective digital economy, relying on co-dependent service delivery.

- **Consolidate Clarity of Understanding** of the needs of Australia's digital businesses that seek to compete in the global digital marketplace. There are numerous Australian businesses across multiple sectors that have successfully built their digital operations for the global marketplace. Capturing their experience and perspectives on the enabling digital service delivery requirements can bring the clarity of a focus for industry effort. For example, the recent ChildStory (2015) initiative by NSW Family and Community Services is encouraging in regards to the value of adopting such a co-design approach with extended user communities.
- **Strengthen Quantification of the Digital Economic Impact.** As explained by Deloitte Access Economics and in OECD (2014), it is particularly challenging to

generate a fully quantified measurement of the national Digital Economy. Direct GDP-related metrics, as referenced earlier in this paper, currently overlap with estimates of the significant indirect benefits, i.e. the consumer surplus and welfare gains generated from utilising the digital services market. Continuing support should be provided to the development of economic models that provide a consistent quantification of the full contribution of the Digital Economy. The availability of such strengthened estimation will undoubtedly assist national recognition of the full economic significance of future digital services and similarly encourage industry attention to the service delivery challenges discussed here.

- **Establishing a Progress Benchmark** can be a valuable technique for providing common focus across a diverse industry grouping. Further research is needed to identify and isolate those metrics which may reliably reflect the effectiveness of co-dependent delivery for digital services to the Australian marketplace. In the government sector, such a benchmarking approach has been initiated by the Digital Transformation Office with the recent baseline establishment of its Digital Transformation Index for government services. In a more directly commercial example, the impact of Netflix's ISP Speed Index publication can be seen in the widespread market debate and industry participant responses.
- **Commence the definition of an Open Collaboration Framework** for industry use. Encompassing such essentials as the scope of open data availability, cross-industry operating customs and coordinated service performance assurance, such a framework initiative can bring structure and greater predictability to the challenges of co-dependent service delivery.

Progress with such initiatives will require a closer engagement between Australia's peak telecommunications, IT sector and broader business bodies, to ensure that while ever the benefits of an emerging digital economy are promoted, consideration extends to the co-dependent service delivery ecosystem that will underpin it. By adopting the principles described in this paper as a framework, these industries have the potential to ensure that new services are developed in informed anticipation of the delivery ecosystem and as such, this environment is well prepared, predictable and reliable.

Further, it may be worth noting that the current review of the Australian Communications and Media Authority pays regard to the full extent and complexity of the emerging environment articulated in this paper as a way to guide the formulation of a future regulator best positioned to maximise the national opportunity.

Conclusion

As we enable the accelerating adoption of digital services, industry objectives should encompass not only responding to the interests of service consumers, but also ensuring the wellbeing of a dynamic service delivery sector. The principles offer a basis for a broad ecosystem to evolve the practices and co-dependent relationships required to achieve this goal. They are universal and apply to Australian-originated services as well as imported and globally originated services. While maintaining the autonomy of supply-side participants, they are designed to encourage collaboration, fostering successful development of the new digital markets and consumption of digital services. Such development is essential for the ongoing economic and social advancement of Australia.

With strong leadership and collaboration, these principles can be a winning formula to promote a vibrant digital economy as a key growth driver.

References

Alcatel-Lucent. 2015. Evolving operations to capture the open collaboration opportunity. Strategic White Paper. Available at: http://www2.alcatel-lucent.com/landing/managed-services/?s_cid=smm15_tmc0685_ar

Arthur D. Little. Bell Labs Consulting. 2015. Reshaping the future with NFV and SDN. The impact of new technologies on carriers and their networks. Available at: http://www.slideshare.net/ceobroadband/adl-bell-labs-2015-reshaping-the-future

Australian Bureau of Statistics. 2014. Catalogues: #8166 - Summary of IT Use and Innovation in Australian Business; #5206 – Australian National Accounts, National Income, Expenditure and Products.

Chetan Sharma Consulting. 2012. Operator's Dilemma (and opportunity): The 4th Wave. Available at: http://www.chetansharma.com/OperatorsDilemmaFourthWave.htm

ChildStory. 2015. NSW Family and Community Services. Available at: www.childstory.net.au

Deloitte Access Economics. 2015. The Connected Continent II. How digital technology is transforming the Australian economy. Available at: http://www2.deloitte.com/au/en/pages/economics/articles/connected-continent.html

Infrastructure Australia. 2015. Australian Infrastructure Audit: Our Infrastructure Challenges. Available at: http://infrastructureaustralia.gov.au/policy-publications/publications/australian-infrastructure-audit.aspx

Moore, J F. 1993. Predators and Prey – A new Ecology of Business. *Harvard Business Review*, May/Jun 1993.

OECD. 2014. Measuring the Digital Economy: A New Perspective. OECD Publishing. Available at: http://dx.doi.org/10.1787/9789264221796-en

TM Forum. 2014. OSS/BSS Futures, Preparing the Future Mode of Operation, Frameworx Exploratory Report IG1118. Available at: https://www.tmforum.org/resources/standard/ig1118-oss-bss-futures-preparing-the-future-mode-of-operation-r14-5-1/

TM Forum. 2015. Internet of Things, How billions of touchpoints impact customers. Quick Insights report. Available at: https://www.tmforum.org/resources/research-and-analysis/internet-of-things-how-billions-of-connected-touchpoints-impact-customers/

It's only the beginning: Metadata Retention laws and the Internet of Things

Clinton Fernandes
University of NSW

Vijay Sivaraman
University of NSW

Abstract:

This article examines the implications of selected aspects of the *Telecommunications (Interception and Access) Amendment (Data Retention) Act 2015*, which was passed by the Australian Parliament in March 2015. It shows how the new law has strengthened protections for privacy. However, focusing on the investigatory implications, it shows how the law provides a tactical advantage to investigators who pursue whistleblowers and investigative journalists. The article exposes an apparent discrepancy in the way 'journalist' is defined across different pieces of legislation. It argues that although legislators' interest has been overwhelmingly focused on communications data, the explosion of data generated by the so-called Internet-of-Things (IoT) is as important or more. It shows how the sensors in selected IoT devices lead to a loss of user control and will enable non-stop, involuntary and ubiquitous monitoring of individuals. It suggests that the law will need to be amended further once legislators and investigators' knowledge of the potential of IoT increases.

Introduction

On 26 March 2015, the Australian Parliament passed data retention laws after five years of community uneasiness, rumours, discussion and debate about the extent to which such laws may violate people's privacy. Known as the *Telecommunications (Interception and Access) Amendment (Data Retention) Act 2015*, it was the Abbott Government's third tranche of national security legislation (after the *National Security Legislation Amendment Act (No. 1)* 2014 and the *Counter-Terrorism Legislation Amendment (Foreign Fighters) Act 2014*). It compels telecommunications providers to retain a defined set of data for a period of two years, whilst reducing the number of agencies able to access such data. The law received Royal Assent in April 2015 and comes into force on 13 October 2015.

The confusion over metadata

When the Attorney-General and the Minister for Communications announced the successful passage of the Bill, they said, 'Metadata is the basic building block in nearly every counter-

http://doi.org/10.18080/ajtde.v3n3.21

terrorism, counter-espionage and organised crime investigation. It is also essential for child abuse and child pornography offences that are frequently carried out online' (Brandis & Turnbull 2015). Earlier that same day, however, the Attorney-General had said in Parliament that 'the word "metadata" … is a jargon phrase of no clear and specific meaning and no technical standing' (Brandis 2015). Indeed, few aspects of the Bill caused as much controversy and confusion as the term 'metadata.'

The confusion had started as early as 2010, when rumours about the Labor Government's plans for a data retention scheme surfaced in the technology press (Grubb 2010). The Senate Standing Committees on Environment and Communication began an inquiry soon afterwards, and issued a report listing a range of criticisms about the data retention proposals such as its inconsistency with the Privacy Act, its unreasonably differential treatment of online and offline information, and claims that the scheme would in any case be 'unlikely to be effective or useful to law enforcement' (SSCEC 2011).

The Government subsequently announced plans to review the proposals via public consultation, and in July 2012 released, via the Attorney-General's Department, a Discussion Paper on the proposed national security reforms. A central part of the argument for a data retention scheme was that technological change and changes to industry structure, practices and consumer behaviour were rapidly eroding agencies' ability to intercept telecommunications and communications data, which were 'unique and fundamental tools that cannot be replaced by other investigative techniques… cost effective, timely, low risk and extremely successful tools in obtaining intelligence and evidence' (AGD 2012). Without such reforms, the argument went, there would be a serious decline in agencies' capabilities.

As the push for a data retention scheme gained renewed momentum after the September 2013 elections, the new Government pointed to advice from the Australian Federal Police (AFP) that 'between July and September of 2014 telecommunications data was used in 92 per cent of counterterrorism investigations, 100 per cent of cybercrime investigations, 87 per cent of child protection investigations and 79 per cent of serious organised crime investigations' (Brandis & Turnbull 2015).

Confusion over the meaning of 'metadata' intensified after the new Attorney-General George Brandis was unable to explain what the term meant in an interview with Sky News:

> Brandis: "The web address, um, is part of the metadata."
>
> Journalist: "The website?"
>
> Brandis: "The well, the web address, the electronic address of the website. What the security agencies want to know, to be retained is the, is the electronic address of the website that the web user is . . . "

Journalist: "So it does tell you the website?"

Brandis: "Well, it, it tells you the address of the website."

It later transpired that Senator Brandis had been trying to say that investigators wanted telecommunications companies to retain the IP addresses of users' devices rather than 'web address', because URLs and browsing histories were specifically excluded from the data retention proposals.

There is, of course, no formal definition of 'metadata' in Australian telecommunications law. The predecessor to the 2015 law, known as the *Telecommunications (Interception and Access) Act 1979*, was silent on the types of data that telecommunications providers had to retain for law enforcement and national security purposes, and also for how long they had to retain it. Different providers therefore retained different types of information based on their individual billing, marketing and taxation requirements. The result was a considerable variation across the industry. The word 'metadata' did not appear anywhere in the new law either; instead, s. 187A(1) lists certain categories of information such as the characteristics of the subscriber, account, device and service, the source, destination date, time, duration and type of communication, and the location of the equipment or line used in connection with a communication. These categories of information allow investigators to establish primary facts and the likely existence of a (criminal) network in order to determine whether to seek a warrant for a listening device.[1]

The new privacy protections

In listing specific categories of information to be retained, the new law adopts the approach of defining 'metadata' specifically and narrowly, and 'content' non-specifically and therefore broadly. It thus avoids the conceptual error of trying to list content in any detail, because such an approach would have the unwelcome consequence of including within the reach of the law, by omission, content that the Parliament actually wanted to prevent authorities from accessing. The law also contains an explicit prohibition against warrantless access of information that falls outside the listed categories. It specifically prohibits warrantless access of web-browsing histories.

Whereas previously metadata could be accessed by such bodies as the Victorian Taxi Directorate or the Wyndham City Council, the new law ensures that only specified agencies – in the main, crime or corruption investigative agencies – can access metadata. It reduces the number of agencies empowered to access metadata from 85 to 21. However, more agencies can be added to this list. The newly-created Australian Border Force was added a few months after the passage of the Act.

In Parliament, the Attorney-General gave an assurance that the new regime would not be used to prosecute citizens who downloaded content in breach of copyright. Since the metadata access regime is concerned with enforcement of the criminal law, and breach of copyright is a civil wrong, there was, he said, no capacity for anyone other than the 21 crime or corruption investigative agencies to access metadata. Although there are criminal provisions in the *Copyright Act*, they do not relate to breach of copyright but to other actions such as internet piracy. The law also provides (section 281(2)) that a party to a civil action is unable to obtain a subpoena or a notice of disclosure in respect of a breach of copyright claim or any other form of civil claim against a telecommunications service provider that retains metadata solely for the purpose of being compliant with the provisions of the Act.

The problem of whistleblowers and investigative journalists

Despite the new privacy protections, and notwithstanding the ability of technically knowledgeable users to conceal their tracks (Huston 2015), the Act may have a negative effect on journalism in Australia by the all-encompassing and retrospective nature of the data retention regime. By requiring the storage, for a period of at least two years, of everyone's e-mail addresses, phone and VoIP numbers, time, date, type and duration of all electronic communications, location information such as cell tower data, and the names and addresses of the parties, the Act provides the authorities with a digital picture of users' movements, contacts, interests, hobbies, associations, etc over a period of two years. Such a picture may not be comprehensive, but it is nonetheless very revealing. By way of example, one might be able to make inferences about a young woman who makes a long phone call to an abortion clinic and then her boyfriend but not her mother. Police investigators hunting down a whistleblower might similarly be alerted by a public servant who phoned a newspaper's switchboard and whose phone's geo-location then matched that of the journalist who wrote about a leaked document.

The specific problem for journalists (and members of parliaments) and their sources stems from the fact that in Australia, whistleblower investigations are treated as leak investigations. Such investigations are carried out under Section 70 and section 79 of the *Crimes Act*. Section 70 forbids disclosure of certain information by Commonwealth officers ('any fact or document' in their knowledge or possession 'by virtue of having been a Commonwealth officer'). It attracts a penalty of up to two' years in prison. Section 79 of the *Crimes Act* prohibits the disclosure of 'official secrets', which include 'a prescribed sketch, plan, photograph, model, cipher, note, document or article, or prescribed information'. It attracts a penalty of up to seven years in prison if the offence is carried out with the 'intention of prejudicing the security or defence of the Commonwealth'. There are no public interest defences or exemptions for journalists. Section 79 has two important 'secondary disclosure' provisions (sub-sections (5) and (6)) that criminalise the receipt of leaked documents by journalists if they know or are reckless to the fact that the disclosure was made without authorisation. A journalist faces two years in prison, and up to seven years if the offence is carried out with the 'intention of prejudicing the security or defence of the Commonwealth.' Once again, there are no public interest defences.

Before the 2015 data retention law, police and prosecutors had faced the obstacle of not being able to prove the mental element – that the journalist in question knew or was reckless to the fact that the disclosure was made without authorisation. All journalists had to do was shut up and not incriminate themselves, and the investigators would find it very difficult to disprove that the journalist believed when publishing the material that it was just another one of many government-authorised disclosures.

However, the two-year data retention provisions mean that investigators will be able to look back over suspected whistleblowers' connections, interests, contacts, hobbies and other patterns of life over a period of two years in retrospect – long before the journalist printed the story in question. They may have the ability to see when and how a source contacted a journalist, how the journalist managed the process of interacting with the source, whether there were covert tactics involved, and other evidence that allows the construction of a case to demonstrate that the journalist knew that the disclosure was unauthorised.

As such, the data retention law tips the balance against the media by making it much easier for prosecutors to prove the mental element of the offence. Given their low level of technical proficiency, most journalists will find it almost impossible to guarantee confidentiality to a source. Even if a few journalists are technically proficient enough to encrypt their communications – and most are not – the 'first contact problem' (the fact that a whistleblower has contacted a journalist) remains.

A narrower definition of 'journalist'

Curiously, the new law refers to 'a person who is working in a professional capacity as a journalist' (Division 4C) – a definition apparently borrowed from the *Criminal Code* (Division 119). This is a narrower definition of journalist than that contained in the shield law designed to protect the confidentiality of journalists' sources. This law, known as the *Evidence Amendment (Journalists' Privilege) Act 2011*, says (Division 1A) that a journalist is 'a person who is engaged and active in the publication of news and who may be given information by an informant in the expectation that the information may be published in a news medium'. A news medium means 'any medium for the dissemination to the public or a section of the public of news and observations on news'. If the aim were to protect journalists, then the broader definition is to be preferred. Reformist politicians might wish to amend the new law's definition of 'journalist' to bring it in line with the *Evidence Act*. Consistency of terms across legislations is a worthy goal.

Journalist Information Warrants

In response to concerns about the chilling impact of the new law on journalism, Division 4C creates a category of 'journalist information warrant', which is a requirement that police obtain a warrant before they obtain a journalist's metadata for the purpose of identifying a source or sources. The law also creates a position of Public Interest Advocate, appointed by the Prime Minister, to make submissions to the warrant issuing authority that a journalist information warrant should not be issued because the public interest would be harmed.

There is a danger that such a Public Interest Advocate may well prove to be only a cosmetic measure, if the past track record of approvals for telecommunications interception warrants is any guide. The 2013-2014 Annual report shows that federal judges and Administrative Appeals Tribunal members approved 4,007 interception warrants out of 4,025 warrant applications. Only 18 were refused or withdrawn (AGD 2015). That means that warrant applications are successful 99.6 per cent of the time – one of the rare areas of public administration where such a high success rate is enjoyed. One commentator has described the warrant process as 'a rubber stamp mechanism' (Dorling 2015).

The Internet of Things

Legislators' interest has been overwhelmingly focused on communications data as an investigative tool. However, of arguably as much importance (or more) is the explosion of data generated by the so-called "Internet-of-Things" (IoT). The term IoT (Gubbi et al 2013) refers to the network of physical objects or "things" embedded with electronics, software, sensors and connectivity to enable objects to exchange data with the manufacturer, operator, and/or other connected devices. Such devices are finding increasing use in a wide range of applications: smart-homes and buildings (smoke-alarms, motion sensors, security cameras), health monitoring systems (wearable medical and fitness appliances), automobiles, industrial automation environments (fridges, climate-control, machine telemetry), and agriculture (soil monitoring, irrigation control). Forecasts by Gartner and ABI estimate the number of IoT devices will reach 26 to 30 billion by 2020. Interestingly, these devices will communicate among themselves and with the 'cloud' automatically, i.e. objects will exchange data without the knowledge of the user, revealing information on individuals: location, interests, health, habits and so on. Studies by Notra, Sivaraman et al (2014) establish some markers on the kinds of information captured by IoT. These studies shed light on the kinds of information malicious attackers may be able to obtain, and also serve as a pointer to the way in which IoT data may serve as a legitimate investigative tool if it were added to the s. 187A(1) list of information that must be stored for two years.

IoT devices may be categorised into three groups based on the way they communicate –

- those that are directly controlled by the user smartphone (Direct Access);
- those controlled by an external server (External Access);
- those that use the smartphone as a gateway (Transit Access) (Sivaraman et al 2015).

This simple categorisation based on the communication model makes it easier to identify vulnerable points, as briefly summarised next. A detailed study of each of the devices discussed below can be found in (Sivaraman et al 2015).

In the Direct Access model, the user's mobile app communicates directly with the IoT device, typically over the home WiFi network. In turn, the device then updates the cloud-based server on its current status. One example of such a device is the Philips Hue light bulb – the user can change bulb colour and intensity via the app while at home, which is communicated to the bulb via the home network and takes effect immediately; subsequently the bulb updates the external server on its current settings, so that the user can also check and change status of the bulb via a web-portal (e.g. when away from home). The Belkin WeMo motion/switch is another example of a direct access device, and works in a similar way to the bulb. The direct access model is most suitable for devices that the user needs to be able to control from within the house even when Internet connection is lost. Many household appliances such as light bulbs, power switches, and door locks fall into this category. Typically, these devices use WiFi, which makes them susceptible to be snooped upon by eavesdroppers who can steal user credentials to gain unauthorised access.

In the External Access model, the user does not interact directly with the IoT device. Instead, the device communicates over the Internet with the external cloud-based sever. The user's app retrieves relevant data (such as current status) and issues commands (to change status) by communicating with the external server (over the Internet). The advantages of such as approach are that

(a) the server can process the raw data from the IoT device before serving it to the user for consumption via the app, and

(b) the communication can be better secured at the server via end-to-end encryption and authentication, rather than relying on the mobile app.

The drawbacks of this model are that

(a) the user may lose the ability to monitor or control their device even from within their home if their Internet connection is down, and

(b) the user has no visibility into the data that is being exchanged between the IoT device and the server, which can be a concern that private data is being uploaded without the user's knowledge.

Example devices in this category include the Nest Protect smoke-alarm (now owned by Google) and the Withings baby-monitor.

The Transit Access model is typically used by smaller IoT devices that have only a short-range wired or radio connection (example short-range radio technologies include Bluetooth, BLE, Zigbee, RFID and NFC), and do not run the TCP/IP protocol stack. They tether with the smartphone, which is used as a relay to communicate with the cloud-based server over the Internet. The smartphone app may or may not be able to control the device directly or see the data in transit to the server. Examples of this model include the Fitbit fitness tracker and the Withings weighing scales. The transit model is suitable for wearable devices that need to keep form-factor small and energy use low; in terms of security, they may be vulnerable both on the short-range radio link, and on the Internet link from the smartphone.

Security and Privacy risks

In Sivaraman et al (2015), two representative IoT devices from each category were examined. Their security and privacy risks were profiled in experiments that ranged from passive snooping of personal information to active man-in-the-middle attacks. The findings were as follows:

Direct Access devices are the most susceptible to direct security attacks. Transit access devices are protected by the fact that they use very short-range radio (Bluetooth or Zigbee) that are difficult to snoop on, due to constraints on proximity and sniffer hardware, and moreover they do not run full TCP/IP stacks and are hence not always online. External Access IoT devices are relatively easier to be secured by manufacturers, since they have full control over both ends of the communication (namely the IoT device and the cloud server), and can hence manage their encryption/authentication keys and firmware versions more easily without needing user involvement. Direct Access devices, by contrast, allow users to directly access the device, which not only requires the device to respond to discovery mechanisms (such as the Simple Service Discovery Protocol or SSDP), but also take user input for setting up the necessary security keys. These allow intruders to snoop on the home WiFi network (for which a whole gamut of sniffing and cracking tools are available) to conduct reconnaissance (to discover what devices exist), eavesdropping (to deduce keys/passwords), and active attacks (ARP spoofing to masquerade as a legitimate device by assuming its address, DNS hijacking to redirect a web-page address to an incorrect server) to compromise these devices. A manufacturer therefore has to weigh up the benefits of direct access (namely providing low-latency in-home access to the device, even if the broadband link goes down) against the extra effort needed to implement foolproof authentication mechanisms for legitimate users in the home. This leads us to believe that direct access IoT devices are likely to be the most insecure in the years to come as they struggle to develop appropriate access control mechanisms.

External Access devices carry the most potential to take private user information without the user's knowledge. The Nest smoke-alarm sends encrypted data daily to its servers, which has the potential to contain information about the location of the user within their house at all times and their bedtime habits (i.e. turning lights off to sleep). This does raise questions in the consumer's mind on what data is actually being sent (since there is no visibility into the raw data) and how it is being used. Though wearable devices (predominantly communicating using the transit access model) also send personal user data to cloud servers (through the phone), their sensing capabilities (e.g. heartrate or steps) are generally more clearly understood by the user who chooses to wear them, unlike household appliances whose sensing capabilities (motion, light, etc.) can be more surreptitious.

The biggest threat for devices that use Transit Access (typically wearables and healthcare devices) lies in the pairing of the device to the user's smartphone. Though the short radio-range gives it some inherent protection, and Bluetooth/Zigbee sniffers are more expensive and less common, there is a non-negligible possibility of illegitimate device access in public places, such as in cafes or on public transport. Short of a Faraday cage in which the pairing is conducted, the most fool-proof way seems to be to give a unique code to the legitimate user (such as the 4-digit one-time code displayed on the Fitbit Charge heart-rate monitor) during the pairing process – this however is only feasible if the device has a display, which may not be cost-effective for very small form-factor devices.

Future directions – the continuing need for techno-policy

Security is clearly only one concern among many that manufacturers of IoT devices are dealing with. The surge in demand for IoT is leading many to rush to market with their product, and increasing user appeal to gain market traction can become more paramount than ensuring foolproof security. Further, the application domain (e.g. healthcare versus home automation) as well as business model (e.g. revenue from device versus from the data) can dictate many aspects such as the form factor, onboard resource availability, and communication patterns of the device, which in turn have a direct bearing on the complexity of the security schemes that can be incorporated. Nevertheless, the classification of IoT devices based on their communication model gives important insights into the likely security and privacy challenges that will be faced by devices in each of these categories.

The increasing uptake of consumer IoT devices poses security and privacy concerns at an unprecedented level. Although law-makers have mostly focused on communications data as an investigative tool, the data generated by IoT devices may serve as a legitimate investigative tool if it were added to the s. 187A(1) list of information that must be stored for two years. We expect that further research into the technical features of devices as well as their investigatory implications may lead to pressures for further law reform once legislators' and investigators' knowledge of the potential of IoT increases. There is no reason why the definition of 'journalist' cannot be amended right away to bring consistency across different pieces of Commonwealth legislation.

Bibliography

AGD. 2012. *Equipping Australia against emerging and evolving threats*. Canberra, Australia: Attorney-General's Department.

AGD. 2015. Telecommunications (Interception and Access) Act 1979 Annual Report 2013-2014. Canberra, Australia: Attorney-General's Department.

Brandis, G. 2015. *Commonwealth, Parliamentary Debates – Senate, 26 March 2015: 2519* (George Brandis, Senator).

Brandis, G; Turnbull, M. 2015. Data Retention Bill passed by Parliament. *Joint Media Release by the Attorney-General and the Minister for Communications*. (March 26, 2015).

Dorling, P. 2015. Security laws bring us closer to the day when journalists will be jailed for reporting. *Sydney Morning Herald*. (March 17, 2015.)

Grubb, B. 2010. Inside Australia's data retention proposal. *ZDNet*. (June 16, 2010). Retrieved from http://www.zdnet.com.au/inside-australia-s-data-retention-proposal-339303862.htm

Gubbi, J; Buyya, R; Marusic, S; Palaniswami, M. 2013. Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, September 2013. 29(7):1645-1660.

Huston, G. 2015. Metadata Retention and the Internet. *Australian Journal of Telecommunications and the Digital Economy, Vol 3, No 1*.

Notra, S; Siddiqi, M; Habibi Gharakheili, H; Sivaraman, V; Boreli, R. 2014. An Experimental Study of Security and Privacy Risks with Emerging Household Appliances, *First*

International Workshop on Security and Privacy in Machine-to-Machine Communications (M2MSec), San Francisco, USA.

Sivaraman, V; Notra, S; Velushomaz, V; Boreli, R. 2015. Security and Privacy Evaluation of six consumer IoT devices. Available at Networks Research Group, NICTA, Sydney, Australia. http://www2.ee.unsw.edu.au/~vijay/publications.html

SSCEC. 2011. The adequacy of protections for the privacy of Australians online. Canberra, Australia: Senate Standing Committee on Environment and Communications.

---

[1] For the sake of brevity this article uses the word 'metadata' to refer to these categories.

The NBN is broken. Here's the fix.

A change of leader. Time for a change in direction.

Phil Dobbie
Freelance journalist, podcaster and telecommunications marketer

Abstract: The approach to the NBN has been fated from the beginning. This paper explores how the original design was more to do with constraining Telstra's monopolistic ambitions than developing a sensible broadband policy for Australia. The result is a solution that is expensive, constrains competition and is blighted by Telstra's infrastructure – including the widespread use of asbestos – with a one-size-fits-all approach that satisfies few. The ambition of ubiquity is also examined. How can it be ubiquitous if many people choose not to subscribe? With the optimistic air of change that has come from a new Prime Minister, this is the time to look at a realistic option which accepts that the approach will include government on-budget expenditure, establishes a future-proof approach and provides the opportunity for those who want it to pay a realistic amount towards getting connected. The analogy is, governments build roads, not driveways. So why should we assume anyone building a national telecommunications network should worry about connecting right up to the front door, especially for those who don't want it.

Introduction

If we look back over the last six or seven years, can we consider the evolution of the NBN to be anything short of a disaster? Is anybody entirely convinced it will ever be finished, according to plan? And, by plan, you can take your pick, because there have been so many of them.

It seems Stephen Conroy's grand vision was nothing short of a fairy tale – a very Grimm one. Back in 2009 the Senator figuratively donned his red cape and marched into the forest, little knowing that a big bad Telstra lurked there. "My, what big profits you have," the innocent Conroy would have observed. "All the better to monopolise you with," comes the reply.

That was certainly the view of Maha Krishnapillai in one of my early *Twisted Wire* podcasts on ZDNet back in 2009. In *The Economics of the NBN (*Dobbie 2009a*)* Krishnapillai, who at the time was the director of Government and Corporate Affairs for Optus, described the incumbent as a "rogue corporate", who "price gouges the industry for their benefit", with the economy, "held hostage by one private monopoly extracting monopoly rents".

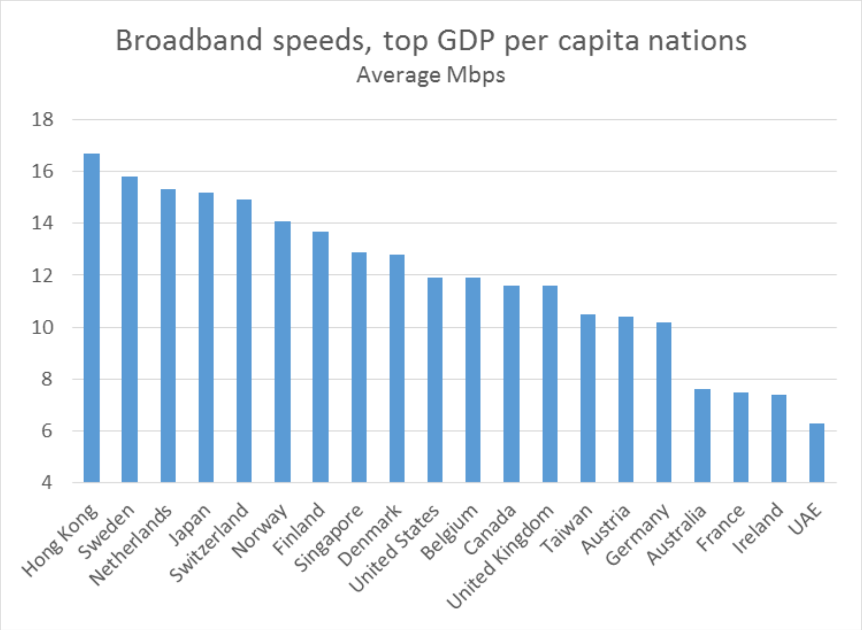
Sadly, the NBN started its life as a retaliatory move against the strong stand Sol Trujillo took against the government. Senator Conroy had clearly taken the view that, if Telstra wouldn't play ball and help build a broadband network, the government would do it itself. Showing Telstra who's boss seemed almost as important as building the infrastructure.

The quickly formulated strategy had many holes in it – not least, the expense of it all. The revised approach taken by the current government is a compromise, but the solution it offers hardly improves our standing on the league table of broadband speeds.

In this article I will track how we got to where we are today and suggest that one sensible approach, that balances cost and benefits to the nation, has not been considered. And, unless NBN has already put in its order for thousands of street cabinets, it's not too late to switch direction.

Where we stand

Take the top 20 most productive countries in the world, and all but three have faster internet speeds than Australia. From this list I have excluded very small populations, together with Saudi Arabia and Bahrain, two countries not included in the *Akamai State of the Internet Report* (2015). The three that fall below Australia are the United Arab Emirates, a country with a huge income discrepancy, along with France and Ireland.



Data source: *Akamai State of the Internet Report* (2015).

It's ironic that Alcatel-Lucent, a company that is busy getting broadband to so much of the world, has done little to increase speeds on their home turf. It's more concerning to Australians, though, that we continue to experience some of the slowest speeds in the western world.

You can take some comfort from the fact that things are improving. In the first quarter of 2012 Akamai had Australia averaging download speeds of just 3.5 Mbps. We've more than doubled that in the last three years. If we can do that again, by mid-2018 we wouldn't be far from where Hong Kong, Holland, Sweden, Japan, Switzerland and Norway are today. Sadly, those countries have all shown tremendous growth and that's not likely to stop. So, I doubt we'll ever get anywhere close to them, particularly as the upward impact of the NBN has been compromised by the new multi-technology approach, that will see fewer premises hooked up with fibre. We are, it seems, destined to remain in that third tier amongst developed nations.

Does it matter?

There's been a lot of debate about the importance of broadband. In an open letter to the ITU Conference in Korea last year, the Broadband Commission for Digital Development (2014) urged delegates to push ahead with broadband as a top priority, arguing that digital inclusion is "of paramount importance to ensure that no one, and no society, is left behind".

In developed nations, though, won't the delivery of technology, tried and tested throughout the world, simply respond to consumer demand? In a country like Australia, where the average full-time worker is making more than $1,500 per week (ABS 2015), can't we trust consumers to make their own decisions on what they spend money on, and see suppliers respond to that demand? Can't the free market determine the way forward?

In which case, why has Australia been so slow to adopt faster broadband? Some argue it's because we have such a disparate population. Our average speeds will always be hindered by huge distances and remote communities. Certainly, with just 3.2 people per square kilometre (Wikipedia 2015) you'd have to go trekking through Mongolia to find a more sparse population.

Yet Australia is one of the most urbanised nations on the planet – more so than the US, Canada or the UK. What's more, when I examined broadband speeds using ZDNet Speedtest data in 2012 (Dobbie 2012) I found that the fastest DSL coverage was often in small towns, where populations were small and lived close to the exchange, and where copper diameters tended to be larger than in cities. In these areas only a handful were living on remote farms far from the exchange. Most enjoyed fast speeds with low contention.

In many countries the non-urban population is far more disparate. Take the UK as an example. It has a far more densely packed population, but a smaller proportion live in urban areas. Eden, for example, is a district of more than 2,000 square kilometres in the heart of the English Lake District with just 25 people per square kilometre (Eden District Council 2015) – 52,000 people that would be very difficult to reach with high speed broadband.

Geography is not the issue

If we dismiss the geographic argument as the reason for our poor showing in the league table of internet speeds, we can come to only one conclusion about our dismal performance: the competitive environment.

To give Senator Conroy some credit, that's the issue he was trying to correct when he announced in September 2009 that Telstra would need to find a way of splitting itself up into wholesale network and retail divisions. On my Twisted Wire podcast (Dobbie 2009b) he described it as fixing a regime that was broken: "a mistake by the Hawke government taken further by the sale of Telstra by the Howard government".

Few in the industry disagreed with him. Mistakes had been made. Telstra should clearly have been split before it was sold. Had that happened, there's little doubt that we would be experiencing faster broadband speeds today as Telstra's network division pushed on, with the promise of revenues from multiple wholesale customers.

It would have been a good move for Telstra retail too. In that same podcast Simon Bartholomeusz from Business Spectator said that they could thrive, cut free from the diversion of infrastructure. Certainly that was the case in the UK. When BT was split, back in 2005, retail revenues slid, but profits steadily improved (Dobbie 2011), showing they'd become vastly more efficient through the process.

The litany of disasters

Of course, Telstra didn't split in the same manner as BT or Telecom New Zealand. Instead they tied the process to the NBN. As customers migrated to the new network, Telstra would switch off the copper connection and be recompensed for it. It satisfied Senator Conroy because it resolved two issues – it saw structural separation occur, whilst theoretically expediting the rollout of the NBN. Telstra had an incentive to ensure they played along.

It was a nifty negotiation on Telstra's part. They'd gone from the threat of having to divest themselves of their share in Foxtel and being barred from future 4G spectrum auctions, into a model where they were paid compensation for handing over customers, even though they'd continue to receive revenue from many of them. Nonetheless, it was argued, this was separation. Telstra no longer owned the last mile – except in regional Australia where the copper network, curiously, would be maintained because of some archaic principles around what constitutes a standard phone service.

As part of the deal Telstra gave access to its ducts, supposedly making it cheaper and quicker for NBN to shoot fibre through. It wasn't clear at the onset what state those ducts were in and, it seems, the prospect that some, if not most, were riddled with asbestos cement, would make it hugely dangerous and expensive to shoot anything through them. Perhaps NBN should have read Telstra's own assumption, contained in a fact sheet issued in 2013, that "unless the pit is made of plastic it will be assumed to contain ACM (asbestos containing material) and treated appropriately" (Telstra 2013).

A change of government saw a change of approach, with Malcolm Turnbull arguing the need for a faster rollout, highlighting the likely escalation in costs if things were done the old way. It's possible the asbestos issue alone could have brought the project to a screaming halt. The multi-technology mix approach would, he argued, speed things up and contain costs. Protracted negotiations were then held with Telstra to get them to vend-in their copper without bumping up the NBN's costs by too much. Using copper for the last-mile at least minimised the risk that the asbestos threat posed.

The whole process, though, has generated enormous anomalies. In a bid to create a workable business model, the original plan was dependent on NBN being a fixed-line monopoly. That meant Telstra and Optus needed to close down their HFC networks. Try finding an economist who can justify disposing of a working asset, particularly one with a clear upgrade path.

Secondly, the cross-subsidisation approach presented enormous challenges. The cost of reaching and maintaining services in regional Australia is huge, requiring NBN to effectively impose a tax on metropolitan users to help fund the remainder of the network.

This presented a challenge. Competitors could cherry-pick the easier-to-serve metropolitan areas, particularly large multi-dwelling units, without worrying about the cost of serving the rest of the country. Labor's approach was simply to ban competition, a rather stark economic policy in this day and age.

The current government believes infrastructure competition should be allowed, and TPG has been quick to reach for the low-hanging fruit – apartment buildings close to their existing fibre network. *Communications Day* (Wilton 2015) speculated that they may already be offering services in as many as 350 multi-dwelling buildings, with plans to reach 90,000 individual households by the end of the year.

Such a move cuts holes in the NBN's cross subsidisation approach. The government is left with the choice of either raising NBN prices further in metropolitan areas – increasingly the likelihood of more competitors undercutting them – or charging competitors a levy, so that everyone, in effect, pays the cross subsidy. It's an approach that I know has not been well received by those seeking to fibre-up buildings in competition to the NBN. There's also the deeper question of whether such a measure could be challenged by the Trans Pacific Partnership (TPP). Wikileaks (2015) released what they claim to be a 2013 draft of the TPP, which discusses whether controls on subsidies should be extended to state-owned enterprises. That could potentially rule out cross subsidisation and charging competitors that subsidy, particularly those funded by another TPP country.

The price we pay

If the competitive issues raised by the NBN are a problem, the cost structure is worse. Those who still cling to the original model, a utopia of fibre for all, built by a government monopoly, should consider the 2012-15 Corporate Plan (NBN 2012), which assumed an average revenue per user (ARPU) exceeding $40 at the onset and escalating to $100 by 2039 (in nominal dollars). Even the latest plan (NBN 2015a) keeps ARPU below $44 for just the first few years and is reliant on higher ARPU down the track to make the business model work.

Sadly, I think the original plan was a pipedream. The NBN assumed different prices dependent on the speed of your connection, even though higher access speeds had no discernible impact on NBN's cost structure. It was clearly a way to make NBN pay for itself. To me it was reminiscent of Telstra's response to a competition notice in 2001. The telco was in trouble for offering low-end retail broadband plans that were close to the same price as their wholesale broadband product. To pacify the regulator, Telstra offered wholesale customers tiered pricing – even though it cost Telstra no more to offer the product, whatever the speed used. In effect Telstra was using wholesale pricing to determine the retail pricing structures of its customers. The NBN was doing the same, and still is, although the opportunities for greater speeds are now diminished by the technology.

So, we are caught between a rock and a hard place. The original plan would have offered high speed broadband, but assumed people would be prepared to pay a lot for it. Early launch pricing in no way reflected what would have to be charged a few years down the track. The alternative is still expensive and customers can expect lower speeds.

As I pointed out earlier, we're spending a lot of money to reach the stage that many countries are at now, or were at several years ago. Those countries are charging a lot less than Australian retailers will be able to afford, given the high wholesale costs of the NBN. Right now BT in the UK is offering FTTN plans (speeds up to 38Mbps), with 40GB usage, plus sports content, for £28 per month. That's around sixty of our rapidly diminishing Australian dollars.

According to the current NBN Wholesale Broadband Agreement (NBN 2015b), to match that today, a wholesale customer would be paying $34 for the access circuit, plus the connectivity circuit and backhaul. Take a quick scan of the prices offered by cable operators around the world today, and you'll see Australians will be paying well above the odds for the moderate improvements they'll be seeing in their broadband speeds.

Figures from the OECD Broadband Portal (OECD 2014a), released in September 2014, show broadband prices in Australia range from US$32 to $105.60, compared to $28.30 to $59.10 in the UK – a country Malcolm Turnbull often pointed to when, as shadow minister, he was making the case for a multi-technology approach. The UK customers are paying less, but enjoying faster speeds. In fact, their cost per megabit-second ranges from $0.32 to $2.43, compared to $0.48 to $7.47 in Australia. That was a year ago. Our prices don't reflect the increased impost of NBN wholesale pricing, so we're likely to be paying a lot more down the track to receive the services they are currently enjoying in Britain.

The NBN is just too bloody expensive

Clearly, the NBN is costing too much and that provides a real challenge to one of the original aims of the network – ubiquitous access. Only if everyone is connected and using the internet can government departments and companies rely on it as a channel for doing business. Telehealth only works if people are online, and online voting will only replace booths at local schools when everyone is connected. And, even then, where do you go for the sausage sizzle?

The real challenge to ubiquity is not whether you can have a broadband connection – for many it's a question of how much it costs. In a May 2013 article I analysed the 2011 census to see which areas had the highest penetration of home internet (Dobbie 2013a). Four of the top 10 local government areas for broadband connectivity were on Sydney's moneyed upper north shore, whilst penetration was lowest in areas with low household income. Is the digital divide less to do with geography and more to do with income? In which case, if the NBN is making broadband more expensive, could it be making the digital divide worse than before? Will it really achieve a public good if many people can't afford it?

Willingness to pay

In August 2014 the government released a cost benefit analysis (Department of Communications 2014) compiled by the Vertigan panel, which used willingness to pay as the measure of the utility that individuals and the economy received from the NBN investment.

They used a technique called choice modelling, asking customers to choose between possible internet plans. The approach found that someone currently paying $75 for a 10 Mbps service, would pay $20 to double their speed, but the incremental value rapidly diminishes as the original speed increases. They also found a massive discrepancy between informed respondents – who were told some of the benefits that could be derived from high speeds ahead of choosing a plan – and the uninformed audience, who weren't. The latter group would pay just $5 to go from 10 to 20Mbps.

Whilst I am sure the reasoning is solid, the research seems to put a high price on the benefits. In other words, it accepts that people will be paying a lot more for broadband in Australia. If that's the case, it's another example of how the NBN, by charging a premium, could be broadening the digital divide, making NBN out of reach of lower income households.

OECD data (OECD 2014b) shows that in the OECD we currently rank 21st for broadband penetration (fixed line, fixed wireless and satellite) with just 27.7 subscribers per 100 inhabitants. Switzerland, at the top of the table, has 48.9 connections per 100 inhabitants and, as I have already observed, average speeds twice our own.

So, the story of our situation gets worse. We're behind the rest of the world in terms of speed, we pay more than most and have an expensive project that will push prices higher, potentially preventing more people from becoming part of the connected age. It seems a long way from the low cost, ubiquitous broadband we were promised at the onset. Despite this, the NBN Corporate Plan 2016 (NBN 2015a) envisages 4.4 million subscribers by 2018, bringing in $2.5 billion in revenue. Good luck with that!

A problem ignored

NBN's biggest problem – and always has been – is that it has been treated as a project that will provide a financial return. It's going to tackle the issue of access across all parts of the country, and it will, miraculously, pay for itself and provide a return on the investment. Remember Conroy's claims in 2009, on the formation of NBN, that the company could raise its own debt, with half the risk being carried by private investors?

Since then, the whole project has been driven by this need to provide a return – a project that will provide a public good, without any costs appearing in the budget. It's an investment, no more, no less.

Whilst that might be fine for a metropolitan network, it seems unreasonable for a commercial project to carry the responsibility for funding a regional roll out. That, surely, falls into the domain of government support.

For example, the government is happy to spend money on roads. Over the next five years the Federal Government is flagged to cough up more than $50 billion on land transport projects in partnership with State and Territory Governments (Commonwealth of Australia 2014). If broadband is considered as another essential infrastructure, is it beyond the pale to consider that it should also attract some government subsidy?

In fact, if we assume that NBN will not achieve its fiscal objectives, with the Corporate Plan assumptions dissolved by competitive activity and the impact of mobile networks, then, likely as not, it will appear as an on-budget item at some point. Isn't it just a matter of political expediency to make the call now and start working to a realistic set of assumptions?

The regional story

The biggest issue for the NBN is regional Australia and the complexities that cross subsidisation has created. Had Telstra's separation occurred before the NBN had been started, likely as not the network arm would already have rolled out FTTN to large parts of Australia and would be looking at the viability of providing fibre to some premises, where the returns made sense.

If we'd gone down that road, the government would be stepping in to provide support for builds in regional Australia. It was the plan with the Opel project, when the government was set to invest almost a billion dollars in regional broadband. If the government was prepared to invest taxpayers' money in regional Australia then, why not now?

The answer might be because the recent cost benefit analysis showed it's not worth it. Malcolm Turnbull had long argued of the need for a cost benefit analysis for the NBN. Before him, Mick Minchin repeatedly made the same point. When the report (Department of Communications 2014) was finally delivered, it showed net benefits of $24 billion if the build was focused on non-rural areas, falling to $17.9 billion when the fixed wireless and satellite areas were included. In other words, according to this report, the benefit to the nation would be greater if the NBN *wasn't* rolled out to regional Australia.

If Labor had enlisted the Vertigan panel to conduct a cost benefit analysis like this all those years back, surely the conclusion would be not to build at all. The benefits derived from regional coverage don't counter the costs and in the cities we'd surely see commercial forces drive infrastructure investment, particularly if Telstra operated as a vertically separated entity.

Despite this conclusion, nobody ever doubts the need for better broadband in regional Australia. Yet the Vertigan Review seems to indicate they're not prepared to pay for it. At least, not right now.

A look at the future

For all the confused negotiations and policy direction changes, Australia needs high-speed broadband as a matter of urgency. In fact it's likely to be vital for the future of the nation.

Almost half of all jobs today will be replaced by machines within the next 20 years[i]. That's the prediction of Michael Osborne, a University of Oxford Associate Professor and an expert at robotics research. He admits many jobs, like mental health counsellors and primary school teachers, will be exempt, but others, like telemarketers, tax preparers, even those in the legal profession, are ripe for replacement (Osborne 2014).

Yet this displacement of jobs wasn't considered in the NBN's cost benefit analysis. The 'willingness to pay' approach assumes the social benefits you receive from fast broadband – such as reduced travel time as you work from home – will mean you will value the benefits more and, therefore, be convinced that you should pay more.

But does this approach take account of the jobs of tomorrow? A coal miner might place little importance on broadband today, but when he loses his job and there are no other opportunities except online, he might take a different view.

When I put this to Henry Ergas, Professor of Infrastructure Economics at the University of Wollongong, and one of the authors of the cost benefit analysis, he suggested many things will change at an individual level over 20 years, but overall incomes will rise. With that rise in income, so will the willingness to pay more for broadband services.

That might be so, but what if technological change will be as rapid as the likes of Michael Osborne would have us believe? Then the needs of individual sections of society – those displaced by the change – could become more important than any increase in aggregate income.

Had the NBN's cost-benefit analysis been taken at face value, there would be no benefit from rolling out to regional Australia. Without faster broadband, people with displaced careers would have no adequate digital infrastructure to turn to.

The argument could be extended to the question of speed. Nobody needs very fast speeds now because they predominantly use broadband to watch TV and browse websites. What if, in 20 years, jobs present an entirely different infrastructure requirement? Our willingness to pay would be much higher, because our careers depended on high speeds, but sadly we were asked the question back in 2014, when speed was less important.

A better way

The problem is, we don't know what the future holds and what technology will be needed. It's certainly dangerous having governments make decisions on these things. OPEL's Wimax proposal is a case in point. They could have invested in a technology that was quickly superseded by 4G.

So, what is the best approach going forward? After seven years interviewing people in the industry, often on the vagaries of the NBN, the most sound advice came from Peter Cochrane, a 38-year veteran of British Telecom, on my Crosstalk podcast two years ago (Dobbie 2013b). Cochrane argued that fibre is the future, but telcos shouldn't take it all the way. "They're continuing with this old idea that they have to get into the home and install stuff," he said.

Instead, the alternative is that NBN builds fibre down the street, provides as many access points as possible, and that's it. It's left to the market - the retailers and the homeowners – to decide what happens next. The homeowners commission or carry out the work, by whatever means, at a time that makes sense to them. The analogy is that governments build roads, they don't build your driveway.

This approach seems future proof, as much as anything can be. Those who want fibre to the home immediately can pay to connect, with the NBN ensuring the cost is minimised by offering as many access points as is feasible. The coal miner who loses his job and sees a future online, connects once he has come to this realisation.

Sure, it's an approach that would see a far slower uptake and would compromise NBN revenues, but it would be preparing us for the future and would cost less than funding FTTN, an interim technology that many countries have already surpassed.

It also suits the government's free market rationale as competition develops from companies offering connectivity to the home. In fact, it would create competition at one of the most expensive and diverse elements in the whole delivery chain. Government subsidies could be provided for households where connected costs exceeded a certain level.

In the meantime, we'd still need our copper connections. That would satisfy many who don't see the need for the NBN right now. And it would mean a further renegotiation with Telstra to hand it all back to them. Presumably the same arrangement would stand, that Telstra would be paid as copper is switched off, but the copper network would only be switched off once everyone had moved to the NBN. That could take decades. Meanwhile, Telstra could continue to be the provider of last resort, using the money it receives from the Universal Services Obligation to maintain its old network.

There are numerous benefits in this approach. The build costs would be significantly reduced as the NBN focuses largely on rolling fibre down the street, not worrying about the complexity of access. The legacy agreement between NBN and Telstra could still stand, but cash paid out would be spread over a far longer timeframe, giving NBN more chance to effectively balance revenue and expenditure.

The only drawback is ubiquity. Not everyone will be on the NBN, but, unless you make it free, that will never happen anyway. As I have argued, the high cost is the biggest challenge to ubiquitous access, particularly as those seeking lower prices move to wireless.

Is it too late for a move like this to happen? Probably. But it's surely worth some discussion, particularly as so much political change is happening right now. I don't think the fibre purists would be too upset at the idea of paying to connect to the NBN. After all, it's no different from paying to connect to the Foxtel network, or paying Telstra to add an extra line to your home. To me it seems a simple and effective way of building high speed broadband and sharing the cost with those who derive the benefit. What's not to like?

Conclusions

What is clear is that Australia is spending a lot of money to bring us in line with where many other countries are today, or were a few years ago. It is expensive to build and that means high prices for consumers. In the meantime it has inhibited competition and investment.

Despite all these issues, the current government made only marginal changes to the approach taken by Labor. Sure, they introduced a different technological approach, but the aspirations of the NBN – low cost, ubiquitous, uniform pricing – seem to have been lost in the complexity of the project.

The Labor government also made the fatal assumption that everybody wanted it. Instead, society has been deeply divided, making the whole project a political hot potato. So much so, these days it seems the less it's talked about the better.

The reality is that the government took on too much with this project. There needs to be a change in direction, one which recognises that people will join the NBN party at different stages in their lives. When they do, they'll be prepared to pay towards it. The government's role should be to make that move affordable, by ensuring homes are close to a fibre access point. Who delivers that connection can be open to competition. Change to that approach, and accept that some costs will be budgeted expenditure, not investments, and many of the issues of the NBN go-away. And Australia will have fibre to the home, for those who want it.

References

ABS. 2015. Average Weekly Earnings, Australia, May 2015. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/6302.0/

Akamai. 2015. The State of the Internet Report. Retrieved from https://content.akamai.com/PG2061-SOTI.html

Broadband Commission for Digital Development. 2014. Open Letter from the Broadband Commission for Digital Development to the ITU Plenipotentiary Conference 2014.Retrieved from http://www.broadbandcommission.org/Documents/open-letter-itu-pp14.pdf

Commonwealth of Australia. 2014. Budget 2014-15. Building Australia's Infrastructure. Appendix B. Retrieved from http://budget.gov.au/2014-15/content/glossy/infrastructure/download/Infrastructure.pdf

Department of Communications. 2014. Independent Cost-Benefit Analysis of the NBN. Retrieved from https://www.communications.gov.au/departmental-news/independent-cost-benefit-analysis-nbn

Dobbie, P. 2009a. The Economics of the NBN. Retrieved from http://www.zdnet.com/article/the-economics-of-the-nbn/

Dobbie, P. 2009b. Special edition Telstra break-up podcast. Retrieved from http://www.zdnet.com/article/special-edition-telstra-break-up-podcast/

Dobbie, P. 2011. By the Numbers: BT Predicts Telstra's Future? Retrieved from http://www.zdnet.com/article/by-the-numbers-bt-predicts-telstras-future/

Dobbie, P. 2012. Up to Speed: Small Towns Quick to Download. Retrieved from http://www.zdnet.com/article/up-to-speed-small-towns-quick-to-download/

Dobbie, P. 2013a. Will the NBN Fix a Broadband Availability Gap? Retrieved from http://www.zdnet.com/article/will-the-nbn-fix-a-broadband-availability-gap/

Dobbie, P. 2013b. A Cheaper Way to Roll Out Faster Broadband. Retrieved from https://soundcloud.com/crosstalkcommsday/a-cheaper-way-to-roll-out

Eden District Council. 2015. Profile of Eden. Retrieved from http://www.eden.gov.uk/your-community/edens-statistics/profile-of-eden/

NBN. 2012. Corporate Plan 2012-15. Retrieved from http://www.nbnco.com.au/assets/documents/nbn-co-corporate-plan-6-aug-2012.pdf

NBN. 2015a. Corporate Plan 2016. Retrieved from http://www.nbnco.com.au/content/dam/nbnco2/documents/nbn-corporate-plan-2016.pdf

NBN. 2015b. Price List. Wholesale Broadband Agreement. Retrieved from http://www.nbnco.com.au/content/dam/nbnco2/documents/sfaa-wba2-product-catalogue-price-list_20150904.pdf

OECD. 2014a. Fixed Broadband Subscription Price Ranges. Retrieved from http://www.oecd.org/internet/broadband/oecdbroadbandportal.htm

OECD. 2014b. OECD Fixed Broadband Subscriptions per 100 Inhabitants, by Technology, December 2014. Retrieved from http://www.oecd.org/sti/broadband/1.2-OECD-WiredWirelessBB-2014-12.xls

Osborne. 2014. The Second Machine Age. Retrieved from http://www.robots.ox.ac.uk/~mosb/blog/2014/11/06/second-machine-age/

Telstra. 2013. Telstra Fact Sheet: general Asbestos Information. Retrieved from http://www.telstra.com.au/uberprod/groups/webcontent/@corporate/@about/documents/document/uberstaging_241654.pdf

Wikileaks. 2015. Secret Trans-Pacific Partnership Agreement (TPP) Treaty: State-Owned Enterprises (SOE) Issues for Ministerial Guidance. Retrieved from https://wikileaks.org/tpp-soe-minister/

Wikipedia. 2015. List of Countries by Population Density. Retrieved from https://simple.wikipedia.org/wiki/List_of_countries_by_population_density

Wilton, P. 2015. "FTTB race on as TPG passes 350 MDUs" *Communications Day* September 9, 2105

Radio Communication by Artificial Satellites

Simon Moorhead
Ericsson Australia & New Zealand

Abstract: A remarkable paper from 1961 demonstrates that the Post Master General's Department was at the forefront of technological developments concerning radio communications by artificial satellites before the launch of Telstar.

Introduction

It is widely acknowledged that Arthur C. Clark's paper on Extra-Terrestrial Relays published in *Wireless World* in October 1945 (Clark 1945) conveyed his most prescient prediction – that geostationary satellites could provide global communications. It should be remembered that only German V2 rockets existed at the time and Clark's proposal also necessitated the future development of rockets sufficiently powerful to deploy such satellites.

The historic paper (O'Grady & Craig 1961) was written only 16 years later and demonstrates a thorough understanding by the Post Master General's Department (PMG), of the engineering principles of satellite communications. This paper preceded the launch of Telstar by NASA in July 1962 and Early Bird in April 1965, which later became Intelsat 1.

The paper is by F P O'Grady, then Deputy Director General of the PMG and E R Craig, Divisional Engineer at the PMG Research Laboratories. The introduction provides a broad overview of the communication technologies available in 1961, which is fascinating in itself. But the detailed analysis of satellite technology is what surprises the reader. Many pages are provided of path loss formulas, system parameters, orbital conditions, antenna ratings and even low earth orbit designs for television.

The PMG was clearly well versed in the possibilities of satellite communications for Australia before the launch of Telstar.

It is timely for the *Journal* to publish this article in the year in which NBN™ (NBN Co) plans to launch two new generation K_a band satellites, each to provide an aggregate of 80 Gbps of bandwidth to remotely located subscribers in Australia, rationed at a wholesale rate of 25 Mbps per subscriber (Locke 2015).

http://doi.org/10.18080/ajtde.v3n3.12

References

Clark, Arthur C. 1945. "Extra-terrestrial relays", *Wireless World* [London], October 1945, pp. 305-308, quoted at http://lakdiva.org/clarke/1945ww/

Locke, Sarina. 2015. 'NBN Co's satellites promise internet speeds a hundred times faster than current dial-up for regional Australia', ABC Rural, 9 February 2015. Available at: http://www.abc.net.au/news/2015-02-09/nbn-groundstations-ready-for-satellite-launch/6075626

O'Grady, FP; Craig, ER. 1961. "Radio Communication by Artificial Satellites", *Telecommunication Journal of Australia,* June 1961, pp.2-12.

The historical paper

The authors

F. P. O'GRADY

F. P. O'GRADY, co-author of the article "Radio Communication by Artificial Satellites" is Deputy Director-General of the Postmaster-General's Department. Since joining the Department in 1917, Mr. O'Grady has had a most distinguished and varied career within the Department and with the Weapons Research Establishment. Details of Mr. O'Grady's career were given in the October, 1957, issue of the Journal following his appointment as Deputy Engineer-in-Chief. He is a Member of the Institution of Engineers, Australia, and a Senior Member of the Institution of Radio Engineers, Australia.

For many years Mr. O'Grady has shown a keen interest in the Journal and has contributed a number of articles to it. He is at present Chairman of the Council of Control of the Society. It is a source of gratification to all concerned with the Journal that Mr. O'Grady, despite his heavy administrative responsibilities any many other commitments, is still a regular author of articles.

E. R. CRAIG

E. R. CRAIG, co-arthor of the article "Radio Communications by Artificial Satellites", received his B.Sc.(Eng.) degree with Honours in Electrical Engineering from St. Andrew's University, Scotland. After four years with the Metropolitan-Vickers Electrical Company, Manchester, he joined the Australian Post Office in 1949. He served as an Engineer, Grade 1, in Radio Section, Central Office, and then in the South Australian Administration where he was concerned with radio-telephone and broadcasting equipment design, installation and maintenance. In 1954 he was promoted to the Research Laboratories, as Divisional Engineer, Radio Plant Applications. Major activities of the Division while he was in charge included the provision of 12 Victoria-Tasmania channels via Flinders Island, overhaul of the Tanybryn-Stanley system and the design of master oscillators for Radio Australia.

Mr. Craig is at present Divisional Engineer, Radio Equipment Development in the Research Laboratories. He is an Associate Member of the Institution of Electrical Engineers, London.

http://doi.org/10.18080/ajtde.v3n3.12

RADIO COMMUNICATION BY ARTIFICIAL SATELLITES

F. P. O'GRADY, M.I.E.Aust., S.M.I.R.E.Aust. and
*E. R. CRAIG, B.Sc.(Eng.), A.M.I.E.E.**

The Postmaster-General's Department in common with Telephone Administrations in other parts of the world is naturally very interested in the theoretical and practical possibilities of using artificial satellites for radio communication purposes. The Post Office is responsible to the Commonwealth Parliament for the provision of all public telephone, telegraph and radio communication facilities within the Commonwealth and, in conjunction with the Overseas Telecommunications Commission (which is responsible for all external telecommunications), makes provision for the connection of the public network within Australia with the networks of other countries. In carrying out its responsibilities it naturally makes use of all technological developments wherever there is a clearly established case for their adoption.

HISTORICAL

The Department is rather proud that Australia has always been quick to adapt its services to incorporate new discoveries. Most people are familiar with the fact that communication from England to Australia was inaugurated by submarine telegraph cable as far back as 1872. It will be remembered that this involved the construction of a very long and difficult section of overland pole route known to this day at the Adelaide-Darwin Overland Telegraph Route. This early effort was followed in fairly short order by submarine telegraph cables to Tasmania, New Zealand and across the Pacific to other countries.

The telephone was invented by Alexander Graham Bell round about 1876 and was adopted by Australia very shortly afterwards, at first for local exchange service and the first telephone trunk line between Hobart and New Norfolk in Tasmania was erected as early as 1888. Sydney and Melbourne were conected by telephone as far back as 1907. The invention of the thermionic valve and other important contributions made it possible to extend the range of communication both for telegraph and telephone purposes at a very rapid rate. Some of these new techniques such as amplifying valves were added on a limited scale to even some of the oldest of the submarine telegraph cables, many of which are still giving good service.

The overseas telegraph cables were supplemented by high frequency radio telegraph systems some years ago. Earlier proposals had been made for communication between England and Australia by low frequency radio methods. These, however, involved the use of a number of intermediate repeating stations and the total cost would have been rather high. The work of Marconi and other prominent workers in this field demonstrated that high frequency radio communication without intermediate repeaters was a practical and commercial proposition. The so-called Beam Wireless Service was therefore opened at a comparatively early date and considerably assisted Australia in trade, commerce and culture by improving the flow of communication at reasonable rates. Similar radio telegraph services were subsequently added to quite a number of other countries.

Radio telephone service was added to the Beam Wireless Service at a later date between England and Australia and gradually the whole telephone network within this country has been brought within reach of the overseas radio telephone link and through it to most of the world's telephones.

Although the service given by the Beam Wireless links for telegraph, telephone and facsimile services has been of great value to the countries using it, it has been known for some years that the limitations imposed by nature would prevent a perfectly satisfactory service ever being given. While it would not be correct to rule out the possibility of further discoveries being made which might improve the present techniques used in high frequency radio methods, it does seem clear that with the present state of our knowledge further substantial improvement is unlikely.

The limitations briefly are those due to the nature of the ionosphere which is a very variable means of reflecting radio waves. The variations give rise to fading and distortion and other effects which make it impossible to produce either a telegraph or telephone service which is really comparable with the performance given easily by modern land-line or cable systems. For example, it is also almost impracticable to design an H.F. radio system with multiplex facilities for more than about four telephone channels.

INTRODUCTION OF PRESENT TECHNIQUES

Repeatered Submarine Cables: The production of satisfactory designs for the incorporation of undersea thermionic amplifiers in submarine telephone and telegraph cables has been watched with intense interest by communication engineers throughout the world. Early efforts in this direction were suspended during World War II and as is often the case the suspension itself probably had the effect of considerably improving the performance of the first system which finally went into commercial use. Very worthwhile improvements, for example, had been made in the production of reliable valves and associated components during the war years and therefore for the first time it became a commercial proposition to lay cables which incorporated amplifiers to lie on the bottom of the sea without attention for many years. Once the reliability of this undersea repeater was established, it became possible quickly to adapt for submarine cable use the same amplifying principles and the same multiplexing principles which had proved so successful in every part of the world on overhead land-lines or in buried land cables. Briefly, these techniques make it possible to carry many separate telephone and telegraph messages on a single conductor. The separation between individual channels is adequate at all times, i.e., the cross-talk and noise produced in one channel from any other channel or groups of channels meets the standards which are laid down by international expert committees to meet commercially acceptable limits. The variations in volume and articulation with time are also maintained within very narrow limits.

In simple terms, the modern carrier systems of communication furnish a thoroughly satisfactory standard of performance with a steadily decreasing cost per channel mile. These cost reductions are made possible by many separate innovations, notably the mass production which is now such an essential feature because of the large scale utilisation of carrier. The introduction of transistors and of various automatic regulating devices have also contributed notably to the reduction in first cost and in annual charges. The application of such high grade engineering design to submarine cables thus results in the provision at quite competitive costs of multi-channel cables capable of carrying from 12 to 120 channels with current designs.

The use of these new techniques on the Trans-Atlantic route has already demonstrated that the high frequency radio telephone channels at least are now finding the new competition a very difficult one. The absence of fading and of noise and distortion so characteristic of high frequency radio telephone conversations has really brought about a new era in world-wide communication. Within each Continent the rapid introduction of multi-channel carrier systems has gone far to remove the old rather arbitrary distinction between local calls and trunk line calls. Most countries have already gone a long way by extending local call areas in order to take advantage of the economic savings which are now made possible by the relatively cheap provision of multi-channel systems. The submarine repeatered telephone cables promise to do in the international sphere what has already been done within each Continent, i.e., to make it possible to regard the world as a single entity in a telecommunications sense.

Evidence of this is found in the fact that places like Hawaii are now regarded as part of the nation-wide direct dialling system of the United States telephone network for the purposes of a numbering plan. Subscriber direct dialling is not yet possible, for example, between these two places but operator dialling is extensively employed and is currently

* See page 79.

being arranged also on the Trans-Atlantic route. So obvious is this development, in fact, that attempts have already been made to produce a world-wide telephone numbering plan to facilitate the rapid introduction of these submarine cables and associated signalling equipment. The importance of international agreement on such matters is obvious from the difficulties already encountered by most administrations in adapting even Continent-wide existing systems to a uniform numbering plan which will be satisfactory to the multitude of telephone subscribers who are being asked nowadays to do more and more of their own operating by dialling longer and longer series of digits from their own telephones. It is interesting to note in passing that part of this new planning has involved the United States, long regarded as a bastion of letters as well as figures on subscribers' dials, being compelled to fall into line and announce that they have already taken the first step on the road to the elimination of letters simply because of their inability to weld a combination of names and numbers into a nation-wide numbering plan, let alone a world-wide one.

As mentioned earlier, the Australian Post Office and the Overseas Telecommunications Commission have never been slow to adopt new improvements where they are clearly justified, consequently it is no surprise that arrangements were made some time ago to lay repeatered submarine cable between Australia (via New Zealand) and Canada. In Canada it will connect with the existing network within that Continent and therefore reach across to the Trans-Atlantic cables terminating on the eastern side of Canada. The first section of the new cable between Australia and New Zealand will be brought into service by June 1962. It is interesting to note that the first section of this Trans-Pacific cable will go into service on an operator dialling basis from its inception. Operators in the key exchanges in Australia will be able to dial subscribers direct in any part of New Zealand and vice versa.

Microwave Systems: The history of engineering development has shown time and time again that while the introduction of an entirely new system may appear to bring to an end one or more of the existing systems, there are many cases where, in fact, the opposite occurs. It seems almost as if a challenge is made which results in the older system being improved or modified to meet the new challenge and often it not only survives but in some cases lives to see the new rival displaced in turn. While therefore the earlier statement that H.F. radio communication systems appear to have reached the foreseeable limit in improvement is true enough radio engineers in other fields have not been idle. Intense activity has gone on in many separate fields to make better use of radio as a medium of communication. One of the significant developments has been in the use of frequencies considerably higher than the so-called H.F. band.

A great amount of knowledge has of course been accumulated over recent years in the characteristics of propagation of radio waves. Provided the sending and receiving stations are located in a direct line of sight, the ionosphere plays no part in the propagation. In this case, the transmission loss between the two points within optical distance of one another is much more constant than is the case when reflection from the ionosphere is involved. Variations in attenuation do occur but they are much more modest and can readily be taken care of by relatively simple automatic regulation devices. A second benefit of this use of optical path radio systems is the fact that very wide band-widths can readily be utilised. These wide band-widths have become possible by the nature of the propagation and by the use of a number of war-time and post-war developments. Early systems used magnetron and klystron valves and some of these continue to give good service. Developments in travelling wave tubes and many other devices have contributed to improve still further the reliability of these optical path systems. Now it is possible to take advantage of mass production of components and even of sub-assemblies, particularly the multiplexing equipment which is often the same as used for land-line carrier systems. The result has been a notable drop in cost per channel mile. The band widths are sufficient for 600 to 960 telephone channels or for television relay purposes. Systems are available with quite wide choice of simultaneous use of one or more television channels and hundreds of telephone channels. Reliability is already very high but is enhanced by automatic changeover to spare channels.

It is natural that very rapid expansion of these microwave broad band systems has taken place in all countries. The only practical limitation on the system has been the need for an optical path, but repeaters have been developed which enable two or any number of optical paths to be utilised in tandem to span almost any conceivable distance. All that is required is a relatively simple unattended repeater which picks up and retransmits the signals received over the first optical path on into the next path and so on. Obviously, the microwave engineer welcomes the occurrence of mountain tops suitable for unattended repeating stations, provided of course they occur at about the right intervals. Much ingenuity has been expended in planning the use of sites thus provided by nature to provide networks of microwave facilities.

In some cases where nature has been unkind and the terrain is too flat to serve the microwave engineer's purposes, he has been forced to use high steel towers. These, however, are relatively very expensive although one must admit that they are capable of being placed just where they are needed and often have advantages to the maintenance engineer over some mountain sites. It is natural that engineers have thought of ways and means of beating nature by some way of elevating the repeating station high above the earth in order to extend the range of their optical paths. Captive balloons have been considered but so far have not been found practicable. Aeroplanes flying high overhead in small circles and carrying the repeaters are an obvious possibility and some years ago two of the largest corporations in the United States seriously endeavoured to sell this idea. So far, however, no commercial use has been made of this technique, though F.C.C. approval has been obtained for a year-long experiment costing $7 million to relay four television programmes from Purdue University over a service area 400 miles in diameter. The programmes will be broadcast using video tape recorders installed in the aircraft which will circle at an altitude of about 25,000 feet.

Engineers studying the behaviour of the ionosphere have naturally thought also of the possibility of artificial ionospheres and it is interesting to note that patents have been taken out at various times for ways and means of improving on nature by placing reflecting media of various kinds high above the earth. Some of these involve clouds of various substances which are known to be good radio reflectors. Even if they are dissipated over a period it is thought that replenishment would not be an uneconomical task. However, none of these devices have yet passed into the stage of commercial adoption. The facts are, of course, that the world until recently had lacked the means of placing such artificial reflecting media just where we need them.

USE OF SATELLITES

It was necessary for the development of rocket devices to be taken to its present stage before one could really see emerging a possible and at the same time practical artificial satellite for communication purposes. It is obvious that an artificial satellite is the answer to the microwave engineer's dream since it gives him a repeating station so high that his optical path becomes almost infinite (Ref. 1). It becomes possible for him to contemplate world-wide communication by one or more artificial satellites properly placed. In 1955, J. R. Pierce of the Bell Telephone Laboratories published early calculations (Ref. 2) which showed that such a scheme would be quite practicable from the radio engineering point of view. It is true, however, that only in the last two or three years has it been possible to show that rocket technology has advanced sufficiently to allow such a project to be seriously contemplated.

The modern guided rocket has already made it possible to place artificial earth satellites in orbit and while the final form of these satellites from the communications point of view is far from settled it is clear that there are a number of methods which can be utilised. Even the earlier suggestion of placing clouds of material above the earth for the purpose of reflecting radio waves has been revived because of the present-day possibilities of placing them there and maintaining them in position by rocket devices.

It is natural therefore that the Post Office and the Overseas Telecommunications Commission in Australia have followed developments of these devices with a great deal of interest and a number of studies are proceeding in conjunction with similar authorities overseas to keep abreast of possible developments in this new field. It should perhaps be emphasised very strongly that in the opinion of the people best qualified to judge in the American Telephone and Telegraph Company, in the British Post Office and in this country there is no evidence which will justify any change in the present programme of laying repeatered submarine cables between many points on the earth's surface. The reasons are obvious, in that—

(a) the techniques of the cable method are well known;
(b) the performance can be guaranteed in advance;
(c) the capital costs are accurately known as are also the annual running expenses.

On the other hand, no real information is available at this early stage on the likely costs of artificial satellite methods nor can any real guarantees be given of either initial performance or performance over a period of years.

The pressure for the provision of more telephone channels throughout the world is very great indeed and there is therefore simply no alternative but to continue with the provision of the tried and proven technique of the repeatered submarine cable to meet this current demand. On the other hand, it would be quite wrong to regard the satellite methods as necessarily being impracticable or unduly costly. Sufficient evidence is available to show that the method is promising and there is therefore a clear case for intensive research and development work in this field.

The role of a prophet is never a very happy one and it is noteworthy therefore that there are very wide variations in the estimates being put forward by various individuals as regards—

(a) the time required to produce a commercial system for either television or multiplex telephone purposes;
(b) the perforance which will eventually be guaranteed; and
(c) the cost.

It is noteworthy in the meantime that the United States Federal Communications Commission has authorised a one-year experiment in space communications, involving the launching of an earth satellite. The Bell System had recommended to the F.C.C. this one year's intensive experimental programme in order to accumulate quickly the necessary experience and design data to enable a commercial system to be evolved, based on tentative plans for a number of ground stations which will enable America to communicate with England, France and West Germany. The cost of providing the basic facilities has been estimated in one public statement at 170 million dollars. The cost of launching a single satellite of the size and weight necessary for the proposed service has been estimated at about 3 million dollars. It is hardly necessary to mention that any such figures must be regarded as extremely tentative at the present stage of development. (The initial experiment will be controlled by the National Aeronautics and Space Administration who will work in conjunction with the British Post Office and other European Administrations who will provide ground stations in Europe.)

At this stage it is important to mention that while the repeatered submarine telephone cable gives excellent service within the limits of its design parameters, it does not provide a very wide band width compared with present-day microwave radio systems. There is a very complex relationship between the size and materials of the cable, the design of the amplifying unit, the spacing of the repeaters and the overall cost which at the present time results in standard designs providing 120 telephone channels as a maximum. The complex relationship, of course, also is related to distance and naturally one finds that the system providing the larger number of channels is practicable only on the shorter distance routes. For the Trans-Pacific cable now on order 80 telephone channels will be provided. Here again, it is important to note that submarine cable equipment designers are not idle either and equipment known as Time Assignment Speech Interpolation (TASI) is being installed between England and America. This takes advantage of the fact that in an ordinary telephone conversation there are quite long intervals of silence. It is possible to stack segments of information from one channel in the idle periods of another by ingenious devices with the end result that double the number of channels can be obtained for the same overall band-width. This means that in due course when the commercial demand justifies it, it will be possible to increase the channels on the Trans-Pacific cable to 160.

Other developments having the same end result may also prove to be practicable and it is known that intensive work is going on in various laboratories in this regard. Even with all of these devices, however, the present submarine cable design does not give a band-width comparable with the band-width of a microwave system carrying, say, 960 telephone channels or one or more television channels. It is possible, therefore, that even for the relaying of television programmes or for the transmission of data or equivalent information requiring comparable band-widths, the satellite communication system may prove to be a commercial success. It is undeniable that the television industry is now a very widespread one and is growing rapidly in most countries. It is probably true that money is available in commercial circles to justify quite heavy expenditure on television relay facilities.

It is at this point, however, that it is wise to mention some conditions which may readily be overlooked. At least as far as communication on this earth is concerned the regular occurrence of night and day will be a limiting parameter for many people. Even the most enthusiastic user of the radio telephone service between England and Australia finds the novelty wears off when he must get out of bed to talk on the telephone. Similarly, the relaying of television programmes is not likely to have much attraction except on very rare and important occasions if the programme is received at a time when the people are either at work or in bed.

An examination of the world network of electrical communication, taking into account this time factor and also other well-known factors of a commercial and social character, is necessary before one can forecast likely public demand for telephone, telegraph or television services. There is a natural tendency to regard the Trans-Atlantic route as a typical one. It is undoubtedly true that here are linked together the two largest aggregations of people requiring telephone, telegraph and television facilities. The distances are within the range of likely satellite communication systems and the time factor allows quite a reasonable number of hours overlap for the use of these services without imposing hardship on one end or the other. It seems reasonably certain, therefore, that if satellite methods are to prove in on a commercial basis they will do so on this route long before they do so on any other route.

Some indication of the estimated demand for telephone communication on the Trans-Atlantic route is given in Appendix I. These estimates have been furnished by the Bell System as part of their study of future trends on this route. On other routes a careful study must be made of the time and other factors mentioned above before any sensible estimate can be made of the possible attractions of this new technique. It is clear, however, that the new method does offer the possibilities of transmitting a much wider band of frequencies than can be anticipated from present types of repeatered cables.

An extensive literature now exists on satellite communication methods. Quite a number of combinations of equipment and methods have been proposed. Some of the typical literature on this subject is found in references 3 to 12.

SATELLITE REPEATER TYPES

The satellite repeaters are of two main types — passive and active. The passive repeater exemplified by ECHO I now in orbit is an inert object and is nothing more than a large metal surface which reflects radio waves. Various configurations have been suggested such as large flat plates, corner reflectors and even clouds of half wave resonant needles. The most favoured form of passive reflector appears to be the large sphere. In the case of ECHO I it has been a diameter of about 100 feet (Fig. 1).

Present plans seem to favour active repeaters which will obviously contain much the same elements as microwave repeaters used in what are now appropriately called Earth Bound Radio Systems. The repeaters, however, must obviously be made very small and very reliable indeed. (Fig. 2.) They must also require very small amounts of power to operate them. This means that as much use should be made as possible of high gain aerials but this in turn requires that the altitude of the satellite must be controlled. This calls then for still more equipment. The performance of the complete system must depend also, of course, upon the height above the earth of the

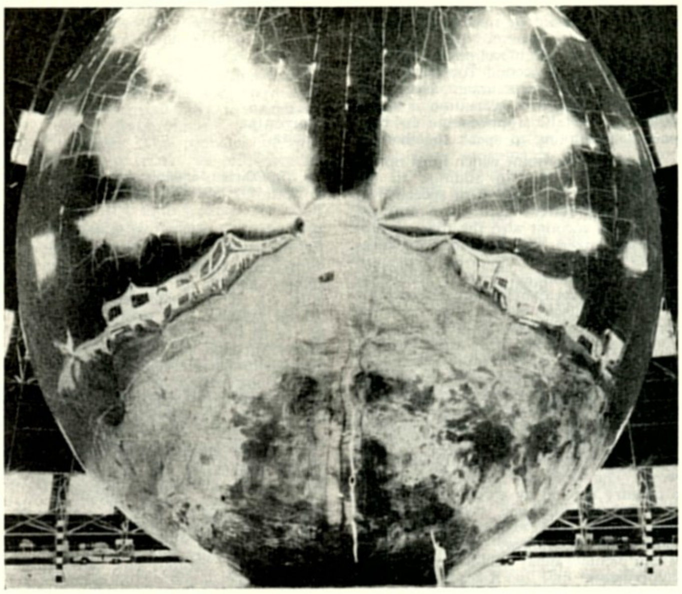


Fig. 1.—Project Echo Balloon Satellite.

repeater, on the effective power of the transmitter and on the sensitivity of the receiving devices on the ground. The performance of the system also depends very greatly on the frequency and present thinking is that the system should operate roughly between 1000 and 10,000 Mc/s. Probably, it would operate best between 2000 and 6000 Mc/s. Frequencies below 1000 Mc/s suffer from a high cosmic noise level and it is difficult to get sufficient gain from the aerials. Frequencies above 10,000 Mc/s will probably suffer from too much variation in attenuation due to rain, fog and other natural occurrences.

The outstanding advantage of the passive satellite is the fact that all costly radio equipment is on the ground (Fig. 3). It may or may not be regarded as an advantage but it is true that the passive satellite means that any number of people can use the one satellite without mutual interference (unless, of course, future history shows that phenomena at present unknown may begin to show up when a great number of transmitters bombard a single metal reflector many miles above the earth, with the signals passing through the atmosphere and the ionosphere).

The path loss (Appendix II) will probably be of the order of 250 db or higher for a passive system. This appears to make a large capacity, i.e., wide bandwidth system impracticable if reasonable standards of performance are to be achieved. The use of active repeaters reduces the path loss to figures in the region of 180 db. This makes a system with a capacity of 1000 telephone channels or one television channel possible though it is still about 40 db higher than the path loss of a typical average microwave repeater section of 35 miles as used today. It is apparently proposed to make up the difference in systems now under design by the use of very large aerials on the ground such as 60 foot diameter dishes or 50 foot square horns (Fig. 4), the use of negative frequency feedback modulation schemes and to sacrifice some of the fading margin normally allowed. Current American design figures are given in Appendix III.

Some of the problems involved in the use of active repeaters include:—

(a) the effects of high energy radiation on transistors and solar cells are known to be significant.

(b) the cooling of heat dissipating components such as valves without the presence of gaseous cooling media poses unusual problems;

(c) reliable life data on components in such an environment is not available.

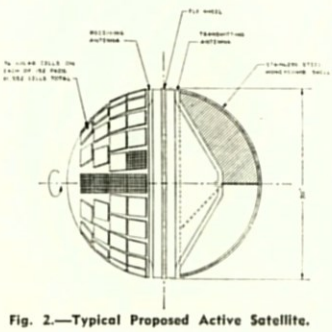


Fig. 2.—Typical Proposed Active Satellite.

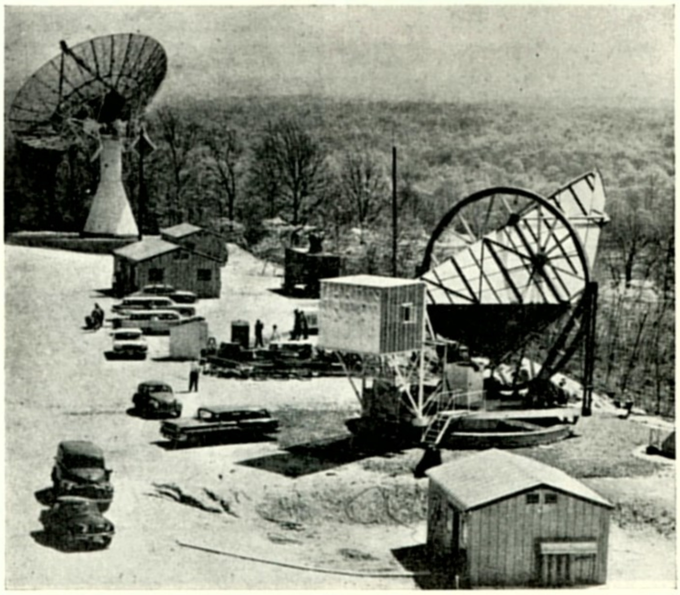


Fig. 3.—Holmdel Ground Station used for Project Echo.

POSSIBLE ORBITS

Either type of satellite repeater may be placed in any orbit desired, subject to the well-known laws of mechanics. The payload capacity of the now available rockets does limit the possibilities and some compromise is essential. The optimum choice is still under discussion, possibilities being a low or high altitude circular orbit or particular forms of elliptical orbit (Appendix IV).

A circular orbit at an altitude of 1000 to 6000 miles would allow a satellite weighing up to ½ ton. A passive reflector in this range of altitude would be practicable for some applications. The problems of transmission path delay, interference and jamming would be less serious with this orbit but there are disadvantages. The major ones are the large number of satellites required for world wide coverage (30 to 50) and the complicated steering and tracking arrangements required at the ground stations for effective use of the satellites. It is of interest that the American Bell System proposals for a world-wide system use this orbit, at an altitude of 6,000 miles.

A satellite in circular orbit at an altitude of about 22,300 miles, if launched in the correct direction over the equator, would remain stationary as viewed from the earth's surface and would be within sight of nearly half of the globe. Thus only three satellites would be required to provide communication over substantially all populated areas (Fig. 5). The payload of available rockets would restrict the repeater to a weight of 200 lbs., which is insufficient in the present state of the art. In addition, the very long path introduces a delay of ¼ second or an echo delay of half a second. Echo suppressors would be necessary for telephone communications with attendant troubles from syllable clipping. With an echo delay of 1 second (obtained on a two-hop path) experiment (Ref. 13) has shown that a conversation is sometimes completely stopped due to both parties attempting to speak together.

An important point which must not be overlooked is that in addition to the total time of propagation of speech over the satellite system itself there must be taken into account also the time of propagation over the existing networks within the terminal countries. It is possible, for example, that a particular satellite system would have acceptable delay time itself but by the time the terminal is extended within the country concerned the total delay time between two subscribers may be quite intolerable. It is hardly necessary to stress that satellite systems cannot deliver communication direct to any subscriber except possibly in military and special applications but must deliver the traffic to some switching centre in an established network. The time of propagation within a country is fixed by a complex relationship between distance, type of conductors, use or otherwise of loading coils, nature of equipment used, some of which includes delay in filters and similar components, etc. In Australia, for example, the distance from Sydney to Perth is comparable with the Trans-Atlantic crossing and any satellite system delivering traffic to Australia would certainly have to take account of the propagation time Sydney to Perth.

Elliptical orbits have been suggested in an attempt to make most efficient use of a rocket's payload. It is thought that 700 lbs. could be placed in an orbit with a perigee height of 300 miles and an apogee height of about 13,000 miles (Fig. 6). It is characteristic of elliptic orbital systems that to an observer on the earth the satellite appears to travel slowly through its apogee and quickly through its perigee. This is advantageous in that the period of visibility between two correctly sited ground stations appears to be longer (Ref. 12).

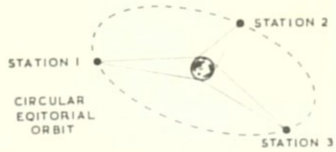


Fig. 5.—Three Satellites in 24-hour Orbit would cover populated area of the earth.

TECHNICAL STANDARDS

The application of artificial satellites for commercial purposes such as incorporation in the P.M.G. or O.T.C. networks requires that such systems be integrated with existing services and compete economically with alternative means of providing service. Also performance standards which have evolved over many years must be met before the system can be classed as fully satisfactory.

The important property offered by this new means of communication is the ability to provide broadband bearers over ranges of up to 10,000 miles in one hop. Baseband widths of up to 5 Mc/s are envisaged at present but there is no theoretical limitation to prevent very much broader bands being possible.

Some of the factors which are being considered by the Post Office relate to what can be described under the general heading of transmission standards and

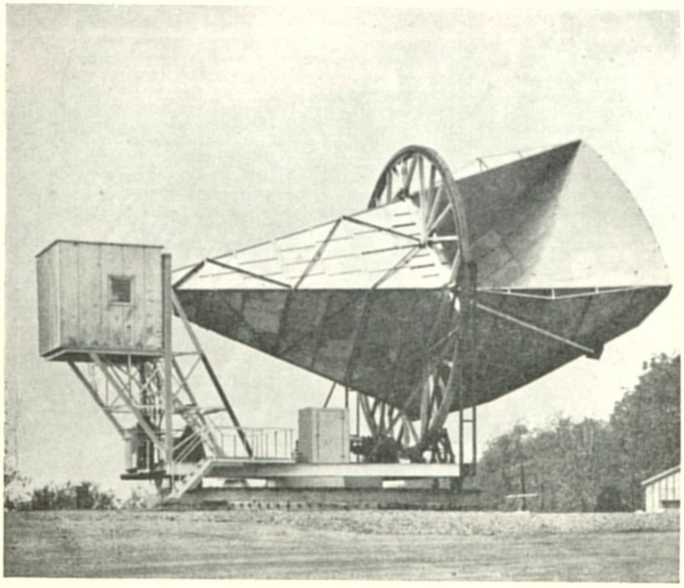


Fig. 4.—Project Echo Horn Reflector Receiving Antenna.

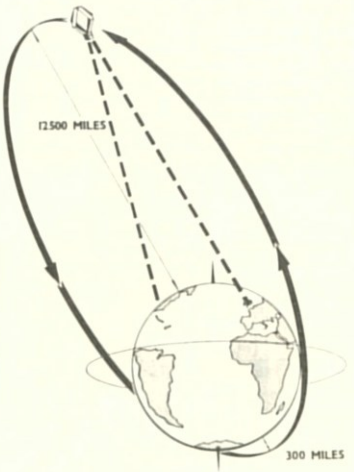


Fig. 6.—An Elliptical Orbit allows a large Satellite to Operate at a great distance.

 http://doi.org/10.18080/ajtde.v3n3.12

include transmission delay, noise, bandwidth, frequency allocations, secrecy and reliability. These items will now be discussed in turn.

Transmission Delay: The problem of transmission time between terminals has been referred to in connection with synchronous (24 hour orbit) satellites. The propagation time gives a delay of about 5.4 milli-seconds per 1,000 miles of radio path length so that echo from the far end terminal is delayed by 10.8 milli-seconds for each 1,000 miles of path. Delays of more than a second could therefore be incurred and it is by no means certain that this would allow workable comercial telephone circuits to be derived.

Delay time has been considered by International Committee (CCITT) in connection with conventional means of providing service and it has been recommended that a magnitude of 250 milli-seconds one way delay time should not be exceeded. 100 milli-seconds of this is assigned to end connections so the recommended maximum delay on an international line is set at 150 milli-seconds, giving a maximum echo delay of 300 milli-seconds.

The route United Kingdom to Australia is an important one where, because of the long path length, the time delay will be large. The shortest possible loop or echo delay of 120 milli-seconds would be given by propagation along the surface at the speed of light. For comparison, the loop delay through the proposed cable via Canada will be about 280 milli-seconds. Using satellites, the delay will depend on the altitude and number of hops required. A satellite at low altitude is only visible over a comparatively small area, so that a large number of hops would be needed. The path length is therefore not much greater than the distance over the surface because the "zig-zag" path (from terminal to satellite 1; to repeater 1 on the ground; to satellite 2; to repeater 2 on the ground; and so on) is confined to a narrow strip of altitude. If, on the other hand a lesser number of higher altitude satellites are used, the path is covered in a lesser number of hops, but the total path length is longer.

For reasons such as atmospheric drag and heating, it is not practicable to consider seriously the use of very low altitudes such as say 250 miles. An additional reason against this low altitude solution is the consequential need for a large number of satellites, with a correspondingly large number of ground stations. The theoretical sites for some of these would fall in oceans or unavailable territories. A probable satisfactory altitude would be in the range 3,000 to 4,000 miles with say 4 or 5 ground repeaters employed. Adding 100 milli-seconds for terminal networks, the minimum echo delay will amount to about 0.5 and 0.6 seconds respectively, or about twice the recommended maximum for international circuits.

Noise: Practice in the Australian Post Office on noise is based on the recommendations of the appropriate international committees. For microwave bearer systems this body is C.C.I.R. which has laid down allowable noise on a statistical basis. The recommendations are not directly applicable to satellite systems but performance of this general standard will be required.

Bandwidth: The bandwidth required for a satellite communication scheme depends on the modulation system to be used. American proposals call for an R.F. band of 125 Mc/s giving 500 Mc/s per system (two assignments in each direction from the satellite). This particular system uses negative frequency feedback to improve the system's signal/noise ratio by up to 20 db.

Frequency Allocation: Any frequency not seriously affected by the atmosphere (including ionosphere) is useful for satellite communications. This puts the range from say 100 to 10,000 Mc/s with a broad optimum between 2,000 and 6,000 Mc/s. There are many services located in this band but it has been possible to repeat allocations with geographical separations of a few hundred miles so that congestion has not yet become very acute. The advent of satellite transmitters with interference potential over nearly half the earth's surface will alter this situation and serious problems are likely to arise. It is expected that this aspect will be discussed by the I.T.U. in 1963. (Appendix V.)

The converse problem of interference to the satellite system can be caused by a variety of factors both natural and man-made. Radio emissions from the sun and other objects can affect the noise performance of masers and parametric amplifiers. (Appendix VI and Refs. 14, 15 and 16.)

Another factor is thermal emission picked up from the atmosphere when the aerials are at low elevation angles (say up to 5° above the horizon).

Secrecy: No difficulties are anticipated in maintaining secrecy on satellite circuits which is as important for a public service as it is for military circuits. The standard frequency division multiplex equipment in itself minimizes accidental eavesdropping and further protection can be given using the methods developed for H.F. radio systems.

Reliability: The reliability of a satellite communication scheme depends on the separate reliabilities of the equipment and the radio path. Equipment reliability will not be known with certainty until experience has been gained with a pilot system. However when such data comes to hand, any deficiency that is apparent may be removed by straightforward engineering development.

The reliability of the radio path will depend on the number and locations of the satellites in orbit. In general a path reliability of at least 99 per cent. is necessary and a sufficient number of satellites must be available to meet this figure. About 30 satellites in a 3,000 mile circular orbit would be needed for a 2,500 mile path.

COSTS

Now a word on the economics of communication via satellites. The estimates put forward on costs are much less precise than the engineering estimates and it is certain that some of the very low charge rates which have been quoted are too optimistic. They are based only on the cost of providing and maintaining the satellites and ground terminal stations. Estimates on the cost of this bearer provision also vary widely, capital investment ranging from £50 million to £150 million with annual charges for satellite replacement from £2½ million to £19 million.

The cost for the AT and T proposed world-wide scheme is £51 million giving 600 telephony channels between terminals or if a television channel between terminals is added the cost is expected to be £76 million. Annual charges are not yet published.

CONCLUSION

The cost estimates, inaccurate though they may be, nevertheless show that the method could be economic for international communications and could supply broadband facilities not otherwise possible. Available telephone channels between continents could be multiplied by a large factor but to realise the reduction in operating costs which might be expected to result, these extra channels must be fully loaded. This problem of usage was thought to be sufficiently important to justify a serious editorial article in "Telephony" (Oct. 29th, 1960). The article advocated an immediate campaign to introduce bi-lingual education so that enough subscribers would be available to make a large number of international trunk circuits pay. It must be emphasised however that the success of such telephone channels depends on a solution being found to the time delay problem. Subscribers will not be attracted to a service which does not allow natural conversation but instead requires unusual operating procedure similar to that necessary on "press-to-talk" equipment.

New services, not otherwise possible, can result from satellite relay systems. Television relaying is probably the most important of these and an international network of high quality is quite practicable. High speed data transmission will also be possible and indications are that this class of traffic will increase greatly in the future.

At this stage it does not seem possible to consider seriously the broadcasting of television programmes to individual homes by satellite means. With passive satellites it may be physically possible using Megawatt transmitter powers and refined receivers with steerable aerials, but such a complicated domestic installation would not be likely to be acceptable. The aerial and receiver for ordinary homes must be assumed to be simple and with this restriction, transmitter powers are not yet available for use in active satellites to provide a satisfactory grade of service. (Appendix VII.)

REFERENCES

1. Extra Terrestrial Relays; Arthur C. Clark—Wireless World Oct. 1945.
2. Orbital Radio Relays; J. R. Pierce —Jet Propulsion—April 1955.
3. Transoceanic Communication by Means of Satellites; J. R. Pierce and R. Kompfner—Proc IRE March 1959.
4. Satellites for World Communication —Hearings and Report (No. 343)

of the Committee on Science and Astronautics. U.S. House of Representatives—U.S. Government Printing Office May, 1959.
5. Communication Using Earth Satellites; Jerome B. Wiesner — IRE Transactions on Military Electronics Jan. 1960.
6. Frequency needs for space communication. Docket No. 11866 before the Federal Communications Commission USA July 1960.
7. Wide World Communications; Charles M. Mapes—Wire and Radio Communications—December 1960.
8. Radio Communication Using Earth Satellite Repeaters; Louis Pollack —Electrical Communication, Volume 36 No. 3 1960.
9. ECHO and Civilian Communication J. R. Pierce—Telephony, January 14, 1961.
10. Communication via Satellites—Wireless World—February 1961.
11. Active Satellites; L. Pollack — Wireless World February 1961.
12. The Use of Satellites for Telephone Communications; W. F. Hilton. Hawker—Siddeley Technical Journal —August 1960.
13. Simulating Speech through Space— Bell Labs. Record—August 1960.
14. P.M.G. Dept. Research Laboratory Report 5186: Noise Figure Bandwidth and Stability of Junction Diode Parametric Amplifiers — A. Korpel.
15. P.M.G. Dept. Research Laboratory Report 5219: An Analysis of Junction Diode Capacitance Modulation —A. Korpel.
16. P.M.G. Dept. Research Laboratory Report 5260: An Experimental Parametric Amplifier for 900 Mc/s—A. Korpel.
17. Satellites and Scientific Research; Desmond King-Hele (book). Published by Routledge and Kegan Paul —1960.
18. "Dependance of the Maximum Range of Tropospheric Scatter Communications on Antenna and Receiver Noise Temperatures"; Arthur H. Hausman. I.R.E. Transactions on Communications Systems Dec. 1958.

APPENDIX I

FORECAST OF GROWTH— TRANS-ATLANTIC ROUTE

To illustrate the views of a responsible section of the American communications industry, some published information (from Ref. 7) has been reproduced below and in Appendices III and V.

"Significant figures in forecasting future demand across the Atlantic are as follows:

The population of United States has increased about 60% since 1920 but the telephones in use within that Continent have increased by more than 5 times. The increase, in fact, is from some 13 million to over 70 million telephones. Outside the United States the increase has been of a similar order. The telephones have increased from 7 million in 1920 to about 62 million in 1960, an increase of almost eight times. By contrast, although there has been a tremendous upward surge in world population of about 1,000 million people, this represents only an increase of 60%.

Another significant figure is the increase in the number of telephone conversations. In the United States they increased by five times from 1920 to 1960. The really significant figure, however, is the increase in the number of trunk line conversations as distinct from the total. In the period 1920 to 1960 the trunk line calls increased from 16 million to over 532 million, i.e., an increase of over 3,000%. This gives important evidence of the trend for people to speak over steadily increasing distances more and more frequently as part of the growth of a country. Overseas radio telephone service was established in U.S.A. to England about 1927. The number of messages increased from 11,000 in 1927 to over 3 million in 1960. When the first repeatered submarine telephone cable was placed in service the traffic to England increased 90% in one year. Similarly messages to Alaska and Hawaii have increased about 75% and by 80% respectively since repeatered cables were laid to these places.

In forecasting future growth it is obvious that an important factor is the relatively small use of the telephone in countries outside the United States. If even a few of these countries progressively increased the number of telephones per capita to figures similar to those now applying in the United States, it is evident that the future demands for inter-Continental communication would be very great indeed compared with present-day usage. It is anticipated, for example, that the telephones in the United States would increase to 235 million by the year 1980 and that trunk line calls will increase to about 2,500 million by the same year. There is no doubt that telephone growth in many undeveloped countries is now showing signs of at least approaching some of the earlier figures of the United States. Taking even a conservative view there seems little doubt that there could be 265 million telephones outside the United States by 1980. This is based on a figure of only seven telephones per 100 of the population. Adding the 235 million anticipated for the United States gives a possible world total of 500 million telephones in 1980.

Experience in the United States has shown that close co-relation has existed between the number of telephones, the number of trunk line calls and the population at various years. As undeveloped countries become more industrialised it is a fair assumption that the same factors which led to a demand for telephones in the United States would be at work in these other countries. The overseas calling rate per 1,000 world telephones for calls between the United States and overseas points increased from 7 to 25 between 1945 and the present time. The trend of these curves shows that a figure of 200 calls per 1,000 world telephones by 1980 would be a reasonable forecast. This indicates that by 1980 it would be necessary to handle about 100 million overseas calls. In fact, this estimate seems to fit remarkably well with the trend of the curves applying from 1927 to that of 1960. It would be necessary to provide about 10,000 channels to handle this amount of traffic in 1980. When telegraph, data transmission and special military and other private line services are taken into account, it seems that at least 12,000 channels would be necessary by that year. The American authorities estimate that of this total of 12,000, it would be necessary to terminate about 3,500 in Great Britain and Central European Area. It should be emphasised, of course, that none of these calculations take television into account. As a matter of general interest, the foregoing figures approximate to about 50 telephone cables of the type now currently being installed."

APPENDIX II

PATH ATTENUATION FOR PASSIVE AND ACTIVE REPEATERS

The radio path attenuation is considered below in terms of the loss between isotropic aerials. Thus aerial gains, feeder losses, etc., must be included with the path loss figure to obtain the attenuation from transmitter output to receiver input terminals.

For satellite communication systems the aerial gain factor will be large and most conveniently calculated in terms of the effective aperture area. The relation is:—

Gain over an isotropic aerial (in db) $= 10 \log (4\pi A/\lambda^2)$

Where $A =$ Effective area of aerial aperture (usually between one half and two-thirds of the actual area).

$\lambda =$ Wavelength.

Consistent units (sq. metres and metres or sq. ft. and feet, etc.) must be used in the above. Fig. 7 shows the aerial gain in terms of the above relation.

The path conditions are different depending on whether passive or active satellites are used. The two cases are therefore treated separately below:—

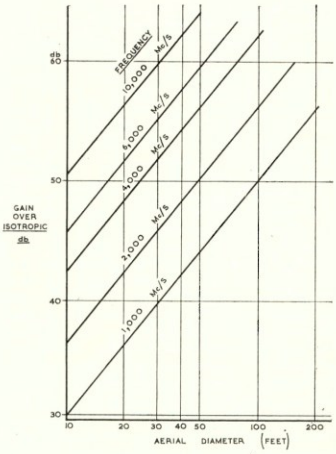


Fig. 7.—Aerial Gain as a Function of Diameter and Frequency.

Passive Repeaters: In this case the path loss is considered between isotropic aerials at the transmit and receive ground terminals and the attenuation calculation must therefore include the effect of the reflector performance. The reflecting properties of many possible types of passive repeater have already been evaluated for radar purposes so the standard radar equation may be used to work out the path loss. In the case of a spherical reflector, which is the type most likely to be used, it is convenient to use the equation:—

Path Attenuation between isotropic aerials (in db)
$= 20 \log (16\pi d_m^2/\lambda D)$
where d_m = geometric mean of the distances between the satellite and the two terminals,
and D = Diameter of the satellite.

All quantities must again be in consistent units.

Fig. 8 shows this relation over a typical range of conditions.

As an example, consider a satellite of 100 ft. diameter located at a distance of 1,000 miles from one terminal and 2,250 miles from the other. The geometric mean distance $= \sqrt{1{,}000 \times 2{,}250}$ = 1,500 miles and let us say the frequency is about 1,000 Mc/s giving a wavelength of 1 foot. The path loss is then:—

$20 \log (16\pi\ (1{,}500 \times 5{,}280)^2/1 \times 100)$
$= 270$ db.

If ground aerials of 60 ft. effective diameter were used in conjunction with this satellite each would provide a gain of about 45 db so the attenuation from transmitter to receiver, ignoring feeder and filter losses, etc., would be around 180 db.

Active Repeaters: In this case, each section of the path is considered separately and the attenuation worked out from the transmit terminal to the satellite and then from satellite to ground receive terminal. The methods familiar in connection with conventional microwave systems are used, the relation for propagation in free space being:—

Path Attenuation between isotropic aerials (in db)
$= 20 \log (4\pi d/\lambda)$
where d = length of path under consideration.

Distance and wavelength must be in the same units.

This relation is plotted in Fig. 9.

For an example, let us assume an active satellite at 22,000 miles distance and as in the example of the passive satellite above, a wavelength of one foot. The path loss is then:—

$20 \log (4\pi\ (22{,}000 \times 5{,}280)/1)$
$= 183$ db.

If the same 60 ft. (effective) diameter aerial were used at the ground terminal and the satellite aerial were equal in gain to an isotropic aerial an aerial gain improvement of 45 db would be expected. The attenuation from transmitter to receiver would therefore be about 138 db.

Comparison of this result with that obtained from the passive repeater example illustrates the justification for intensive research and development to make a reliable active repeater.

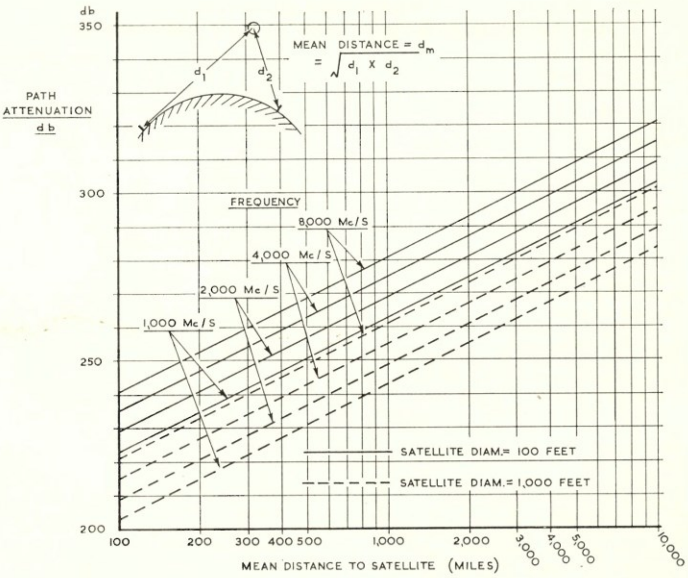


Fig. 8.—Path Attenuation as a Function of Distance and Frequency for Passive Satellites.

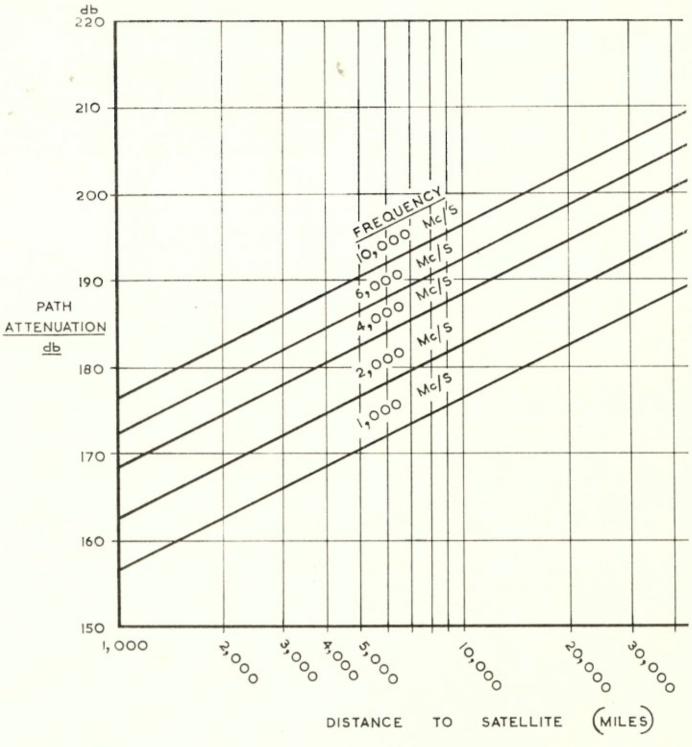


Fig. 9.—Path Attenuation as a Function of Distance and Frequency for Active Satellites.

APPENDIX III
ACTIVE SATELLITE REPEATER SYSTEM PARAMETERS

Experimental Path	USA (Holmdel)—Europe (Paris)
Satellite, altitude	2500 miles
orbit	circular polar
period	2 hours 55 minutes
velocity	14,450 mph (4 mps)
Mutual visibility time, best pass	approx. 30 minutes $7\frac{1}{2}^{\circ}$ above horizon
Maximum range to satellite	4600 miles
Maximum path loss	130 db
Minimum range to satellite	2500 miles
Minimum path loss (reference value)	125 db
Ground antenna effective area	1700 ft^2 (60′ dish)
Temperature of ground receiver	30° Kelvin
Noise in 10-mc band	—144 dbw
Power of ground transmitter	1 kw
Satellite antenna	Isotropic — 3 db
Temperature of satellite receiver	3000° Kelvin
Noise in 100-mc band	—114 dbw
Power of satellite transmitter	1 watt
With satellite at MAXIMUM RANGE:	
Margin relative to system objective	— 1 db
Margin above FMFB threshold (C/N = 12 db)	2 db
Modulation	large index FM
Improvement	21 db
Baseband	5 mc
R-F spectrum (30 db down)	104 mc
Radio frequency	6 kmc
S/N for TV, p.t.p. signal to r.m.s. noise	48 db
Noise in message channels	38 dba at zero level
Number of message channels	600

Since the above figures were published, advice has been received that the proposed satellite altitude has been altered to 6,000 miles. This is to avoid one of the maxima of the Van Allen radiation belts which has been found to occur at about 3,000 miles altitude.

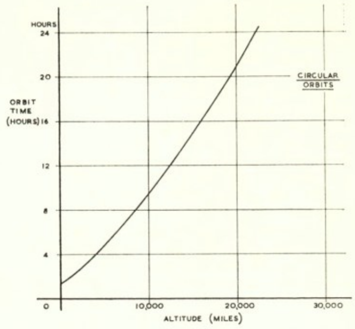


Fig. 11.—Orbit Time as a Function of Altitude for Circular Orbits.

APPENDIV IV
ORBIT CONDITIONS

At the altitudes of interest for communication purposes, the only force acting on a satellite is due to the earth's gravitational attraction. The satellite is therefore constantly falling towards the centre of gravity of the earth and since the mass of the satellite is completely negligible compared with the earth's mass, the earth may be considered to be stationary.

Referring to Fig. 10 assume that the satellite is propelled horizontally from A with a velocity v. (The function of the rocket and guidance system is to provide this initial impetus in the correct direction.) If the velocity is of the correct value, after any given time, such as when the satellite has reached position B, the satellite will have fallen a distance which exactly compensates for the curvature of the earth and will be in a stable circular orbit. We may therefore equate the acceleration of the satellite towards the centre of the earth (centripetal acceleration) with the constant acceleration due to gravity and this allows the orbit time to be easily calculated.

If r is the distance from the earth's centre to the satellite, the centripetal acceleration $= v^2/r$.

The acceleration due to gravity is inversely proportional to the square of the distance from the earth's centre, so taking the conventional surface value of 32.2 ft./sec./sec. the acceleration due to gravity at the satellite $= 32.2\ R^2/r^2$ (where R is the radius of the earth).

Thus $v^2/r = 32.2\ R^2/r^2$ ft./sec./sec.

(R & r in feet)

so $v = 5.7\ R/\sqrt{r}$ ft./sec.

It is convenient in calculations to express the distance to the satellite in terms of ratio to the earth's radius so, converting the units to miles and seconds

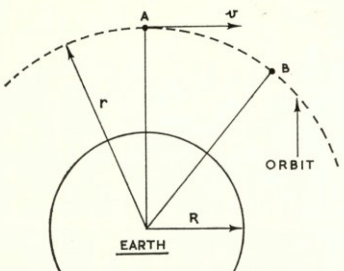


Fig. 10.—Calculation of Orbit Time for Circular Orbits.

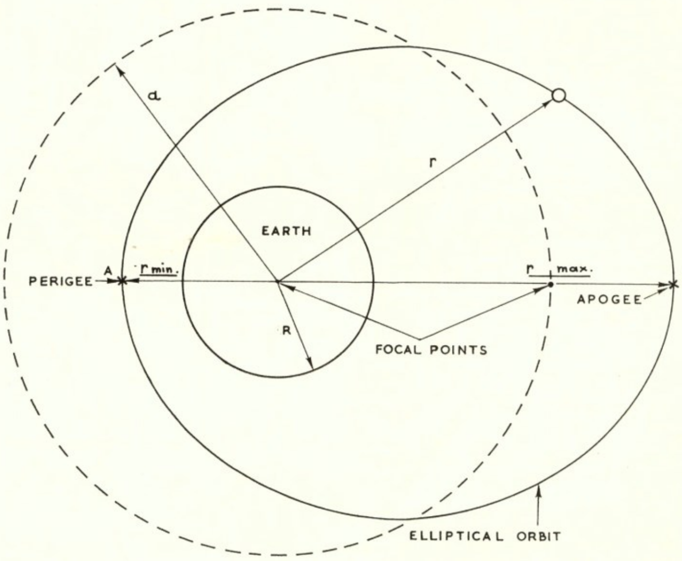


Fig. 12.—Calculation of Orbit Time for Elliptical Orbits.

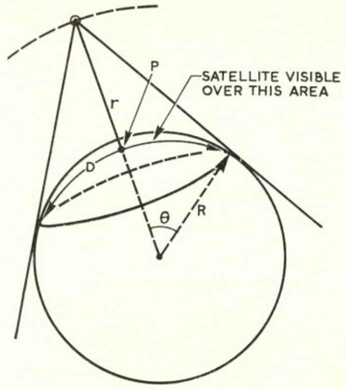


Fig. 13.—Calculation of Area Visible from Satellite.

and using a value for R of 3,960 miles the velocity may be written as

$v = 4.91\sqrt{R/r}$ miles per second ..(1)

The distance around a circular orbit is given by $2\pi r$ so the orbit time, T, may be calculated by dividing this distance by the velocity. The result is:

$T = 1.34r^{3/2}/R$ minutes

or $T = 84.4\ (r/R)^{3/2}$ minutes ....(2)

Fig. 11 shows orbit time as a function of altitude for circular orbits.

If the initial velocity of the satellite at A in fig. 10 differs from that required at the altitude of A to ensure a circular orbit one of three things will happen. If the velocity is much too low, the satellite will spiral down to earth and fail to go into any repetitive orbit. On the other hand if the velocity is higher or slightly lower than required for a circular orbit, the satellite will move in a stable elliptical orbit. For the higher velocity, point A on the figure, where it has been assumed that the initial impetus is given, will become the perigee (point nearest to the earth) while the apogee (point furtherest from the earth) and the two focal points of the ellipse will be located as shown in Fig. 12. For the lower velocity, the perigee and apogee will be located opposite to those shown on the figure.

The velocity of the satellite will vary around the orbit in accordance with the law of Kepler which states that the radius vector (r) sweeps out equal areas of orbit in equal times. The extent of the variation depends on the eccentricity of the ellipse which is defined by the equation

$e = (r\ \text{max.} - r\ \text{min.})/2a$

where $a = (r\ \text{max.} + r\ \text{min})/2$ which is the average distance of the satellite from the earth's centre. The velocity at any point and the orbit time can be easily calculated by introducing this average distance into equations 1 and 2, the results being:—

Velocity $v = 4.91\sqrt{(2\ R/r) - (R/a)}$ miles/second ....(3)

and Orbit Time $T = 84.4\ (a/R)^{3/2}$ minutes ....(4)

Visibility time: For communication purposes it is necessary to know the distance and time over which a satellite is visible.

The distance over which the satellite is visible at any time is a circle on the earth's surface centred immediately below the satellite (at the "sub-satellite" point P), as shown in Figs. 13 & 16. The diameter of this circle is the section of great circle D whose length is given by $2R\theta$ where θ is the angle in radians subtended at the earth's centre as shown. Thus the diameter

$D = 2R\cos^{-1}(R/r)$ miles ......(5)

where r and R are in miles and $\cos^{-1}(R/r)$ is in radians.

Thus the diameter D depends only on satellite altitude and the variation with this is shown in Fig. 14.

The time a satellite is visible over any point on the earth's surface depends on where the point is situated relative to the movement of the centre of the circle shown in Fig. 16 and the velocity and altitude of the satellite. The time will be a maximum when the centre of the circle passes through the point, i.e. when the satellite passes directly overhead. For circular orbits, where the velocity and altitude are constant, this maximum duration of visibility is shown as a function of altitude in Fig. 15.

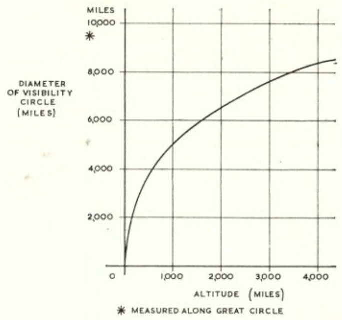


Fig. 14.—Diameter of Visibility Circle as a Function of Altitude.

If the centre of the circle does not pass through the point it is only during a portion of the maximum period that the satellite will be visible as shown on the plan diagram in Fig. 16. Consider first the point shown at A. The satellite will be visible from this point for the proportion of the maximum time that the chord CC is to the diameter of the circle or,

$$\text{Duration of visibility} = \text{Maximum duration} \times \frac{\text{length (A1 to A2)}}{\text{length (D1 to D2)}}$$

The more interesting case is where two points, such as A and B, must communicate via the satellite. This can only happen when A and B see the satellite simultaneously so the above procedure must be applied twice. Thus A sees the satellite when the sub-satellite point is located between A1 and A2 while B sees the satellite over the range B1 to B2. The common visibility range in this case is A1 to B2 so Duration of Common Visibility = Maximum duration

$$\times \frac{\text{length (A1 to B2)}}{\text{length (D1 to D2)}}.$$

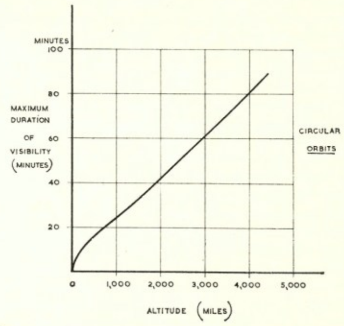


Fig. 15.—Maximum Duration of Visibility as a Function of Altitude for Circular Orbits.

The above simple theory is adequate to assess the suitability of an orbit for a particular communication system but to allow estimates of the number of satellites required for any system and to appreciate the advantages claimed for particular elliptical orbits, it is necessary to consider the major perturbations to be expected.

Orbit Perturbations: It has been assumed above that the earth is a perfect homogeneous sphere so that the gravitational attraction is constant anywhere at a given radius from the centre and that drag due to the atmosphere is negligible. At the altitudes of interest for communication satellites (1000 miles and over) the second assumption is permissible even though the air drag is increased greatly by a retarding effect due to electrified particles, but gravitational variations do have a marked effect on the satellite's motion.

The earth is markedly flattened at the poles the dimensions being (ref. 17)

Equatorial radius = 3963.18 miles

Polar radius = 3949.89 miles

This polar flattening, or as it is more often termed, the equatorial bulge, causes a variation in gravitational force from equator to poles and is the most important perturbing agency being some 10,000 times more effective than the gravitational forces due to the sun and the moon. The effect is to impress two distinct motions on the orbit as described below. Terms to be used are indicated in Fig. 17.

In the absence of the equatorial bulge the plane of the orbit would remain fixed in direction and the earth would rotate around its axis as shown once per day. Each successive pass of the sub-satellite point would be located westward on the earth's surface from the preceding one by the number of degrees of longitude corresponding to the orbit time (15° per hour).

The first effect of the equatorial bulge is to cause the plane of the orbit to precess around the earth's axis. The angle of inclination of the orbit to the equator, (i) does not change, while the orbital plane rotates slowly around the earth's axis in the opposite direction to the satellite's motion. If this is from West to East, as is usual to take advantage of the earth's angular velocity to reduce the rocket thrust required, the orbital plane rotates from East to West. The appropriate rate of rotation is given by

Rate of rotation $= X = 9.97\ (R/a)^{7/2}$ Cos (i) degrees per day where R and a are as previously defined.

The rotation varies from 0°/day for a polar orbit to 8°/day for a low equatorial orbit.

The second important effect is that the orbital ellipse rotates steadily on its own plane, forward (in the same direction as the satellite motion) for near equatorial orbits and backward for near polar orbits. The perigee thus moves forward (or backward) and the latitude of the perigee is constantly changing. The rate of rotation of the ellipse is given by

Rate of rotation $= 4.98\ (R/a)^{7/2}$ $(5\ \mathrm{Cos}^2\ (i) - 1)$ degrees per day.

The rate varies from 17°/day forward for low equatorial orbits through zero at $i = 63.4°$ to approximately 4°/day backward for low polar orbits. Further information on these perturbations may be obtained from the reference (17).

It is possible to exploit these perturbations to give economy in the number of satellites required as has been suggested recently in connection with the use of highly elliptical orbits (ref. 12). This takes advantage of the long time spent in the vicinity of apogee (where the velocity of the satellite is at a minimum) and by arranging the orbital constants such that the perturbations keep the apogee on the sunlit side of the earth where the traffic is expected to be heaviest, the most effective time utilisation of the satellite is obtained.

APPENDIX VI

RECEIVER AND AERIAL RATING BY EFFECTIVE TEMPERATURE

It is common practice to rate receiver noise performance in terms of the well-known Noise Factor.

This Noise Factor (or Noise Figure) is the ratio by which the input signal/noise ratio is degraded by the receiver and for the better class of receiver a few years ago was typically about 10 db.

In a perfect receiver, the input noise power consists wholly of thermal noise generated in the resistive components of the source impedance. It is not necessary to know the actual value of this resistive component when the concept of Available Noise Power is introduced as the available Noise Power depends only on temperature and bandwidth. In a two-terminal network, Available Noise Power (in Watts) $=$ kTB

where k $=$ Boltzmann's Constant $= 1.38 \times 10^{-23}$ joules/°K

T $=$ Temperature in °K $= (°C + 273)$

B $=$ Noise Bandwidth in cycles/sec. (Approximates to "3 db bandwidth".)

From this reasoning, it can be seen that noise factor measurements include temperature as a prime parameter.

For conventional types of receiver, noise factor measurements usually assume a room temperature of 20°C (i.e., 293°K) since most signal sources (signal generators, aerials, etc.) are in thermal equilibrium with an environment of this temperature. The source resistance thus generates an available noise power of 4×10^{-21} Watts/cycle of bandwidth. Thus for a 4 kc/s bandwidth, the power would be 1.6×10^{-17} watts or 168 db below a watt (dbw). The noise power at the input of an imperfect receiver appears to be greater than this by a multiplying factor equal to the noise factor of the receiver.

This method of rating receiver performance may be used to calculate directly the sensitivity of receiving systems in all cases where the ultimate sensitivity of the system is limited by receiver performance. However, in cases where other sources of noise are significant, the Effective Temperature (or Apparent Noise Temperature) is a more convenient parameter which can be applied to the aerial system as well as to the receiver. There are two main reasons behind the use of this idea.

One reason is that in modern receivers using Masers or Parametric Amplifiers the noise contribution from the receiver is extremely low (i.e. the Noise Factor is close to unity). Thus variations in the source temperature are very important since the receiver-generated noise no longer swamps the source noise by a factor of 10 or so as in conventional receivers.

The other reason follows from the advent of Radio Astronomy and Satellite Communications where the signal source is an aerial pointing into space. The volume of space or the objects included in the polar pattern of the aerial may be much lower or higher in temperature than the earth and it is no longer realistic in system design to use room temperature in noise calculations. The net radiation into the aerial from all directions (main beam, side and back lobes) will generate a signal across the aerial terminals and this signal is used in noise calculations.

APPENDIX V

SEPARATIONS REQUIRED BETWEEN TERMINALS TO PREVENT INTERFERENCE BETWEEN SYSTEMS ON THE SAME FREQUENCY

Type of System vs.	*Stationary Satellite Relay*	*Low Altitude Active Relay*	*Passive Relay*
Stationary Satellite Relay	50 miles for co-ordinated systems, up to hemispheric otherwise	150 miles for co-ordinated systems, 2000 miles to hemispheric otherwise	200 miles for co-ordinated systems, 2000 miles to hemispheric otherwise
Low Altitude Active Relay	150 miles for co-ordinated systems, 2000 miles to hemispheric otherwise	150 miles for co-ordinated systems, 2000 miles or more otherwise	250 miles for co-ordinated systems, 2000 miles or more otherwise
Passive Relay	200 miles for co-ordinated systems, 2000 miles to hemispheric otherwise	250 miles for co-ordinated systems, 2000 miles or more otherwise	400 miles for co-ordinated systems, 2000 miles or more otherwise
TH Ground Microwave	100 miles with some co-ordination 250 miles otherwise	250 miles	350 miles
Low Power Ground Microwave	60 miles with some co-ordination, 150 miles otherwise	150 miles	200 miles
Radar	Hemispheric	2000 miles	2000 miles

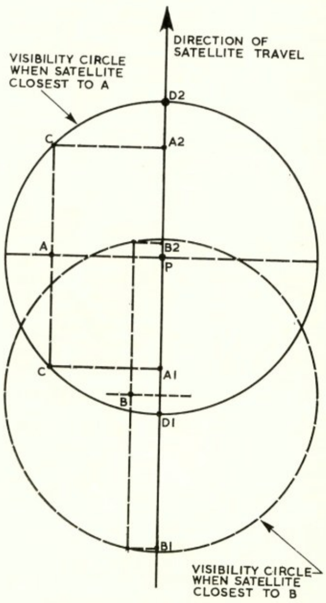


Fig. 16.—Calculation of Visibility Duration.