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Universal Service in the Spotlight

Editorial

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Abstract: In the December issue papers cover a range of telecommunications related issues both locally and internationally, including Universal Service, legacy telecommunications equipment and a timely review of the progress of the rollout of Ultra-Fast Broadband in New Zealand. A theme in this issue focuses on Universal Service and provides discussion on what a revised Universal Service should constitute and how this revised Universal Service should be delivered. As the digital transformation of government and community service delivery progresses there is a need to consider how new and upgraded telecommunications infrastructure can be best utilised to provide Universal Service. Another theme in this issue considers how telecommunications and service providers are working to ensure that legacy telecommunications equipment is identified, upgraded where necessary and connected to the National Broadband Network or replaced. Readers will also find an interesting update on the provision of reliable telecommunications to Antarctica and how Ericsson is celebrating the milestone of being a significant contributor to Australian telecommunications over the past 125 years.

In This Issue

In this issue the *Journal* contains two themes on Universal Service and legacy telecommunications equipment. There are also other papers on a range of topics including how Ericsson is celebrating 125 years in Australia.

Ericsson Celebrates 125 Years in Australia provides a review of the extremely valuable contribution made by Ericsson to the Australian telecommunication industry over the past 125 years. The paper looks back and identifies the key milestones and events that have led to this long and successful relationship between local telecommunication operators and one of the most innovative global telecommunication equipment and system vendors.

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Ultra-Fast Broadband in New Zealand: Progress Accelerating highlights the progress being made in New Zealand to rollout a national ultra-fast broadband network primarily based on fibre to the premises. New Zealand's successful approach to modernising their telecommunications infrastructure is a model that demonstrates what can be achieved with the right approach.

Telecommunications coverage of the Australian Antarctic Territory has been a challenge for more than 100 years and in the past decade the scope and complexity of telecommunications and broadband demand has escalated considerably. *Information and Communication Technology in Antarctica* offers readers a brief review of the current state of telecommunications to and within the Australian Antarctic Territory.

The rapidly changing technologies used for modern telecommunications are highlighted in the *Internet of Things for Smart Homes and Buildings: Opportunities and Challenges* and *Software Defined Networking – Shaping up for the next disruptive step?*

An industry case study theme on legacy telecommunications equipment provides a focus on why it is important as the National Broadband Network (NBN) is rolled out to either connect, upgrade or replace the legacy systems used on the telecommunications network. The guest theme editor Mr Matt Tett, Enex TestLab, introduces the topic in *Legacy Telecommunication Systems* and highlights why there is a focus on keeping legacy telecommunication systems going, especially when new telecommunications infrastructure is installed.

Legacy PSTN Applications cause confusion: Disclaimers are no substitute for actual service discusses how reliability of service is an issue moving to the converged broadband networks. *Continents to Islands: The Effect of Widespread interconnectivity on Critical Infrastructure and Legacy Systems* describes how industrial control systems and other 'untouchable' legacy devices have complicated the shift to the NBN. *Shall we hook up the old stuff?* investigates the risk associated with connecting legacy equipment to modern telecommunication networks and discusses some of the reasons for concern.

A public policy theme on Universal Service focuses on why the provision of Universal Service should be subjected to a Federal government review in 2016 and how Universal Service might be updated to utilise the NBN and wireless technologies including mobile cellular and Wi-Fi. The Universal Service challenge is complicated by several factors including the twenty year contract signed in 2012 for the ongoing provision of the existing Universal Service regime.

The guest theme editor Professor Gerard Goggin, University of Sydney, introduces the Universal Service theme in *It's Time: Reimaging Universal Service for Digital Life* and reinforces the need for a review to bring Universal Service into the 21st century.

Better Telecommunications Services for all Australians highlights the need for Universal Service to be inclusive, affordable and based on the NBN and other wireless network technologies including mobile cellular.

Who are you going to call? The Future of the Universal Service Obligation considers how Universal Service can be provided and proposes two options that are to expand the existing twenty year contract with Telstra or to open up Universal Service provision to all retail service providers and in doing so to look for an affordable, accessible and empowering approach.

From Universal Service to Universal Communications discusses how Universal Service provision could be facilitated by competition between telecommunication companies and retail service providers to bring Universal Service into the 21st century.

Contact-ability framework for the delivery of universal services argues that the Universal Service should be adapted to provide a means for consumers to be contactable utilising whatever technology and service is most appropriate. The framework described is based on four key factors including availability, affordability, accessibility and service standards. To reinforce how the framework would operate in practice there is an additional need for online service delivery and literacy and empowerment.

NetCare: Providing Free or Low-cost Universal Access to Telecommunications and Broadband provides a policy framework for the Federal government provision of universal access to telecommunications and broadband including telephony, government services and the Internet. The paper identifies why in the 21st century government and industry would benefit by providing consumers with universal access to telecommunications and broadband services.

Universal Service

The Coalition government led by the Prime Minister Malcolm Turnbull has recently identified technology and innovation as key areas of interest so it is disconcerting that the government's promised review of Universal Service did not commence in 2015 and if the review is to be completed before the 2016 Federal election it needs to be commenced early in the new year.

Telecommunications is now an essential service and it is vital for the nation that the government provides every Australian with free or low-cost access over the telecommunication networks to government services and to facilitate participation in the global digital economy.

It is time to shift from a 20th century approach to the provision of telecommunications and the Universal Service to a 21st century approach that fully empowers every Australian by ensuring that access to services offered over telecommunication networks becomes an accepted, free or low-cost part of everyday life.

Looking Forward

In 2016 a student paper prize will be launched with the winner being offered the chance to be join with Telsoc members and key telecommunication industry executives at the Charles Todd Oration held in Sydney annually.

In March the theme will be *Block Chain Technologies (e.g. Bitcoin)* and how the global finance industry is looking to harness this technology to facilitate cheap secure financial transactions between consumers and suppliers but also in a machine to machine context for financial transactions carried out at an ever increasing speed on the global markets.

Papers are invited for upcoming issues and with your contributions the *Journal* will continue to provide the readership with exciting and informative papers covering a range of local and international topics. The Editorial Board values input from our readership so please let us know what themes you would like to see in the coming year.

All papers related to telecommunications and the digital economy are welcome and will be considered for publication after a peer-review process.

Mark A Gregory

Ericsson Celebrates 125 Years in Australia

Simon Moorhead
Ericsson Australia & New Zealand

Summary: 2015 marks the 125th anniversary of Ericsson supplying telecommunications equipment in Australia. The history of Ericsson in Australia is précised here and the paper entitled "Establishing L M Ericsson Crossbar Production in Australia" is included for historic reference.

Introduction

Ericsson began sales in Australia in 1890 through its agent C A Fahlstedt in Sydney. Initially, sales consisted exclusively of telephones and spare parts for telephones, not telephone exchanges. In the 1890's Ericsson was a key supplier of Magneto telephone equipment and Coffee Grinder & Biscuit Barrel models appeared in Australian's homes and businesses in 1890s. Ericsson magneto phones were praised in rural and regional areas for their operational reliability. Australia and New Zealand became one of Ericsson's largest markets outside Europe. In fact, in 1900, sales in Australia were greater than in Sweden.

In 1902, Ericsson's senior engineer Hemming Johansson, who would subsequently become president of the company, travelled to Australia and South Africa, which was also a major market. Johansson wanted to demonstrate the company's technical expertise and had brought with him a small switchboard with a central battery system.

Hemming Johansson later wrote about the visit as follows. "Through a stroke of luck, leading engineers from various telephone companies were attending a conference in Sydney during my visit. An offer to arrange a practical demonstration of the latest equipment and discuss technical matters with these gentlemen was readily accepted".

In conjunction with Johansson's trip, Fahlstedt was replaced in Sydney by the Scottish businessman James Paton. Ericsson also recruited agents in other parts of the country and sales were expanded to include switches.

The Australian Post Office (APO), later called Telecom Australia, then AOTC, then finally Telstra, soon began replacing the manual switching system with the automatic Strowger system, and other suppliers took over the market, even with respect to telephones. Ericsson's telephones were renowned for their high quality and sales continued to be sufficiently

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successful to enable James Paton to establish a sales company in Australia in the early 1920s called the Ericsson Telephone Manufacturing Company.

Australia did not emerge as a major market until after James Paton's death in 1949. The new manager for the Australian market was an Australian named Les Rowe, who established a new Ericsson sales company called L M Ericsson Telephone Co. Pty Ltd (ETA) for the sale of switching systems. He faced a tough challenge as the APO had already signed an extensive multi-year contract with two British companies, Standard Telephones & Cables (STC) and Telephone & Electrical Industries (TEI), for delivery of telephone exchanges.

When the expansion of the telephone network began after World War II, the Strowger system was considered limited and outdated. Les Rowe thus saw his chance and presented a small demonstration version of the crossbar switch to the APO’s Director General and followed up on this by submitting an offer. At the time, however, the Director General was not receptive.

Rowe stubbornly continued his efforts to influence the APO and took every opportunity to praise the advantages of the crossbar system. When these efforts did not succeed, in 1953 he donated a 60-line crossbar switch to the APO for use in its laboratories. The APO's engineers were extremely impressed by the crossbar switch and in January 1954 ordered an additional 60 lines to be added to the switch that Rowe had donated.

In July 1954 the APO ordered two 600-line exchanges, one for Sydney and one for Melbourne. In late 1956, with growth in demand for telecommunications, the APO established the Automatic Network and Switching Objectives (ANSO) Committee to investigate options for a new Subscriber Trunk Dialling (STD) telephone system for Australia. The committee undertook extensive studies of various telephone systems, and through laboratory experiments came to the conclusion that Ericsson’s crossbar switches were at the time superior to those produced by its competitors, which included International Telephone & Telegraph (ITT - the ultimate parent of STC) and Siemens.

The APO was now seriously considering abandoning the Strowger system, and in 1959 chose the Ericsson crossbar system for the Australian telephone network, thanks mainly to their flexibility for small, medium and large exchanges. Ericsson was selected to provide a 6,300 line crossbar exchange to be located in Toowoomba, and the system was delivered in 1960.

Initially, the Ericsson crossbar switches were manufactured under licence by STC and TEI in Australia, but Ericsson believed that there was room for another manufacturer. In 1960, the company purchased Trimax Transformers Pty Ltd, which was renamed L M Ericsson Pty Ltd (Ericsson Australia) in 1963.

After this acquisition, the company's production was converted to telecom equipment. Soon after, a new production plant was built at Broadmeadows in Victoria (the subject of the following historic paper). When STC's and TEI's licences expired in 1963, they were not renewed by the APO. Instead, manufacturing was awarded according to a bidding procedure which resulted in Ericsson capturing one third of the market for public telephone exchanges in Australia.

By the middle of the 1960's, Ericsson was experimenting with Stored Program Control (SPC) which was initially devised at Bell Telephone Laboratories. It was evident that electronic SPC exchanges were the way of the future, and Ericsson and Televerket (the Swedish PTT) decided to combine their research efforts to commercialise a digital switching product.

Therefore in 1970, Ericsson and Televerket formed a joint development company called ELLEMTEL. The new product was designated AXE, and featured the decentralisation of the processor functions to enable the modular construction of large and small exchanges.

Australia was one of the first countries to purchase the AXE with an order from the APO in 1977. The first generation SPC exchanges were hybrid electro-mechanical switching under SPC control (AKE and ARE). The first generation of AXE were also hybrid using reed relays for switching. With the advent of Pulse Code Modulation (PCM), the system was enhanced with a digital group stage largely developed by Ericsson Australia.

Ericsson Australia also played an important collaborative role with the APO to optimise the AXE to the unique requirements of the Australian telecommunications environment. Australia has long collaborated with strategic partners to develop solutions tailored to local needs. This *Journal* contains many technical papers describing where Ericsson and the APO have worked together to adapt the AXE platform to meet real-life technical challenges.

The next significant technological innovation spearheaded by Ericsson (and others) was the development of the cellular mobile telephone system and the introduction of the CCS7 signalling system. Mobiles continue to have a dramatic impact on world-wide communications today. Space does not permit me to detail the numerous technological and regulatory advances throughout the world during the 1970's and 1980's, except to say that Ericsson emerged in the 1990's as one of the dominant suppliers of mobile telephony, utilising the AMPS and GSM standards.

In the mid-1980s, Ericsson Australia was awarded the contract for a nationwide Advanced Mobile Phone System (AMPS – American 1st generation mobile standard) from Telecom Australia. This was followed in the early 1990s by an order for a Global System for Mobile communications system (GSM – European 2nd generation mobile standard).

In 1992 Telecom Australia and the Overseas Telecommunications Commission were merged into the Australian and Overseas Telecommunications Corporation (AOTC), renamed Telstra Corporation in 1993. The subsequent privatisation of Telstra, and the introduction of network competition in Australia, provided Ericsson with the opportunity to supply equipment and services to several new carriers, including Vodafone, Optus and Hutchison.

Ericsson has continued the development of mobile broadband and was a major contributor to the international standardisation of 3rd Generation (3G wideband CDMA) and 4th generation (4G Long Term Evolution LTE) mobile systems. At the present time, Ericsson Australia has been awarded significant contracts in Australia for wideband CDMA and LTE, as well as the related packet data nodes and cloud services.

The evolution path to 5th generation (5G) mobile services is referred to as the “Internet of Things”, providing broadband everywhere, anytime. 5G standardisation is being driven by the significant increase in mobile data volumes, throughput and the number of connected devices. 5G will also provide improvements in battery life and lower latency for critical control of real time systems (for example smart vehicles).

In 2015, Ericsson celebrated its 125th year of supplying telecommunications equipment in Australia. Ericsson Australia has delivered Australia’s 1G, 2G, 3G and 4G mobile networks and is now collaborating on 5G. This is a significant milestone considering the technological changes that Ericsson has successfully innovated for well over a century in this country.

Acknowledgements

This history was précised from the historical content on the Ericsson global website: "The History of Ericsson – Australia" (Wickman nd). The content covering Ericsson supplying crossbar to the APO and the establishment of the factory at Broadmeadows was précised from "LM Ericsson 100 Years: Volume II" (Attman_&_Olsson_1977) and "Establishing L. M. Ericsson Crossbar Production in Australia" (Spongberg 1967). The content covering the development of cellular mobile systems was précised from "The Ericsson Chronicle: 125 years in Telecommunications" (Meurling & Jeans 2000).

References

Attman, A; Olsson, U. 1977. "LM Ericsson 100 Years. Volume II: Rescue, Reconstruction, Worldwide Enterprise 1932-1976". (*Trans.* Green, A; Green, E; Bradfield, K). Örebro Sweden: Ljungföretagen, 1977.

Meurling, J; Jeans,R. 2000. "*The Ericsson Chronicle: 125 years in Telecommunications*". Stockholm: Informationsfrlaget.

Spongberg, C. A. 1967. – "Establishing L. M. Ericsson Crossbar Production in Australia" *Telecommunication Journal of Australia* Vol 17, No. 2 June 1967.

Wickman, M. nd. "The History of Ericsson – Australia". Available from: http://www.ericssonhistory.com/places/oceania/Australia/

Introduction to the historical paper

On 6 December 1963, Ericsson opened a purpose-built factory at Broadmeadows in Victoria to manufacture crossbar switching equipment for the Australian Post Office. The historic paper entitled "Establishing L M Ericsson Crossbar Production in Australia" (Spongberg 1967) by C. A. Spongberg, who was the factory manager at the time, was published in the June 1967 issue.

The paper describes the establishment of the factory and the transfer of Ericsson skills and processes to ensure proper quality assurance and documentation. Broadmeadows was used continuously for the production and distribution of telecommunications equipment from 1963 until 2007. It comprised a cosmopolitan workforce of some 3,000 employees at its peak, and the multi-cultural aspect was typical of the manufacturing sector in Australia after the Second World War.

Broadmeadows was a state of the art manufacturing site that fabricated most of the crossbar exchanges, AXE exchanges, PABXs, queuing systems, network terminating units and, in later years, even mobile phones. The scope of these manufacturing activities incorporated or spanned the range of design, testing, metal fabrication, metal plating, painting, component testing, printed circuit board manufacturing, board and system assembly, wire manufacture, transformer winding, capacitor manufacturing and system testing.

The factory was at the forefront of adapting automated control and industrial robots for activities such as high-speed "pick and place" for circuit board assembly. (One automated production plant was commissioned in 1990 by the then Prime Minister R. J. Hawke.) This technology later transitioned to undertake surface mount assembly for AMPS and GSM transceivers. Broadmeadows was also the centre for the repair and refurbishment of Ericsson mobile phones, before amalgamation with Sony.

Local manufacturing began to wind down from 1998 and production shifted over the next three years to off-shore contract manufacturing facilities. Distribution continued from Broadmeadows until the end of 2007 when the factory was completely closed and the administration and models were relocated to Docklands and Port Melbourne.

The historical paper

ESTABLISHING L M ERICSSON CROSSBAR PRODUCTION IN AUSTRALIA

C. A. SPONGBERG, M.A.I.E.E., Dip.E.E., B.M.E.*

INTRODUCTION

In previous issues of this *Journal* announcements have been made of the adoption by the Australian Post Office of the L. M. Ericsson crossbar system as the new standard for automatic switching in the Australian telephone networks. References have also been made to the manufacturing agreements between L. M. Ericsson, Sweden and two Australian manufacturers Standard Telephones and Cables Pty. Ltd. and Telephone and Electrical Industries Pty. Ltd, both of Sydney, New South Wales, for the production of subject equipment.

It is the intention of the author of this paper to describe the third phase of this development — the production of L. M. Ericsson crossbar equipment by L. M. Ericsson Pty. Ltd. in Victoria, Australia.

In order not to repeat what has already been published by other writers in the crossbar production field, it is not intended to give a detailed explanation of the various production processes, but rather cover the subject of production from an administrative and organisational point of view. It is hoped by this to bring to light some important factors which are to be covered in the establishing of production facilities.

Background of L. M. Ericsson in Australia

L. M. Ericsson Telephone Company Pty. Ltd. was formed in 1951, primarily as a Sales Company of the L. M. Ericsson Group. Ten years later the Company acquired its first factory in Australia by entering as a main partner in the former Trimax Transformers Pty. Ltd., Coburg, Victoria.

Trimax had, since 1937, been a supplier of transformers, amplifiers, power supplies and other telecommunication equipment to the Australian Post Office. At the time of the acquisition, the name of the Company was changed to L. M. Ericsson-Trimax Pty. Ltd., and the Company undertook, in addition to earlier production lines, the assembly of crossbar P.A.B.X. equipment.

When L. M. Ericsson Telephone Company Pty. Ltd. was granted contracts with the Australian Post Office for crossbar equipment, both for city and rural exchanges as well as trunk and telex exchanges, it became apparent that additional production facilities were required adequately to cope with the volume of orders. The contracts stipulated that the bulk of the equipment should be produced in Australia, and detailed plans for the implementation of local production by L. M. Ericsson were drawn up during 1961-62. The name of the manufacturing and trading company became L. M. Ericsson Pty. Ltd.

PLANNING AND ERECTION OF FACTORY

Factory Facility Planning

The successful conveying of technical production know-how from one country to another is a matter of balance. The appropriate importing of a product, a process, a management system or control, is influenced by the interaction of the technical, cultural, political and economic systems of the two countries.

Attitudes and regulations regarding such things as labour, importation, investment have a bearing on the forecasting and controlling of costs for labour, material, overhead and capital. The most suitable production processes have to be chosen together with machine and tool investment, in conjunction with effective production planning, to establish adequate and economical output and inventory levels. All these factors play a vital part in the decisions and actions to be taken when planning for production.

Experience from similar operations in other parts of the world is of course advantageous, as long as such experience is effectively combined with local practices. Each new situation must be thoroughly considered.

Within the L. M. Ericsson Group an internationally-trained staff of people is available for new factory facility planning. This group of engineers and economic advisers is located at the parent company in Stockholm, Sweden and helps to establish factory layouts, suggests machine and tool procurement and the selection and training of specialist personnel. After the commencement of production, the group's services are available for helping further development of production processes and factory management procedures.

Due to continued technical developments in the equipment to be produced, and the possible introduction of improved processes of production, the factory must have a layout which is also able to handle changes. Such changes are usually governed by the general plans for stages of growth which can vary from one factory to another depending on local circumstances.

Location of Factory

When selecting land for a factory for the production of crossbar equipment, there are five main points which require thorough investigation and subsequent decision:

(i) Supply of labour.
(ii) Gas, water, sewerage and electricity supply.
(iii) Access to main transport facilities.

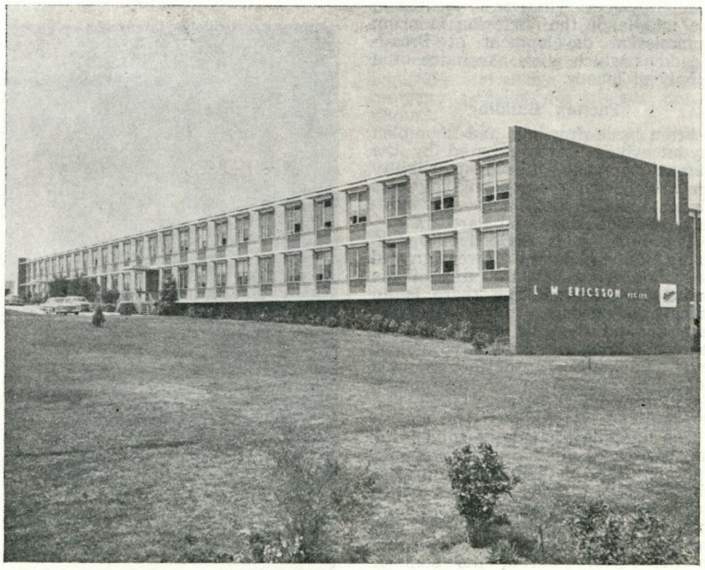

Fig. 1 — L. M. Ericsson Pty. Ltd., Broadmeadows, Victoria.

* Mr. Spongberg is Factory Manager, L. M. Ericsson Pty. Ltd., Victoria.

Fig. 2 — Tea Break in the Cafeteria.

(iv) Air cleanliness.
(v) Financial aspects.

After a study of the conditions in Victoria, it was decided to locate the L. M. Ericsson factory in the northern part of Melbourne at Broadmeadows. In our study, areas such as Frankston, Dandenong, Greensborough, Lilydale and others were considered, but in each of these places one or more of the requirements were not at that time fully met. The site is located in the middle of the Victorian Housing Commission development at Broadmeadows which gives assurance of a supply of labour.

Factory Building

From basic drawings and floor plan layout which were prepared by the parent company, the responsibility for the design of the building was given to the Melbourne firm of architects, Garnet Alsop and Partners.

The building is divided into two floors, of which the lower ground floor has about half the area of the main floor. In addition there is an office building across the front of the factory, and there is also a central store adjoining the factory with floor level coinciding with the factory main floor. The excavation for the foundations started in December 1962, and the building was completed to such a

The building is made of solid brick and has a new method of natural roof lighting. This method of lighting has given excellent light at work bench height even during winter days, with a minimum of artificial light. This lighting method increases the temperature in the factory during the summer months, compared with, for example, a saw-tooth roof construction. The factory is ventilated through mechanical filters, and is pressurised to keep dust out. In the Paint Shop, there is an additional pressurised system over and above the factory pressure, for the same reason. The building was erected by F. T. Jeffrey Pty. Ltd. and was officially opened on December 6, 1963 by the former Postmaster-General, the Hon. C. W. Davidson.

Early in 1967 a company-sponsored Child Minding Centre opened to take up to 90 children in the 3-5 years age group. This building is fully equipped with beds, play rooms and facilities for the serving of hot and cold meals. The Centre is on a strictly non-profit basis, with a staff of one matron and about nine nurses. A Social Hall has also been built on the premises for the employees of L. M. Ericsson. It offers facilities for evening entertainment such as dancing, movies, study and other various club activities.

HIGHLIGHTS OF PRODUCTION

The production of crossbar equipment is facilitated by a high degree of standardisation of piece parts. The main components, the RAF Relay and the RVD Switch, are employed in such large quantities as to permit a well developed mechanisation of both machine-shop processes (primary departments) and of the assembly-wiring-testing operations (secondary departments).

In the primary departments the emphasis is on making full use of the standardisation by investing in high speed, advanced tooling to minimise production lead-time and tool maintenance. The predominance, (70%) of the work is in the press-shop, making it possible to employ simple automatic feeding and stacking devices. Wherever progressive tooling has not been introduced, the arrangements of the required machines and the associated operations for a particular piece-part is such that it achieves a progressive flow of work operations with a minimum of inter-operation delays.

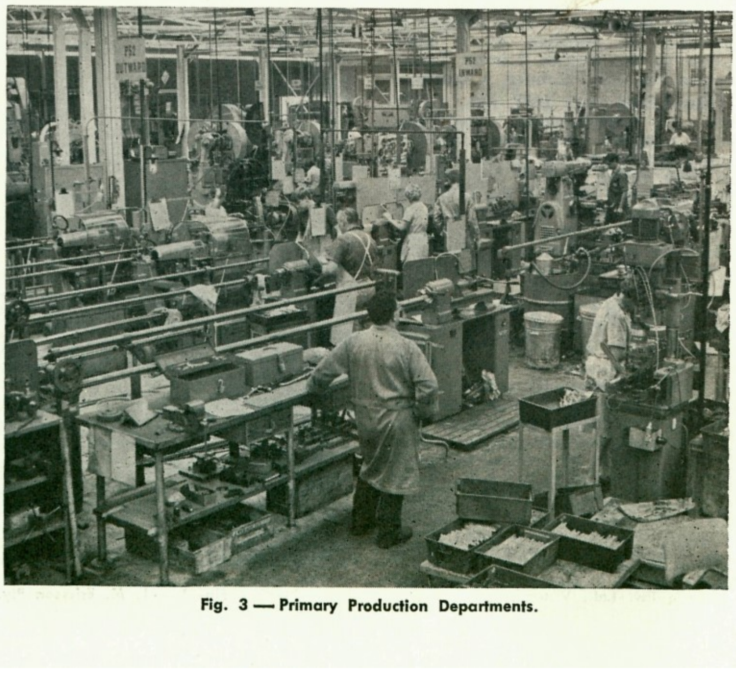

Fig. 3 — Primary Production Departments.

Fig. 4 — Secondary Production Departments.

In general the machine tools are of standard types. Only a few special purpose machines are in use, for example, contact riveting, jack and plug assembly and strip tinning. These machines were designed by L. M. Ericsson in conjunction with the design of the piece parts.

A flow-line concept has also been introduced in the secondary departments. The successful implementation of a relay set production flow-line, including all operations from coil winding, relay adjustment, cable-form making, wiring, testing and packing has been in operation since the end of 1966. Further improvements of the individual handling operations are being undertaken to gain additional reductions in lead-time and work-in-progress.

Another highlight of production which may be of interest, is the successful introduction of the metric measuring system including established tolerances in accordance with the recommendations of the International Organisation for Standardisation (I.S.O.) in all phases of our production, including the production of tools. Contrary to some opinions in the industry, the training of the operators, leading-hands, tool-room and inspection personnel is less difficult with metric than commonly assumed.

A course in measuring technique was arranged for a few people in leading and supervisory positions. No other arrangements were made except a ban on all measuring devices not graduated in metric dimensions.

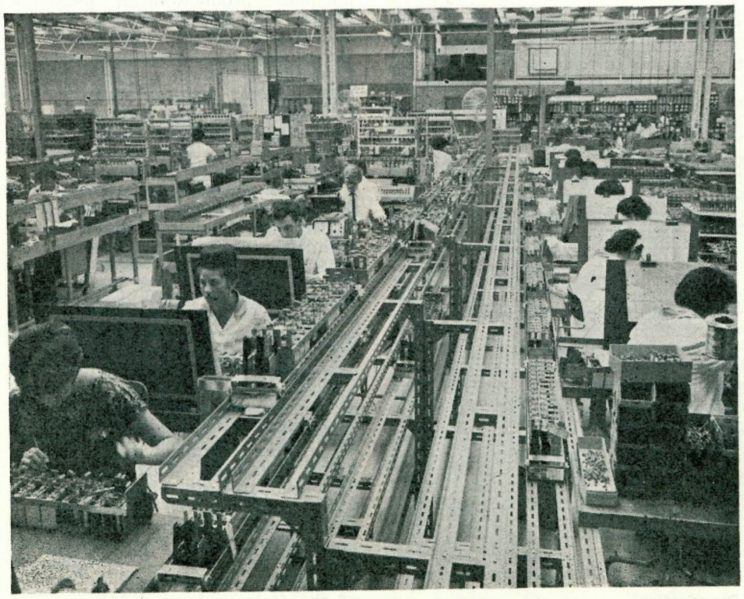

Fig. 5 — Flow-Line Production of Relay Sets.

MANPOWER REQUIREMENTS

The estimate of manpower requirements is a part of the factory facility planning. As such, it was originally a plan showing the numbers and types of managers, technicians and workers needed at the start of production in Broadmeadows. The plan outlined a program for supplying these needs from local and overseas sources and included specific steps to develop local manpower into successively higher supervisory levels.

The original team from the parent company for the factory consisted of a Factory Manager, Production Manager, Technical Manager and six Foremen. The personnel selected had previous experience in similar work positions in the Swedish factories or abroad. The team was engaged on this project for periods ranging between six months to three years. Their main task was to help select and train local personnel at all levels of production supervision and technical support. The training not only included the conveying of information of various production processes, but also the know-how of making full use of documentation supplied and acquiring knowledge of the inherent company policies not always documented.

The Production Engineering, Planning, Procurement and Personnel Management was handled by locally employed people, some of whom were sent to the parent company for study. Exchange of knowledge continued through the years and will continue to do so as the factory grows and new products and/or production methods are being contemplated. It is recognised that the different stages of growth of the factory will require different contributions of knowledge from the parent company.

Training of Factory Personnel

With the establishing of production facilities in Melbourne the Management was faced with problem of starting production operations from scratch. Speed was essential because of contractual requirements. This in itself imposed a heavy load of selection-recruitment on the Personnel Department.

Speed was also essential from another point of view. The training scheme had to be short and efficient to reduce precedents of low performance and productivity which could have become a problem in time. It was decided to organise training facilities under the supervision of the Personnel Department with assistance from a professional group of training consultants. The organisation selected to undertake this project was chosen mainly because of the new process analysis method of training which had been developed by the consultants and been used successfully in other parts of the world. The essence of the technique is the thorough analysis of the operation to be taught so as to determine the precise skills required for its proper performance. This skill analysis is followed by the design of appropriate selection tests and training procedures. The training method incorporates special methods for the development of both skill and consistent output.

Relay adjustment was the first process analysed in accordance with this method. The result was encouraging and as a consequence all major operations in the secondary departments are today covered by this scheme.

ENGINEERING TO SUPPORT PRODUCTION

It is essential that strong engineering support for factory operations be provided. This type of engineering, to be distinguished from design-development engineering, is giving support and guidance to the production operations from the point of product engineering, including the setting of quality standards, provision of tooling and methods to the point of appraising the conformity of set quality standards of the product produced or purchased. In other words, function controls of all required technical input information of the products for the production/purchasing, and by means of its own inspection activities in the factory and of sub-suppliers, it is able to obtain all necessary output information of the products-in-process or completed, to adequately control quality at the most efficient level.

In a broad sense the organisation covers four major functions:

(i) Product Control
(ii) Production Engineering
(iii) Quality Control
(iv) Inspection.

The four functions constitute an integrated control effort in an overall company quality control system to assure quality of the products at minimum costs and render assistance to the production in cases of non-conformity to set standards.

Product Control

The Product Technique Section is in charge of all product drawings related to production. It is responsible to accumulate performance requirements of the products, act in the capacity of a common pool of product know-how and instigate actions to assure full use of existing L. M. Ericsson documentation. It is responsible for issuing of requisitions for alterations or changes of the products being produced. It investigates production problems related to design and suggests changes in design to facilitate production. Furthermore, the section is responsible for planning and availability of documentation to be used by the Production Planning Department in formulating the production program.

The Record and Print Distribution Section is in charge of the recording of official technical documentation used within the company. It serves as a printing and distribution centre of copies for a number of permanent drawing files located in various areas of the office and factory buildings. It is the responsibility of this section to issue new copies of these files whenever the originals are subject to changes or obsolescence.

The Chemical and Metallurgical Laboratory is in charge of any raw materials testing required for the purpose of establishing sub-suppliers. Any subsequent test requested by the Incoming Goods Department on batch deliveries of raw materials is also carried out by this section. It is the responsibility of this section to assist production in the control of electroplating, painting, impregnation and heat treatment processes.

Production Engineering

Work Study is responsible for the critical analysis of the way and conditions under which work is done and the development of better and more economic methods and measurement of the labor required.

Tools and Methods is responsible for the design of tooling, special machine and ancillary equipment, the preparation of tooling schedules, estimating tool production times and investigation of production problems related to tooling.

Quality Control

Inspection Planning has the responsibility for any action required to determine that quality objectives and goals are sufficiently defined to permit adequate production. It plans and directs the inspection measurements and controls to be provided on processes and products. It is also responsible to analyse quality assessment reports and other feedback information from the field and make recommendations for adjustment to product design, production processes and inspection procedures.

Quality Assessment is responsible to designate quality characteristics to be measured in establishing methods and procedures for performing a continuous assessment of the quality of products being produced. Its main objective is to determine the actual level of quality and to detect any significant variation to such levels. The information is reported to Management and the parent company and is used by Inspection Planning in the direction of corrective actions.

Reliability Laboratory is in charge of reliability studies of components being produced and/or purchased. The standards of reliability required for the products are determined by the technical departments of the parent company. It is then the responsibility of this section to appraise conformity to these standards. Reports of the tests performed are submitted

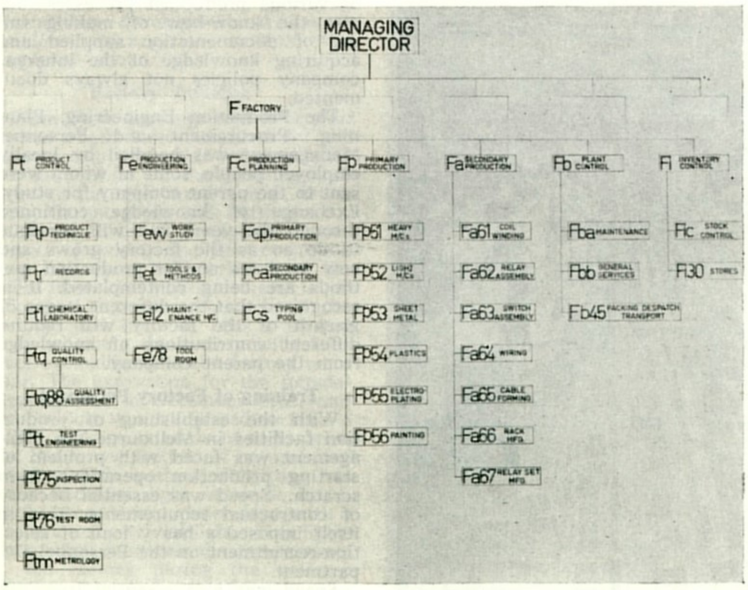

Fig. 6 — Factory Organization.

to the parent company and to certain customers on their request.

The reliability activities may be grouped under three headings:

(i) Establishing the reliability requirements.
(ii) Reliability analysis of components prior to production.
(iii) Continuous reliability testing of components of approved design, purchased or of own production.

Establishing the Reliability Requirements: The initial new design control activity is the responsibility of the technical departments of the parent company. The reliability targets and standards have been chosen with due attention to the state of the technical art and the overall functional requirements as experienced from actual operations in the field. The standards are thus very realistic and cannot be altered without the consent of the parent company.

Reliability Analysis of Components Prior to Introduction: This portion of the reliability activities is covered by the parent company in its approval of the design for production. In the design approval is also included the recommended production processes and tools to be used to attain desired reliability level. It is a well established L. M. Ericsson practice to keep the production of a newly-introduced product for several years as close as possible to the department responsible for the design. This practice is for the purpose of obtaining adequate attention to production processes and their effect on the product reliability. Not until the design is proved feasible to be produced in large quantities is the product authorised for production in other factories within the L. M. Ericsson group.

Similar caution is exercised on the introduction of purchased components. The reliability testing facilities are being utilised to assess all aspects of the component reliability before approval is granted to use such component in an L. M. Ericsson product. As a reference, a list of approved suppliers and their components is issued to the Purchasing Departments within L. M. Ericsson. The list is maintained by the Quality Control Department.

Continuous Reliability Testing of Components of Approved Design, Purchased or of Own Production: Continuous testing is necessary for the purpose of making sure that the design and production data continuously and repeatedly result in the production or purchasing of products with required reliability. This will normally involve the taking of random samples from the running production or Incoming Inspection. The samples are subjected to detailed examination and accelerated tests in accordance with established procedures and standards. In addition to the continuous reliability assurance on the products, the continual testing provides exhaustive data on which to base reliability improvement programs.

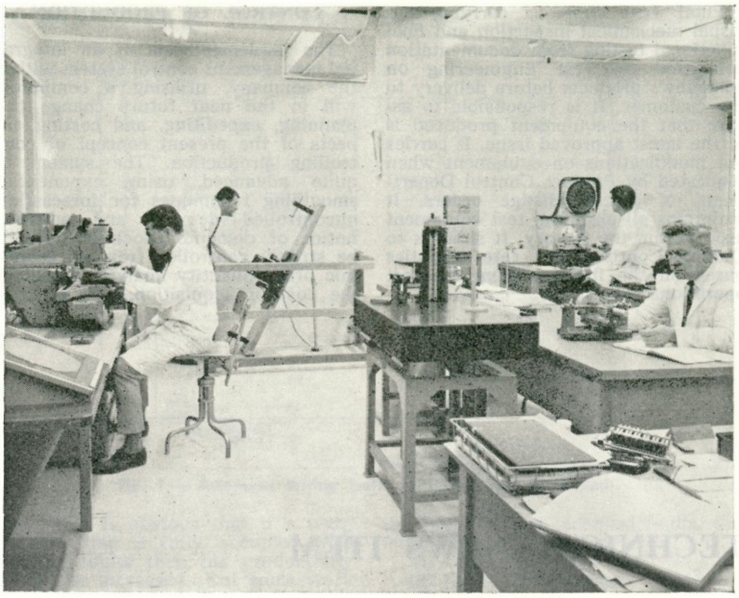

Fig. 7 — Metrology Department.

Production Test Engineering is in charge of test methods, instructions and the design of electrical test equipment used by inspection authorities and certain production departments in the factory. Included here are techniques for creating measurement practices and instrumentation procedures for the application to those quality information requirements that are established by the Inspection Planning Section.

Metrology is in charge of calibration and re-checking of electrical and mechanical measuring devices used within the company. It conforms with N.A.T.A. (National Association of Testing Authorities) requirements for registration. The section is also responsible to carry out "First-Off Piece Part Examination" from new or modified tools and to render service to tool room and production when special examinations are required.

Inspection

Incoming Goods Inspection is responsible to ensure that incoming raw material and components from subsuppliers are subjected to test and inspection as laid down by Quality Control. It acts in this capacity as a receiving and distribution point working from test schedules and sampling tables. The actual tests are performed by the various specialised test authorities within the factory organisation. The section is also responsible to maintain a suppliers' quality rating system.

Piece Part Inspection is carrying out quantitative and qualitative inspection and sorting of parts being produced. It works from inspection instructions and sampling tables provided by Quality Control. It is responsible to record fault rate on piece part production and submit weekly inspection reports. On request from Quality Control it performs special quality auditing.

Assembly Inspection is responsible to carry out test and inspection procedures required during the various stages of assembly and adjusting operations. It works from test instructions and sampling tables provided by Quality Control. The section is requested to record fault rate on a daily basis and submit reports to Quality Control.

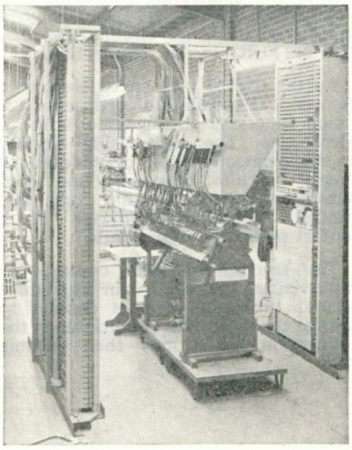

Fig. 8 — Automatic Test Equipment for the Final Inspection of Rack Wiring.

Final Test Room is carrying out visual mechanical inspection and final functional testing from documentation submitted by Test Engineering on company's products before delivery to the customer. It is responsible to assure that the equipment produced is of the latest approved issue. It carries out modifications on equipment when requested by Product Control Department on official change orders. It maintains all electrical test equipment used within the factory. It submits to Quality Control fault rate statistics based on the findings from the test operations.

CONTROL OF PRODUCTION

The implementation of an integrated management control system within the company, utilising a computer, will in the near future change the planning, expediting, and costing aspects of the present concept of controlling production. The system is quite advanced, using exponential smoothing techniques for forecasting uncontrolled demand and advance notice of demand. Stock levels will be strictly controlled from an economic order quantity analysis based on the cost of acquisition, cost of possession and some safety stock parameters. It is not possible to cover adequately the complexity of this system in this paper.

CONCLUSION

In conclusion it may be said that the factory today is effectively producing equipment, but that quite a lot of work always lies ahead to keep pace with the competition in the telecommunication field. It is a true challenge with real incentives, for both the customer and the supplier.

C. A. SPONGBERG

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Ultra-Fast Broadband in New Zealand: Progress Accelerating

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Abstract: The New Zealand Government's Ultrafast Broadband (UFB) initiative is now more than halfway completed. Pleasingly, deployment of Fibre to the Premises (FTTP) has tracked ahead of schedule over the last two years. As at September 2015, deployment was 56% complete, with over 800,000 households and businesses able to connect, equating to around 44% of the NZ population able to connect to an optic fibre broadband service. Communal deployment has been completed in 11 of the 35 eligible towns and cities, meaning fibre has been laid on public lands, enabling every household to order a UFB connection. A further eight towns/ cities are expected to be completed by June 2016. Uptake of UFB services is accelerating as Retail Service Providers (RSPs) increasingly see UFB as the right choice for themselves and their customers. Presently around 10,000 households and businesses connect every month. With over 130,000 connections in place as at September 2015, uptake is around one in 6, indicating that there is still a long way to go for New Zealanders to connect to improved broadband. Importantly, deployment to "priority" premises (businesses, schools and health facilities) is close to completion, and many of these customers report that UFB usage has helped them improve business productivity or service delivery. The goal for the UFB initiative is recognised as being delivered well by the New Zealand Government, to the point that at the 2014 election it committed to provide additional funding to increase the FTTP rollout from 75% population coverage to 80%.

Introduction

A key policy plank of the newly elected New Zealand National Government (Key 2008) back in 2008 was a $1.5 billion fund for the rollout of UFB, aiming to accelerate deployment of FTTP to reach 75 per cent of the population, across 33 towns and cities by the end of 2019. The Government specified that the focus in the period until the end of 2015 should be to provide access to priority broadband "end users" (being businesses, schools & health services) as well as greenfields developments and certain tranches of residential areas.

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The Government specified that taxpayers' investment should be made in conjunction with the private sector, and directed so that it should fund wholesale-only, open-access, communal infrastructure (being fibre and ducting on public land rather than customer-specific connections). Companies selling services to end users would be prohibited from owning a majority stake in any UFB infrastructure operator.

During 2009 the Government issued a tender document known as the "Invitation to Participate" (MED 2009), and formed a Crown-owned company, Crown Fibre Holdings (CFH, www.crownfibre.govt.nz) to manage the UFB initiative. CFH is structured on sound commercial principles, to achieve the best possible outcome from the Government's investment in FTTP, supplemented by private investment through the formation of a number of Public-Private-Partnerships.

The Government's policy defines UFB to mean the availability of broadband services at a minimum speed of 100 Megabits per second (Mbps) downstream and a minimum of 50 Mbps upstream. By comparison, according to Akamai (Akamai 2015) the average Internet speed in New Zealand is currently around 8.4Mbps downstream and less than 1Mbps upstream. Importantly, the Government's policy is that the UFB network must be capable of being upgraded to offer services at speeds of 1 Gigabit per second (Gbps) on UFB services using Gigabit Passive Optical Networking (GPON) technologies which are being deployed throughout residential areas. The network already offers 10 Gbps on P2P Ethernet technology for enterprises and carriers, with a smaller network footprint largely focused on business areas. All the FTTP services are offered on a wholesale basis under defined Service Level Agreements (SLAs) from any premises within a "candidate area" (a town or city) through to a point of interconnect at which RSPs offer their broadband services to end users such as households and businesses.

In late 2010, CFH signed contracts with two electricity lines companies: Northpower (covering the city of Whangarei), and WEL Networks (covering the cities of Hamilton, Tauranga, New Plymouth and Wanganui). Together these represented about 15% of UFB coverage. In May 2011, CFH signed a third contract with Enable Services Limited, a regional fibre optic network operator owned by the Christchurch City Council, to provide coverage for the city of Christchurch and some surrounding townships, or about 15% of UFB coverage. Each of these three contracts formed a "Local Fibre Company" (LFC) joint venture between CFH and the respective Partner: these are known as Northpower Fibre, Ultra Fast Fibre (UFF) and Enable Networks Limited.

A fourth contract was also signed with Telecom Corporation of New Zealand (Telecom), the country's incumbent telecommunications company, to deploy UFB across the remaining towns and cities, representing about 70% of UFB coverage.

As required by the UFB tender requirements, Telecom took a proposal to its shareholders to "de-merge" into two entirely separate companies, one called Chorus which owns the local UFB and copper network infrastructure, and another now known as Spark which owns the mobile network and relationships with residential and business customers. The proposal was overwhelmingly agreed, and in November 2011, Telecom's former network division called Chorus was listed on the New Zealand Exchange and the Australian Securities Exchange.

UFB Deployment

As shown in Figure 1, deployment has progressed strongly since early 2013 when an update was provided in this journal (MacMahon & Milner 2013). By June 2013, just over 300,000 households and businesses were able to connect. As at the end of September 2015, this had more than doubled to over 800,000. Overall deployment is currently 5% ahead of plan, with all of CFH's four Partners expected to complete their build before 31 December 2019.

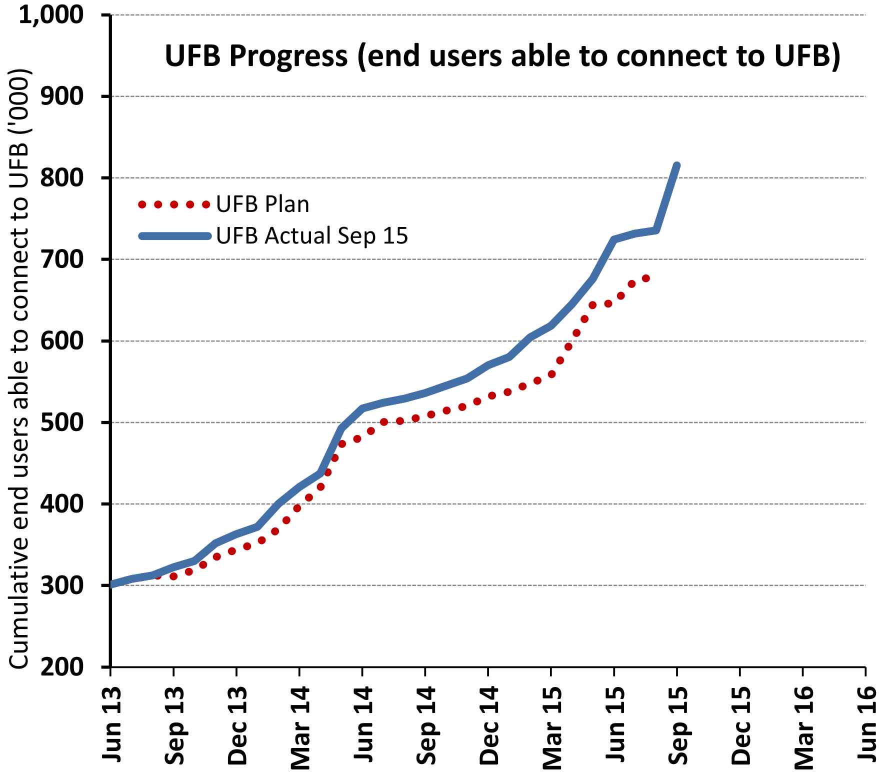

Figure 1: UFB deployment progress

Deployment to "priority" premises (businesses, schools and health facilities) is well progressed, with around 93% of businesses within coverage areas able to connect to fibre as at September 2015, ahead of the target of 90% by December 2015. CFH's partners are on track to offer connections to all schools within coverage areas by December 2015, and all urban public hospitals can already connect.

The number of end users able to connect increased sharply in September 2015, due to use of a new geo-spatial view of end users. This more accurately counts end users in Multi Dwelling Units (MDUs) and multiple tenancies in commercial buildings, and also incorporates growth of end users in areas where UFB was deployed in 2011-2015, particularly high growth parts of Auckland.

Looking at each of the Partners in turn, Northpower completed UFB deployment in Whangarei in May 2014 and is now focussed on customer connections. UFF, the LFC covering central North Island locations such as Hamilton and Tauranga, is expected to complete deployment in early 2016. Enable, CFH's Partner for Christchurch and nearby satellite towns, expects to complete deployment in 2018. Finally, CFH's largest Partner Chorus has already completed six towns and expects to finish deployment including major centres such as Auckland and Wellington in late 2019.

The remainder of fiscal 2016 is expected to see UFB deployment completed in a further eight towns and cities, including North Island cities such as Hamilton, Tauranga and Rotorua, smaller centres such as Masterton and Greymouth and the South Island tourist mecca of Queenstown.

The level of deployment in each eligible town and city as at the end of September 2015 is shown in Figure 2 below.

UFB connections

New UFB connections have grown steadily from 2,000 per month in mid-2013 to exceed 10,000 by September 2015. Gross connections per working day have increased month-on-month by over 100% during 2015 as Partners have added installation capacity to meet increasing demand. As at the end of September 2015, more than 133,000 connections were in place, with penetration of 16.4%. (See Figure 3 below.) Demand appears to be following a classic "S-curve" driven by consumer usage and industry evolution *(*see Section 4 below*)* as well as a level of latent demand as new areas are completed.

The rapid increase in uptake across New Zealand has caused some challenges for the LFCs and Chorus, with SLAs for connections being stretched over recent months. All parties are putting considerable effort into providing increased capability into the field to improve connection rates and automating back office processes to satisfy customer demand *(*see Customer Usage of UFB Services for more detail*)*.

Figure 2: UFB deployment by town / city

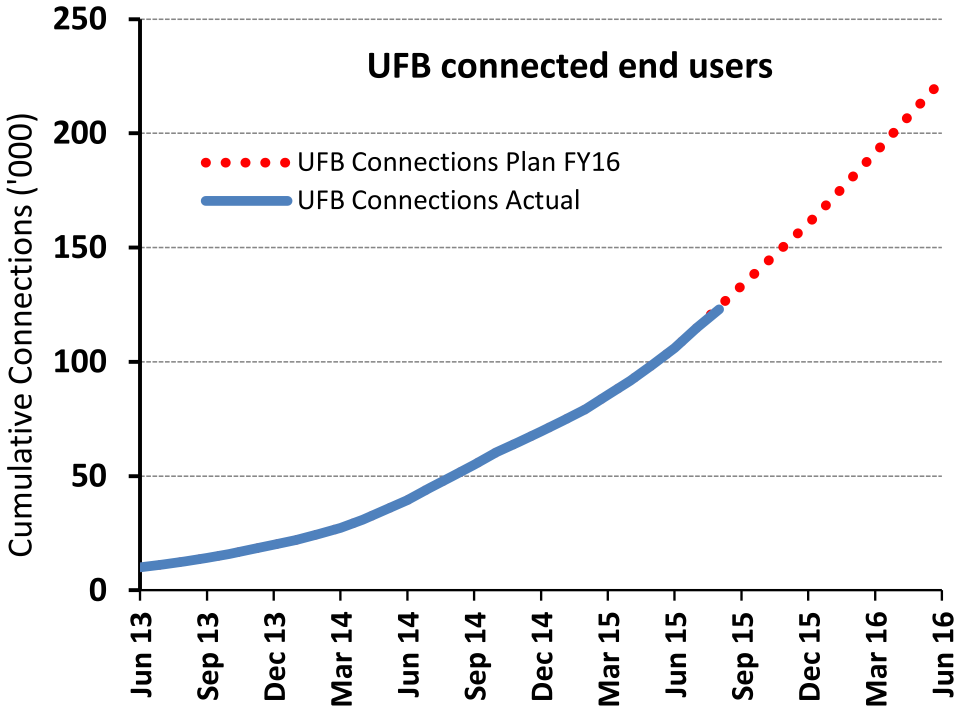

Figure 3: UFB connections progress

Looking at some specific locations, Whangarei, a city of around 53,000 people north of Auckland, continues to have the highest uptake with 22%. CFH's partner Northpower completed deployment of UFB in Whangarei in May 2014 (the first city in Australasia where every household can connect to FTTP), and since then have had a strong focus on customer connections. As Whangarei has only 60% Internet penetration (that is, six homes in every 10 have a fixed broadband service), more than one in every three broadband services in the city is now on fibre.

Other provincial cities make up the next top locations for uptake, including Tauranga (a rapidly growing city on the east coast of the North Island), Blenheim (in the Marlborough region at the top of the South Island) and Timaru (south of Christchurch)

The city of Dunedin was the winner of a Chorus competition called "Gigatown" in late 2014. This entitles Dunedin residents and businesses to access UFB at speeds of 1 Gbps Down, 500 Mbps Up at concessional prices. As a result of the competition, uptake in Dunedin has increased rapidly and at 20% is now the third highest of any town or city.

Events such as technology expos and promotional campaigns to celebrate the completion of deployment are known to have stimulated demand in some locations.

By contrast, locations with lower uptake tend to be characterised by a smaller number of competing RSPs, challenges with backhaul availability, lower percentage built / smaller addressable market, and/ or competition from a Hybrid Fibre Cable (HFC) network.

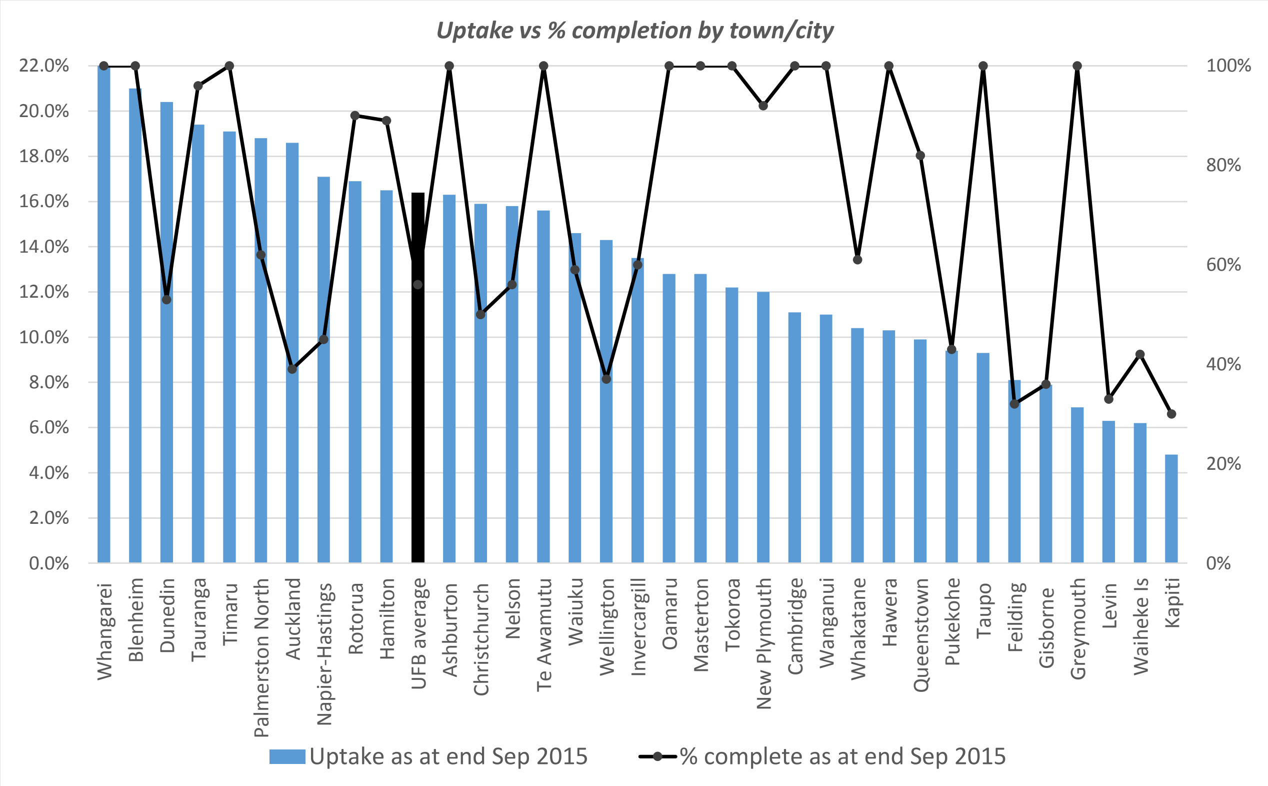

Figure 4: UFB uptake by town/ city

It is interesting to note that whereas Internet penetration in New Zealand tends to be well-correlated with household income, this correlation has not to date extended to UFB. Whangarei and Blenheim have strong UFB uptake but rank 28th and 20th highest in income amongst NZ towns & cities; by contrast, Masterton and Queenstown rank 3rd and 4th respectively on household income, but have below average uptake.

What is Driving Uptake?

In this section we briefly examine some of the factors which are contributing to growing uptake of UFB services which has been seen since 2013.

Video streaming:

In the last two years New Zealand, like Australia, has seen a proliferation of video streaming services launching. These include global market leader Netflix, Sky-TV's Neon, Spark's Lightbox service as well as Quickflix, Video Ezy on Demand and others. Usage of music streaming services such as Spotify and strong interest in video gaming also appear to be driving growth. Increased streaming has helped Chorus UFB connections to increase data usage to 174 GB per month (Chorus 2015), more than double the level of legacy copper connections. According to Statistics NZ 2015, one in three broadband connections now has unlimited usage, compared with just one in twelve a year ago.

Bundling

Major RSPs have been offering product bundles to customers for some time, but in the last two years this has increased. Vodafone was the first RSP to offer pay-TV services delivered via UFB multicast as a "triple play" offer with broadband and voice. Energy retailer Trustpower offers UFB connectivity and landline services with its electricity and gas services. And New Zealand's third mobile operator, 2Degrees, has moved into selling fixed broadband (including UFB) in 2015 with the acquisition of Snap, a smaller operator.

Value-added services

RSPs are also looking to differentiate with new value-added services. Spark, for example, has launched a home security and automation service called MorePork (named after a species of native owl). For businesses, Vodafone offers Microsoft Office 365, cloud-based back-up and storage as well as web hosting. Others offer packages for specific market segments such as gamers (with traffic prioritisation), shared sites (with managed campus WiFi) and so forth.

RSP marketing

As the addressable market for UFB services has grown, RSPs have naturally found it more attractive as a broadband access technology. RSPs progressively enabled handovers at UFB Points of Interconnect around the country, with Spark (formerly Telecom Retail) in August 2014 the first RSP to offer UFB services in all locations where FTTP has been deployed. A further milestone was in May 2015 when Spark launched telephony services over fibre. This means Spark, which had previously retained a copper line for telephony when migrating customers' broadband to UFB, can now offer a fibre-only solution. This improves Spark's economics for migrating customers to UFB, clearly an important point as the firm is New Zealand's largest RSP.

Re-pricing of UFB services vs alternatives

UFB services were initially priced at the higher end of the broadband market. During 2014 CFH's Partners reduced the price of services at 100 Mbps and introduced new, attractively priced services at higher speeds such as 200 Mbps. As RSPs have taken up these services, retail prices for services at 100 Mbps and above have fallen sharply. In late 2015 entry level UFB services cost much the same as competing copper (ADSL and VDSL) services but for a vastly superior service performance. As described in Section 5 below, demand is now shifting towards higher speed services, which offer both CFH's Partners and RSPs more attractive Average Revenue per User.

RSP consolidation

Since 2012 there has been a series of mergers amongst major RSPs. Vodafone bought TelstraClear in 2012 and smaller firm WorldXChange in 2015. CallPlus (owner of the Slingshot and Flip brands) bought competitor Orcon in 2014, and FX Networks was purchased by Vocus of Australia also in 2014. Mobile operator 2Degrees bought fixed broadband firm Snap in early 2015. M2 Group of Australia in turn bought the CallPlus Group, and finally Vocus and M2 announced their intention to merge. The effect of this rapid consolidation is yet to be fully seen, but it appears to be allowing RSPs to unlock synergies between disparate businesses. For example Vocus / FX had a strong focus on the enterprise & carrier market, while M2 / CallPlus was stronger in the mass market.

Small and Medium Enterprises

SMEs are a customer segment which UFB can substantially benefit. Converged access, multi-site WAN, video-conferencing, remote working/ mobility and cloud-based services are just some of the opportunities for SMEs to use UFB to improve their business operations. However, RSPs have been comparatively slow to target this segment of the market to date, perhaps because of legacy high-margin revenue streams. We anticipate demand will increase of its own accord as customer understanding of fibre service potential develops, but it will also be interesting to see if major RSPs take a more proactive role in targeting the SME segment.

Increasing speed of UFB services

It is now apparent that demand for UFB services is moving towards higher speed services. As shown in Figure 5 below, the September quarter saw the proportion of new connections added at 100 Mbps and above almost double. Currently more than two in every five new residential connections take a service at 100 Mbps of above. One in ten takes a service at 200 Mbps or above. It is suggested that this is a function of improved RSP marketing and pricing of higher speed services, as well as increased consumer demand as a result of video streaming and concurrent device usage in the home. It is also interesting that the take-up of 1Gbps services is expanding, although from a small base. It was not expected that this trend would arise so early in the initiative, but driven by the Chorus Gigatown experience early adopters are now demanding these higher rate services.

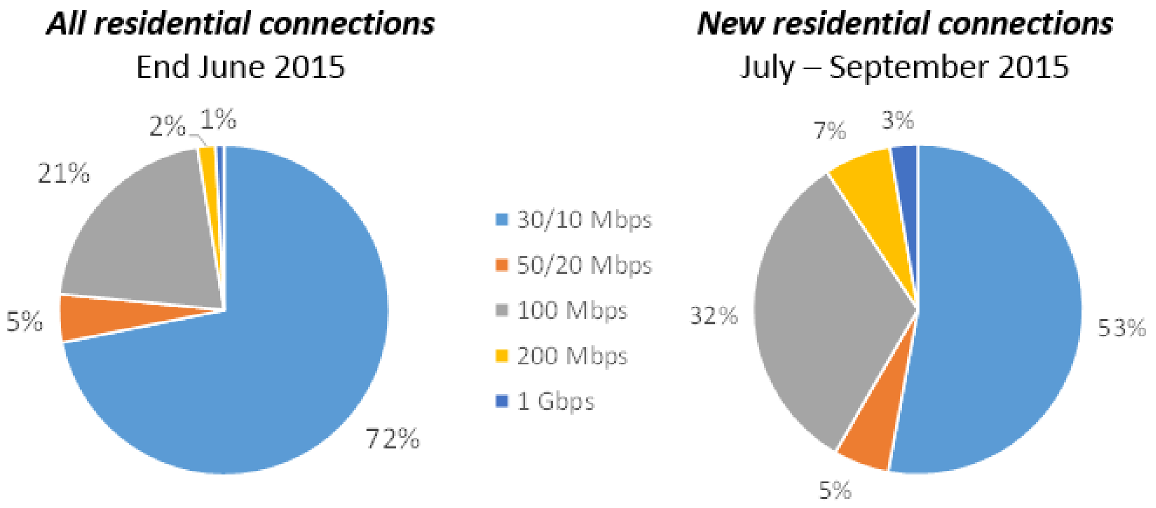

Figure 5: UFB residential connections by speed tier

Improving the Connections Process

CFH's four Partners have increased field workforce resources significantly to meet customer demand for UFB installations. However, a sharp increase in UFB orders, which commenced in June 2015 due to additional RSP marketing, has placed pressure on connection leadtimes. Further increases in installation capacity are necessary and are in train. The average period to complete a new UFB connection has increased to around 40 calendar days, and all partners are focussed on reducing this.

Meanwhile, both CFH's Partners and major RSPs are investing in improved business processes and IT systems to deliver an improved end-to-end UFB customer installation experience. This will continue until at least mid-2016. Until automation of appointment scheduling between UFB Partners and RSPs is in place, CFH's Partners have agreed to manage all post-sale customer interaction until the UFB service is live.

Separately, CFH's Partners are improving UFB installation techniques (with installation using "ruggedised" cable along a fenceline or in a slot trench notable in the last period of time) and extending subcontractor roles for specialist installation types such as MDUs.

All of these initiatives are aimed at improving the customer experience when being connected to a fibre service. At the same time though, many of these initiatives also result in reduced costs for delivering customer connections, which is an added benefit.

Finally, the Government has said it is considering changing legislative requirements for consent for UFB installation to be received from landlords, bodies corporate, and (in the case of Rights of Way) neighbours. One option is to emulate the Australian model of designating some forms of UFB installation as "low impact", with a statutory right of access applying to such installations. Legislative change may help to shorten installation times, as consents are frequently a cause of delay.

Extending coverage of improved broadband

In late 2014 the Government proposed that UFB coverage should be expanded from 75% of the population to at least 80%. This was supported with up to $210 million in funding from the Future Investment Fund. CFH has been tasked with forming contracts to achieve this increase, and in September 2015 a Request for Proposals was issued.

At the same time the Government said it would extend its Rural Broadband Initiative (RBI), a sister project of the UFB which is managed by the Ministry of Business, Innovation and Employment and aims to improve broadband services in areas not covered by the UFB programme. The Government has also created a Mobile Blackspot Fund to address gaps in wireless coverage along main roads and in tourist areas. These projects are to be funded via a continuation of the industry's Telecommunications Development Levy to a total of $150 million. In October 2015 CFH was asked by the Government to lead commercial implementation of both projects after policy aspects are confirmed.

Customer usage of UFB services

Customer usage of UFB is wide-ranging and diverse. Below are two examples of the benefits being derived amongst "priority" customers such as businesses and health facilities.

GoMedia is a fast-growing outdoor advertising firm. It was fitting that this business, with its nationwide communication needs, should be the 100,000th customer to take up UFB, in June 2015. The firm needed to bring three separate businesses together, and to share and store large files. It had to be able to upload and download high-resolution images quickly to meet clients' tight deadlines. Director Mike Gray says "it's all about speed of delivery. Having UFB will definitely help." Pricing of the firm's 100Mbps symmetrical fibre service is similar to its previous copper service. The business also uses cloud-based services including Microsoft Office365, Skype for Business videoconferencing, and file storage service OneDrive.

WellSouth is a primary health care network which works with general practices to provide healthcare to 300,000 people in Otago and Southland. CIO Kyle Forde says UFB has also allowed WellSouth to trial video conferencing systems in rural practices and to roll out HealthCloud, a secure health network for its 85 practices. "That means better outcomes for patients with doctors, clinicians and medical practices easily able to see their history and access information on treatment options." Forde says clinicians are also logging on for their continued medical education. "Clinicians would rather spend time with patients than travel to and from training."

Regulatory review

In response to the ceaseless growth in the role of digital communications in the lives of New Zealanders, the Government is considering updating the regulatory regime. A review of the *Telecommunications Act* is underway, and takes specific note of convergence, the growth in "over the top" services and jurisdictional issues caused by national regulation of services delivered over the Internet. It is possible that the review will lead to revised models for pricing of regulated services, and/ or seek to update New Zealand's "Telecommunications Services Obligations" (analogous to the Universal Service Obligation in Australia). The review may also lead to development of a clearer copper-to-UFB migration path. To date, migration to fibre in New Zealand has been entirely led by consumer demand, in contrast to Australia where it has been driven by a Government-supported "copper switch-off".

The Government has also proposed changes to the National Environmental Standards for Telecommunications Facilities in order to smooth future deployment of UFB and mobile networks.

Conclusions

Deployment of UFB in New Zealand is ahead of schedule and the proportion of the population with access to FTTP is now approaching 50%.

Demand for improved broadband services is accelerating, driven by changing consumer usage, new applications and services, and an evolving industry. However, uptake still has a long way to go, with only around one in six of addressable households and businesses connected so far. Uptake amongst SMEs has been below expectations and needs to increase if New Zealand businesses are to take full advantage of the opportunities to improve productivity which UFB can support.

It is highly encouraging to observe the extent of development within the telecommunications industry over the past two years. Both CFH's Partners and RSPs have innovated in areas such as UFB products (at both wholesale and retail levels), pricing (offering faster and cheaper UFB services), installation processes (such as fence-line and slot trenching) and IT systems (building improved interfaces between CFH's Partners and RSPs).

While progress of the UFB initiative to date is meeting expectations (Adams 2015), there is clearly some way to go before it could be said that New Zealand had made the most of its capabilities. The roadmap towards completion of UFB deployment by the end of 2019 is fairly clear. The full extent of usage of the network, however, is only just being explored, and offers great promise for the future productivity, innovation and competitiveness of New Zealand. In the meantime, the expansion of FTTP coverage is underway, and new initiatives are being put in place to ensure digital equity in rural parts of New Zealand which are beyond economic FTTP coverage.

References

Adams, A. 2015. "More New Zealanders connecting to Ultra-Fast Broadband network", November 2015 media release. Available at: http://www.beehive.govt.nz/release/more-new-zealanders-connecting-ultra-fast-broadband-network "

Akamai. 2015. State of the Internet Report, Q2 2015 (September 2015). Available at: https://www.stateoftheinternet.com/resources-report-state-of-the-internet.html

Chorus Limited. 2015. NZ Broadband Market Quarterly Update, September 2015, page 10. Available at: https://www.chorus.co.nz/the-nz-market/quarterly-broadband-update

Key, John. 2008. "Better Broadband for New Zealand." Speech presented at the Wellington Chamber of Commerce, Wellington, Apr. 22, 2008).

MacMahon, R; Milner, M. 2013. "Ultra-fast broadband in New Zealand: Early adoption experience". *Telecommunications Journal of Australia,* Vol 63, No 1, February 2013.

Ministry of Economic Development. 2009. "Ultra-Fast Broadband: Invitation to Participate in Partner Selection Process". Available at: https://www.crownfibre.govt.nz/media/4824/invitation-to-participate.pdf

Statistics New Zealand. 2015. *Internet Service Provider Survey*, October 2015. Available at: http://www.stats.govt.nz/browse_for_stats/industry_sectors/information_technology_and_communications/ISPSurvey_HOTP2015.aspx

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Information and Communication Technology in Antarctica

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Abstract: The Australian Antarctic Division has a long history of providing telecommunications as part of the support provided to expeditioners within the Australian Antarctic Territory. Since the days when Mawson's expedition in 1911 setup the first transmitter at Commonwealth Bay, the Division has provided continuous and increasingly sophisticated telecommunications capability that now includes data to support medical services, science, education and Internet access. The provision of telecommunications to Antarctica relies on satellite transmission for backhaul.

Introduction

Telecommunications has always been a part of Australia's operations in Antarctica. The Australasian Antarctic Expedition from 1911 to 1914 led by Douglas Mawson, set up a transmitter at Commonwealth Bay, and a relay station on Macquarie Island. At that time a rotary-arc transmitter and Morse code were used to send weather information and personal messages to Hobart.

Since that time Australia has seen many changes in the telecommunications used to support its Antarctic operations surrounding the three continental stations of Casey, Davis, Mawson and Macquarie Island. This has progressed from the use of Morse code on HF (High Frequency) Radio, through the use of voice and Telex over radio, to the first use of a satellite phone in the early 1980s.

The introduction of permanent satellite communications in the late 1980s revolutionised communication between Australia and its four Antarctic stations. The network, known as ANARESAT, uses Intelsat geostationary satellites to provide telecommunication links between Australia and the stations. The first satellite earth-station, which includes a 7.3 m dish antenna, was installed and commissioned at Davis in March 1987. Mawson was commissioned in January 1988, Casey in March 1988, and Macquarie Island in December 1988.

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The advances in telecommunications and IT continue at a rapid pace and today's Antarctic Expeditioner expects to be able to access all the latest social media, to sit down to breakfast with the latest newspapers, and to receive mobile phone calls from family, while having excellent medical care, access to the latest weather forecasts when planning field trips, a safety net of local radio communications and vehicle satellite tracking, and collection and processing of a multitude of scientific data.

Current Facilities

Today an Australian Antarctic station consists of a number of major buildings that are connected by fibre optic cable. This is used to provide an IP network to all areas on a station and in some cases is extended by a 2.4GHz link to nearby scientific installations such as the penguin monitoring equipment on Béchervaise Island at Mawson.

The core IT system at each station consists of a redundant pair of host servers providing virtual machines for services including exchange email, file and print, software update distribution, Maximo maintenance database, network monitoring, etc. The storage is on a small SAN backed up to a separate disk storage system. Redundancy is critical for an Antarctic station that is isolated for at least six months of the year, so as well as the redundant online spares, a complete set of cold spares is kept in a separate building from the server room.

Figure 1 – Christmas in Antarctica is a time for activities that rely on communications

Telephony System

The AAD telephony system spans all of our sites and is based on the Open Source 'Asterisk' Telephony platform and Cisco IP phones. This provides a high level of flexibility which allows for:

- Automated remote configuration via the Asterisk database.
- Number portability across the AAD system;
- Integrated voicemail with notification and delivery via email;
- Call detail recording to data base with advanced web report generation
- Accurate call charging to expeditioners who are able to access their real time call records via a Web interface.

The voice switches at each station are connected by an IAX2 (Inter Asterisk Exchange rev 2) trunk to the Asterisk cluster in the AAD Head Office in Tasmania. Significant improvement in bandwidth efficiency across the satellite links was obtained by using the trunked version of the IAX2 protocol to allow multiple voice streams to share a single trunk to another server, reducing overhead created by IP packets. In addition to these trunks, each station switch is interfaced to Iridium and Inmarsat terminals to provide alternative routing of calls. Redundancy is allowed for at each station with the provision of a second Asterisk system running on an embedded PC in a separate building.

GSM Phone system

Most of a station's mechanical and electrical systems are monitored by a building management system (BMS) which collects information on the state of the heating, ventilation, refrigeration, water, sewerage, communications and electrical generation and distribution systems. Status and alarm messages are sent via a paging system to the relevant station maintenance personnel. This paging system is now being replaced by an SMS system based on the open source software, OpenBTS. The hardware incorporates a Linux embedded PC, software-defined radio (SDR) and a 10W PA installed at the base of the antenna tower and can operate in temperatures down to -40 degC with a 4 hour battery capacity. The antenna is a vertically polarised, 8 stack, 12dB gain folded dipole stainless steel antenna array and provides a line-of-sight range of approximately 20km.

Figure 2 – (a) Technician up a mast at Casey; (b) Davis communications building and mast

In the OpenBTS implementation, the handsets appear as SIP endpoints and authenticate to the Asterisk PBX, and messages are sent using RFC 3428. The associated voice capability, and the ability to geo-locate a phone, provide an addition level of safety on the Antarctic Stations.

Radio Infrastructure

Australian Antarctic Stations operate a range of radio equipment for communicating with ships, aircraft, field camps and station personnel using the HF and VHF bands. The fibre optic network at a station is used to connect the radio base stations to the central operating positions. At each transmitter site, an embedded PC can connect up to 4 radios to the IP network via a USB audio interface. An implementation of the Asterisk voice switch establishes voice connections from the operator positions to the radios as required. All radio traffic is digitally recorded to hard disk and kept for more than three months. The immediate use of this facility is that the operators can replay the last conversation at the push of a button, if they miss part of the transmission. The customisable GUI for the operators uses touch screens and enables them to utilise any radio at any station in the AAD network.

Satellite Systems

As mentioned in the introduction, the ANARESAT network uses Intelsat satellites to provide the main communications link between Australia and the Antarctic stations. Each Antarctic station is equipped with a C-Band Intelsat Standard-F2 earth station and associated equipment. Since the initial installation, equipment and bandwidth has been upgraded regularly to meet the changing needs of the Australian Antarctic programme (AAp). The current capacity to Casey and Davis is 1.2Mbps.

An Inmarsat BGAN terminal is installed at each station to provide basic backup to the ANARESAT system. The BGAN standard IP service enables essential phone and email communication to continue in the event of a fault with the ANARESAT system. It also allows AAD Head Office staff remote access to the station LANs and ANARESAT satellite equipment for fault finding purposes.

Figure 3 – Aurora over ANAREsat Radome

Inmarsat BGAN terminals are also used to provide similar basic phone and email services to the Wilkins Aerodrome near Casey and summer scientific field camps.

A third satellite service at the stations is provided through the Iridium system and provides a single telephone circuit that is interfaced to the Asterisk phone system. Wide use of the Iridium system is made for remote field communications utilising portable and vehicle mounted handsets.

WAN optimisation

Our Stations are connected by Satellite connections that have very limited bandwidth and are under an ever increasing pressure from users wishing to access social media, music and video streaming, IOS and app updates, podcasts, amongst many others. To handle this situation, we utilise a number of WAN optimisation technologies including:

- The routers on stations provide the following functions on the WAN port:
  - Packet fragmentation and interleaving to reduce VoIP latency
  - IP Header compression
  - Reserved bandwidth queues to prioritise essential services
- Wide Area Application Services (WAAS) server:
  - Compresses and caches traffic to increase the efficiency of the link.
  - Caches IOS and other software updates
  - Performs TCP protocol optimisation
- Database replication and hosting on station to provide local access for applications including.
  - Maximo
  - Asterisk
  - Windows File shares using technologies as DFS and DFSR to share common paths and replicate files to and from stations

To maintain and efficiently operate this suite of ICT equipment in Antarctica, we have developed and installed a number of remote monitoring systems which now monitor:

- Satellite equipment
- LAN and WAN to provide real time and historical data
- IT server infrastructure including historical trends

Medical and Science use of ICT

The ICT infrastructure at a station is relied upon by a number of critical users, and medical is perhaps the best example. Video Conferencing via IP conferencing units is used for remote consultations and monitoring of procedures. In addition, real-time monitoring of patient vital-signs during surgical procedures or in the recovery ward is possible by the remote monitoring of the anaesthetic machine. Modern X-ray and Ultrasound equipment produce digital images that are transferred via a DICOM (Digital Imaging and Communications in Medicine) system for viewing by specialists in Australia.

Weather forecasts play a vital role in enabling safe and efficient operations in Antarctica. During the summer period, Bureau of Meteorology forecasters are stationed at Casey and Davis to provide regular local forecasts to support air and field operations. They rely heavily on the timely transmission of forecast models from Melbourne as well as data collected locally by a network of automatic weather stations that report via wireless and satellite links.

Much of the current and future scientific exploration of Antarctica will be done using satellite remote sensing. Capturing the data that covers the Australian Antarctic Territory required the establishment of x-band satellite reception facilities at Casey in 2009. Initial image processing is done at Casey and then transferred by the network to Australia.

All of our Antarctic Stations carry out scientific research all year round. During the winter period, much of the work is carried out by automated instrumentation that can be remotely monitored and controlled by Australian-based researchers. The data collected is transferred by the satellite network for processing in Australia. As an example, at Davis, the climate research team operate a 'light detection and ranging' (LIDAR) instrument, in combination with three radars (operating at 2, 33 and 55 MHz), to gather information on atmospheric density, temperature, wind velocity and aerosols in the middle atmosphere (10-100 km up).

Conclusion and the Future

Technology will continue to develop at a fast pace and the AAD will need to use the technology that best meets its needs in a harsh, remote environment. New modulation techniques will be used to make more efficient use of the available satellite bandwidth and new satellite networks will offer new opportunities for improved Antarctic communications.

A new set of computing infrastructure will be installed at our stations over the next year which will offer Scientists the ability to collect, process and store more data from their instrumentation. Telemedicine applications will enhance the medical care available to expeditioners as more network bandwidth becomes available.

It is an exciting future for Antarctic ICT.

Internet of Things for smart homes and buildings: Opportunities and Challenges

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Abstract: Pervasive sensing facilitated by Wireless Sensor Networks (WSNs) technologies offers the integration of modern technology into daily routine. The smart sensing approach offers the ability to sense ambient parameters and the use of different objects in the urban environment. Identification and monitoring technologies, WSNs, wireless communication protocols and dispersed intelligence for objects are primitive elements of a smart environmental solution. The WSNs with the application of the Internet of Things (IoT) and Cloud computing are producing smart home solutions. The present research work aims to develop smart home and building solutions based on IoT and cloud computing. The research work recorded recent practical challenges and limitations encountered while designing the IoT-based smart environment. The research identifies the IoT idea, through the conjunction of WSNs, the Internet and distributed computing with data mining and machine learning, as an approach to apply in smart homes to benefit humankind.

Keywords: Wellness, Ambient assisted living, smart home monitoring, intelligent sampling, event and priority, WSN, Wellness Protocol, Internet of things, cloud computing.

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Introduction

A few years ago, the development of the Internet of Things (IoT) was considered as a technology of the next generation. Due to the advances in digital technology, IoT is no longer just a buzzword – rather it is realistic technology. The forecast for future growth and investment is encouraging: Cisco predicts that 25 billion devices will be connected by the end of 2015, and 50 billion by 2020. In the 21st century, more devices than persons are connected to the internet — over 12.5 billion devices in 2010. In the Internet of Things (IoT) prototype, some objects available in the environment will be on the communications network and can be accessible in any part of the world. Radio communication and sensor network technologies will take shape to fulfill the new challenges, among which are the information and communication systems to be deployed in the ambient environment. Indisputably, the key asset of the IoT approach is the extraordinary impression it will make on various aspects of the daily activities of consumers. IoT is listed by the US National Intelligence Council (NIC) in the table of six "Disruptive Civil Technologies" with prospective influences on US national power. NIC forecasts that by the year 2025, internet-based nodes may be present in everything — from food packages to healthcare medicines and measuring instruments, from tiny household objects to furniture and more (Atzori et al 2010; Cook 2012).

In the past decade, extensive research has been undertaken in terms of the modern technologies based on wireless sensing, such as smart sensor and actuator platform and nodes, radio communication protocols, heterogeneous sensor networks, and software-defined radios. In the recent few years, the sensor data have crossed the boundaries of the local home gateway server and reached to remote access through the internet. This sensing information is analysed and processed at a higher abstraction level for decision making through data mining and machine learning algorithms and models. The recently emerged field that integrates the sensing data with internet facilities for remote access is the semantic sensor web (Aijaz 2015; Khan et al 2014; Yang et al. 2014).

In this multifaceted situation, the application of the IoT model to an urban environment is of interest to inhabitants. Many national government research and development centres have adopted advanced information and communication technology solutions in the supervision of people's activities, and this adoption is introducing the Smart City and Home concept. Even though there has not been until now a well-recognised and globally established definition of "Smart City and Home", the ultimate objective is to make better use of available resources, and enhance the quality of the services presented to the people, while reducing the operational costs of the common facilities. Additionally, monitoring the activities and generating the wellness profile of people is another key focus. These two objectives can be pursued through the disposition of an urban and suburban IoT: i.e., a radio communication framework that delivers integrated, simple, flexible and cost-effective access to services for people, consequently enhancing transparency to the inhabitants. An urban and suburban IoT possibly will bring a number of benefits in the supervision and utilisation of conventional facilities, such as:

- transportation and car parks;
- lighting;
- observation and care of common spaces;
- sewage and water supply systems;
- electricity distribution; and
- emergency health services.

At the micro level, the Smart City approach includes the Smart Home scenario; but the aspects of data analysis, data mining and machine learning define the particular facilities of Smart Home solutions. A Smart Home solution has various applications for ambient assisted living (AAL). The AAL supports and suggests the wellness model and activity forecasting that may help inhabitants to improve their life span. Additionally, it links this decision-making information to a web server for remote access to the caregiver and emergency support services. Early adopters of such technologies are accepting and allowing it in their homes (Ganz et al 2015; Vongsingthong & Smanchat 2014; Yang et al 2014).

There is still a series of questions that arise as to how the IoT applications and solutions would develop and be deployed into smart homes and buildings, so there are numerous new problems regarding networking characteristics. As a matter of fact, the devices comprising the IoT will have restricted resources in relation to both computation and power capabilities; thus the suggested resolutions must consider the effective use of resources in addition to scalability issues. Additionally, these questions are linked with security, reliability, complexity, discoverability and interoperability. Extensive acceptance of such modern technology could lead to future risk. Undeniably, it is clear that usage of daily objects and other activities, which are linked to IoT, could trigger distribution of information and generate security concerns.

Numerous industry, standardisation and research organisations are presently pursuing research in the development of resolutions to satisfy the hi-tech requirements. One of the best possible approaches could implement some pilot projects to test and deploy sensors, handle the large sensor data and upload the information into cloud servers. There is a large number of companies that have invested big money in research and development on IoT, such as smart sensors (Bosch, STMicroelectronics, IoT ignition lab Moscow), embedded systems (ARM, Infineon), software (Atos, SAP, Microsoft Azure), network vendors (Ericsson), telecoms (Orange) and application integrators (Siemens, Philips) (Chen et al 2014; Ganz et al 2015; Gluhak et al 2011; Tunca et al 2014).

In our research, we present a realistic approach to obtaining the optimal performance from an IoT-based smart home monitoring system. Realistic application for activity detection and pattern forecasting for ambient assisted living raises different challenges. To offer a consistent solution, we have implemented a smart home, based on an integrated framework to analyse the inhabitants' activities from real-time data. The system is executed on two levels: hardware and software. At the hardware level, heterogeneous wellness sensors are deployed to get multi-activity and multi-event data, and to collect it into the server through a coordinator. The software modules are subdivided into different levels, such as data logging, data extraction and data storage; but their ultimate task is to forecast the change in activity and correlate it in real time or near real time with the wellness of an inhabitant.

The rest of the paper is organised as follows. Section II provides a common arrangement of IoT for AAL with an overview of the system architecture for an urban IoT that can be facilitated by the deployment of wireless sensors and networks (WSNs), sensor data uploading and analysis. Section III presents the description of the developed system; this section describes the smart wireless sensing nodes and web service approach for the realisation of IoT services, with the related data presentations and radio communication protocols, and the associated upper-layer technologies. Finally, Section IV presents the experimental results based on the realistic Smart Home.

General structure of IoT for Smart Home

Implementation of the IoT concept into the real world is made possible through the amalgamation of numerous enabling technologies. The following section presents the structure of the IoT approach that our research group implemented in the last few years (Ghayvat et al 2015).

Sensor configuration and placement

Each wireless sensor network has a Coordinator (C). There is precisely one Coordinator for each single network, and this is the device that takes the network establishment responsibility of the network. This Coordinator receives data from its associated sensor nodes and also undertakes remote configuration and fault detection. The Routers (Rs) are applied to extend the network coverage area for wireless communication. In addition to the Coordinator and Routers, there are two more types of devices: a device that can be configured (programmed) as an end-device (ED) or an end-device plus router (EDR). They transfer their data directly to their parent; the parent may be the Coordinator or another Router node. An ED cannot communicate the data of other nodes. The Routers retransmit the packets of their neighbours onto a designated path, while the EDR node can convey its data and its neighbours' data as well. The nodes are distributed at different distances within the home environment, and data is sent over the network to the Coordinator. The smart monitoring and automation system is designed for heterogeneous sensors. The Coordinator has the power to select channels, PAN ID (personal area network unique identification number that only belongs to a particular WSN), security policy and stack profile for the network. Discovery of the efficient radio channel for WSN operation is the responsibility of the Coordinator. (Bakar et al 2016; Ghayvat et al 2015; Kelly et al 2013).

Sensor data analysis

The smart home environment requires activity recognition of daily living from basic sensor data, and these raw data sets are composite and irregular to translate into predefined scenarios. Even after converting this raw data, it is somewhat problematic to ensure appropriate pattern and activity generation, because these data sets are on different time and sense modalities. In a smart home, data analysis includes two levels: lower level sensory data and higher level activity data. The analysis is based on data-mining and machine learning algorithms and models. Low-level sensory data classification turns observations into activities. Before this classification process, the raw data collected from low-level sensors must go through some data analysis phases such as pre-processing, segmentation and feature extraction. Activity recognition and discovery is performed after the classification phase. Figure 1 shows the steps of low-level sensor data analysis (Suryadevara & Mukhopadhyay 2012). All the events are categorised and recognised from sensor data; events include preparing food, eating, using the toilet, timing of Medicine, entry and exit from home and more.

Upload of data

Finally, after processing and analysis, the extracted information is used for decision-making to evaluate high-level actions to know more about inhabitants' routine and habits. Finally the data is uploaded into a website, which can be accessible by remote client/caregiver/support staff (Suryadevara et al 2013; Suryadevara & Mukhopadhyay 2012; Suryadevara et al 2015).

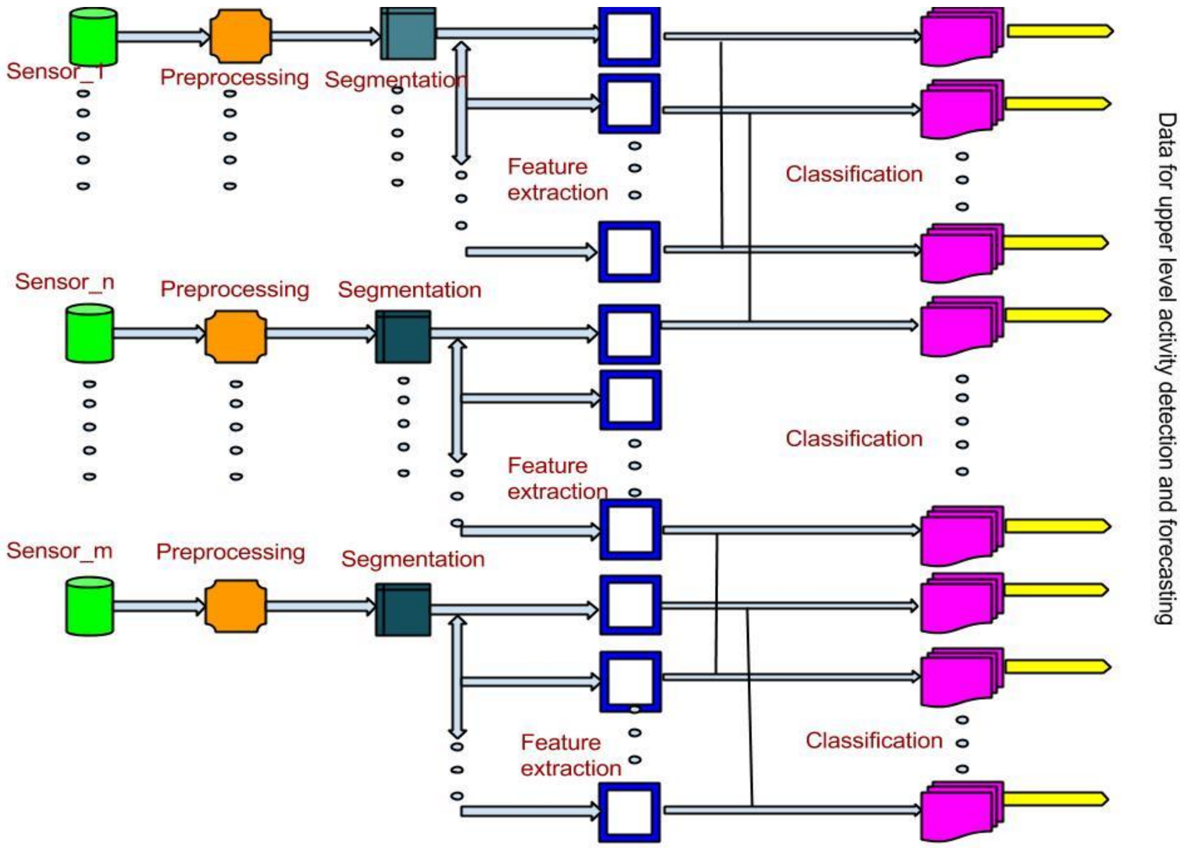

Figure 1. Low-level sensor data analysis

Description of the developed IoT-based Smart system

Our Wellness protocol includes the RF communication definitions, data mining, and machine learning models. This protocol defines a comprehensive smart home solution, starting from the sensor node to real-time analysis, data streaming, decision-making, and control. Figure 2 shows the functional blocks of the wellness protocol-based smart home monitoring solution through cloud computing.

Figure 3 represents the layered architecture of the wellness protocol for an IoT-based smart home solution. The wellness devices in Figure 3 are the intelligent wireless sensor nodes (IWSNs), which are designed on the Intel Galileo board: these nodes transmit the data to the coordinator. The coordinator is connected to a local home gateway server through a serial communications port. The extraction of data from the raw packets is done by data acquisition software logic. Extracted data is stored in a MYSQL server. From there, depending on the application, the information is uploaded to a website.

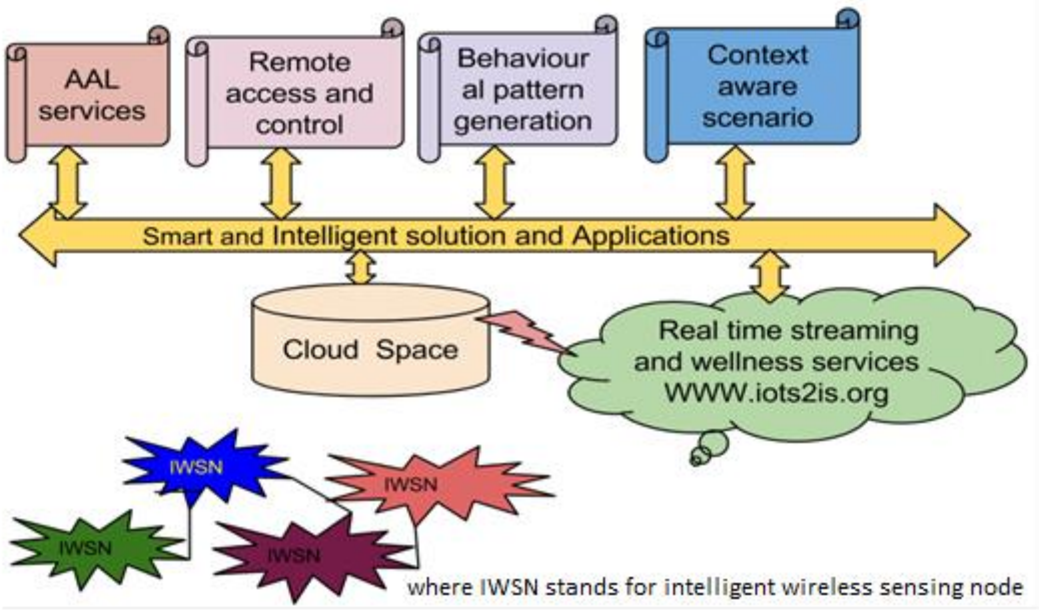

Figure 2. Functional Description of the Developed Smart Home Monitoring System

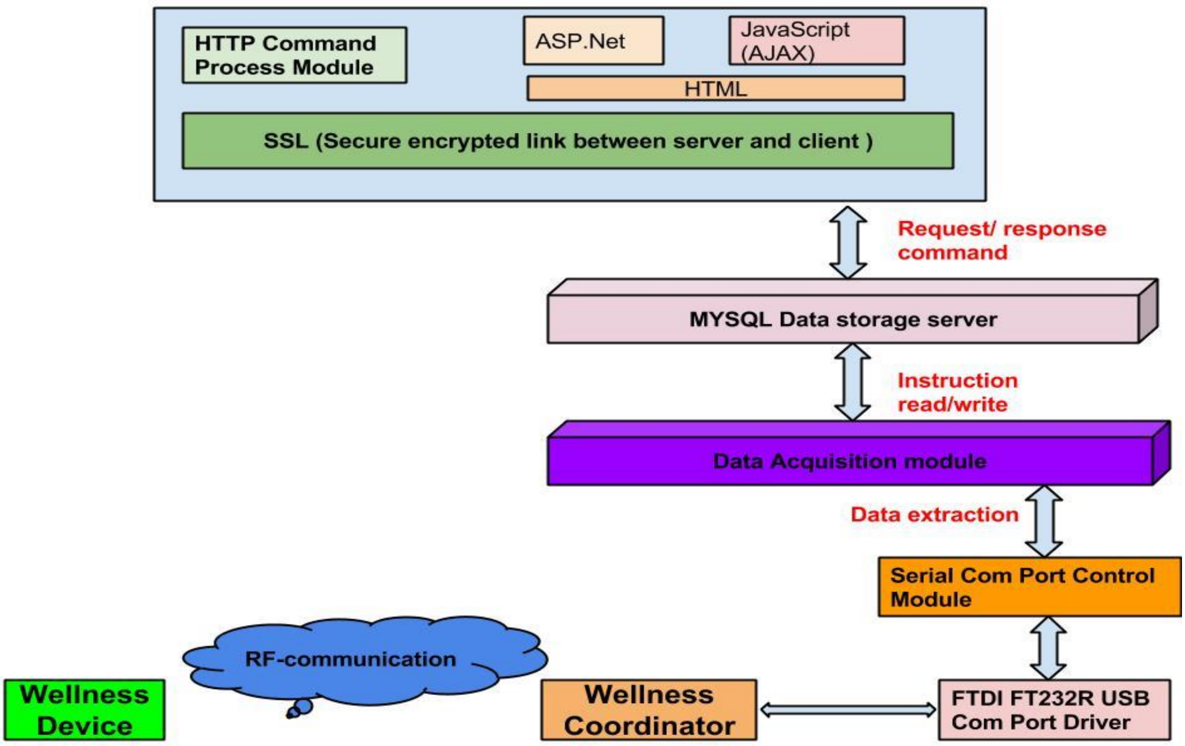

Figure 3. Wellness protocol system architecture

Most of the IoT-based smart home systems perform well in the testing environment but fail to offer reasonable performance in a realistic home environment where an inhabitant lives a regular life. The wellness protocol-based smart home solution has been developed and implemented in the realistic existing home (Ghayvat et al 2015). The layout of the smart home with sensor location and placement is shown in Figure 4. It displays the home for Ambient Assisted Living (AAL). As we can see, it contains a network of heterogeneous sensors. These sensors are temperature, force, Manual Alert button and electronic and electrical (E&E appliances sensing) appliances monitoring units. All the sensing nodes are based on event and priority logic defined by the wellness protocol.

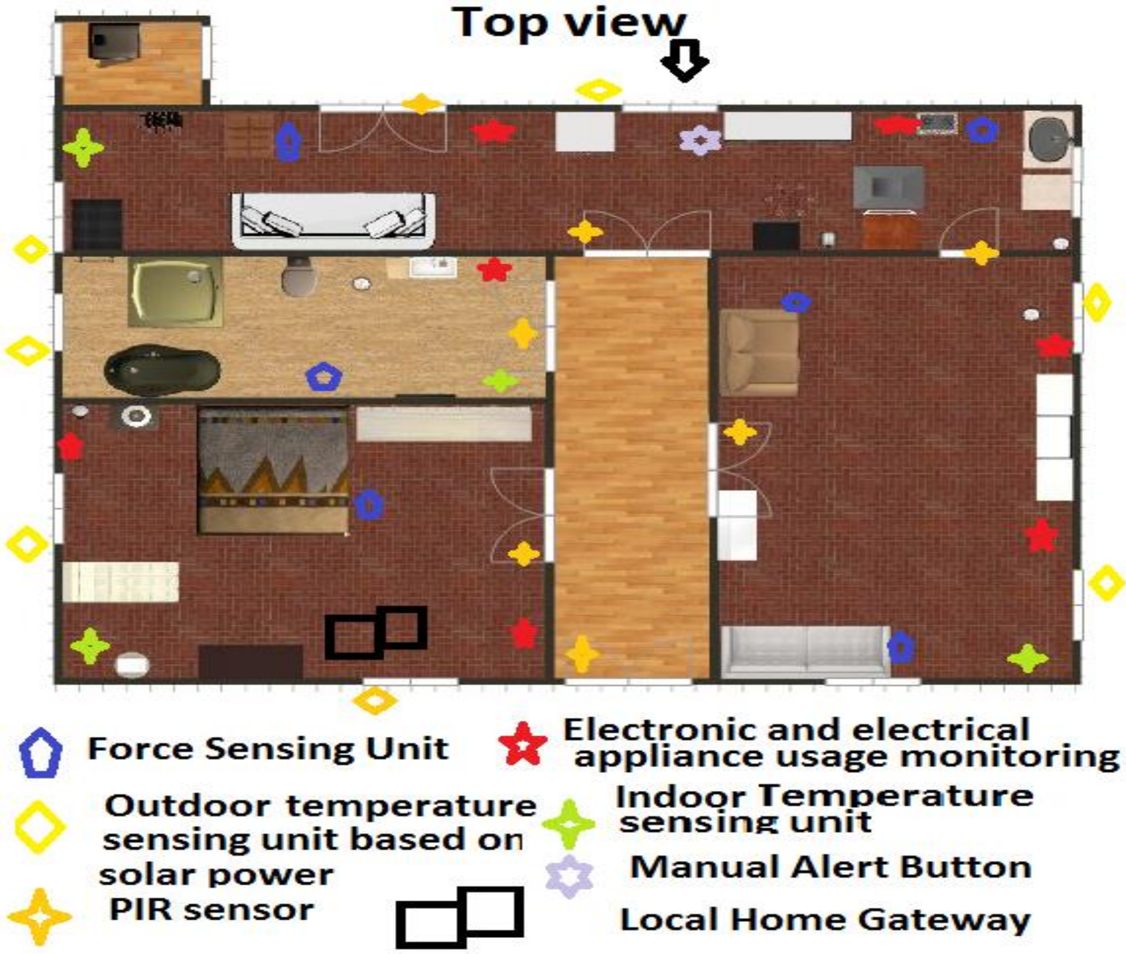

Figure 4. Layout of sensor deployment in the smart home

Figure 5 shows a toaster (appliance) plugged into an E&E sensing unit for usage and power monitoring. Figure 6 presents the manual indication button: this indication button is utilised in the wellness system for some useful applications, such as whenever an inhabitant takes food, or any health emergency. By getting the timing of one's food habits, the wellness machine learning model can produce very accurate and efficient forecasting. Figure 7 presents the outdoor temperature sensing unit to measure the outside ambient temperature.

Figure 5. Toaster plugged to wellness protocol based E & E power usage and control unit

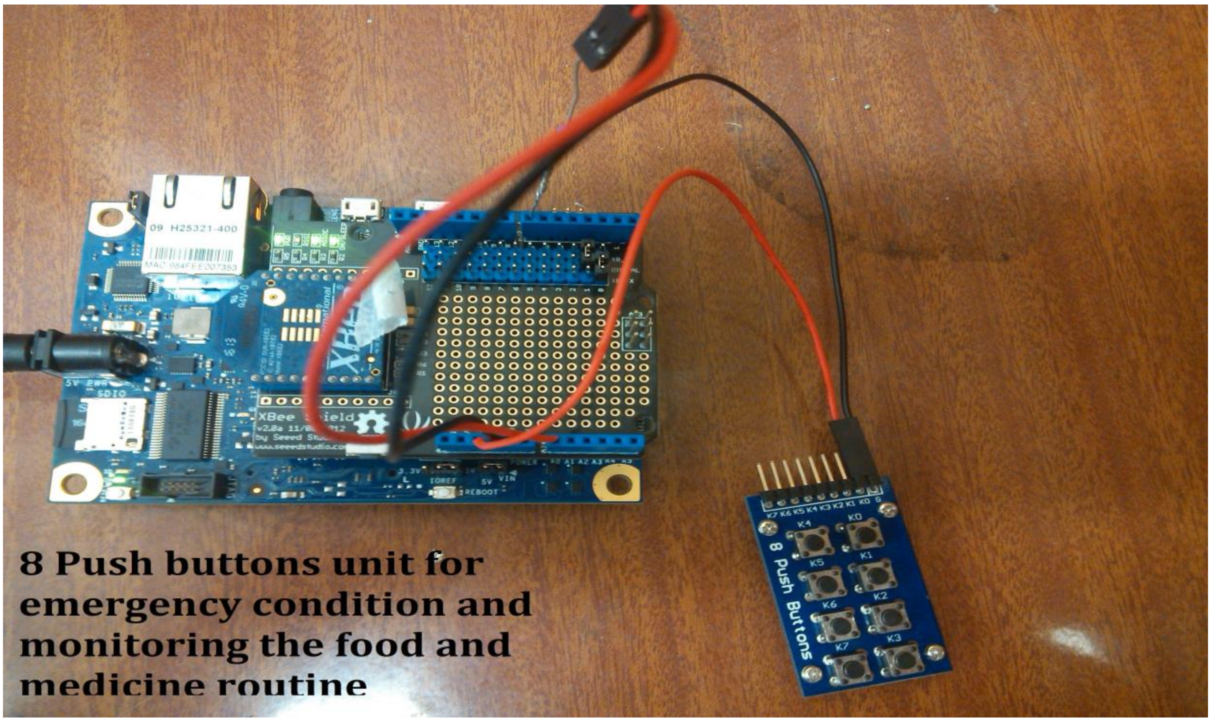

Figure 6. Wellness based manual push button based Indication (alert button) unit

Figure 7. Outdoor sensing unit for outside temperature measurement

The data from wellness end-nodes is communicated to a Coordinator in the home gateway server laptop. The local server collects the data; this local home gateway is programmed by the wellness sensor data acquisition algorithm to extract useful information from the data packets. The issue of large volumes of data is therefore resolved at the node level; then the analysis of the extracted data is done by data mining and machine learning algorithms. These machine learning algorithms analyse the information to produce the activity of daily living and context-aware scenarios. From the local server, that information is analysed and uploaded to the website over the internet. Figure 8 shows the local home gateway and the wellness-based coordinator, which has been designed on an Intel Galileo board.

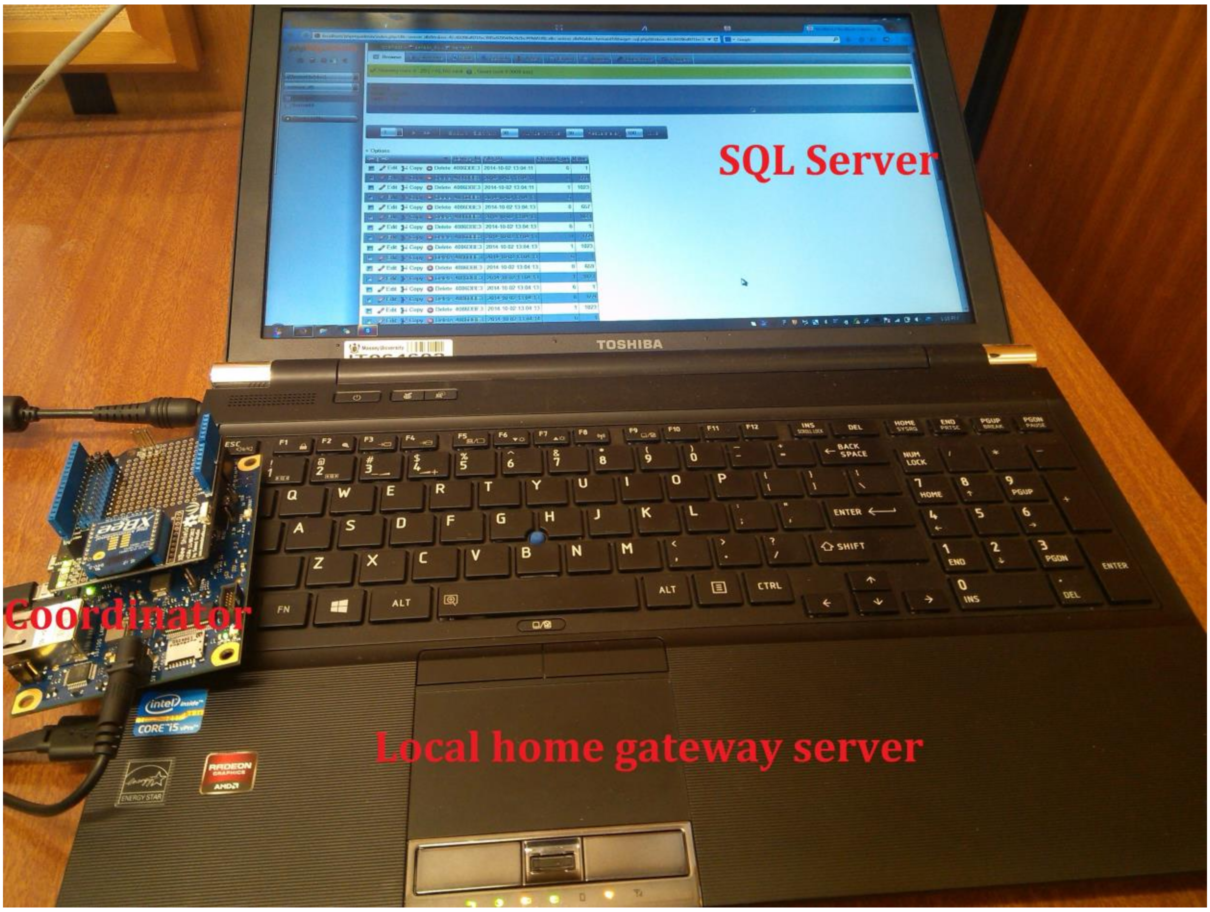

Figure 8. Local home gateway server

Select date 2015-08-30

Time	Food or Medicine/Supplement
08:03:42	Food
08:05:21	Medicine
11:33:18	Food
11:38:42	Medicine
15.32.54	Food
18:33:42	Food
18:35:30	Medicine
21:33:42	Food

Figure 9. Real-time healthcare information uploaded onto the website

Results and discussion

An IoT-based smart home system has been developed. The data has been collected and passed through data mining and machine learning algorithms for the decision-making process. The final information is uploaded onto the website. The information through this website is only accessible to an authenticated user via a registered email id and password.

Select date	2015-08-30

Time begin and end	Household object type	Occupancy duration
21:50:30 to 7:00:42	Bed	09:10:12
07:15:38 to 07.26:21	Toilet	00:10:43
07:50:20 to 08:09:29	Dining table	00:19:09
08:23:32 to 09:54:21	Sofa-set	01:30:49
11:19:11 to 11:50:52	Dining table	00:37:41
12:10:27 to 13:33:54	Sofa-set	01:23:27
13:55:44 to 14:04:51	Toilet	00:08:07
15:21:31 to 15:33:42	Dining	00:12:11
17:01:29 to 17:08:44	Toilet	00:07:15
17:11:43 to 17:34:22	Sofa-set	00:22:39
18:10:24 to 18:40:55	Dining table	00:30:31
19:10:42 to 20:38:21	Sofa-set	01:27:39
21:38:32 to 21:42:22	Toilet	00:03:50

Figure 10. Real-time Non-electrical appliances usage information uploaded onto the website

Figures 9 and 10 show snapshots from the wellness monitoring website. This website contains the data from the most recent few months. To see the monitoring history from a particular day, the client has to select a day. Figure 9 presents the monitoring of food and medicine of an inhabitant. The inhabitant takes breakfast in the morning and medicine just after that, and has the routine of having medicine thrice a day. Figure 10 shows the information on the non-electrical appliance usage. It shows sleeping, eating and toilet activities: for example, on 30th August, an inhabitant slept for 9 hr:10 mn:12 s.

Figures 11 and 12 represent the processing delay time between the local home gateway server and the cloud server. In the local home gateway approach, the computer system and server are deployed at the home to collect the data and process it, while, in the cloud-based approach, all the data from the WSN is directly uploaded to a cloud-based web server. Figure 11 shows the delay for raw data uploading while Figure 12 presents the delay for decision-making information and uploading. In both cases, the processing delay time for the local home gateway server is slightly higher than for a cloud-based approach, since the cloud-based server approach avoids the intermediate stages of placing the local home gateway computer in the smart home. In data uploading the difference of delay between cloud and local for both the cases of raw data uploading and processed information uploading was about 400ms. However, the delay difference between cloud and local home gateway approach is small but reasonable to effect real time data uploading into a web-server when the system contains a large number of sensors and processing.

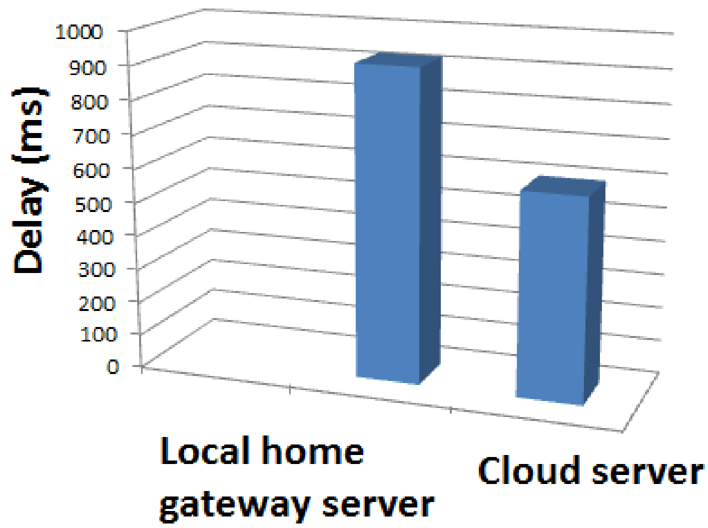

Figure 11. Raw data processing delay for gfbvcloud and local home gateway approach

Conclusion

In summary, our vision of the future is that IoT will become an advanced service in sensing, communications, monitoring and producing information from vast amounts of data. An IoT-based smart home system helps to support an improved quality of life. What would be the possible inhabitants' lifestyles? The present IoT-based wellness system has been implemented for activity monitoring and wellness forecasting in the smart home. The information has been uploaded onto a website either by a local home gateway server or cloud server. New research challenges of security and privacy arise due to the connection between the cyber and physical worlds to fulfill consumer demands. It is expected that these research problems will be resolved in the future.

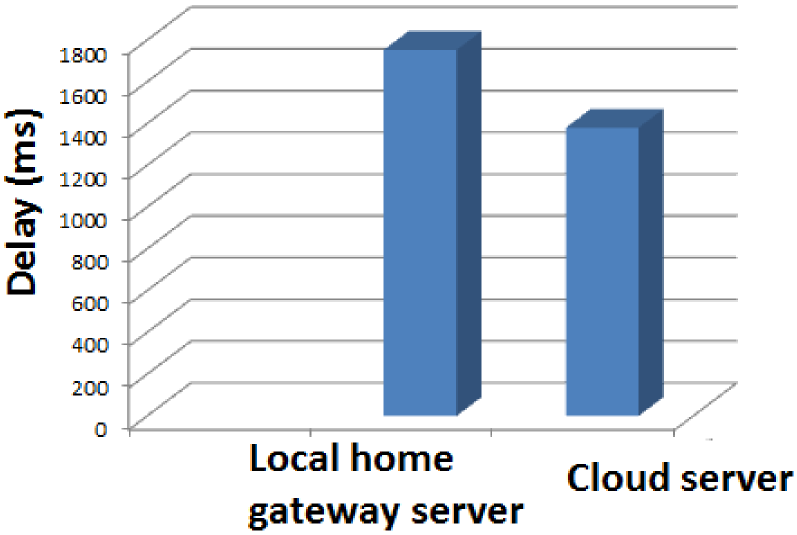

Figure 12. Final information uploading delay for cloud and local home gateway approach

References

Aijaz, A. 2015. Cognitive Machine-to-Machine Communications for Internet-of-Things: A Protocol Stack Perspective. *Internet of Things Journal, IEEE, 2*(2), 103-112.

Atzori, L; Iera, A; Morabito, G. 2010. The internet of things: A survey. *Computer Networks, 54*(15), 2787-2805.

Bakar, U; Ghayvat, H; Hasanm, S; Mukhopadhyay, S. 2016. Activity and Anomaly Detection in Smart Home: A Survey. *Next Generation Sensors and Systems* (pp. 191-220): Springer.

Chen, S; Xu, H; Liu, D; Hu, B; Wang, H. 2014. A vision of IoT: Applications, challenges, and opportunities with China perspective. *Internet of Things Journal, IEEE, 1*(4), 349-359.

Cook, D. J. 2012. How smart is your home? *Science (New York, NY), 335*(6076), 1579.

Ganz, F; Puschmann, D; Barnaghi, P; Carrez, F. 2015. A Practical Evaluation of Information Processing and Abstraction Techniques for the Internet of Things. Inter*net of Things Journal*, IEEE Volume:2 , Issue: 4 pp 340 - 354

Ghayvat, H; Mukhopadhyay, S; Gui, X; Suryadevara, N. 2015. WSN-and IOT-Based Smart Homes and Their Extension to Smart Buildings. *Sensors, 15*(5), 10350-10379.

Ghayvat, H; Mukhopadhyay, S. C; Gui, X. 2015. Sensing Technologies for Intelligent Environments: A Review. *Intelligent Environmental Sensing* (pp. 1-31): Springer.

Gluhak, A; Krco, S; Nati, M; Pfisterer, D; Mitton, N; Razafindralambo, T. 2011. A survey on facilities for experimental internet of things research. *Communications Magazine, IEEE, 49*(11), 58-67.

Kelly, S. D. T; Suryadevara, N. K; Mukhopadhyay, S. C. 2013. Towards the implementation of IoT for environmental condition monitoring in homes. *Sensors Journal, IEEE, 13*(10), 3846-3853.

Khan, M. S; Islam, M. S; Deng, H. 2014. Design of a Reconfigurable RFID Sensing Tag as a Generic Sensing Platform Toward the Future Internet of Things. *Internet of Things Journal, IEEE, 1*(4), 300-310.

Suryadevara, N; Mukhopadhyay, S. C; Wang, R; Rayudu, R. 2013. Forecasting the behavior of an elderly using wireless sensors data in a smart home. *Engineering Applications of Artificial Intelligence, 26*(10), 2641-2652.

Suryadevara, N. K; Mukhopadhyay, S. C. 2012. Wireless sensor network based home monitoring system for wellness determination of elderly. *Sensors Journal, IEEE, 12*(6), 1965-1972.

Suryadevara, N. K; Mukhopadhyay, S. C; Kelly, S. D. T; Gill, S. P. S. 2015. WSN-Based Smart Sensors and Actuator for Power Management in Intelligent Buildings. *IEEE/ASME Transactions on Mechatronics, 20*(2), 564-571.

Tunca, C; Alemdar, H; Ertan, H; Incel, O. D; Ersoy, C. 2014. Multimodal wireless sensor network-based ambient assisted living in real homes with multiple residents. *Sensors, 14*(6), 9692-9719.

Vongsingthong, S; Smanchat, S. 2014. Internet of Things: A Review of Applications and Technologies. *Suranaree Journal of Science & Technology, 21*(4).

Yang, G; Xie, L; Mantysalo, M; Zhou, X; Pang, Z; Da Xu, L; Kao-Walter, S; Chen, Q; Zheng, L.-R. 2014.; A Health-IoT Platform Based on the Integration of Intelligent Packaging, Unobtrusive Bio-Sensor, and Intelligent Medicine Box. *IEEE Transactions on Industrial Informatics, 10*(4), 2180-2191.

Software Defined Networking – Shaping up for the next disruptive step?

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Abstract: Software-Defined Networking (SDN) has emerged as a networking paradigm that can remove the limitations of current network infrastructures by separating the control plane from the data forwarding plane. As an immediate result, networks can be managed cost-effectively and autonomously through centralising the decision-making capability at the control plane and the programmability of network devices on the data plane. This allows the two planes to evolve independently and to open up separate horizontal markets on simplified network devices and programmable controllers. More importantly, it opens up markets for infrastructure providers to provision and offer network resources on-demand to multiple tenants and for service providers to develop and deploy their services on shared infrastructure resources cost-effectively. This paper provides an essential understanding of the SDN concept and architecture. It discusses the important implications of the control/data plane separation on network devices, management and applications beyond the scope of the original SDN. It also discusses two major issues that may help to bring the disruptive technology forward: the intent northbound interface and the cost-effective SDN approaches for the industry.

Introduction

The Internet has scaled enormously over the last five decades, partly due to its appropriate and universal level of abstraction at the IP layer (network layer), supporting any type of underlying physical networks and vast number of users and applications. The success is also brought about by the adoption of connectionless connectivity and resilient distributed routing mechanisms, allowing scalability and robust message delivery. However, the Internet has reached a point where it is extremely difficult to explore new architectures and flexible platforms that support emerging applications such as social networking, cloud, and big data platforms.

It has been difficult to introduce innovation in applications because legacy networks have become too rigid, yet too complex to manage, and no automation is available to handle the

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complexity. The decision-making capability (routing, managing, monitoring, and load balancing) is distributed across various network devices. The data plane and the control plane of networking devices are tightly coupled and vertically integrated, making it difficult for the Internet to evolve.

To support high-level network policies such as quality of service (QoS), network operators have to configure each network device manually and individually. This approach becomes impracticable, error prone and costly for large and dynamic virtual networks where network devices (virtual servers and virtual switches) may come into existence on-demand and move about within the infrastructure. In addition, it has been difficult for the Internet to deal with many important issues over the last few decades such as mobility, security, programmability, limitation of address space, and managing wireless sensor and optical networks.

Efforts have been undertaken to make the Internet more adaptable and manageable though active networks, programmable networks (Feamster et al 2013), and clean slate design (Greenberg et al 2005). All these projects realise that without separating the control plane (the part that is making network-wide decisions) from the data plane (the part that is responsible for forwarding data) it is difficult to innovate and revolutionise the Internet.

Software-defined networking (SDN) has emerged as a networking paradigm that can remove the limitations of current network infrastructures (Open Networking Foundation 2012). The intent of SDN is to separate the data forwarding plane from the control plane by centralising the network state and the decision-making capability, providing programmability on the control plane (SDN controller), simplifying the operation at the forwarding plane (SDN network devices), and abstracting the underlying network infrastructure to the applications (Gude et al 2008). The separation of the control plane and the data forwarding plane is through a programming interface between the SDN network devices and the SDN controller.

By separating the network's control logic from the underlying network devices, SDN enables network programmability, allows simplified and autonomous management, stimulates application, and hence opens up markets and opportunities for vendors, network and service providers.

SDN concepts and technologies have been developed to the point where the next step is crucial as all players (network equipment manufacturers, software vendors, original device manufactures, and enterprises) are evaluating appropriate strategies for their organisation in terms of cost-effective transition from legacy networks and the most beneficial SDN-enabled solution. This paper aims to provide a simple and clear explanation of SDN, its architecture, and the functionality of its components. The paper explores the scope of SDN in terms of the relationships of the technology with infrastructure providers, service providers, and cloud service providers. The paper also discusses emerging issues that are being addressed by SDN.

The rest of the paper is organised as follows. The fundamental architecture of SDN is introduced in the next section, followed by a concise description of the OpenFlow protocol that allows the separation of and the communication between the control and the data planes. The main components and the functionality of the SDN controller will be discussed in a subsequent section, followed by the description of several SDN-enabled applications. The paper discusses issues faced by this disruptive technology and concludes with remarks concerning the next step.

SDN Architecture

The basic elements of SDN include: SDN devices, SDN controller, and applications. The SDN devices contain components for deciding what to do with incoming traffic (frames or packets). The SDN controller programs the network devices and presents an abstraction of the underlying network infrastructure to the SDN applications. The controller allows an SDN application to define traffic flows and paths, in terms of common characteristics of packets, on the network devices to satisfy its needs and to respond to dynamic requirements by users and traffic/network conditions. The Open Networking Foundation defines a high-level architecture for SDN (Berde et al 2014) with three main layers as shown in Figure 1.

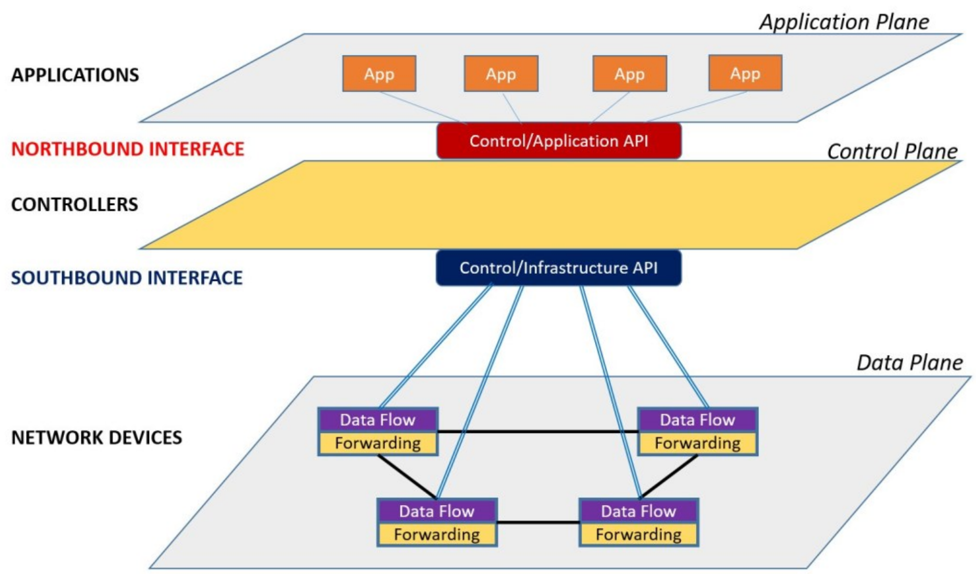

Figure 1 – Software-defined networking – a high level architecture

Infrastructure Layer

This layer consists of SDN devices (both physical and virtual) that perform packet switching and forwarding. Specifically, an SDN device is composed of an application program interface

(API) for communication with the controller, an abstraction layer, and a packet-processing component. The abstraction layer abstracts an SDN device as a set of flow tables. The packet processing function decides on actions to be taken, based on the results of the evaluating incoming packets relative to flow entries in the flow tables.

Control Layer

This layer provides the logically centralised control functionality that supervises the network forwarding behaviour through an open interface. An SDN controller controls, through a southbound API, all SDN devices that make up the network infrastructure; and implements policy decisions such as routing, forwarding, load balancing, etc. It provides an abstract view of the entire network to the applications through a northbound interface.

Application Layer

This layer consists of end-user applications that utilise the SDN communications and network services (Goransson & Black 2014). Through the controller the applications are able to affect the behaviour of the underlying infrastructure by configuring the flows so as to route packets through the best path between two endpoints, balancing traffic loads across multiple paths or destined to a set of end points, reacting to changes in network topology such as link failures and the addition of new devices and paths, or redirecting traffic for purposes of inspection, authentication, segregation, and similar security-related tasks.

The following sections describe the standardised southbound interface, OpenFlow, and an SDN controller.

OpenFlow

OpenFlow is a standardised protocol (Open Networking Foundation 2013) that defines the southbound communication between a controller and an OpenFlow switch. The communication messages between the two are transmitted over a secure channel that is implemented via a Transport Layer Security (TLS) connection over TCP. Through the exchange of commands and packets, the controller defines and programs the switch's packet forwarding behaviour, and the switch performs the packet forwarding accordingly and reports its configuration status and traffic conditions.

User traffic is classified into flows based on its characteristics. An OpenFlow switch performs packets lookups and forwards according to the flow they belong. A **flow** is a set of packets transferred from one network endpoint (or set of endpoints) to another network endpoint (or set of endpoints). The endpoints may be defined as IP-TCP/UDP address pairs, VLAN endpoints, or switch input-output ports, etc.

To the controller, an OpenFlow switch is presented by a set of flow tables. A **flow table** consists of flow entries. A **flow entry** comprises header fields, counter fields, and action fields. The header fields are used to identify the flow of a packet, the counter fields are used to collect statistics of the identified flow, and the action fields provide the instructions and actions the switch has to perform on the packets of that flow (Figure 2).

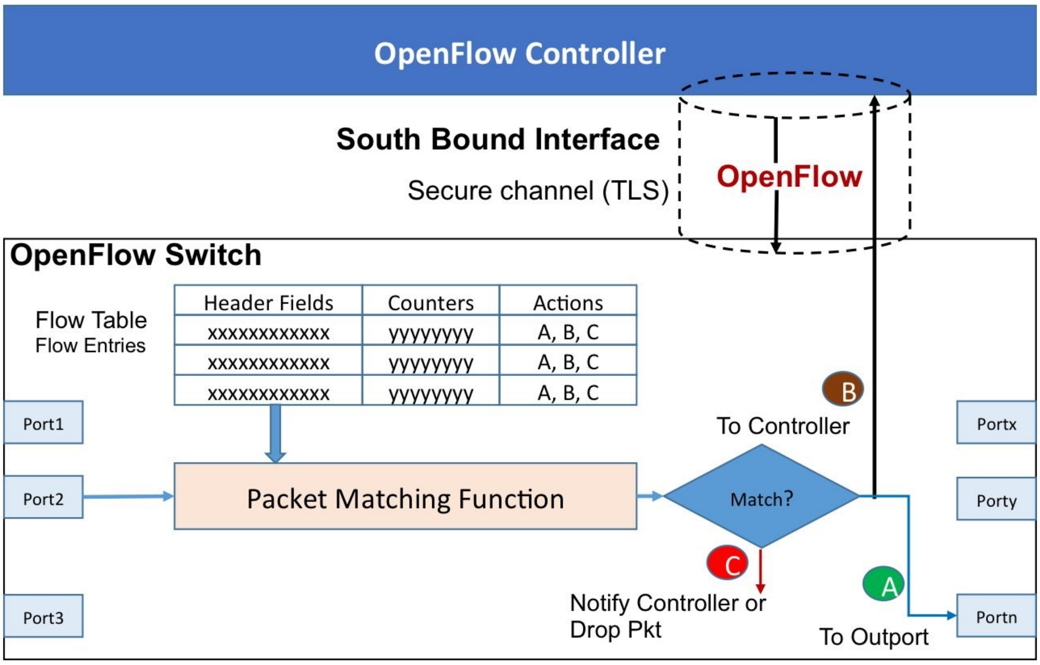

Figure 2 – OpenFlow switch – basic operation

The controller, based on its knowledge of the underlying network topology, device capability, and application requirements, defines a flow with appropriate fields and uses the OpenFlow protocol to program the switch with necessary flow tables and entries.

OpenFlow defines three types of messages:

- controller-to-switch,
- asynchronous, and
- symmetric messages.

Controller-to-switch messages are used to manage and program the switch (e.g., setting switch configuration, sending flow tables, requesting traffic statistics). The asynchronous messages are from the switch to the controller without having been solicited by the controller. They are used to notify the controller of changes in the switch's state and to report network events including errors. The symmetric messages are used by both the switch and the controller for ascertaining the liveness of the connection.

The main functions of an OpenFlow switch include interacting with the controller through the OpenFlow protocol, identifying traffic flows through packet matching, performing packet forwarding, and reporting statistics and switch state to the controller.

When a packet arrives at the OpenFlow switch, it is matched against the flow table to determine whether there is a matching flow entry. The match fields associated with the incoming packet cover layer 2 to layer 4 headers. They include Port (switch ingress port); VLAN (ID and priority); Ethernet (source and destination addresses, and frame type); IP (sources and destination addresses, protocol, type of service); TCP/UDP (source and destination ports). If a matching flow entry is found, the packet may be dropped, modified, or forwarded depending on the instructions and actions associated with that flow (see Figure 2). A table-miss is the term used to describe the situation when no matching entry is found and in this case appropriate actions may include dropping the packet, forwarding it the controller, or continuing to the next table. Readers are referred to (Open Networking Foundation 2013) for additional features.

SDN Controller

The controller is the software that manages all shared resources of the underlying network infrastructure among applications. The controller communicates with the network devices to obtain information about them in order to build the global information state of the underlying network infrastructure, and programs the application-specific configurations and policies onto these devices in order to control their forwarding behaviour. Furthermore, the controller also offers an execution environment for programming of the network (Gude et al 2008). Figure 3 depicts core functional modules and interfaces of an SDN controller.

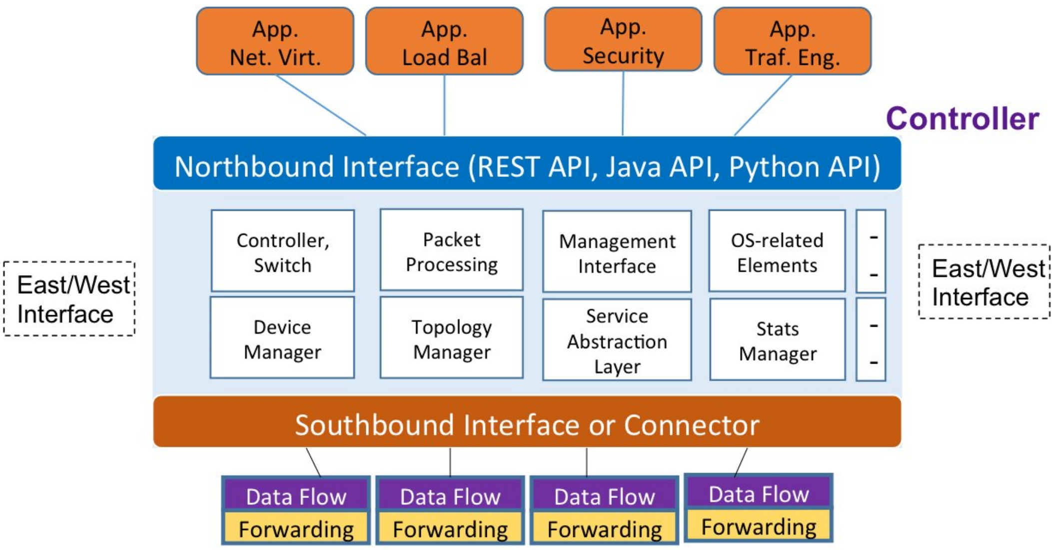

Figure 3 –Components of an SDN controller

Core Component Functions

The basic set of components of the SDN controller may include:

Device Manager. Device Manager manages devices in the network. Device manager registers to the device listeners so that it is notified when a device is added to or removed from the network. It is also notified when the device IP addresses have been added, updated or removed.

Packet Processing Unit. Packet processing processes packet headers and payloads. Each packet contains source MAC addresses, destination MAC addresses, message type, its parent and payload. Usually packets are handled for different protocols such as Ethernet, IPv4, LLDP (Link Layer Discovery Protocol), UDP (User Datagram Protocol), so there are functions to create packets for every protocol that the controller can handle.

Topology Manager. The topology manager identifies topology changes in the network. It sends out the LLDP messages with the switch and its port addresses. If the received LLDP messages match a known switch then a new link is established in the network. The topology manager maintains an up-to-date topology of the network and sends the topology updates to network applications.

Routing. Depending on the protocol the routing manager implements the routes between the source and destination addresses provided.

Openflow Implementation. An OpenFlow module exists in every controller to provide functions related Openflow messages, actions, table entry, flow rules, matching of flow rules, message queues and statistics. In principle, a controller may support other protocols to manage its switches and underlying networks as required by the application.

Controller Interfaces

A controller interacts with the infrastructure layer and the application layer through open interfaces: Southbound and Northbound interfaces.

Southbound Interface or Control/Infrastructure Interface

The interaction between the controller and its network device is realised through a communication channel, within which is an application programming interface (API). A Transport Layer Security (TLS) connection between the device and its controller is often established as the secured communication channel. The southbound API is basically a layer of device drivers. This allows the controller to use different southbound APIs and multiple protocol plug-ins to manage a whole range of physical and virtual devices including SDN devices and legacy devices.

Northbound Interface or Control/Application Interface

The interaction between the controller and the applications can also be realised through a communication interface. However, the communication is more efficient by a software API rather than a formal protocol. This API enables the programmability of the controllers by exposing network abstraction data models and other functionalities for use by applications at the application layer. There is currently no standard northbound API. Various APIs have been implemented in various shapes and forms (REST API, Java API, Python API, etc.) Some present a low-level interface, providing access to the network devices. Others may provide high-level APIs that give an abstraction of the network itself. The controller may use the API to inform the application of events that occur in the underlying network (e.g., state or topology changes). Applications may use the API to respond to a received event and alter the behaviour of the network (e.g., flow modification).

In cases where multiple controllers are deployed to handle cross-domain networks, an East/Westbound interface is required to provide the logically centralised control functionality.

SDN featured applications

Ultimately, business applications and network services are the driving forces behind the development of the network infrastructure. In this section, however, only several applications that highlight specific features of SDN will be discussed: ease of network management, enabling network virtualization in cloud computing context, and embracing network function virtualisation.

Network Management

Today's networking software is typically embedded within the network device, managing network devices requires manual operation on individual network devices. Network management is thus difficult, laborious, error-prone, and costly; and yet it is not flexible to deal with the dynamic nature of network conditions. Software defined networking offers an effective solution to this network management problem. The separation of the control plane from the data forwarding plane allows a centralised network controller to control the overall behaviour of the network. Network policies concerning security, topology, quality of service, etc., can be translated to network management tasks and management commands. The controller then can use an API between the control plane and the data plane to program the devices *autonomously* to obtain the desired network behaviour. The network devices in the data plane can also use the same interface to inform the controller the changes in its status and operating conditions, allowing the controller to respond to these changes by working out appropriate responses and direct the device to adapt to the new situation.

Procera (Kim & Feamster 2013) has been developed as a network control framework using SDN paradigm. Procera has been deployed in Georgia Tech campus and several home networks. Google deployed OpenFlow in their production network (Sushant et al 2013). Operations are scheduled depending on the available bandwidth in the network. Sushant demonstrated that effective resources utilisation was achieved with SDN and OpenFlow. Sivaraman (Sivaraman et al 2013) proposed an architecture for virtualising the access network via open APIs to enable dynamic service quality management.

SDN Network Virtualisation for Cloud Computing

IT resources have been virtualised, provisioned and offered as cloud services over the last few years through a cloud computing model. Openstack is an open-source platform for orchestrating and maintaining clouds. OpenStack creates an abstraction layer above compute, storage, and network resources. This abstraction provides APIs that applications can use to provision virtual resources to a cloud service, independent of the hardware resources. An SDN network virtualisation can be implemented as a component of OpenStack. This component could be an interface to an OpenFlow controller that would control physical/virtual switches (Leon-Garcia et al 2015). An example of network virtualisation is illustrated with the following scenario where a service provider submits a request for a virtual network (VN) to OpenStack (see Figure 4).

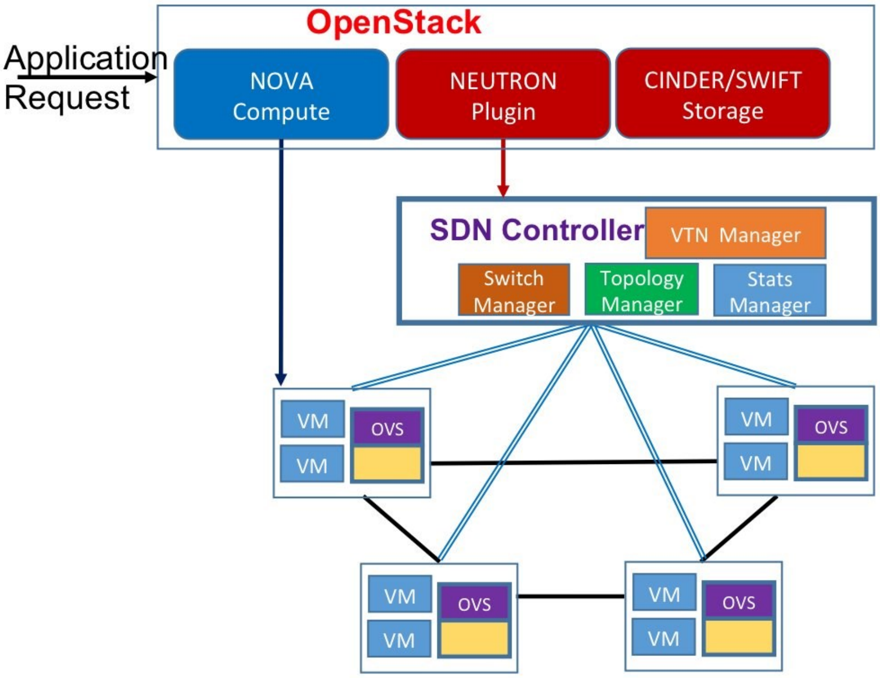

Figure 4 – SDN network virtualisation for cloud computing with open stack

The request specifies the topology of the VN, the resources required for each virtual node (number of virtual machines and virtual switches), and bandwidth requirement for each virtual link. The OpenStack computing orchestrator responds to the request by scheduling the virtual machines (VMs), where virtual network nodes and switches (OVS or Open vSwitch in Figure 4) reside, in the data centre. The OpenStack orchestrator delegates an SDN controller (through its Virtual Network Tenant (VTN) manager) to schedule the VN by sending the request to the SDN controller through its northbound interface. The SDN controller creates and maps the required virtual switches and links to available physical resources. The controller creates and installs forwarding policies in OpenFlow-enabled switches.

Network Function Virtualisation (NFV)

According to the Open Data Center Alliance:

> "NFV is a network architecture concept in which the network is implemented through software, virtualising classes of network node functions. Under the NFV concept, virtualisation technologies are used to implement network node functions on industry-standard commodity hardware, including servers, switches, and storage devices that can be moved to or instantiated in, various locations in the network as required, without the need for installation of new equipment" (Open Data Center Alliance 2013).

Functionality of network appliances and devices such as load balancers or intrusion detection systems, often realised by specialised hardware, can be implemented under NFV. Multicore processors and network interface controllers are powerful enough to be programmed to be many different types of network devices. SDN may be used to implement certain parts of NFV. Usually security firewalls are being implemented in a dedicated hardware component at the network edge. They are now being virtualised and deployed anywhere in a network using OpenFlow-based devices (physical or virtual). Firewalls inspect incoming packets and make a decision to forward them, to drop them, or to steer them to another destination for further analysis. SDN with its programmability and flow matching ability can easily accommodate these firewall actions. Similarly, with SDN and OpenFlow technology, a network device can act as a load-balancing appliance by inspecting incoming packets and forward them to appropriate replica servers.

Discussion

Within less than 50 years the Internet, through its universal connectivity, has reached every corner of the globe with killer applications such as world-wide-web, email, and social network applications. Software-Defined Networking (SDN) has emerged as a networking paradigm that can remove the limitations of current network infrastructures by separating the control plane from the data forwarding plane. As seen from the discussion of featured application of SDN, the significance of the control/data separation includes:

- *Opening up network devices and controller markets*. The controller (implementing the control plane) and the network device (implementing the data plane) can be developed independently by different manufacturers/providers and this opens up their market horizontally for innovation and opportunity.
- *Simplifying network devices*. The network device becomes much simpler as it does not have to deal with complicated and distributed information and decision-making. Inexpensive but high performance switches dedicated to forwarding packets can be developed for applications that need speed such as real-time video streaming.
- *Facilitating autonomous management*. The network can be programmed to a desired configuration to deal with changes in the network conditions such as topology or traffic conditions *autonomously*.
- *Centralising control of network behaviour*. The controller is implemented in software and it controls all the devices within its network infrastructure *centrally*.
- *Enabling network virtualisation*. The controller provides an abstraction of the underlying network infrastructure to the applications, and this provides a mechanism for partitioning the network resources and allocates them to relevant applications/tenants through virtualisation.
- *Embracing network function virtualisation*. Network functions and services can be developed and virtualised and installed from the controller to appropriate devices and network strategic points.
- *Allowing network programmability*. The controller understands the needs of the applications through its northbound interface and resources available of the underlying network infrastructure through its southbound interface. It can program the network for new deployment possibilities.

Software-defined networking promises to be a disruptive technology that revolutionises the Internet with the ability to generate and schedule huge number of virtual networks on demand, to program and to manage them autonomously, and to support business applications and network services. Whether the potential of this technology is realised depends on several factors: the ease at which innovative and emerging business applications and services can be developed over the north bound interface; and the specific SDN-based approach that allows cost-effective transition to the new networking paradigm. These two issues are discussed below.

Development of Intent Northbound Interface.

Innovation and rich applications are recognised as the driver of the revolutionised Internet. However, this happens only if the developers are free to concentrate on developing their applications rather than being burdened by the complexity of networking. This is where a standardised Northbound API is needed. The debate is whether one API is adequate for all types of applications. Clearly, network services such as network virtualisation and load balancing are closely linked to characteristics of networking and require intimate knowledge of network resources such as traffic load, routing scheme, link bandwidth. Other business applications make use of the underlying network for simple connectivity without strict requirements on network resources. Recently, it is realised that it is *unreasonable* or even *unproductive* to require an application to express its requirements of network resources in a **network-specific language**. The application needs not to know how the network is being deployed to satisfy its needs. The application, however, knows exactly its objectives, its policies, and its requirements and constraints. An NBI should be designed to reflect this understanding in order to support a large class of applications and services. The intent-based networking is in that spirit and the promising **Intent Northbound Interface** (NBI) is being developed (Janz 2015) by the Open Networking Foundation (Figure 5).

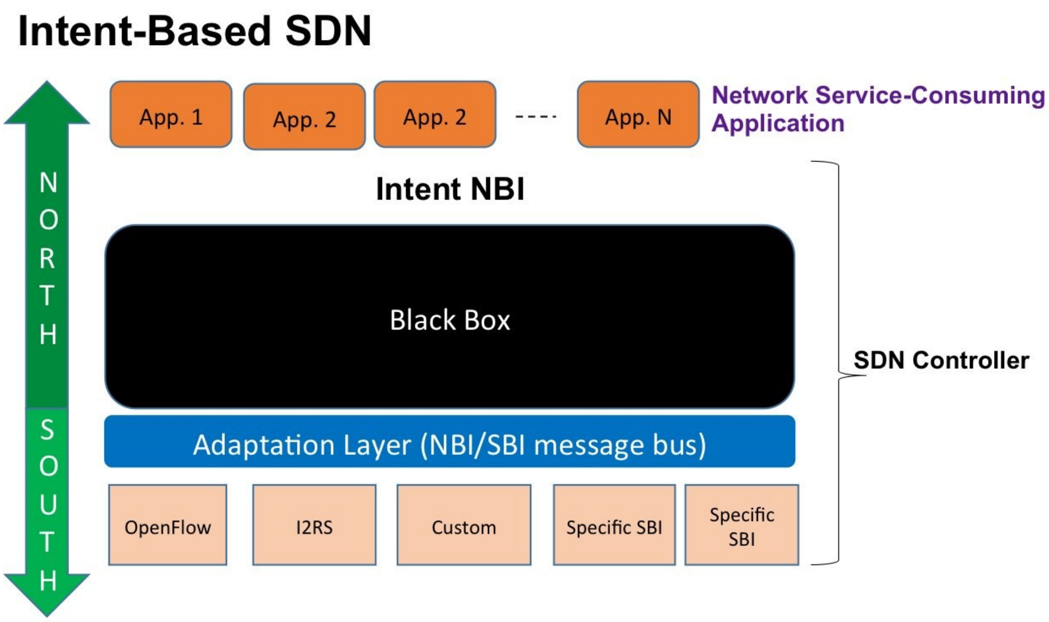

Figure 5 – Intent Northbound Interface in intent-based SDN (Janz 2015)

It is for an application to express its "intent" and for the control plane (controllers) to translate the intent to the network setting and resources necessary to satisfy the needs of the application. The intent is for the application to express its request in terms of information and directives in a simple and common language, and for the controller to obtain adequate inputs to map the request down to network specific instructions. As it is difficult to translate diverse application needs, expressed in application-specific language, to the expressions the controllers can understand and function, it is suggested that that API be composed of iterative levels of refinement until the application needs can be decomposed into a set of base API functions for the controller. A group of support such as dictionary database, negotiation procedure, and compiler may be needed at various levels of refinement.

Cost-effective SDN-based approaches?

The concept of SDN can be accomplished in other ways than the OpenFlow-centric approach coupled to Open SDN as discussed so far, but which would be the most beneficial for the industry?

SDN via Existing APIs.

With this approach, the behaviour of the network can be manipulated by sending management commands to the network devices to configure them. Existing CLI, SNMP or RESTful API or their enhanced versions can be used to program legacy switches but they do not allow fine-grain control of individual flow. This approach requires no controller or upgrading existing switches to OpenFlow-enabled switches. However, it does not solve all the problems that can be addressed by an Open SDN solution. The network programmer still has to interact directly with *each individual switch*. The approach does not revolutionise the networking industry as most issues remain unaddressed.

SDN via Hypervisor-Based Overlay Networks.

With this approach, virtualised overlay networks are built on top of and without modifications to the underlying physical network. An overlay network interconnects virtual machines (nodes) by virtual links (tunnels between two end points of the overlay network). The data sent by a virtual machine through a virtual link is encapsulated using IP-based tunnelling protocol. The tunnelling mechanism is referred to as MAC-over-IP tunnelling whereby the whole MAC frame is encapsulated within an IP packet. The network edge switches (virtual switches) will serve as virtual tunnel endpoints of these virtual networks. Each node in the overlay network knows its adjacent edge switch through a central overlay controller. Cisco offers Virtual eXensible Local Area Network (VXLAN), Microsoft uses Network Virtualization using Generic Routing Encapsulation (NVGRE), and Nicira offers Stateless Transport Tunnelling Protocol (STT) (Goransson & Black 2014). This approach provides an effective way for data centres to extend their VNs over and cross-domain data centres without altering the underlying physical infrastructure. However, it does not to address issues in the physical infrastructure such as programmability and automation. It still requires manual configuration.

Conclusion

SDN makes the network open and programmable, allowing new capabilities and services to be simply created on demand. It has the potential to be a disruptive technology in many market segments: network device vendors, service and infrastructure providers, network operators, and data centres. This paper provides a high-level understanding of software-defined networking through its concepts, architecture, and interfaces. It highlights the features and implications of the Technology with several SDN-based applications. Finally it discusses two major issues that may help to bring the technology to the next step: the intent northbound interface and the cost-effective approaches for the industry.

References

Berde, P; Gerola, M; Hart, J; Higuchi, Y; Kobayashi, M; Koide, T; Lantz, B; O'Connor, B; Radoslavov, P; Snow, W; Parulkar, G. 2014. 'ONOS: Towards an Open, Distributed SDN'. Proceedings of HotSDN'14. August; Chicago, USA.

Feamster, N; Rexford, J; Zegura, E. 2013. 'The Road to SDN: An Intellectual History of Programmable Networks'. ACM Queue, Technical Report, New York, USA.

Goransson, P; Black, C. 2014. *Software Defined Networks - A Comprehensive Approach*. Morgan Kaufmann.

Greenberg, A; Hjalmtysson, G; Maltz, D; Myers, A; Rexford, J; Xie, G; Yan, H; Zhen, J; Zhang, H. 2005. 'A clean slate 4D approach to network control and management'. *Computer Communication Review*, Volume 35, Issue 5, 41–54.

Gude, N; Koponen, T; Pettit, J; Pfaff, B; Casado, M; McKeown, N; Shenker, S. 2008. 'NOX: Towards an operating system for networks'. *Computer Communication Review*, Volume 38, Issue 3, 105–110

Janz, C. 2015. 'Intent NBI – Definition and Principles'. Open Networking Foundation, Version V2, July 2015.

Kim, H; Feamster, N. 2013. 'Improving Network Management with Software Defined Networking'. *IEEE Communications Magazine*: 114-119.

Leon-Garcia, A; Bannazadeh, H; Zhang, Q. 2015. 'OpenFlow and SDN for Clouds'. *Cloud Services, Networking, and Management*, Chap. 6. Editors: da Fonseca N; R. Boutaba R. IEEE Press.

Open Networking Foundation. 2012. White Paper. 'Software-Defined Networking: The New Norm for Networks'. Palo Alto, USA.

Open Networking Foundation. 2013. 'OpenFlow Switch Specification'. Version 1.4.0

Open Data Center Alliance. 2013. 'Master Usage Model: Software-Defined Networking'. Rev. 2.0.

Sushant J; Kumar, A; Mandal, S; Ong, J; Poutievski, L; Singh, A; Venkata, S; Wanderer, J; Zhou, J; Zhu, M; Zolla, J; Hölzle, U; Stuart, S; Vahdat, A. 2013. 'B4: Experience with a Globally-Deployed Software Defined WAN', Proceedings of the ACM SIGCOMM. August 2013; Hong Kong, China, 2-14

Sivaraman, V; Moors, T; Habibi Gharakheili, H; Ong, D; Matthews, J; Russell, C. 2013. 'Virtualizing the access network via open APIs'. Proceedings of the ninth ACM conference on Emerging networking experiments and technologies. December 2013; Santa Barbara, CA, USA, 31-42

Legacy Telecommunication Systems

Theme Editors Introduction

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Abstract: The subject of legacy telecommunication systems is often overlooked in the pursuit of technological advancement, yet somehow the result is often less than graceful with end users left walking a tightrope between technology they are familiar with, and the evolving replacement systems.

Introduction

Legacy Systems are all around us, whether we like it or not. If those futurists amongst us are correct then we are going to see an ever increasing prevalence in the coming few years with connected technology supplanting many legacy devices in our day-to-day lives through the "Internet of Things (IoT)".

Almost every aspect of our business and personal lives touch legacy devices, from financial through to traffic systems.

Human nature is most comfortable with familiarity; therefore change is often resisted. Organisations logically take a risk averse approach when deploying new technologies. Whether from a disaster recovery perspective, "let's just leave the old system running until the new one is bedded in and proven." To issues with migration, "the new system does 90% of the work the system it is replacing, so let's just leave the old one handling the 10%."

Legacy systems ironically are often here to stay, and the longer they are left the less people know about them – developers, system admins, even technicians are long gone. I recall a client who was in the wholesale supply of petroleum products, a middle-man as it were, they had their core server system which handled all their day to day transactional processing which was over ten years old. Their CIO once said to me during an audit, don't breath, or go near that box it handles over $2m a day and we don't know how it works, if it goes down, we're stuffed (I wonder what their governance team thinks of that?). Similar stories are

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heard the world over. We all know custom software owners who have no access to their code and the original developers are likewise long gone, they have no path to change or even remediate security issues should they arise, so their solution generally is to try and plug the gaps with other technologies glued together, making an existing problem even worse.

Critical infrastructure has been a victim of legacy services for a long time, with the advent of the Internet and lower cost public communications networks people often find a quick "fix" is to put systems online that were never intended to

Financial services are also critical; many core-banking systems are long overdue for replacement or updating. However the standby claim is that "the system is too BIG." Therefore bolt-ons and stopgap fixes abound. This doesn't necessarily make them any less secure or functional, but it is not very efficient.

Another client, a very large retailer, still ran a mainframe system nationally, and their comfort came by the fact that their multinational vendor continued to provide annual support contract, albeit at a significant premium, but more importantly supplied replacement parts, so while the base software system was in the dark ages, the hardware could still be maintained and therefore keep their shaky system up. Inevitably the vendor finally pulled the plug and said they no longer could manufacture replacement parts. Most businesses would have seen the writing on the wall years before and planned a replacement, but no, this client following in the footsteps of our other client, decided it was better to pay for continual environmental monitoring of the equipment with alerts going off should the, temperature, humidity etc change. In the vein hope that any variation would indicate a prospective issue coming.

The greatest ones we have heard of though come when a supplier is seeking to change a fundamental piece of the jigsaw puzzle. We operate a network connected device interoperability test laboratory that enables technology vendors to come in and test their existing products on nbn services. The original premise under the former government was that as the copper network was replaced by fibre networks certain legacy technologies needed to be tested to ensure that they continued to operate. This is particularly critical in systems such as remote/tele health care and monitoring and alarm systems, such as medical, intrusion etc. There are also a plethora of other legacy systems connected to the PSTN/POTS network which boggles the mind, traffic control systems, vending machines, accessibility devices. With the new government the move to multi technology mix means that the interoperability lab is even more relevant as vendors need to ensure that their existing products remain compatible and that future changes and emerging products interoperate across all the network delivery technologies.

What added further complexity is the number of Retail Service Providers (RSP), each with their own configuration. So the vendors don't just test against a National Broadband Network service, they also test against the services offered by each of the RSPs.

With the coming of the IoT this is going to be increasingly more relevant. Likewise mobile networks, and particularly where vendor technologies rely on an "always" on, or "always" up network connectivity. Since the demise of dedicated copper services, critical legacy systems, such as healthcare, ATM/EFTPOS, wagering/lotteries and alarm monitoring systems providers are having quite a time seeking the backup route back to their bases. Often moving from two terrestrial/cabled services to a mobile service. These in themselves can prove problematic due to interoperability/compatibility issues with the technologies as carriers may have differing configurations. A prime example is mobile and satellite communications networks where the network traffic these days has a variety of systems in place which seek to optimise packets and prioritise various traffic classes.

Conclusion

Bottom line is that legacy systems are here to stay, and while our communications networks are becoming ubiquitous and advancing in technological leaps and bounds, the providers and vendors, on both sides of the table, need to be aware of the impact that change can bring and ensure that their customers and ultimately the end-users continue to be the beneficiary of the technology delivered in the first-instance.

Shall we hook up the old stuff?

Security implications of legacy systems on the Internet

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Abstract: Computer systems, technologies and applications that do not meet current standards, known as legacy systems, are increasingly connected to the Internet for various reasons. Connecting them to an environment that they were never intended for can potentially have serious operational security risk implications. This article discusses some of the reasons.

Introduction

Connecting legacy systems (Wikipedia 2015a) to the Internet can have serious implications for these systems and the environments they run in. These systems are typically designed to safely run in an intended, targeted environment, and not connected to the Internet.

The environments in which these systems can operate are described by a number of attributes with implicit requirements. These environmental attributes could be physical conditions, such as temperature range, humidity or pressure. For example, some computer systems need to run in harsh conditions like the extreme temperature ranges found in space while others may be deployed in the desert, the Arctic Circle or underwater.

Products like computer systems are typically optimised and built to meet the conditions of a particular environment. While theoretically a system could be built to function under any conditions, it is usually cost prohibitive to develop and deploy.

A set of requirements covering environmental suitability, security and usability is usually defined prior to a system being built. These requirements help to ensure that all parties involved in designing, building, commissioning and using a system get a better understanding of what can and cannot be expected. For critical systems, independent parties will also verify whether the set of requirements – matching environmental conditions for example – are in line with defined standards and practices. In these cases, meeting a particular standard might become a requirement in itself. Examples of these standards include the National Electrical Installation Standard (NEIS) (NEIS 2015) in the United States; DIN V 66304 (DIN 2015), a

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standard for industrial automation by the German Institute for Standardisation; or SAS 45, the Australian Standard for Safety (Standards Australia 2015).

Assuming that developers of legacy systems did not intend these systems to be connected to the Internet, these systems will not be designed to protect against the threats usually found in such a networked environment. An example of a typical threat is a Denial of Service attack (Wikipedia 2015b). Depending on the legacy system involved and its original requirements, this attack may have wider security implications. However, if the intended functionality of the system is not compromised by being connected to the Internet, then one should be able to conclude that it be done safely. On the contrary, if existing functionality is negatively impacted, the impact needs to be analysed and the risks mitigated by either changing the legacy system or introducing mitigating controls.

Some real world scenarios

Imagine a system running on the 23-year-old Windows 3.1 used to link air traffic control at one of France's biggest airports with the country's main weather bureau. (Whittaker 2015) What would be the implications of connecting it to the Internet? While one might question why the system runs on a Windows version that has been out of support for a while, we can assume that within a closed environment it might be cheaper and completely acceptable to run the system as it is as far as threats of being hacked are concerned. Of course the system owners and operators are running the risk that the skills required to support the system may become scarce.

The important question is: What are the implications of connecting this system to the Internet? Obviously the operating environment of the system would change, and connectivity to the Internet would introduce risks to a previously closed system. Suddenly the very dated operating system would become a liability that it might not have been before. Security patching of the system would be almost impossible, since the operating system has been out of support for a long time. The system will now not only have to be protected against physical attacks, but also against attacks over the network with the new connectivity in place (Jackson 2015).

There are many scenarios that would have to be considered that were previously irrelevant because limited connectivity made it impossible to reach the system via the Internet. Given the linkage of the system to other air traffic control systems, the newly-introduced connectivity could compromise their security. Assuming that the system itself cannot be changed, other controls would have to be implemented to protect it against the traffic from the Internet and to mitigate the risk of malicious cyber-attacks.

Another example of a legacy system being connected to the Internet with fewer far-reaching security implications is a government database already available to a limited number of users (Wells 1994). Now the government wants to make the database available to a larger user base by connecting the system to the Internet. Under the assumption that the system had already been built for an environment that needed to be secured against malicious activity, it is likely that no or minimal changes are required to safely connect this government database to the Internet. The biggest threat in this scenario comes from newly discovered attack vectors that emerge from changes in technology rather than changes in requirements.

Conclusion

The mere fact that a system can be classified as a legacy product does not pose a risk when it is connected to the Internet. It is the system's original intended use, and the fact security was never considered in its initial requirements, that create the risk. While any set of requirements for computer systems and applications should include security, these requirements differ between closed systems and systems connected to the Internet. Finally, anyone considering connecting legacy systems to the Internet should be able to answer the following questions prior to establishing connectivity:

1) Is there a good reason, for example a business requirement, to connect the legacy system to the Internet? In other words, what are the benefits versus the risks when connecting a legacy system to the Internet?

2) How does Internet connectivity impact the risk profile of the legacy system and its original intended functionality?

3) Can negative impacts such as increased security risks be mitigated when connecting a legacy system to the Internet?

Once these questions have been answered to everyone's satisfaction and the implications are understood, the decision to connect a legacy system to the Internet may be changed, or the connection made with a clearer understanding of the implications, including the risks, and the mitigations required to address these risks.

References

German Institute for Standardisation (DIN). 2015. Accessed 1 December 2015 at http://www.din.de/en

Jackson, K. 2015. "Microsoft Windows 10: Three Security Features to Know About", Dark Reading, 1 June 2015, Accessed on 1 December 2015 at http://www.darkreading.com/cloud/microsoft-windows-10-three-security-features-to-know-about/d/d-id/1320650

National Electrical Installation Standards (NEIS). 2015. Accessed 1 December 2015 at http://www.neca-neis.org/

Standards Australia. 2015. Accessed 1 December 2015 at http://www.standards.org.au

Wells, R. 1994. "Government Data on Corporations Now Available on Internet: Information: Experimental linkup with the SEC's 'Edgar' database increases public access, but critics say it could impede wider marketing efforts", LA Times, 19 July 1994, Accessed on 1 December 2015 at http://articles.latimes.com/1994-07-19/business/fi-17364_1_public-access

Whittaker, Z. 2015. "A 23-year-old Windows 3.1 system failure crashed Paris airport", ZDNet, 16 November 2015, Accessed online 1 December 2016 at http://www.zdnet.com/article/a-23-year-old-windows-3-1-system-failure-crashed-paris-airport/

Wikipedia. 2015a. "Legacy System", Accessed 1 December 2015 at https://en.wikipedia.org/wiki/Legacy_system

Wikipedia. 2015b. "Denial-of-service attack", Accessed on 1 December 2015 at https://en.wikipedia.org/wiki/Denial-of-service_attack

Legacy PSTN applications cause confusion

Disclaimers are no substitute for actual service

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Abstract: When faced with the need to move their services to the National Broadband Network (NBN), many consumers discover quite late in the process that their new NBN-based service has left their legacy PSTN connect devices behind.

Introduction

As the National Broadband Network (NBN) rollout continues, many consumers are facing the forced disconnection of their copper landline (NBN 2014) and the requirement to move to the NBN if they want to retain landline services.

While the technical aspects of shifting to a new broadband service are reasonably well understood and to a certain extent expected, many Australian residential and business consumers face unanticipated problems if they have a monitored burglar alarm or EFTPOS terminal connected via the PSTN. Some only discover after they have left the PSTN that their new NBN-based service has left their legacy PSTN connect devices behind.

The NBN website states "The nbn™ network presents opportunity in education, business, entertainment, health care and sociability giving everyone the potential to be more productive, more creative, more efficient and more connected for decades to come." (NBN 2015a). The website goes on to encourage readers to 'find out more about the benefits of fast broadband' without any mention of the disadvantages of possibly losing some or all of their PSTN functionality.

The need for legacy modems and DTMF signalling

A common device consumers expect to connect via the NBN is a fax machine, and this is supported by the NBN (NBN 2015b: 29). It is a scanner and printer connected to another scanner and printer via modems that operate at 9600 or 14400 bits per second. This is within NBN's specifications (NBN 2015c), so there is no NBN-imposed technical barrier to a retail service provider (RSP) (NBN 2015d) supporting this service connected via a UNI-V port.

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Similarly, PSTN-connected EFTPOS terminals are a user interface, card reader and printer connected via a 9600 bits per second modem to a service provider and once again this is within NBN's UNI-V specification.

Consumers are likely to find themselves needing to send numbers from a CPE keypad using dual tone multiple frequency (DTMF) signals. Examples include activating credit cards, responding to surveys and accessing customer service phone queues and PABX extensions.

There are also some hidden uses of DTMF such as many medical alarms, home automation devices and some monitored alarms.

The current situation with legacy services

Some providers like Telstra (Telstra 2014) and iiNet (iiNet 2015) state on their websites and in documentation to their subscribers that they can support such legacy services, but that subscribers need to talk to the operator of the legacy service to determine if the service is capable of working via the NBN at all.

Other providers like TPG (TPG 2015a) state that their NBN home phone service does not work with EFTPOS or older Foxtel set top boxes. TPG does not offer an NBN business service (TPG 2015b.2) so those subscribers not only face the disruption of having their copper disconnected but also need to find a new service provider.

FTTP is a mature technology so why is this a problem?

The fibre to the premises NBN was developed from a popular platform used by vertically integrated carriers in other countries. It was adapted for the NBN to support wholesale RSPs that are not obliged to provide telephony services. While it is obviously feasible for any RSP to supply a PSTN replacement voice service, only some have chosen to do so and all are naturally reluctant to take on any responsibility after cutting over from Telstra or their own dial-tone.

How is voice delivered over the FTTP NBN?

There are three ways an RSP can supply voice services. The first is via what NBN call the UNI-V port on the Network Termination Device (NTD). Inside the NTD is a Voice over IP (VoIP) analogue terminal adaptor (ATA) that connects to an RSP using session initiation protocol (SIP). The IP packets are carried by NBN via dedicated network capacity to one of the 121 points of interconnect (POI), where they are handed over the RSP.

It is also possible for the RSP to deliver voice services via the UNI-D port to some sort of IP connected customer premises equipment (CPE) device provided by the RSP. This can be functionally identical to the UNI-D service inasmuch as the traffic can be carried over dedicated NBN aggregation network capacity if the RSP tags the packets appropriately and acquires appropriate NBN Connectivity Virtual Circuit (CVC) services at the serving POI. A key benefit for the RSP is that they can control the CPE entirely and monitor the performance of the voice network on a call-by-call basis if necessary to ensure call quality.

Some RSPs choose to deliver voice services along with general Internet services via the 'best efforts' Internet delivery CVC. With attention to quality of service (QoS) traffic engineering it is possible to achieve a regular high level of call quality, but there are congestion situations within NBN's service level agreement (SLA) with RSPs in which this is not possible and there is no guarantee this will not coincide with the subscriber's alarm reporting a burglary or fire.

Finally subscribers can supply their own VoIP CPE which may be used with a service from their RSP or from some over the top (OTT) provider of voice services. In this situation there is little opportunity for control of the QoS and voice audio quality can be highly uncertain.

Technical challenges supporting modems

At the POI, NBN hands over UNI-V and priority voice traffic to the RSP that can either immediately move them to a time division multiplexed (TDM) network and carry them as they would traditional voice services. Alternatively, they can prioritise the transport of these packets in their network to ensure zero packet loss and minimal jitter. If a third party MPLS network is used to carry this voice traffic there may be factors outside the RSP's control that can cause packet loss or jitter and thus cause interference with the call's audio quality.

At 9600 bits per second a modem data connection is 2400 symbols per second encoded using quadrature amplitude modulation. Any loss of signal results in the decoder losing synchronisation and the modem either drops the call or re-establishes synch. This makes for an unreliable connection which slows transaction processing, leaves visible distortion on fax images or may cause an alarm monitoring service to miss a message from an alarm panel.

The widely used G.729 VOIP codec effectively regenerates human speech at the receiving end using a 'vocoder'. This makes the codec completely unsuitable for carrying modem traffic.

Technical challenges supporting DTMF

DTMF is also used for dialling phone numbers and as such VoIP ATA CPE and service provider gateways have DTMF detectors built in to look for these key presses. It can ignore the event, perhaps because it knows the call is under way or it can send a signal to the remote end of the call to say that a DTMF digit was detected (RFC2833). One reason for sending a signal is that codecs like G.729 rely on data compression techniques to deliver network efficiency and as such they don't carry the actual DTMF signal over audio reliably. So if a signal was sent the receiving end can suppress the call audio for a moment and generate a perfect local DTMF digit. You hear this sometimes when you are on an international call and a part of the remote person's voice is altered into a DTMF tone while they speak. This is being done by the VoIP system used by one of the international voice carriers handing the call.

It may not be obvious but DTMF detection ruins modem connections so it must be disabled during a modem call.

Some CPE sends an audio version of the DTMF and the out-of-band RFC2833 signal. When this arrives at the receiving end, part of the original audio DTMF digit arrives and then the local copy is produced resulting in the actual service looking for the tones becoming confused.

Are there other technical problems?

One feature of alarm diallers and often of fax machines is the 'Mode 3' wired socket that allows the dialler to disconnect all the telephone handsets connected to the PSTN line to ensure there is no interference while it makes its very important call. Making this wiring work for NBN connections is often time consuming for the installer, so in some cases it gets bypassed, leaving the consumer with a handset connected on the NTD side of the Mode 3 socket, thus rendering it useless. The NBN provide a brochure (NBN 2013a) for RSPs in an attempt to improve their familiarity with these issues including Mode 3 wiring. It is an indication of how little businesses with a solid background in providing Internet services know about providing telephony.

Does fibre to the node (FTTN) improve things?

The NBN has not published a Product Schedule for FTTN. The Test Agreement for FTTN required participating RSPs to provide any voice service via existing exchange copper (NBN 2015c). At this point it isn't possible to determine if things will be substantially different with FTTN but an educated guess is that NBN's node equipment will be able to provide an equivalent to the UNI-V service on the same copper loop that delivers the VDSL service.

The problem of double legacy equipment

There remain in use today some automated decadic pulse diallers, often part of a domestic alarm system. This is already legacy equipment on the PSTN and they continue to work only because many Telstra PSTN exchange lines are still capable of supporting decadic pulse dialling. These diallers will need to be replaced because the NBN UNI-V port does not support decadic dialling.

What about non-technical problems?

Many RSPs do not offer number portability with all the other RSPs. Some RSPs offer it with some other RSPs. Some consumers will find that their options are limited if they need to change provider due to their current provider not offering some services via the NBN that they need for the daily business. A few will discover that they are trapped on an island where they can't move away without losing their phone or fax number.

Some technical solutions

One way VoIP operators can avoid these problems is to embed a modem within the CPE either in accordance with ITU T.38 (ITU 2010) or using some proprietary system.

T.38 is specifically used for facsimile traffic. It emulates a remote fax machine and specifies the protocol for communicating with a remote station that in turn emulates a fax machine to complete the call to the recipient. Many VoIP providers support T.38 and given that a fax is often connected to a dedicated PSTN line, there is little harm in migrating this concept to the new world. Some fax machines don't seem to like some implementations of T.38 but fax machines are so cheap now that having to replace an old one is hardly onerous.

Proprietary embedded modem systems can emulate an EFTPOS service or alarm monitoring service or some other modem answering station, communicate via modem or DTMF and send communications out via the internet via the NBN or via 3G or 4G wireless. The disadvantage for RSPs is that the consumer has reduced their need for telecommunications services and in some cases their need will have reduced to the point where they don't need an RSP at all.

Some further solutions

In 2013 the NBN funded a 'Plug Bench' facility to allow equipment suppliers and network connected service providers to test their services with a variety of RSPs over the NBN. This service requires the cooperation of RSPs and many small providers do not have the resources to support providing the necessary services.

One way to improve the current situation would be to imposing a requirement that all large NBN RSPs offer the option of a legacy PSTN compatible voice service.

Another would be to require all NBN RSPs offering UNI-V services to comply with their any-to-any obligations under the CommsAlliance Local Number Portability Code (CommsAlliance 2013) and ensure they can port numbers to and from all the other telephony providers. This would have the effect of forcing some RSPs off the UNI-V ports entirely because they aren't really competent to provide 'carrier-grade' services over them.

A requirement for any RSP providing UNI-V services should be to provide a service at the Plug Bench.

And a further improvement would come from finding an economically viable way for the voice service and the data service to be provided by two different providers. Under the current pricing rules each provider would have to acquire a basic service which is a bundle of a UNI-V and a UNI-D port and that is cost prohibitive. A further barrier to this is that if an RSP does engage a third party specialist voice carrier to handle the migration of legacy PSTN services, that provider finds it difficult to achieve a local number port without disrupting the existing ADSL service on the PSTN line, because a Cat-A port will cause the PSTN and ADSL services to be both torn down and a Cat-D port will be refused because the voice carrier is not the carrier doing the NBN service migration. CommsAlliance has a working group WC50 looking at this but it is incredible how little progress there has been to date given that it's 2015 and we are rapidly approaching the millionth NBN connection.

Conclusions

The forced migration from copper to fibre was needed to move everyone from cheap-to-use copper to expensive-to-use fibre for the good of the nation. It's a little harder to understand now that fibre to the node is part of the mix, and it appears much of the voice will be provided over the legacy copper that runs back to Telstra exchanges.

The primary consequence of this forced migration is to leave consumers to choose from harmful or painful options with no clear right answer. For many the best solution is to find a way to live without the NBN for voice services.

Some of these issues would be less confusing for consumers if RSPs and the NBN made clearer statements about what is known to work and what is known to not work rather than hiding behind disclaimers and leaving it to thousands of consumers to hunt down businesses that no longer exist that sold products that are now obsolete.

I commend more suppliers of PSTN delivered services to take their devices to the Plug Bench, test them against various RSP telephony services and publish the results.

References

CommsAlliance. 2013. 'Local Number Portability', accessed at http://www.commsalliance.com.au/Documents/all/codes/c540

IiNet. 2015 'What happens when the copper gets disconnected?' Accessed at http://blog.iinet.net.au/what-happens-when-the-copper-gets-disconnected-your-guide-to-switching-over-to-nbn/

ITU-T. 1999. 'ITU Recommendation G.177' page 10

NBN. 2013a. 'Security and Medical Alarms on the NBN', accessed at http://www.nbnco.com.au/content/dam/nbnco/documents/security-and-medical-alarms-on-the-nbn.pdf

NBN. 2013b. 'NBN Plug Bench Program', accessed at http://www.nbnco.com.au/sell-nbn-services/new-connections-newsletter/nbn-plug-bench-program.html

NBN. 2014 'Disconnection in the first 15 FSAMs', accessed at http://www.nbnco.com.au/sell-nbn-services/new-connections-newsletter/disconnection-in-thefirst-15-fsams.html

NBN. 2015a. 'Connect to a better future', accessed at http://www.nbnco.com.au/connect-home-or-business/information-for-home-or-business.html

NBN. 2015b. 'Product Catalogue', accessed at http://www.nbnco.com.au/content/dam/nbnco2/documents/sfaa-wba2-product-catalogue-nebs-product-tech-spec_20150630.pdf

NBN. 2015c. 'Trial Agreement', accessed at http://www.nbnco.com.au/content/dam/nbnco2/documents/sfaa-test-description-fttn-200-end-user-trial_20150420.pdf

NBN. 2015d. 'Glossary of terms', accessed at http://www.nbnco.com.au/utility/glossary-of-terms.html

RFC2833. 2000. 'RTP Payload for DTMF Digits, Telephony Tones and Telephony Signals', accessed at https://www.ietf.org/rfc/rfc2833.txt

Telstra 2014. 'Security Alarm Systems', Accessed at https://crowdsupport.telstra.com.au/t5/National-Broadband-Network-NBN/Security-Alarm-systems/td-p/324145

TPG 2015a. 'Important Things You Need To Know', Accessed at https://www.tpg.com.au/nbn

TPG 2015b.2 'Business, Accessed at https://www.tpg.com.au/products

Continents to Islands

The effect of widespread interconnectivity on critical infrastructure and legacy systems

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Abstract: Interconnected devices and the true 'internet' cause security challenges to organisations with critical legacy systems. This article discusses a number of legacy issues around Industrial Control Systems and 'untouchable' legacy devices and proposes a number of easy and effective mitigations to the practices that expose them to the world.

Introduction

Ubiquitous interconnectivity of our devices has an amazing effect on society and our ability to respond to disasters. Widespread access to education, health information and even things as simple as weather alerts and fire warnings can save hundreds of lives with relatively little investment.

Unfortunately, although this connectivity is great for people, it has a grim effect on key pieces of our critical infrastructure—many of which are poorly understood relics of a bygone era. I would argue that we are really seeing a true 'internet' now—we are getting a world of true device-to-device interconnectivity rather than the cold war era paradigm of segmented, isolated and firewalled networks that provide partial interconnectedness.

Universal Plug and Play, NAT, HTTP tunnelling and other ease-of-use technologies mean that your iPhone-programmable Philips Hue light bulb (Philips nd) can talk to a Latvian university students' networked Quirky Egg Minder (Quirky nd) (a very real example of Internet of Things gone too far).

While these technologies are generally not supported in the workplace, ad-hoc Wi-Fi on mobile phones or unauthorised ADSL services can bridge the gap. As John Gilmore said, "The Net interprets censorship as damage and routes around it" (Elmer-Dewitt 1993).

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Internet of (Dangerous) Things

As I write this piece there are over 120 Internet- exposed devices in Australia happily chatting via the Modbus industrial control protocol to anyone that would like to have a conversation (Shodan nda).

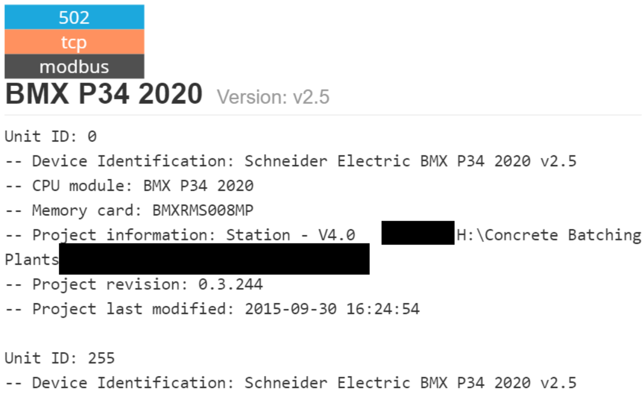

Figure 1 – Concrete batching plant controller, courtesy Shodan.io

Some of these devices control the environment of a data centre or are network controlled power devices, some control the ratios of ingredients used to mix concrete and others make sure industrial safety systems are operating in normal parameters.

Industrial Control Systems (ICS) were developed in a kinder, gentler time, when only people wearing hardhats and overalls could log into them from physically connected luggable computers to adjust a few parameters. Many of them even pre-date the now compulsory blaze orange safety vests seen on industrial sites.

While there is a new generation of secure devices available, the vast majority of still-reliable equipment in the field use naive protocols—they trust their neighbours, are happy to take someone at face value and don't lock their doors at night.

Do not be fooled into thinking this is a problem for large power and water companies. If you operate a remotely modern office building you will have network connected power ('Uninterruptible Power Supply', or UPS, is one of the most ironic acronyms of all time), heating, cooling, fire suppression, door control and a slew of other weird odds-and-ends.

While people may laugh at the networked Egg Minder, we have very similar (albeit larger scale) devices in every industrial building in the country. It's not such a funny idea when the Internet of Things is responsible for the measurements we use to determine food safety.

Real risks

In 2002 Joseph Konopka (or as he called himself, 'Dr. Chaos') (Williams 2005) was sentenced to 13 years in prison for conspiracy to commit terrorism. Konopka, a former system Administrator, recruited teenagers on the Internet to help him commit more than 50 acts of vandalism, including causing 28 power outages and setting fire to a sauerkraut factory.

While Konopka used the internet to coordinate his attacks, he relied on direct physical means (typically arson) to cause the disruptions.

Bear in mind this was prior to 'social networking' and before a lot of research on ICS was available to anyone with a data plan on their phone. It is easy to imagine what a similarly motivated person or group could do now if they were to shift their digital web defacement goals to a more direct physical facing attack.

Untouchables

While ICS are relatively easy to find and measure due to unique protocols, there is a far more insidious problem on the internet - the 'untouchable' systems.

Many readers will recognise these:

- They tend to be a 'beige box' (from original manufacture or from accumulated dust and sun damage);
- they live under a desk; and
- they have a post-it note saying 'Important 24/7 in use. Do not TURN OFF!!, Call <indecipherable> for info' on them.

Untouchable systems typically run business critical functions (as far as anyone can tell), rely on software that won't run on anything later than Windows NT and typically are only truly decommissioned during office moves or when they suck enough carpet fluff into their CPU fan that the processor dies and a series of panicked data recovery attempts begins.

As noted with ICS, untouchables tend to be 'designed' without factoring in Internet connectivity; they are generally desktop builds that require sitting at the keyboard to operate. More often than not they have no IT visibility, in terms both of risk oversight and the fact that IT people cover their eyes and mutter to themselves when passing the locations where untouchables reside.

With demands for 24-hour support, measured Key Performance Indicators and increased efficiency, it is quite common for someone to come up with the idea of installing a remote desktop tool such as Virtual Network Computing (VNC) onto these systems. Typically, this will involve having someone poke a hole in the firewall for it, giving a support officer the ability to log in from home and restart a job should an overnight batch FTP transfer fail.

Every time I've seen these services they are thought of as 'internal' and very little if any thought is dedicated to choosing a strong password or restricting their access. It's just a little work-around that 'we'll get around to fixing later'.

Figure 2 – Non-authenticated Carwash control console courtesy Shodan.io (via @yinettesys)

Shodan.io, billing itself as the 'world's first search engine for internet-connected devices' provides a treasure trove of 'untouchable' and accidentally exposed systems (Shodan ndb). I regularly use it when I encounter an unknown device in a security testing engagement to determine how common the device is and what other services it may share. All too often I've searched Shodan for a relatively obscure model number and found myself with details of an Internet exposed tape backup library or thousands of remote management consoles.

In late 2014 a website called 'VNC Roulette' appeared in conjunction with the German Chaos Computer Congress (Stevenson 2014). It used VNC server scan data to connect visitors to an unauthenticated VNC system at random when they visited the page. This project was spun up largely because of the one gigabit per second internet link available at the congress, and was likely inspired by the public but 'non-interactive' disclosures of open VNC systems by Dan Tentler (Tentler 2014).

Screenshots show people finding themselves (virtually) at the controls of a water pumping facility, alarm systems, an Android mobile phone or the audio visual controls for a meeting room. Many delegates took the legally questionable effort of securing these systems for their owners.

Although the site has been taken down by the operators, it is worth noting that a vaguely motivated party with basic computer skills could reproduce this tool in a fully interactive way by watching a couple of Youtube videos. High bandwidth, cheap server hosting is provided by cloud vendors, typically by the hour, allowing this to be done in hours for tens of dollars.

Boxing or Judo?

Security is an ever-evolving struggle between our attempts to make a system difficult to breach while still being usable, efficient and cost effective. As much as it pains security teams, the convenience of internet (or commercial network) connected control terminals far outstrips the security demands of isolating these devices. In places where interconnectivity is prohibited, there is a tendency for team members to find inventive ways around the larger IT policy in order to meet the demands of their own work. In many cases, this will involve a sneaky 3G dongle here or a rogue ADSL link there.

Security and networking teams really need to work with their businesses and go where the organisation is heading. As much as you would like to ban web browsing in the workplace or prohibit Bring Your Own Device, outside of restricted government areas this tends not to be a viable option.

Implementing 'bastion' hosts to control access to sensitive environments helps secure the critical systems, isolates them from the general desktop fleet and lowers support costs by reducing the number of systems that need custom software installed to manage devices.

Lack of any policy is worse than a non-workable policy and you will find little clusters of cloud services springing up, from teams with private Dropbox clusters replacing your painful per-share provisioning process through to your enterprise source-code on a free Github account because your Subversion repository isn't as friendly to use.

Work with your users, shift their direction and use their momentum like a judoka rather than trying to beat them down like a boxer.

Fixing the mess

Unfortunately, most security and network design takes places at a project level, where a system is considered as a whole, with the inputs and outputs mapped and the importance and functions of various systems entered into a matrix. We rarely revisit these assumptions or the moving targets they were made around.

From my perspective there are four key strategies to deal with the obvious disasters lurking around the corner with increased interconnectedness:

1. Put controls into the purchasing and provisioning processes at your organisation – for all purchases, implement non-technically-worded governance processes to ensure that passwords are chosen and basic security controls/access restrictions are in place.

Know how old systems are and plan for their periodic replacement. IT teams can be easy to ignore but, much like in cybercrime, we can 'follow the money' to identify unsupported computer or device purchases. Likewise, ADSL links on the corporate phone plan should trigger an IT ticket to ensure that they are authorised and adequately controlled.

2. Revisit what you have – network scans are cheap and easy. Blow the dust off the logs from your perimeter Intrusion Detection System and you'll see that hundreds of aspiring computer criminals around the world can manage to scan your environment so surely you can too. We tend to look at IT infrastructure and networks through the keyhole of projects and risk management. A quick periodic perimeter scan and a comparison against previous results will help you find unmanaged systems, accidentally exposed services or stealth changes made outside of change control.
3. Engage collaboratively – as noted above, a ban will give people a reason to route around you. If you are applying a good risk management approach, you will need to identify where you can compromise and make a 'better than nothing' choice in order to save up your political capital for when you really must put your foot down. IT and networking in modern businesses are advisors, not wardens. As I heard Laura Bell ('Stilgherrian' 2015) say earlier this year: 'We need to create an environment where it's actually safe for us to go: "This feels funny. I do not like this. Hello, people, look at this. Does this look strange to you?" '.
4. Build a security culture—Talk to staff members regularly about security and why it is important, especially in the context of your business. Posters or yearly online training courses do not change the way people think about things; they need regular, light touch points.

References

Elmer-Dewitt, P. 1993. "First Nation in Cyberspace". *Time*, December 6, 1993.

Philips. nd. Hue Developer Program. Available at: http://www.developers.meethue.com/documentation/getting-started.

Quirky. nd. '" EggminderSmart Egg Tray". Available at: https://www.quirky.com/invent/243958. (n.d.).

Shodan. nda. Available at: https://www.shodan.io/search?query=port%3A502+country%3Aau.

Shodan. ndb. Available at: https://shodan.io. (n.d.).

Stevenson, K. 2014. Available at: https://medium.com/@kylestev/open-season-on-vnc-servers-around-the-world-4b89a0f8d992#.upg2z0hyb.

'Stilgherrian'. 2015. "Spearphishing and how to stop it: Some lessons from AusCERT". Retrieved from ZDnet: http://www.zdnet.com/article/spearphishing-and-how-to-stop-it-some-lessons-from-auscert/

Tentler, D. 2014. "Atenlabs – Scanning the whole internet". http://atenlabs.com/blog/scanning-the-whole-internet/ . (n.d.).

Williams, J. 2005. 'SUPERVILLAIN' GETS HIS ARSON SENTENCE TOSSED 'DR. CHAOS' WINS AN APPEAL ARGUING THAT A FEDERAL STATUTE SHOULDN'T APPLY TO ARSON CRIMES. *Madison*, Jun 1,2005.

It's Time: Reimagining Universal Service for Digital Life

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Abstract:

This article provides a brief introduction to a timely set of papers critically discussing universal service in telecommunications and proposing policy option. This is a longstanding public policy issue, moving once more into the foreground in Australia. The article puts the papers into context, and argues for the need to reconnect universal service policy with fertile and productive research, policy, social and technology innovation in other areas. Finally, the paper argues for the urgent need to fundamentally reimagine universal service to achieve the still relevant goal of access for all to essential communications technology.

Introduction

Universal service, or the idea of providing a communications service to all, has been a much debated concept in telecommunications policy over the past 25 years, across the world. It has been especially significant in the Australian context.

Australia has been responsible for an innovative approach to universal service, following its definition in the 1991 *Telecommunications Act*, in which it was a threshold social policy to establish the transition to a fully competitive environment. A further innovation occurred with the 1997 amendments that saw accessibility for consumers with disabilities formally incorporated in the universal service obligation (USO). Finally, and most dramatically perhaps, is a development formally outside the universal service framework, but which has proven most consequential upon the concept: the establishment of the National Broadband Network, which has set the stage for a quantum leap in the effective level of the universal service – allowing citizens to expect a broadband service as a national entitlement.

Alongside these innovations in Australian universal service policy, we can place the many criticisms of the suitability, adequacy, efficiency, effectiveness, and fitness-for-purpose (in relation to aims of competition and functioning markets, as well as social and cultural purposes, and needs of consumers) of the now dated USO. For many years, criticism of the USO has been mounting from all quarters: industry, consumers, researchers, and policymakers. With the expectation that government will act soon to review and remake universal service policy, this set of four papers could not be published at a better time. In 2016, a year when various media and communications issues are on the table for deliberation by the Turnbull Coalition government, none is more important than universal service – and it deserves a much more rigorous, wider, comprehensive policy, academic, and public conversation than it has had for a long time.

The impetus for this dedicated public policy section of the *Australian Journal of Telecommunications and the Digital Economy* was the remarkable *Rethinking the Universal Service Obligation* event, organised by the Australian Communications Consumer Action Network (ACCAN), held in Sydney on Thursday 12 March 2015. Facilitated by Rosemary Sinclair (chair of the 2011-2012 Regional Telecommunications Review), this day-long workshop included a wide range of commentators and stakeholders. Amid strenuous debate, it generated a palpable sense of shared purpose.

Broadly, there was a consensus that:

- the current policy framework was outmoded;
- the fundamental uses, requirements, expectations, and desires of Australian consumers and users (be they individuals, households, business or institutional users) had moved far beyond fixed-line telephony to embrace Internet, social, and mobile media; and
- the dynamics of business, industry, economic activity and innovation were not adequately captured by the USO of yore.

For some present also, there was a stark confirmation of a 'democratic deficit', in various senses, between the pro-social possibilities of contemporary digital technology, and the political settlement of the 1991-2015 USO.

The four papers published here provide an invaluable guide to the state of play of these debates. Three of the authors – Reg Coutts, John de Ridder and Holly Raiche – are veterans of the universal service debates, and each has made significant contributions over many years to the understanding and improvement of Australian telecommunications. The fourth author, Rachel Thomas, is a fresh voice in these debates, and draws on considerable expertise in public policy and economics, as well as the longstanding credentials of her organisation ACCAN, to provide a new framework in universal service.

Taken together, the authors' papers suggest that the challenge for all of us in what lies ahead is in marrying the various aspects of universal service policy in its contemporary setting, while doing justice to the transformations involved in digital technologies. All of the authors are in furious agreement about the broad parameters of the present conjuncture. Namely, however it might be phrased, it's a digital life. Digital technologies have become taken-for-grant in everyday life.

To be sure, in Australia especially, we lack good, detailed, longitudinal data – on the use, consumption, and implications of Internet, mobiles, social media, and associated technology – to really gain an accurate picture of Australian digital transformations in the way that, for instance, *Pew Internet and America Life* project does for our North American counterparts. We especially require nuanced, precise knowledge concerning the various groups, communities, and demographics, and the social, cultural, linguistic, gender, and other dynamics that comprise the Australian population to properly understand the 'demand' side of current and future communications.

Better research aside, in many ways, the problem might lie in the fact that universal service policy (especially given its origins in telecommunications policy) has become divorced from the more dynamic social and technological innovation and policy trajectories of digital technologies (especially given computers, Internet, and mobile phones have originated in different kinds of markets, social imaginaries, and legal and policy traditions).

Coutts and de Ridder, in particular, make reference to mobiles as an obvious and essential element in universal service policy. This is something that first began to be proposed approximately a decade ago, and that has been a mainstay in design of universal service, access, and associated policy in developing countries and emerging markets, in particular. Yet mobiles have not been well integrated – if at all – in the universal service policies of the 'global North' countries, especially those members of the Organization for Economic Co-operation and Development (OECD). Mobiles have yielded remarkable universal service-like effects – notably with the invention of pre-paid charging. Yet the near universalisation of mobiles as the mainstay of communications for billions of consumers globally – and for most Australian consumers – and has remained oddly divorced from the issues that universal service needs to address. This gulf is obvious in the 'work-arounds' and glaring omissions that characterise Australian telecommunications affordability policy (discussed by de Ridder).

Thomas draws attention to the need to base universal service policy on fundamental sound accounts of humans, why they communicate, and what the social as well as economic implications of such communication – if properly supported – might be. In particular, she draws on the 'capabilities' and development approach of the distinguished economist and philosopher Amartya Sen, to argue for a holistic approach to universal service and broader communications policy. In doing so, her argument reminds us of two vibrant bodies of work that have gained in richness and influence over the past two decades – precisely because of the need internationally to understand the profound ways in which digital technologies undergird daily life.

The first of these is the work in the ICT4D (information and communication for development) and M4D (mobiles for development) area, exploring the ways to better design technology and policy for local and regional users and communities. The second body of work is that of social policy, sociologists, and political scientists in seeking to find new concepts – digital divide, social capital, social inclusion and exclusion, social innovation, social entrepreneurship, a renewed focus on understanding the persistence of social inequalities, connective action, and so on – to understand digital technologies.

The point here is that there has been much generative, new thinking and practice going on in relation to how we can provide wider, and even universal, access to all when it comes to Internet and mobiles. However, these kinds of rich undertakings have not been well joined up – if at all, really – to universal service policy discussions.

In her article 'From Universal Service to Universal Communications', Raiche offers a cogent, historically-attuned analysis of the peregrinations of universal service policy in Australia. What emerges from her account are two things. In agreement with the other authors, Raiche concludes that 'the 1997 version of the USO does not reflect the way people communicate, the technology they use, or the new regulatory framework'. By new regulatory framework, Raiche is especially referring to the National Broadband Framework, but also to the Coalition government's signature e-government policy – the Digital Transformations Office. What is evident, as Raiche's paper proceeds, is the way that basic policy rationality has failed when it comes to recent USO policy. Most glaringly, the various decisions made along the road to the NBN – notably the contracts struck between the government and Telstra – constitute roadblocks to rethinking the USO. Instead there has emerged a kind of incrementalism that tended to play out behind the scenes. The cost of eschewing good public policy and open democratic discussion has been our current convoluted, patchwork, and ultimately straitened USO.

Against the background of these tangled histories, to echo and amplify the cadence of Raiche, we sorely need a 'newly-imagined universal service obligation'. What former Parliamentary Secretary Paul Fletcher described as the 'underlying policy intention' of USO – 'providing Australians reasonable access on an equitable basis to telecommunications service wherever they live' – remains sound, and obtains broad agreement. How we reimagine this – now, with urgency – to ensure that all Australians share the bounty and gain the capabilities of digital technologies, is the task now at hand; and we thank the authors for getting us well and truly started.

Into the bargain we are grateful to Mark Gregory, the managing editor of *AJTDE*, for his hard work and perseverance, in making this special section a reality. Thanks are also due to Blair Feenaghty and other stalwarts of the *AJTDE* production team, editorial board, and reviewers for their dedicated and unsung labours. *ATJDE*, and its predecessor, the *Telecommunications Journal of Australia* have been the journals of record for research, policy development, and discussion of universal service – so hopefully this latest service to the field will be rewarded by robust debate, stimulating, in turn, better and fairer policy for the future.

Better telecommunications services for all Australians

Further Thoughts on the Universal Service Obligation

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Abstract: The Universal Service Obligation (USO) scheme we have in place in Australia in 2015 was put in place over 25 years ago when the world was very different than what it is today. The paper documents how the current USO entrenches an annual subsidy of some $300 million to Telstra to provide a standard telephone service over an aging copper infrastructure to regional and remote premises across Australia. The current expensive USO scheme is inadequate for people in remote and regional Australia and in the light of the NBN roll out and the demand for mobile services is in urgent need of review. The paper reviews the approach taken to providing high cost telecommunications services in rural areas both developed and developing economies across the world and draws lessons for devising a basis for a way forward. Given the now bipartisan acceptance of the rural and remote component of the NBN roll out and drawing on these lessons, now is the opportunity to scrap the current USO scheme and establish a Universal Service Fund (USF) where the NBN is the Universal Infrastructure wholesale provider with alternative retailers. The paper supports five practical interrelated recommendations that diverts current USO funding to ensure broadband and mobile services extension in rural and remote Australia as well as reimagining future payphones around public WiFi and rural community innovation.

Introduction

Three decades ago, prior to the internet, most Australians – especially people living outside major cities –used a fixed line telephone. Mobile phones were in their infancy, and public payphones were a vital communications service outside the home.

The main role of the Universal Service Obligation (USO) was to provide funding to Telecom Australia (in 1995 becoming "Telstra"), to maintain its copper access network in regional areas where it was deemed uneconomic. This infrastructure subsidy has been funded largely via a levy on telecommunications companies.

In 2015, the Australian society and economy have been forever and fundamentally altered by the internet and new telecommunications technologies. Smart devices and mobile

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telecommunications have increased connectivity, grown the economy and jobs, enabled new industries and boosted productivity.

Consumers are demanding improved mobile coverage, devices are becoming more data-hungry and businesses want access to next-generation networks to improve productivity. Consumers now expect a choice of providers so that they can examine who is best able to meet their needs and give them the best deal.

Unfortunately, public policy on delivering access to the benefits of modern technology outside our major cities is stuck in the past.

The NBN gives Australia a unique opportunity to close the digital divide between city and country by massively improving access for voice and broadband data services using new technologies. With the profound changes the NBN will deliver, government funding and policy arrangements need to change.

As it stands, the USO is a costly and ineffective scheme that is holding Australia back and treating people living in regional Australia as second-class citizens. Through the NBN, taxpayers are spending billions of dollars funding the replacement of copper lines in regional areas, with fixed-wireless and satellite, for the delivery of internet services. Yet in the same areas, taxpayers also help fund Telstra to maintain its copper wire network for fixed-line home phones despite the intrinsic capability of fixed-wireless and satellite technologies to provide a high quality telephone service.

A new, smarter approach is needed. Overcoming the roadblocks to competitive investment in regional Australia will ensure consumers and businesses receive greater coverage, better value, better service and greater innovation.

Vodafone commissioned the author to analyse the current USO and propose recommendations to reshape the USO for the 21st century to deliver reliable communications services for all Australians. The report (Coutts 2015) was released in July 2015 and was included as an attachment to the Vodafone submission to the Shiff Regional Telecommunications Review.

This paper is based on this report (Coutts 2015) and references the final report of the Shiff Regional Telecommunications Review released in November 20115 and also references the ACCAN-commissioned Occasional Paper on the USO by John De Ridder.

Background

When it was created almost 30 years ago, the Universal Service Obligation (USO) scheme was leading-edge public policy. When the Australian telecommunications market was deregulated, the USO was created to ensure that standard telephone services and payphones were reasonably accessible to all people in Australia wherever they resided[i]. This was when the dominant form of communications for Australians was the fixed line home phone and payphones were considered a necessity.

Almost three decades later, the telecommunications market is vastly different. Internet and mobile services are now considered by consumers to be essential and access to fast and reliable broadband is seen as very important. The deployment of fast 4G services has resulted in Australians becoming some of the fastest adopters of internet-enabled smart phones in the world.

The rollout of the NBN will see further changes in the telecommunications market as over time the old copper access network will be made redundant by a mixture of fibre optic cable, fixed wireless and satellite technologies. The NBN can also be used to deliver improved mobile services, particularly in regional Australia.

Despite these enormous changes and the increasing use of data, the USO remains in its original outmoded form as a costly subsidy scheme for fixed-line phone services delivered over the copper wire network[ii]. Each year, the telecommunications industry and Australian taxpayers spend approximately $300 million maintaining ageing copper wire and payphone networks under the complex and opaque USO arrangement (TUSMA 2014).

The NBN rollout and the increasing consumer preference for mobile services anywhere, anytime means now is the ideal time to have a discussion about how best to reshape the USO for the communications needs of today and the future.

The Federal Government has acknowledged the need to modernise the USO. For example, the Agricultural Competitiveness White Paper released in July 2015 (Australian Government 2015) states that "traditional policy responses need to be updated so that internet connectivity can be funded as an essential service."

Australia has the opportunity to create a new universal service scheme that delivers reliable voice and internet services for all Australians using a range of technologies through the NBN.

In addition, some of the current USO funding could be used to improve mobile coverage and choice in regional Australia by co-funding much-needed infrastructure in remote areas and by creating incentives for the industry to innovate, further invest in and share mobile networks.

The report made five interrelated recommendations to replace the current USO scheme with a more transparent and efficient scheme that uses the NBN as a springboard for change. The report did not address other similarly challenging communications services to extend to rural and remote Australia, including the Triple Zero emergency service and Public Safety Mobile Broadband. These could however be incorporated in the proposed scheme.

This paper has provided me the opportunity for further thoughts on the USO particularly given the publication of the Regional Telecommunications Review (Shiff 2015) and the ACCAN Occasional Paper by John De Ridder in late 2015 (De Ridder 2015).

What is the USO?

The USO is an industry and taxpayer-funded scheme designed to ensure that all Australians have access to a 'Standard Telephone Service'[iii] and that payphones are reasonably accessible.

The USO was created to ensure that a voice telephony service could be provided, even in remote uneconomic areas. The *Telecommunications Act 1991* provided that Telstra would bear the USO and all telecommunications carriers would be required to contribute to the cost of it.

Prior to 2012 the Minister, based on advice from the Australian Communications and Media Authority, set the annual level of USO funding. In July 2012 Telstra entered into a contractual obligation to deliver the standard telephone service for a term of 20 years. At this time, the government increased the annual USO levy provided to Telstra and included an annual Budget contribution of $100 million from 2014-15.

Currently, $253 million per annum is allocated to the provision of a standard telephone service, with $44 million per annum allocated to the provision of payphones (TUSMA 2014). It is important to note that funding is provided to deliver uneconomic infrastructure. In effect the current framework brings together the 'infrastructure-provider-of-last-resort' and the 'service-provider-of-last-resort' obligations. With the delivery of the NBN this intertwining of obligations requires a rethink.

Once the NBN is rolled out, Telstra will deliver the standard telephone service over NBN technology within the NBN fibre footprint. Outside the NBN fibre footprint, which includes much of regional Australia, Telstra is required to provide a standard telephone service, largely via its ageing copper network. This appears to be a conflated and redundant requirement given the NBN has in effect become the 'Universal Infrastructure Provider' using modern technology platforms. 'Service provider of last resort' obligations could now be provided by a wider range of providers in more flexible and innovative ways.

Evolution of the USO

When the USO was introduced, Telstra as the incumbent national carrier was chosen to deliver the standard telephone service to high cost/low revenue regional and remote areas. As part of industry liberalisation, all telecommunications service providers contribute to the USO fund in proportion to their industry revenue.[iv]

Over the period of the next 10 years from the mid-1990s, governments conducted a number of reviews to enable the USO to be more technology-relevant and sustainable, with minimal change to the USO as a result.

After much public discussion, the USO service definition was modified to include data[v] and services to enable better access for people with disabilities. Despite attempts to introduce provider contestability and to review ways to improve transparency to the cost of the subsidy provided to Telstra, few changes were made.

Further, the definition of the USO solely around the fixed telephone began to be questioned (Coutts 2004). Despite the significant increase in the reliance on mobile services, including in regional and remote Australia, there has been a reluctance for any policy intervention to deliver greater mobile coverage as part of the NBN.

Mobile services are now considered by many Australians to be their primary avenue of access to broadband and telephony services. Since the launch of 3G HSPA, HSPA+ and 4G LTE data services, mobile has become a reliable and fast mechanism to deliver broadband for many people in regional Australia.

Despite the changes to consumer behaviour (and priorities) and the developments in mobile services, the policy debate about broadband delivery remains focused on fixed services. The more recent policy conversation has been focused on the political debate about the NBN, preventing a fresh analysis of the role of a universal service scheme or consideration of how best to reshape the policy framework.

To put the USO in perspective, the evolution of USO policy can be described in four distinct successive phases.

Phase 1: Coverage

In the early development of telecommunications it was recognised that the value of a telephone increased with its interoperability with more people who were connected. This is the 'externality value' that still applies in many developing markets. The argument is then made for an internal cross-subsidy by the monopoly incumbent to deliver a broad geographic service. A monopoly solution was seen as an acceptable model, largely because this was how telecommunications services were provided up until the 1980's and 1990's.

Phase 2: Affordability

In a developed economy, competition is progressively introduced in high margin segments such as long distance calls. The need for a USO-type scheme is argued to ensure affordable access to all citizens. This is usually funded by the industry rather than by government. Relative to the US that entered this phase in the early 1970s, Australia started this phase in the early 1990s. Competition was the main driver for reducing prices but if there were monopoly areas then the infrastructure subsidy of the USO tacitly expected that these areas would not pay higher prices.

Phase 3: The Internet

The third phase accelerates from the mid-1990s with the transformative impacts of the internet and mobile services. In this phase the standard telephone service is no longer the universal service, broadband has become the norm and smart phones have become an essential tool for both internet access and telephony.

The convergence of telecommunications with information technology and broadcasting and the growth of Over the Top (OTT) services results in reduced viability of levying only telecommunications companies as part of a USO scheme. At the same time, the USO payments to one telecommunications entity, which is usually the original incumbent, distorts competition in higher cost areas, particularly rural and regional areas.

Phase 4: Digital Convergence

Given the convergence of fixed and mobile technologies, the need for integrated fixed and mobile broadband must now be recognised. In Australia this requires a modification of the original strategic decisions behind the NBN, and an examination of the role that the NBN can play in delivering better mobile services in addition to fixed broadband services. It also requires changing the current USO to a more transparent and efficient scheme that uses the NBN network to bring improved services to more Australians.

While there are some programs that facilitate the provision of mobile services, there are no examples overseas of the Phase 4 of the USO policy evolution where governments have committed to an intervention in universal broadband, although the United States is in the process of attempting change. In my view, Australia has the opportunity to be again at the forefront of this policy approach with a forward-looking *Universal Service Fund* (USF)[vi] to replace the USO funding mechanism.

Overseas experience with universal service schemes

Both developing and developed countries continue to grapple with how to intervene effectively in telecommunications markets for the national good. A key observation from experiences overseas of the last 10 years of a universal service scheme, particularly in developed countries, is that these schemes have not been developed to take into account the rapid adoption of new technology.[vii] Indeed, some of the major innovations in universal service policy are in fact coming from developing economies (ITU 2007).

A theoretical framework for universal service schemes has been developed by the International Telecommunications Union (ITU). This defines the two components of the Universal Access and the Service (UAS). The ITU has reviewed the approach taken to policy and implementation of UAS around the world (Intelecon 2009).

European Union

There have been moves to broaden the USO service definition in the European Union to incorporate broadband policy objectives in universal service and access strategies, but there has been a reluctance to include mobile services. There is currently a variety of USO arrangements across Member States.

The European Commission's response is illustrative of the glacial pace of progress. The EU Universal Service Directive introduced a requirement that the scope of universal service obligations be reviewed every three years. To be included in the scope of a universal service policy in the EU, a service has to satisfy two tests:

(a) In the light of social, economic and technological developments, has the ability to use the service become essential for social inclusion?

(b) Are normal commercial forces unable to make the service available for all to use?

This is a somewhat backward-looking perspective, and continues to neglect the need for subsidies to enhance not hinder competition.

United States

In the United States, the $4.5 billion Universal Service Fund (USF) covers a myriad of services. Since 2011, the USF has included broadband and mobile. While it is highly complex, it does take a broad funding approach as I recommend rather than being service-specific like Australia or Europe (KPMG 2012).

Latin America

Latin American countries have been successful in using reverse auctions as a way to achieve competitive tension and allow for the provision of services in areas which have previously not been serviced.

For example, Chile implemented an innovative USO policy that has both achieved spectacular results and confirmed the value of a transparent process. The Chilean approach is based on government funding for specific projects via a competitive tender process. This has resulted in minimising the need for state funding and achieving greater leveraging of private investment with subsidies determined by market forces rather than administrative determinations (World Bank 2002). I note that the Australian Government's Mobile Black Spot Programme has incorporated a similar approach and has garnered significant community support.

In developing countries, mobile broadband offers the most attractive platform for introducing integrated broadband, making no distinction between fixed and mobile. In Mexico, for example, the Government proposes a single mobile wholesale operator initially owned by government but to be then sold.

Africa

The African continent in particular has achieved seen tremendous growth (ITU 2007) in tele-density as a result of the adoption of mobile communications effectively 'leap-frogging' the need for a fixed telecommunications infrastructure as we have known it. A number of countries in Africa are considering mobile broadband and USF schemes to provide affordable access to all.

The potential of a single LTE broadband mobile wholesale has recently received a lot of interest to extend mobile coverage into regional areas (Frontier Economics 2015).

Broader international activity

The ITU World Regulatory Database helps in detecting trends in regulatory practice. Summarising the data supplied on universal service policies over the last 14 years (Hernandez 2014) indicates that:

- Universal Access and Service Funds are rising in popularity, and in 2007 were used in 60 per cent of countries that responded to the ITU survey;
- Obligatory investment in unprofitable areas has correspondingly been declining in popularity; and
- The use of state-imposed tariff controls to benefit all customers or just to benefit specific eligible groups has declined steadily since 2003 and dipped below 20 per cent of respondent countries in 2007.

The OECD has examined reforming the USO for what are called 'next generation' networks where service evolution is considered in a broad service architecture (Xavier 2006). To create an updated USO, it states that the challenge has moved from simply ensuring equitable access to voice services to including broadband, content and applications (Dymond 2010).

In summary, some of the good practices from overseas are:

- The definition of 'essential services' is updated in policy;
- The move towards a Universal Service Fund model to fund required infrastructure and services in regional communities;
- The use of reverse auctions as a way to achieve competitive tension instead of using an administrative approach to costing subsidies;

- The move away from relying on telecommunications industry taxation towards alternative models to fund subsidies; and
- The use of 'smart subsidies' to leverage public investment from telecommunications providers and communities.

It has been argued that there is no economic argument for a universal service scheme in developed economies and that it is just another tax on industry (Cato 1998). If this approach were followed in light of the current Federal Government's deregulation agenda, the USO could be seen as an easy target for removal. In its current guise, the argument for abolition of the USO is compelling. It is essentially an anti-competition tax on industry to benefit of the already dominant telecommunications provider.

In the author's view however, reform of the current USO presents an opportunity for targeted subsidies to protect regional consumer interests and promote competition and innovation.

Rethinking the USO

The current out-dated 'one size fits all' USO scheme has resulted in unintended consequences – taxing some companies and their customers, distorting competition, blocking innovation and subsidising one industry participant at the expense of others.

Over more than a decade, four successive Regional Telecommunications Reviews have all commented on the increasing failure of the USO to achieve its perceived purpose. Unfortunately, successive governments have failed to act to address the crucial role affordable access by all Australians to modern telecommunications plays in our economy and society.

The 2002 Esten Review (Estens 2002) said: "In particular, we found that the current Universal Service Obligation (USO) arrangements are not working well. Nearly all stakeholders are dissatisfied with them and they are neither practical nor functional for modern telecommunications."

The 2008 Glasson Review (Glasson 2008) identified that a new regulatory framework was needed to replace the existing USO legislation and noted that the transition to the NBN provided a clear opportunity to reform the USO.

The 2012 Sinclair Review (Sinclair 2012) made a clear recommendation for greater mobile coverage including the consideration of regional roaming. The current Government has recently announced the first round of implementation of the Mobile Black Spot Programme under a policy approach that incentivises co-investment as discussed later in this report.

The 2015 Shiff Review (Shiff 2015) has agreeable synergy with the author's earlier report and reinforces the need to consider mobile service. However, the report stops short of making recommendations on how to expand mobile coverage, presumably under some belief that policy intervention in the mobile sector is either not warranted or too risky.

The objective of any universal service scheme is to provide an economic incentive to invest in infrastructure to enable affordable access to basic telecommunications services where it is uneconomic to do so without the incentive.

Under the current USO scheme, the most profitable market participant receives 100 per cent of the benefit of the scheme, which results in significant market distortion. With the significant changes in the telecommunications market, including the construction of the NBN fixed wireless and satellite networks in regional Australia, the current USO funding of the copper access network in particular is increasingly redundant.

Consequently, the current USO scheme needs to be urgently updated to address inadequacies in regional telecommunications infrastructure for voice and internet services that cannot be addressed by market forces alone.

The roll out of the NBN to regional and remote premises provides the opportunity and basis for updating the current USO and moving to a *Universal Service Fund* approach. The worldwide trend to a *Universal Service Fund* approach provides for better targeting of the incentive and avoids the narrow legislative prescription of the basic telecommunications service. The 2015 Shiff Regional Telecommunications Review (Shiff 2015) has recommended the establishment of a Consumer Communications Fund which is in line with my recommendation for a USF.

In short, a modern telecommunications infrastructure underpins the digital economy, particularly in regional and remote Australia where its contribution, for example, to the Agricultural sector is recognised. A Universal Service scheme via a *Universal Service Fund* makes sense in Australia because it can improve access to telecommunications services in regional areas where population densities are low and it is often uneconomic for the private sector to provide such infrastructure.

The increasing importance of mobile and the need for choice

For many regional Australians, mobiles are increasingly more important than fixed telephone services (Empirica 2014). Despite this, competitive mobile services are not available to many regional and remote areas of Australia.

The initial starting premise for my report and this paper was that mobile services should be part of a reformed universal service scheme. Today's mobile services support voice and data and have been progressively recognised (Coutts 2004) as an essential element of a modern universal service scheme.

Even though mobile phones are now widely accepted as a way of providing voice and data and are also used to provide public access, developed countries have to date not used USO-style interventions to provide better mobile coverage in rural areas. Policy makers have been wary not to distort the competitive rivalry in addition to coverage licence conditions[viii]. Meanwhile, in developing countries mobile services are often recognised as the only way to provide an accessible and affordable broadband communications service. Developing countries have been less wary.

While there has been an assumption by successive governments in Australia that mobile carriers would continue to expand coverage, the investment required to improve networks is prohibitive where there are large distances and small markets. However in Australia in particular the coverage disparity between Telstra and its two rivals has been increased by actions by State Governments and other factors further deterring regional investment. The build economics in many places in regional Australia mean that even one infrastructure network is not viable without subsidies.

There is, however, a smarter way to approach the issue of mobile coverage expansion beyond the existing coverage footprint by using government funds to encourage private sector investment and boost industry collaboration.

The Federal Government's Mobile Black Spot Programme was borne out of the need to provide coverage to places where it was uneconomical for the mobile carriers to build the infrastructure needed to deliver a mobile service. Unfortunately, State Government intervention[ix] again distorted the potential of this program.

Under the Programme the Government is offering subsidies to improve the business case for coverage expansion, thereby accepting that there needs to be an intervention in the market to deliver coverage to many places outside of the existing coverage footprints of the mobile carriers. By requiring the winning bidder of a site to explore opportunities to share or co-fund with other mobile network operators, the Programme is also helping to create a more competitive market in regional areas.

The Mobile Black Spot Programme process has identified more than 6,000 black spots in need of coverage expansion. The $100 million in Government funding for the first phase of the Programme and $60 million in funding for phase two is a good start in tandem with state government and carrier funding.

The Programme is not enough by itself, however, to deliver improved coverage to every inhabited area that requires it. In my view, a modern policy framework that addresses the need for mobile coverage expansion and competition must include a rural wholesale mobile infrastructure option.

To further improve mobile coverage and choice in regional Australia, this paper therefore recommends that a portion of the current Government USO funding of $100 million per annum be diverted to an expanded Mobile Black Spot Programme. This will provide a sizable fund to improve and expand mobile services and competition in regional Australia. An ongoing[x], as opposed to ad hoc, programme would have the additional benefit of providing greater opportunities for industry collaboration for infrastructure sharing and more strategic long term planning by regional communities about what are the long term objectives of their telecommunications requirements.

The opportunity provided by the NBN

In 2009, based on recommendations of an expert group, the Federal Government announced that it would fund the construction of a wholesale-only fixed National Broadband Network (NBN) to provide broadband services to all premises in Australia, including the remotest seven per cent.

This remote portion was estimated to account for some 25 per cent[xi] of the total capital cost of the NBN. The NBN will deliver broadband services via a mix of fibre optic cable, fixed wireless and satellite to urban, regional and remote consumers.

The NBN will not provide a standard telephone service to the remotest seven per cent of Australia (nbn 2015). It is proposed that these premises will receive NBN fixed wireless or satellite internet services, but will continue to rely on the ageing copper wire network, or equivalent, for their telephone service. As will be discussed below, by proscribing the technology solution, government policy has established dangerous rigidities in objectives and outcomes.

In the recent Vertigan report, the net cost of delivering the NBN's fixed wireless and satellite services has been estimated at $6.1 billion (Vertigan 2014). This represents a huge investment in broadband for regional and remote Australia, and shapes the context for any discussion of a reformed USO scheme.

The case for reform of the USO in Australia has been building for more than ten years as a result of rapid technological change and convergence and a more competitive market. The rollout of the NBN presents an opportunity to manage the progressive retirement of the redundant copper wire network that underpins the current USO scheme, providing an ideal case for urgent reform.

We need to recognise that the entire copper wire network will be retired over time, not just in the metro fibre rollout. The NBN fixed wireless and LTSS satellite services can both provide a high quality telephone service. USO funding can accelerate this opportunity and enable a wider range of better solutions where the standard NBN project cannot deliver the requirements.

It is therefore difficult to justify taxpayer funding to Telstra for the upkeep of a redundant copper wire network while also funding the delivery of superior fixed wireless and satellite services to the very same premises.

The fixed wireless network the NBN is deploying is using point to point LTE technology that is capable of delivering a high quality Voice over LTE (VoLTE) service. The NBN satellite delivery of broadband is also capable of delivering a telephony service called Traffic Class 1 (TC-1) which will benefit remote and indigenous communities in particular. In the long term future satellite deployments (or partnerships) could deliver even better low latency solutions.

The scope of NBN's fixed wireless mandate should be extended to provide an open-access wholesale 4G mobile network that would significantly improve the depth of coverage to residences over the more targeted individual coverage of the three mobile network operators.

Further, the NBN could also provide access to its infrastructure on reasonable terms, including facilities and backhaul, to facilitate the supply of better mobile services in rural and regional areas. A modernisation of the current USO scheme could help fund these important extensions to the NBN network and may go some way to addressing competition distortions caused by current policies in these areas and to reducing the overall funding burden associated with the current cross-subsidy arrangements.

This paper recommends that the Government formally designate NBN as the *Universal Infrastructure Provider* to connect all premises in Australia. This is already part of its roll out remit and would mean that all Retail Service Providers on the NBN would be able to provide voice and broadband services to all premises in Australia.

In parallel, this paper recommends that the Government direct NBN to develop a project plan to assist the industry to expand competitive mobile services in regional Australia by providing access to NBN backhaul and by upgrading its fixed wireless towers to deliver a wholesale 4G regional mobile network. NBN's objective should be to deliver improvements in both fixed and mobile voice and broadband services.

The Government should also plan the phased diversion of USO funding from Telstra to NBN to help fund its Universal Infrastructure Provider obligations via a new *Universal Service Fund*. This fund could help deliver infrastructure to premises and mobile base stations. Consideration should also be given to provide funds for NBN to upgrade its fixed wireless network to enable a wholesale regional 4G mobile network.

Bringing payphones into the modern era

The USO includes the provision of public payphones, the need for which has been challenged by the routine availability of mobile phones. Over five years Telstra has decommissioned half of its payphones in recognition of reduced demand[xii]. Despite the decreasing number of payphones, a set amount of $44 million per annum is allocated under the USO for the provision of payphones (TUSMA 2014).

The question is whether there is an ongoing need for access to some form of public payphone as part of the USO reform. More recently there has also been a growing argument that public open access should be through WiFi, because broadband access now rivals telephony as an essential service. In considering this, we would need to assess demand trends coupled with coverage gaps and competition issues. In November 2014, New York embarked on a new-age payphone infrastructure based on free WiFi that addresses demand from the disadvantaged (Flegenheimer 2014). Closer to home, Telecom NZ (Telecom Asia 2014) and Telstra (Ramli 2014) both have programs which will convert payphones into WiFi hotspots.

Yet unlike New York, these WiFi zones will be available free only to customers of Telecom NZ and Telstra, with customers of other providers able to access these services at a cost. The Government is also expanding the provision of free WiFi, with the indigenous payphone program opening up the concept of public access.

A payphone that provides affordable open access to basic telecommunications (e.g. internet, voice and social networking) is still relevant but needs to be recast around free public WiFi. The risk of competitive distortion of the potential public good needs to be addressed.

As an alternative to traditional payphone subsidies, it is recommended that a review be undertaken into the costs and benefits of the provision of public open access WiFi services in regional centres and other areas. Consideration should also be given to provide funds for small scale community-led telecommunication projects utilising WiFi and other technologies.

In areas of remote Australia where, even with micro-base station technology and incentives, 'continuous' mobile is not realistic, islands of WiFi coverage fed from satellite hubs can provide a much improved mobile experience.

There is therefore an important opportunity to allocate funds towards community led local solutions. The immediate opportunity is WiFi services but it could expand into other services. For example *Universal Service Fund* funds could be allocated to facilitate the development of important end user requirements.

Examples that come to mind include:

- **Farming productivity:** Development of mobile coverage expansion technology that farmers could deploy on their properties using the NBN. Individual farmers could use this technology to deliver improved mobile coverage where they need it, resulting in significant improvements in farm productivity.
- **Disability services:** The key challenge in disability services is to source funds to deliver improvements and changes to disability telecommunications equipment and services. USF funds could be used to deliver telecommunications products for end users that have specific needs.
- **Indigenous communities:** Indigenous communities often have distinct telecommunications requirements that require tailored solutions. Funds could be made available to meet these specific needs.

Recommendations

The basic challenge for universal service policy reform is to deliver a scheme that leverages the NBN, progressively encourages the involvement of the private sector and drives greater competition.

This paper makes five interrelated recommendations to replace the current USO policy with a more transparent and efficient approach by establishing a *Universal Service Fund* which uses the NBN network as a springboard for further service improvement and recognises the importance of mobile services to regional Australians.

Recommendation 1: Universal Service Fund

Establish a *Universal Service Fund* (USF)[xiii], to help fund non-commercial but socially important telecommunications infrastructure. The USF would be funded from contributions via an improved levy scheme that would look to reduce the distortionary impositions of the current arrangements.

Recommendation 2: NBN as the Universal Infrastructure Provider

Consistent with NBN's current remit, formally designate NBN as the *Universal Infrastructure Provider* to connect all premises in Australia. This would mean that all Retail Service Providers on the NBN would be able to provide voice and broadband services to all premises in Australia.

Recommendation 3: NBN as the Standard Communications Service Provider

Plan the phase-out of Telstra's current USO obligation, to maintain its copper network to provide a Standard Telephone Service, and provide funds to NBN to deliver a modern *Standard Communications Service*[xiv] delivering voice and broadband capability to all premises.

Recommendation 4: Mobile coverage and choice

The *Universal Service Fund* should also consider the provision of funding for other essential services such as improving mobile coverage and choice in regional Australia via an expanded Mobile Black Spot Programme. The NBN should also develop a project plan to assist the industry expand competitive mobile services in regional Australia by providing access to NBN backhaul and by upgrading its fixed wireless towers to deliver a wholesale 4G regional mobile network

Recommendation 5: Broader range of telecommunications solutions

As an alternate to traditional payphone subsidies, consider broadening the remit of the *Universal Service Fund* to deliver a broader range of telecommunications solutions for regional communities and other consumers, such as public open access WiFi. Consideration should also be given to providing funds for small-scale community-led innovative communication projects to enable broadband services to all Australians.

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References

ACMA. 2014. "Regional Australia in the digital economy", ACMA Research Snapshot, August 2014. Available at: http://www.acma.gov.au/theACMA/engage-blogs/engage-blogs/Research-snapshots/Regional-Australia-in-the-digital-economy

Australian Government. 2015. White Paper: "Agricultural Competitiveness, Stronger Farmers Stronger Economy", July 2015

Gasman. 1998. "Universal Service: The New Telecommunications Entitlements and Taxes", Cat Policy Analysis No. 310, June 25th 1998. Available at: http://www.cato.org/pubs/pas/pa-310.html

Coutts, R. 2004. "The USO policy debate", *Exchange* 16/32, 20th August 2004.

Coutts, R. 2015. "Better telecommunications services for all Australians Rethinking the USO Report". July 2015. Available at: http://www.couttscommunications.com/Published-Articles/RethinkingTheUSORegCoutts.pdf

De Ridder, J. 2015. "The Future of the Universal Service Obligation (USO)". An occasional paper, November 2015, ACCAN. Available at: http://deridder.com.au/site/wp-content/uploads/2014/05/ACCAN-USO.pdf

Dymond, A. 2010. "Universal Service: The trends, opportunities and best practices for universal access to broadband services", Intelecon Research & Consultancy Ltd., Vancouver BC, Canada. Available at: http://www.inteleconresearch.com/pages/documents/OOCUR_Paper_Dymond_UAStoBroadband.pdf

Empirica Research. 2014. "Telecommunications in Australia", Research Report, 2014.

Estens, R. 2002. Regional Telecommunications Review, Australian Government, 2002.

Flegenheimer, M. 2014. "Pay Phones in New York City Will Become Free Wi-Fi Hot Spots". *New York Times*, November 18th 2014. Available at: http://www.nytimes.com/2014/11/18/nyregion/pay-phones-in-new-york-city-will-become-free-wi-fi-hot-spots.html?_r=1

Frontier Economics. 2014. "Government intervention in the South African broadband market. A country Case Study" Prepared for the GSMA by Frontier Economics, September 2014 Available at: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2014/10/Government_intervention_in_the_South_African_broadband_market.pdf

Frontier Economics. 2015. "Benefits of network competition and complementary policies to promote mobile broadband coverage", A Report by Frontier Economics prepared for the GSMA, February 2015. Available at: http://www.gsma.com/publicpolicy/wp-content/uploads/2015/02/Benefits-of-network-competition-and-complementary-policies-to-promote-mobile-broadband-coverage-Report.pdf

Glasson, W. 2008. Regional Telecommunications Review, Australian Government, 2008. Available at: https://www.communications.gov.au/sites/g/files/net301/f/2008_Glasson_Report_RTIRC.pdf

GSMA. 2013. Survey of Universal Service Funds – Key Findings, April 2013. Available at: http://www.gsma.com/publicpolicy/wp-content/uploads/2013/04/GSMA-USF-Key-findings-final.pdf

Hernandez, Janet. 2014. "Maximizing the Potential of Universal Service Funds (USFs) Through Successful Administration and Management". ITU/BDT Regional Economic and Financial Forum of Telecommunications ICTs for Latin America and the Caribbean March 11, 2014. Available at: http://www.itu.int/en/ITU-D/Regulatory-Market/Documents/CostaRica/Presentations/Session2-1%20Hernandez%20-%20Maximizing%20the%20potential%20of%20USFs%20%282%29.pdf

Intelecon. 2009. Universal Access and Universal Service, 2009 update. Available at: http://www.inteleconresearch.com/pages/documents/UASFFunds2009update-Oct2009.pdf

ITU news. 2007. Connecting everyone by mobile phone, Available at: http://www.itu.int/itunews/manager/display.asp?lang=en&year=2007&issue=07&ipage=universal-telephony

KPMG. 2012. " Understanding the impact of the Universal Service Fund and Intercarrier Compensation Transformation Order", KPMG brochure 2012. Available at:

http://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/Pages/universal-service-fund-intercarrier.aspx

nbn co. 2015. Corporate Plan. Available at: http://www.nbnco.com.au/corporate-information/about-nbn-co/corporate-plan/corporate-plan.html

Ramli, D. 2014 "Telstra payphones to become Wi-Fi hotspots" *The Sydney Morning Herald*, September 30, 2014**.** Available at: http://www.smh.com.au/business/telstra-payphones-to-become-wifi-hotspots-20140930-10nvr1.html

Shiff, D. 2015. "Regional Telecommunications Review", Australian Government, 2015. Available at: http://www.rtirc.gov.au/wp-content/uploads/sites/2/2015/10/RTIRC-Independent-Committee-Review-2015-FINAL-Low-res-version-for-website.pdf

Sinclair, R. 2012. Regional Telecommunications Review, Australian Government, 2012. Available at: https://www.communications.gov.au/publications/2011%E2%80%9312-regional-telecommunications-review

Bushell-Embling, D. 2014. "Telecom NZ turns payphones into WiFi hotspots" *Telecom Asia,* **May** 15 2014.Available at: http://www.telecomasia.net/content/telecom-nz-turns-payphones-wifi-hotspots

TUSMA. 2014. Telecommunications Universal Service Management Agency. 2014. Annual Report 2013-14, p46

Vertigan, M; Deans, A; Ergas, E; Shaw, T. 2014. "Independent cost-benefit analysis of broadband and review of regulation – Volume II – The costs and benefits of high-speed broadband", Vertigan Report, August 2014. Available at: https://www.communications.gov.au/sites/g/files/net301/f/Cost-Benefit_Analysis_-_FINAL_-_For_Publication.pdf

World Bank. 2002. "Closing the Gap in Access to Rural Communications Chile 1995-2002". Available at: http://documents.worldbank.org/curated/en/2002/02/1717449/closing-gap-access-rural-communications-chile-1995-2002

Xavier, Patrick. 2006. " Universal Service for a Next Generation Network Environment", OECD Working Party on Telecommunication and Information Services Policies, 18th April 2006. Available at: http://files.eric.ed.gov/fulltext/ED504163.pdf

Notes

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[i] John De Ridder makes the pertinent point that a USO service should encompass people rather than premises in future.

[ii] An obvious historical relic of the current USO is the need for 'pre-selection' allowing customer selection of long distance carrier

[iii] The Standard Telephone Service (STS) is a service prescribed by regulation. Essentially it is a voice-grade service which enables the user to establish a telephony connection to another user. There is also a set of service performance requirements such as reliability and service quality. Broadband capability is not a remit of the current USO scheme.

[iv] Eligible revenue as assessed by the ACMA for the USO levy termed the *Telecommunications Industry Levy* (TIL).

[v] The requirement is to allow 'reasonable access' to a data service.

[vi] Recommendation 9 of the Shiff Regional Telecommunications Review terms this the Consumer Communication Fund.

[vii] In Australia this is compounded by the scale of the incumbent's geographic dominance.

[viii] Coverage licence conditions for mobile operators were rightly removed in the late 90s review of competition unlike in many other countries.

[ix] It is understood the Victorian State Government would only commit funds to contracts awarded to Telstra.

[x] The Government has allowed $60million for a further round.

[xi] The author assessed this figure based on the NBN 2008 Implementation Study.

[xii] According to the ACMA Communications report 2008-09, there were around 39,328 payphones. According to the ACMA Communications report 2013-14, there were around 17,805 payphones.

[xiii] The Shiff Regional Telecommunication Review recommends a Consumer Communications Fund.

[xiv] The Shiff Regional Telecommunication Review recommends a Consumer Communication Standard.

Who are you going to call?

The future of the Universal Service Obligation

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Abstract: This paper draws upon a research paper prepared for the Australian Communications Consumer Action Network. The focus of this paper is on the best way to provide every adult with universally available, accessible, affordable and empowering communications. Special attention is given to affordability, leading to a litmus test of an affordable broadband tariff. The paper proposes two options for delivering universal service objectives in future. One does not require any carrier to be nominated as the universal retail service provider. The other extends Telstra's current obligations.

Introduction

The current USO arrangements have been overtaken by many changes that will force a review of the future of the USO. It seems clear that the USO policy should now take account of broadband and mobiles and data services as well as voice. In future, the USO needs to provide every adult[1] with universally available, accessible, affordable and empowering communications:

- Availability (coverage) of voice and broadband services should be enhanced through the implementation of the NBN and subsidies to extend mobile services;
- Accessibility (usability) for both voice and data services may be enhanced by applications that are enabled by digitisation; possibly supplemented with new obligations;
- Affordability of both fixed and mobile services needs to be addressed; and
- Empowering (content/apps) such as government providing free access to e-services.

Availability has been the main focus of policy and it may be solved soon with the execution of the national broadband network (NBN). However, given consumer preference for mobiles, a key question for USO policy is how far mobile coverage overlaps the NBN's footprints, because mobile voice and data could become the preferred platform for users seeking service.

Also, the NBN does not solve for the other objectives above. Other policy instruments apart from the roll-out of the NBN are needed.

Affordability has not received enough attention and so it is the longest section in this paper. The market for affordability support could be up to one million households; around half the households who rely on government pensions or allowances as their main source of income.

Mobile voice and data is not considered a problem for affordability at this time. Competition has ensured that cheap and affordable mobile services are available.

The paper considers what fixed network pricing could be considered affordable[2]. It proposes that large carriers could be required to offer a broadband social tariff which is no more than, say, 0.6% of median[3] disposable income. The cheapest retail plans for a basic broadband service on the NBN are three times higher than what we need to overcome low income affordability.

Four options for making affordable broadband (social) tariffs available to those in most need are discussed. The first is to piggy-back existing benefits. Another is to focus on social housing. The third is to impose a social tariff obligation on carriers. And the fourth is to fix NBN wholesale prices; which are part of the affordability problem now.

The paper suggests that the universal principles of availability, accessibility and affordability are not enough to satisfy the aspirations of universal service policy. They are essentially about carriage issues. Content, or increasing the utility of the networks for social inclusion, is important too. Access to e-government could be facilitated with a government portal app that provides free access to government services and the Emergency+ app should be pre-loaded on all smartphones. But, we have to avoid over-reach. Many useful content and applications services will become available without policy intervention.

Finally, the paper tests six options for realising these four policy objectives. There are two compelling options. The first is not to nominate any default retail USO provider (Option 2). This would require only the extension of existing codes and standards by the ACMA to reflect the new fixed broadband, mobile voice and data environment.

The other option is to extend Telstra's USO obligations into mobiles and data while giving it freedom to choose delivery options (Option 6). This would be easier to implement without leading to extra costs. It is considered the safe option.

With the NBN, improved mobile networks and the migration to all-digital services, it is time to revise USO policy.

Universal Availability

Much of the focus of government funding has been on improving the availability of rural communications (Table 1).

Table 1: Announced Funding Programmes for the Bush

Date	Amount	Programme	Purpose
1997	$250m ($50m pa for five years from 1997-98).	Networking the Nation through the Regional Telecommunications Infrastructure Fund	Meet needs of regional, rural and remote Australia
2001	$150m	Extended Zones	Provided untimed local call access
	$46m	Digital Regions Initiative	For health, education and emergency services
2007	$878m	Broadband Connect	OPEL ($600m; cancelled)
2008	$290m over 4 years to 2012	Australian Broadband Guarantee	Provide a metro-comparable service to regions
2009	$3,000m to FY2021	Satellite and fixed wireless in NBN	To serve the last 7% of all premises
2009	$250m	Regional Backbone Blackspots	Improve backhaul
2012 2014	$253m pa $100m (appx $400m with co-contributions)	USO Mobile Blackspots	TUSMA contract with Telstra Awarded to Telstra and Vodafone
2015	$60m	Next round of Mobile Blackspots	Announced May 2015

Source: Author from government sites.

The coverage of the NBN's fixed network will be 93% of premises, which is less than Telstra's copper network. The May 2010 NBN Implementation Study (McKinsey & KPMG 2010) found that "*99.75 percent of all premises are capable of receiving voice over Telstra's copper network, with low latency and high availability providing a high quality of service*" (p319) while "*A number of premises that today receive copper-based voice services will, however, be unable to receive mobile voice services*". This is why Telstra has a contract to maintain and operate that part of its network which falls outside the NBN's fixed footprint until 2032. The mid-term review should consider what happens to any remaining customers after that time.

Given consumer preference for mobiles, a key question is how far mobile coverage overlaps the NBN's footprints; including the remains of the copper network that Telstra has been contracted to maintain and operate.

The December 2013 Broadband Availability and Quality Report (Australian Government 2013) found that *"Approximately 8.8 million premises (81 per cent) have access to 3G mobile broadband services and about 6.4 million premises (59 per cent) have access to 4G services."* However, that estimate was based on October 2013 data; before Telstra announced it would extend its 4G coverage to 95% of the population and before the nearly $400m Mobile Blackspots Programme was announced in June 2015 covering an extra 150,000 sq. km (Australian Government 2015b).

The last 7% of customers who cannot be served by the fixed network will have access to the NBN's fixed wireless or satellite network. At the inception of the NBN, it was planned to make it a monopoly so that it could cross-subsidise the high cost services with a geographically uniform tariff. But, there will be infrastructure competition for the NBN and the current study (Australian Government 2015a) by the Bureau of Communications Research (BCR) is looking into funding options for the NBN non-commercial fixed wireless and satellite networks (e.g. a USO levy).

Universal Affordability

Affordability is one of the three cornerstone principles of universal service and the one least well served by current USO policy. In Table 2 below, just $40m p.a. is Commonwealth funding of affordability (the telephone allowance). As noted earlier (Table 1), the main focus of policy has been on availability.

In Australia affordability has not been addressed through the USO but through carrier licence conditions on Telstra; and implemented through low income measures (LIMAC)[4]. The retail price caps which had applied to Telstra have been removed as part of deregulation.

Table 2: USO related funding

Funder	Programme	Objective	Comments
Commonwealth and industry	USO ($253m p.a.)	Availability	Telstra $253m p.a. to 2032
Commonwealth	Payphones	Availability	Telstra $44m p.a.
Commonwealth	national relay service	Accessibility	$18m p.a. until July 2018
Commonwealth	emergency call handling	Availability	$22m p.a. up to 20 years with a tender to be conducted by June 2016
Commonwealth	NBN voice only migration	Availability	$150m before GST over 10 years shared between Telstra and other eligible Retail Service Providers
Commonwealth	Telephone Allowance to certain eligible pensioners	Affordability	Depending on the beneficiary's circumstance; either $27.20 or $40 per quarter (Appx $40m p.a.)
Commonwealth	New Satellite Support Scheme	Availability	To allow 9,000 premises unable to access NBN's ISS to access commercial satellite services (2014)
Telstra	Access for Everyone meets licensing conditions with solutions endorsed by the Low-income Measures Assessment Committee (LIMAC).	Affordability and Accessibility	A variety of support measures with a focus on voice (e.g. InContact); all funded by Telstra for around $145m pa (2013-14)

Sources: Hawkin and Pavlidis (2015), author (objectives) and sites as linked.

What do we mean by affordable? Ofcom considers that a "*service is considered to be affordable for a consumer if the consumer is able to purchase it without suffering undue hardship*" (Ofcom 2014a; 2014b; 2014c). This echoes another definition of affordability as "*a consumer's ability to pay for and use telecommunications without sacrificing expenditure on other essential services and items"* (Lewin & Milne 2010; p4-5).

This has become even more critical with the Government's Digital First Strategy which says that "*A more digital, networked economy is about far more than broadband. It is about tumultuous change in workplaces. . . . It's about expanding options and opportunities for individuals, whether as consumers, workers or entrepreneurs*". The corollary is that those without access will be deprived of these opportunities.

The market for affordability support

How big is the addressable market for affordability support? One view is given below.

Table 3 – Disadvantaged Customer Segments in 2010

	MAIN SOURCE OF HOUSEHOLD INCOME 2009-10 GOVERNMENT PENSIONS AND ALLOWANCES						
	Receives age pensions	Receives disability and carer payments	Receives unemployment and study payments	Receives family support payments	Receives other payments	Total	All households
No. of persons (000s)	1,687	933	374	727	154	3,875	22,342
No. households (000s)	1,182	647	303	417	379	2,120	8,399
No. in State/territory housing (000s)	98	161	63	134	19	476	
Mean disposable household income, $/week	551	497	403	405	531	478	938

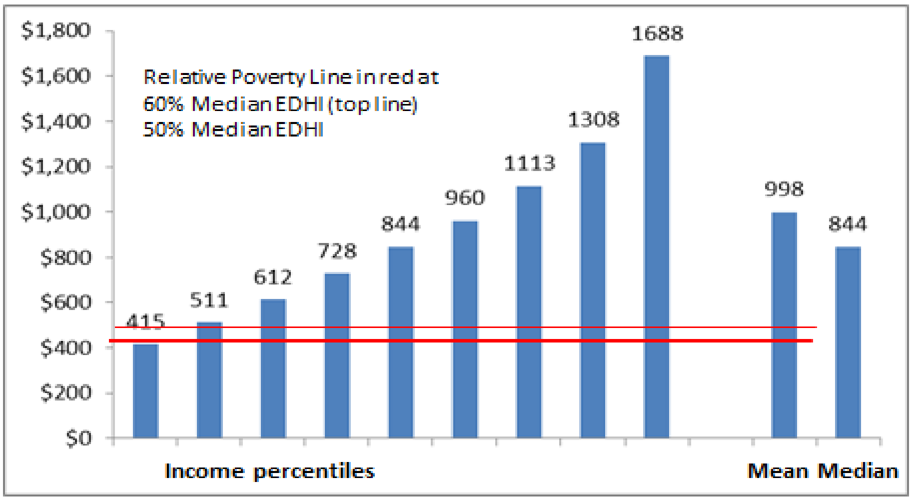
Sources:
ABS Household Expenditure Survey 2009-10 (incl feature article) Cat 6530
ABS Cat 6523, Table 1.1 for overall mean disposable income in 2009-10
ABS Cat 3101 for total persons in 2009-10

The customer segments shown already receive various forms of support, so some of these are likely to need support for affordable telecommunications. Note that the table shows only those for whom the pension or allowance is the "main source" of household income – there are many more age pensions than shown above. Note also that some households may receive more than one type of allowance (e.g. the total number of households where government pensions and allowances are the main source of income is 2.12 million; not 2.93 million, the sum across the row).

Another view of the market for affordability support is derived from what the Australian Bureau of Statistics (ABS) calls the relative poverty line: "*Many developed countries use relative poverty to measure the economic wellbeing of households. These measures identify the proportion of people with an income below a certain fraction of median equivalised disposable household income (EDHI)*"[5] (ABS Cat. 6523).

There is no general agreement on where to draw the line on relative poverty. The OECD publishes various analyses based on 40%, 50% or 60% of median incomes (50% used most often), while Eurostat commonly uses 60% as the cut-off.

Figure 1shows the relative poverty line. At 60% [50%] of the median income, the relative poverty line in Australia in 2013-14 was $506 [$422] per week. At 60% [50%], at least three [two] of the customer segments in Table 3 (median is always less than mean) and up to four million people and up to one million households are below the relative poverty line (Table 4).



Source: Table 1.1, ABS Survey of Income and Housing (6523.0)

Figure 1 – Household Disposable Income by Percentile, 2013-14

Table 4 - People and Households below the Relative Poverty Line, 2013-14

	Population		**Households**	
Poverty Line at:	**Millions**	**Percent**	**Millions**	**Percent**
$506	4.3	19.0	1	12.2
$422	2.0	8.8	0.5	6.0

Source: ABS 6523, Household Income and Wealth 2013-14, Table 1.3

Targets for social tariffs

What can over two million low-income people afford? Can we set quantitative affordability targets? Defining affordability for a minimum level of service requires identifying a threshold above which a household's ability to pay for the service is compromised. Thresholds based on the share of income or expenditure is recognised as one way of analysing affordability (UK Regulators Network 2015).

The threshold can be set as a "social tariff"; a price determined for low income customers. It may be offered voluntarily by service providers as an entry-level tariff or they may be required to offer such tariffs – as argued below.

The following table shows what our target segments spent on three main groups of communications services. The household expenditure survey averages spending by item over all households; whether they bought the item or not. The table uses some adoption rates to exclude people not using the service and then looks at the resulting shares of disposable income and total spending on goods and services[6].

Table 5 – Disadvantaged Segments Communications, 2009-10

	MAIN SOURCE OF HOUSEHOLD INCOME 2009-10 GOVERNMENT PENSIONS AND ALLOWANCES						
	Receives age pensions	Receives disability and carer payments	Receives unemployment and study payments	Receives family support payments	Receives other payments	Total	All households
Mean disposable household income, $/week	551	497	403	405	531	478	938
Total spend on goods and services $/week	565	727	713	834	601	613	1,236
Average spend on ($/week):							
Fixed voice	15.11	14.04	13.56	14.04	15.36	14.14	14.67
Mobile	4.2	9.9	15.88	14.28	5.37	7.23	16.74
Fixed internet	3.09	4.88	7.45	6.47	4.4	4.02	7.77
Adoption rates:							
Fixed voice	100%	85%	82%	79%		97%	
Mobile	92%	83%	100%	95%		98%	
Fixed internet	88%	76%	78%	74%		94%	
Average spend adjusted for adoption rates: $/week							
Fixed voice	$15.17	$16.44	$16.48	$17.79		$14.56	
Mobile	$4.57	$11.88	$15.88	$15.08		$7.41	
Fixed internet	$3.53	$6.46	$9.58	$8.78		$4.26	
As percent of disposable income:							
Fixed voice	2.75%	2.82%	3.36%	3.47%	2.89%	2.96%	1.56%
Mobile	0.83%	1.99%	3.94%	3.53%	1.01%	1.51%	1.78%
Fixed internet	0.64%	0.98%	1.85%	1.60%	0.83%	0.84%	0.83%
Total	4.22%	5.80%	9.15%	8.59%	4.73%	5.31%	4.18%
As percent of total spending:							
Fixed voice	2.69%	1.93%	1.90%	1.68%	2.55%	2.31%	1.19%
Mobile	0.81%	1.36%	2.23%	1.71%	0.89%	1.18%	1.35%
Fixed internet	0.63%	0.67%	1.04%	0.78%	0.73%	0.66%	0.63%
Total	4.12%	3.96%	5.17%	4.17%	4.18%	4.14%	3.17%

Sources:
ABS Household Expenditure Survey 2009-10 (incl feature article) Cat 6530
ABS Cat 6523, Table 1.1 for overall mean disposable income in 2009-10
Morsillo (2012) for adoption rates

To set an affordable social tariff, we need to know what measure of income or expenditure will be measured against the target percentage for affordability. It needs to be easily obtainable and current. For now, let's use median disposable income (EDHI) which in 2013-14 was $844[7].

To illustrate the setting of an affordability target, let's take fixed broadband. As ACCAN says, "*a broadband service at a reasonable price should be a universal right … The NBN is a publicly funded initiative and it should serve community needs. The Government therefore has an obligation to work with retailers to deliver specific services for low income consumers and other classes of consumers for whom the market alone may not deliver adequate or appropriate service*" (ACCAN 2010; p. 4)

In August 2015, the cheapest retail NBN plans for Telstra, Optus, TPG and iiNet averaged $69 pm; which includes line rental but not calls. That's $17.25/week and 2.0% of median and

EDHI. It is up to twice as much as what the customer segments in Table 5 were paying for fixed internet.

It is not getting any better. The ACCC (2015a) reports that NBN retail prices increased 4.6% in real terms (about 7.6% nominal) in 2013-14; the only telecommunications service whose prices increased in the year. This is not helping to achieve affordability. A social tariff for affordable fixed broadband at around $5/week or 0.6% of median EDHI in 2013-14 is needed.

Implementing affordable broadband

The problem with making a social tariff available to, say, those who receive age pensions is that they are not all needy. Tables 3 and 5 included only those whose main source of income was government pensions/allowances. But, that is an ABS construct; not an administrative construct. Tying rights to social tariffs (or vouchers) to existing pensions and allowance regimes may be problematic.

Another approach is targeting, say, those in social housing. A local example of assistance targeted to users in social housing is that provided by infoxchange in Melbourne. In Australia, there are over 300,000 households in social housing (ABS Cat 4102).

A third approach is to mandate social tariffs. These could be imposed by the ACMA either through changes to the Telecommunications Consumer Protections Code, or carrier licence conditions[8] or, more likely, through Determinations issued through Section 2 of the Telecommunications Act 1997[9]. The Determinations approach has been used to require proof of identity to be supplied before supplying pre-paid carriage service number, and to require an informed decision from residential fixed-line telephone customers on NBN Co fibre to the premises infrastructure regarding their backup power supply (backup battery) requirements and to keep appropriate records for a specified period.

Work also needs to be done on what accessibility (including performance and reliability standards) requirements may need to be addressed through codes in a fixed broadband and mobile voice and data context.

A fourth approach changes NBN wholesale pricing to help achieve affordability. Currently, the minimum wholesale cost on the NBN is $24 pm (for 12/1 Mbps) (NBN Co 2015); which is a high place to start from for affordable retail pricing. As illustrated in Figure 2, a “Traffic” pricing model (De Ridder & James 2014) would allow the NBN to cut the current minimum cost by more than a half, leading to affordable retail pricing. The estimated retail price for the entry level plan is below the $5/week target suggested earlier. The scheme administers itself because only low data usage users will take an entry level plan and their service provider will shift the wholesale tariff to the standard tariff when usage grows beyond the breakeven point – and, hopefully, move the user to a new retail plan too.

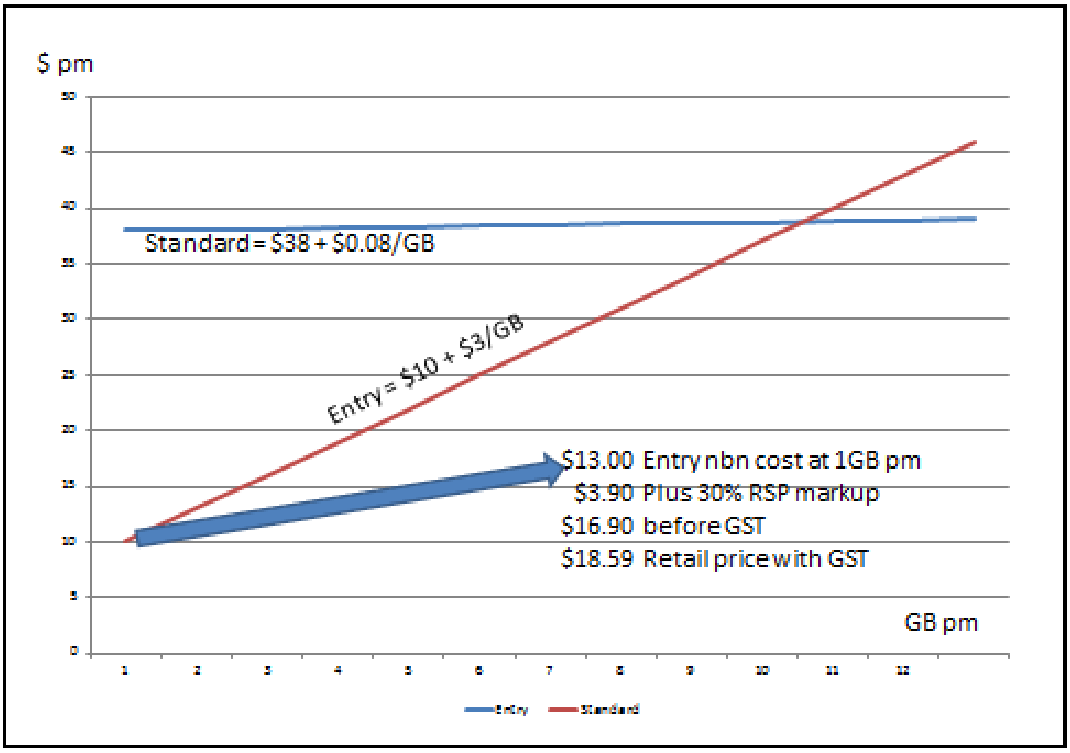


Figure 2: Proposed Standard and Entry Level NBN Wholesale Plans

Morsillo (2012) estimated the total cost of ownership of internet access for low income households. The wholesale traffic pricing proposal above would make a significant difference, as shown in Table 6. The revised prices are based on only 1GB per month of data with Telstra. This would be sufficient to support an affordable voice service, but the 1GB might need to be supported by unmetered access to on-line government services to fulfil the empowerment objective.

Table 6: The total cost of ownership – options for low income households, 2015

	NBN+PC(new)	NBN+PC(recon)	Wireless+Tablet	Prepaid Mobile
Device	$380	$220	$679	$59
Software	$169	$169	$9.00	
NBN/WiFi/SIM	$149	$25		
Internet($pm)	$75 -> $18.59	$49.95 -> $18.59	$50	$30.00
Total 2 year, $pm	$104 -> $48	$67 -> $36	$87.00	$32.00
	Dell laptop, Microsoft Office, $75 pm (100GB), $149 for modem, local calls 50c, STD calls 52c+50c/min		cheapest iPad (Mini 3), Office 365 $12 pm, prepaying $50 for 5GB over a year (or shorter term for aoround $10/GB)	cheapest smartphone 1.3Gb and $250 of included calls

Source: Morsillo method and web sites accessed 15 September 2015

Also, work needs to be done on how to structure social tariffs, because the regressive nature of communications spend discussed earlier is exacerbated by the "poverty premium" (Ofcom 2014a; 2014b; 2014c; SACOSS 2015) which arises through the way low income consumers pay for services; in particular pay-as-you-go for mobile phones or paying for their communications service by non-direct debit payment methods (where a payment surcharge may apply).

Delivery options

The universal service obligation falls on one or more retail service providers – who are you going to call? The NBN has a wholesale service obligation. But it is not enough on its own – retail service providers are not obliged to use NBN networks.

There are six broad USO policy options. All have to be supplemented with affordability and accessibility initiatives for both broadband and mobiles.

One of the three dimensions that differentiates the six options is voice versus broadband (includes voice and data).

The second dimension is the technology platform; fixed versus mobile (plus fixed wireless and satellite components of the NBN on which up to 7% of customers will have to rely).

These two dimensions lead to the six options below:

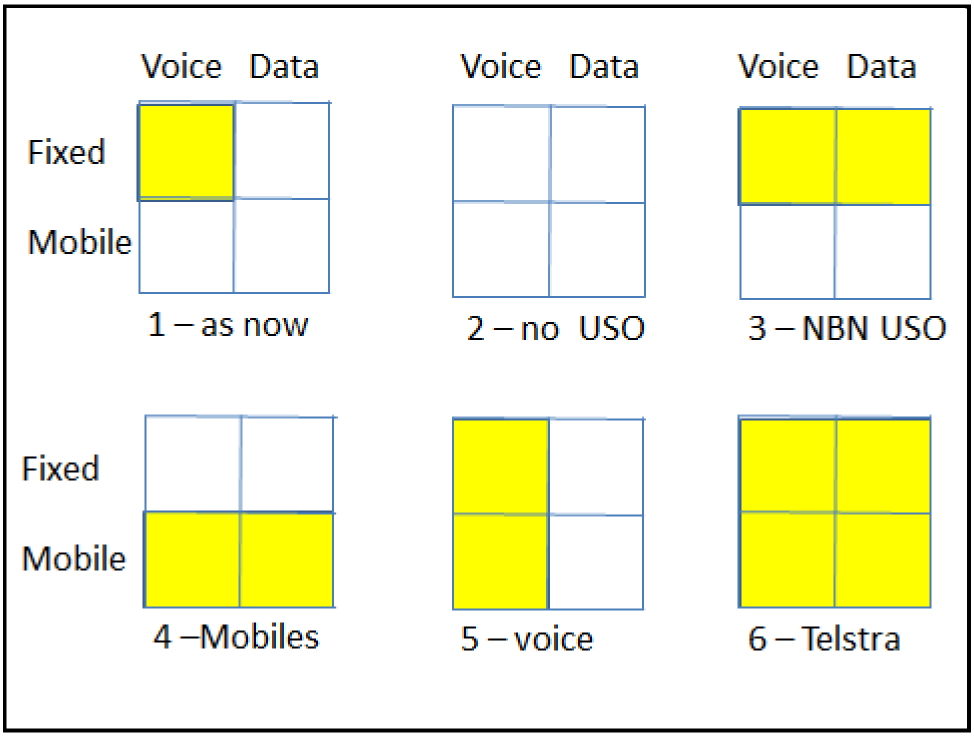


Figure 3: Six USO Options

But the third dimension needs to be added. As described in Figure 3 above, the options are only “supply-side”. They address only availability, noting geographical constraints posed by different platforms. We also need to address the “demand side”, which in USO terms means vertical equity[10] leading to accessibility and affordability.

Figure 4 below above maps the six options against horizontal and vertical equity for voice only (left hand of chart) as well as voice plus data (right hand side of chart). The third dimension is represented by the vertical axis – the higher the better. Option 3 is shown at the lowest point on this axis because it does least in terms of affordability and accessibility; as will be discussed further below. However, this option has the widest spread on availability (horizontal axis) because it includes fixed-wireless and satellite.

Going up the vertical axis, the reason for the question mark just above Option 1 (voice-only) is that we do not know the extent to which improved mobile coverage may make Option 1 redundant.

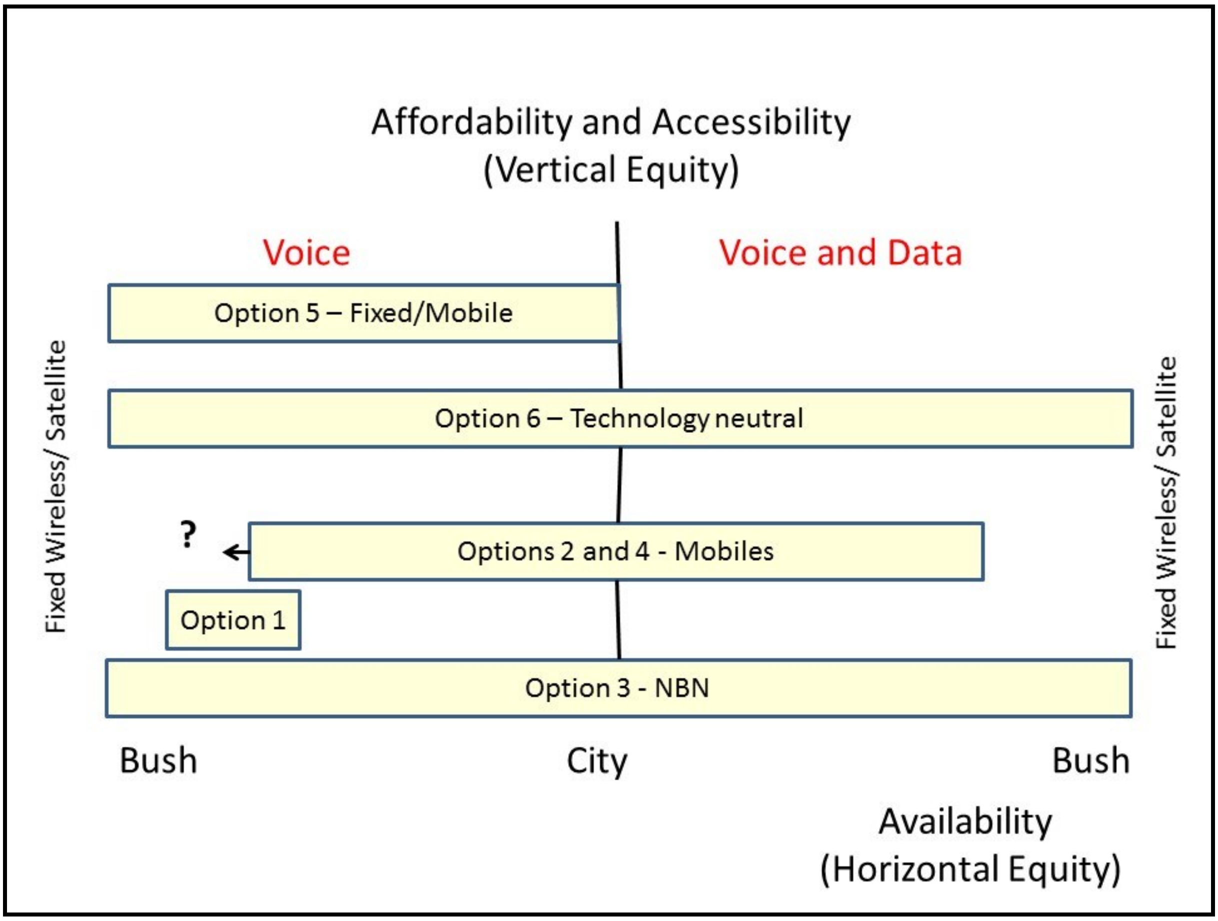


Figure 4: USO Options and Equity

Option 4 (mobile voice and data) has been placed above Options 1 and 3 because mobiles are generally considered to be more affordable than fixed services. Prepaid is part of that outcome but more could be done to make mobiles more affordable.

Option 2 (no USO) is included with Option 4 as it is argued below that mobiles competition, supplemented with obligations to address accessibility and affordability, would not require nominating a universal service provider.

Option 6 (Telstra) is based on nominating Telstra as the universal service provider. It sits higher than Option 3 because it also addresses accessibility and affordability goals. And it is above Options 2 and 4 because of availability (fixed wireless and satellite).

Option 5 (voice-only across fixed and mobile) is high on the vertical equity scale because Telstra has developed a suite of "Access for Everyone" (Telstra nd) measures with the Low Income Measures Assessment Committee (LIMAC) to improve affordability and accessibility for fixed voice services.

Taking a closer look at the six options:

Option 1: Voice-only on the fixed copper network. Telstra has a contract with TUSMA[11] to continue providing the USO over copper in areas not served by NBN's fixed network.

Telstra has also been deemed the default voice-only provider on the NBN (Option 3).

Option 2: The benchmark option, positing no USO obligation (apart from the contract referred to in the previous option). What would happen? Without a default universal service provider, it is likely that mobiles competition could largely satisfy the universal service principles of availability, accessibility, affordability and empowerment. The market will provide, helped by ongoing programmes like Mobile Blackspots.

Of course, mobiles cannot match the 100 percent availability promised with the NBN. Some customers will have to rely on, say, satellite. Under this option, wholesale satellite service costs will be the same as equivalent wholesale metro services with the NBN's cross-subsidies supported by the funding arrangements currently being considered by the Bureau of Communications Research. But there is no guarantee that satellite customers would be attractive to any retail service provider after taking account of backhaul costs and the costs of meeting any special service or performance standards that may be imposed for such services.

Affordability programmes are probably not required. Prepaid mobiles are currently very affordable. This makes Option 2 attractive because nobody has to be nominated as the default retail USO provider. It should not be necessary as the outcomes will look much like what we would expect from Option 4 (mobiles become main delivery platform; but again without any nominated USO provider).

Option 3: This delivers a voice-plus-data USO obligation over NBN networks.

As discussed earlier, there is bi-partisan support politically to include data in universal service, as demonstrated by the investment in the NBN which is designed to offer both voice and data everywhere.

The NBN has been made the default *wholesale* carrier. Unlike Telstra under the existing USO, the NBN is not also the default retail provider. Initially, Telstra will fulfil the role of retail provider of last resort within the NBN fibre footprint for customers – but only for voice. This commitment applies as a contractual obligation to TUSMA. This seems like a temporary measure and ignores data (but see Option 6).

Telstra's voice-only USO role is unlikely to be contested by other fixed providers. That is because, to date, the NBN has not shown much imagination in helping to make access affordable for a basic telephone service. The minimum wholesale price is $24 pm compared with the $16 pm that Telstra is currently charging for unbundled local loop in metro areas. Competition for voice-only service will come from mobiles.

It is unlikely that there would be more competition for voice (or voice and data) services in rural and remote areas even though the geographically uniform $24 NBN tariff is about half the unbundled local loop service price for the copper network in rural remote areas.

If you want a broadband service over the NBN, "who are you going to call?" The obvious default retail provider is Telstra, which should not require a subsidy if (and only if) the NBN maintains geographically uniform wholesale tariffs; which is what the BCR study is seeking to support.

An important related point is that network separation could make some customers un-commercial for Telstra. On the copper network, any customer that covers their directly attributable costs is commercial because that customer then makes a contribution to overheads including the cost of the network. But, with the NBN, what were overheads become directly attributable costs for Telstra[12].

The NBN refers customers to their retail service provider for accessibility issues and does not provide apps or content. But, what the NBN can and should do is to provide wholesale pricing to support retail providers and low income customers.

Finally, if the NBN is privatised, how can we ensure that the Statement of Expectations and other things that the company has agreed to in order to support universal service will survive?

Option 4:

This switches the delivery of the USO to mobile networks. The first era of broadband was '*always on*'. In the next era it will be broadband that is '*always with you*'.

This option does not entail making mobile carriers universal service providers. Competition will drive coverage (aided by continuing support for Mobile Blackspots) and affordability.

With respect to coverage, it is possible that mobile coverage is better than voice provided over copper services. The December 2013 Broadband Availability and Quality Report says that only 0.318m of the 1.4m most poorly served fixed service customers (categories D and E) have access to 3G or 4G; at October 2013 – over 1 million customers rely on copper for voice services. How much has that changed?

With respect to affordability, Telstra is not the cheapest provider in the market, but the Freedom Plus plan in the pre-paid mobile column of Table 6 is 0.9% of median EDHI; less than what disadvantaged segments were paying according to Table 5.

What about untimed local calls? Calls from mobiles are national. The fact that they are all timed is not an issue for current mobile users whose calls are short relative to fixed voice calls. The May 2010 NBN Implementation Study suggests (p321) providing a "*home-zone*" in which a voice service could be provided over a mobile network with untimed local calls offered within a zone corresponding to the user's premises. That may be considered inadequate as the Extended Zones that apply to country areas are very large. But, if voice in future is carried as data, timed calls become redundant as data is not timed.

It may be necessary to set standards for the quality of voice calls or ensure other aspects of service to support the four pillars of universal service policy. As noted earlier, the ACMA has powers to achieve this.

This approach has a number of attractions. First, any requirements would apply to several retail service providers. Second, it would promote a contestable market. Third, where it is not contestable (due, say, to lack of coverage), there is a natural default provider in Telstra. Fourth, the infrastructure is privately funded (with some direct subsidies for extending coverage).

Option 5: This would confine the USO to voice, as now, but include mobile networks. It is difficult to see what would be gained by this option. As noted with Option 1, a voice-only USO is no longer socially or politically acceptable. All the other options include both voice and data.

Option 6: A safe, technology-neutral option, broadening the USO to include data, and made available across both fixed and mobile networks. Telstra could be nominated as the universal service provider for both voice and data. Technological neutrality would then mean Telstra would not be constrained to use the NBN if a more efficient alternative is available.

This is the "safe" option, as Telstra is already a proven universal service provider ticking all the boxes (availability/accessibility/affordability) with respect to voice services. It is easy to see Telstra's obligations extended to data; which would need the LIMAC safeguards adjusted accordingly. This should also include replacing the current definition of standard telephone service with another definition consistent with voice over broadband.

Unless Telstra had to price its social tariff below the floor set by NBN wholesale prices, there should be no need to revisit subsidy arrangements with Telstra (the current TUSMA contract for voice over copper would continue). However, if the NBN de-averaged wholesale prices so that prices in the bush are higher, Telstra would be disadvantaged if retail service pricing continues to be uniform geographically. This is because other retail service providers would not have to serve the bush. It would be better that NBN pricing remains geographically uniform and is supported by the arrangements that the Bureau of Communications Research is to recommend shortly.

Best pick options

The six options are tested against the universality principles in Figure 5. Option 3 (NBN) is the best in terms of availability alone but relies on retail service providers for two of the four universality principles and is not helping them at all with affordability. Whatever the RSPs do with the NBN is covered in options 2 and 6.

Universality Principles

Options	Availability	Accessibility	Affordability	Apps/Content
1 – copper status quo	<7%	Due to LIMAC (Telstra only)		N/A
2 – no USO	>90%	ACMA obligations		
3 – NBN USO	100%	See your RSP	Poor	
4 - mobiles	>90% +Blackspots	ACMA obligations		
5 – voice-only fixed/mobile		Low Income Measures		Only mobile
6 – technology neutral		Low Income Measures		

Figure 5 – Comparison of the six options

Option 1 is temporary and limited to voice. So, that can be dismissed along with Option 5 which is also voice only.

Option 2 (no USO) seems very attractive and is similar in terms of outcomes to Options 4 (mobiles) and 6 (Telstra) because it would probably be driven by mobiles. In Options 2 and 4 no formal designation of any carrier(s) as the universal service provider(s) is required. The desired outcomes could be achieved through obligations on accessibility and affordability imposed by the ACMA under the Telecommunications Act.

References

ACCAN. (2010) Our Broadband Future — What Consumers Want.

ACCC. 2015a. "Telecommunications competitive safeguards for 2013–14. Changes in the prices paid for telecommunications services in Australia 2013–14". Available at: http://www.accc.gov.au/system/files/906_ACCC%20Telecommunications%20reports%2002013%E2%80%9314_web_2-June-2015.pdf

ACCC. 2015b. Draft "Draft FAD, Fixed line Services Review. Public inquiry into final access determinations for fixed line services – primary price terms. Further Draft Decision – Outstanding Issues". Available at: http://www.accc.gov.au/system/files/ACCC%20FSR%20FAD%20Further%20Draft%20Decision%20-%20Public%20Version_1_0.pdf

ACMA. 2013. "Connected Citizens: A regulatory strategy for the networked society and information economy". Available at: http://www.acma.gov.au/theACMA/connected-citizens-regulatory-strategies-for-a-networked-economy-and-society

ACMA. 2015a. "Australians get mobile – Using mobile devices for voice, messaging and internet access". Available at: http://www.acma.gov.au/theACMA/engage-blogs/engage-blogs/Research-snapshots/Australians-get-mobile

ACMA. 2015b. "The Aussie VoIP evolution". Available at: http://www.acma.gov.au/theACMA/engage-blogs/engage-blogs/researchacma/The-Aussie-VoIP-evolution

Australian Government. 2012. Telecommunications contract and grant registers. Available at: https://www.communications.gov.au/who-we-are/department/funding-reporting/telecommunications-contract-and-grant-registers

Australian Government. 2013. Department of Communications. "Broadband Availability and Quality Report: National Overview". Available at: http://www.minister.communications.gov.au/malcolm_turnbull/news/broadband_availability_and_quality_report_national_overview

Australian Government. 2014. Statement of Government Expectations. Letter to Executive Chairman, NBN Co. Available at: http://www.nbnco.com.au/content/dam/nbnco2/documents/soe-shareholder-minister-letter.pdf

Australian Government. 2015a. Regional Telecommunications Review, Consultation. Available at: http://www.rtirc.gov.au/consultations/

Australian Government. 2015b. "Mobile Black Spot Programme to deliver almost 500 new or upgraded base stations with total investment of $385 million". Available at: http://www.minister.communications.gov.au/malcolm_turnbull/news/mobile_black_spot_programme_to_deliver_almost_500_new_or_upgraded_base_stations_with_total_investment_of_$385_million#.Vmd6HHKhdy3

Australian Government. 2015c. TUSMA. Available at: https://www.communications.gov.au/what-we-do/phone/tusma

Corbin, Teresa. 2015. "The Future of the USO in a Multi Technology Environment"; talk to Comms Day 20th April 2015

Coutts, Reg. 2015. "Better telecommunications services for all Australians: Rethinking the USO". Available at: www.communications.gov.au/sites/g/files/net301/f/Vodafone%20-%20Attachment%20B.pdf

De Ridder, J. 2015. Submission to the Bureau of Communications Research: NBN Funding Options Consultation Paper. Available at:

www.communications.gov.au/sites/g/files/net301/f/submissions/DeRidder_Consulting_Pty_Ltd.pdf

De Ridder, J.; James R. 2014. "Affordable retail pricing on the NBN". Australian Journal of Telecommunications and the Digital Economy, Vol 1, No 1, Article 5. http://telsoc.org/ajtde/2013-11-v1-n1/a5

Eardsley, A. 2009. "Telecommunications and Community Wellbeing: A review of the literature on access and affordability for low-income and disadvantaged groups". Final report for the Telstra Low Income Measures Assessment Committee (LIMAC). Sydney. Social Policy Research Centre and Journalism and Media Research Centre, University of New South Wales. Available at: www.sprc.unsw.edu.au/media/SPRCFile/Report9_09_Telecommunications_Community_Wellbeing.rtf:

European Commission. 2005. "Affordable telecommunications services - users' rights". On the Review of the Scope of Universal Service in Accordance with Article 15 of Directive, 2002/22/EC, COM (2005 203, May, European Commission, Brussels. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV:l24108h

Feijoo, C; Milne, C. 2008," Re-thinking universal service policy for the digital era: setting the scene – an introduction to the special issue on universal service", info, Vol. 10 Iss 5/6 pp. 4 - 11 See: http://www.emeraldinsight.com/doi/abs/10.1108/14636690810904661

Goggin, Gerard. 2010. "Realising Universal Communications". Paper for ACCAN. Available at: http://www.accan.org.au/files/Reports/Realising%20Universal%20Communications.doc

Hawkins, W.; Pavlidis, K. 2015 "Affordability and 21st century telecommunications services", Australian Journal of Telecommunications and the Digital Economy, Vol.3 No. 2.

Humphry, J. 2014. "Homeless and Connected: Mobile phones and the Internet in the lives of homeless Australians". Australian Communications Consumer Action Network, Sydney. Available at: https://accan.org.au/files/Grants/homelessandconnected/Homeless_and_Connected_web.pdf

Lewin, D; Milne, C. 2010 "Are telecommunications services universally affordable across the EU? An independent assessment for Vodafone". Available at: http://www.plumconsulting.co.uk/pdfs/Plum_Nov2010_Affordability_of_telecommunications_services.pdf

Liberal Party of Australia. 2013. "The Coalition's Plan for E-Government and the Digital Economy". Available at: http://www.malcolmturnbull.com.au/assets/Coalitions_Policy_for_E-Government_and_the_Digital_Economy_%282%29.pdf

McKinsey; KPMG. 2010. NBN Implementation Study.

NBN Co. 2015. Price List, 1 February 2015. Available at: http://www.nbnco.com.au/content/dam/nbnco2/documents/sfaa-wba2-product-catalogue-price-list_20150201.pdf

Morsillo, R. 2008. "Indigenous culture and communications". Telecommunications Journal of Australia, Vol. 58 No. 1

Morsillo, R. 2012. "Broadband affordability in Australia: Looking beyond availability". Telecommunications Journal of Australia, Vol. 62, No 5.

Ofcom. 2014a. "Results of research into consumer views on the importance of communications services and their affordability". Available at: http://stakeholders.ofcom.org.uk/binaries/research/affordability/affordability_report.pdf

Ofcom. 2014b. Futuresight report: "Affordability of essential communications services. A Qualitative Research Study. Final Report July 2014". Available at: http://stakeholders.ofcom.org.uk/binaries/research/affordability/Futuresight-Report.pdf

Ofcom. 2014c. Jigsaw report: "Affordability of communications services essential for participation". Available at: http://stakeholders.ofcom.org.uk/binaries/research/affordability/Essential_Comms_Services.pdf

Ofcom. 2015. "Strategic Review of Digital Communications: Discussion document". Available at: http://stakeholders.ofcom.org.uk/consultations/dcr-discussion/

Pavlidis, K.; Gadir, J. 2013. "Improving affordability of communications". Australian Journal of Telecommunications and the Digital Economy, Vol 1, No 1, Article 10. See http://doi.org/10.7790.

Powell, E. 2015. "Understanding affordability pressures in essential services". UK Regulators Network. Available at: http://www.cerre.eu/sites/cerre/files/Emma%20Powell%20UKRN.pdf

Raiche, H. 2010. "Universal Communications in a Broadband World". Paper for ACCAN. Available at: www.accan.org.au/files/Reports/ACCAN_Universal_Communications.doc

SACOSS. 2015. South Australian Council of Social Service. Cost of Living Update, No.22, March Qtr 2015 Available at: https://www.sacoss.org.au/sites/default/files/public/documents/Reports/Cost%20of%20Living%20Reports/150520_CoL%20Update%20No22_Telecommunications_final.pdf

Telstra. 2012. Definitive agreement with NBN. Available at: *https://www.telstra.com.au/abouttelstra/download/document/2011-definitive-agreements-telstra-nbnco.pdf*

Telstra. nd. "Access for Everyone". Available at: https://www.telstra.com.au/aboutus/community-environment/community-programs/access-for-everyone

Vertigan, M. et al. 2014. Independent cost-benefit analysis of broadband and review of regulation Volume I – National Broadband Network, Market and Regulatory Report, Vol. 1. Available at: https://www.communications.gov.au/sites/g/files/net301/f/NBN-Market-and-Regulatory- Report.pdf

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Endnotes

[1] Note that traditionally the USO was about providing affordable service to every household. But, now communications are personal because of mobiles; hence adult rather than household.

[2] This supposes that providing vouchers or increasing government allowances would be politically unacceptable.

[3] The **median** is a form of average where exactly the same number of people or households fall either side of a certain amount. The **mean** is the simple average.

[4] See Telstra's *Access for Everyone* site for details of its support programmes. Representatives on the LIMAC Committee include the Australian Council of Social Services, the Smith Family, the Saint Vincent de Paul Society, the Salvation Army, Jobs Australia, Homelessness Australia, Anglicare Australia and the Council on the Ageing.

[5] Equivalised means standardised for household composition. For example, "*a couple household with one child would need $1,800 weekly disposable income to have the same equivalised disposable household income (EDHI) as a lone person household with a disposable income of $1,000".*

[6] Although disposable income is less than expenditure, *"The ABS has long advised that some low income households have characteristics that indicate they have a higher standard of living than that implied by their incomes alone"* (p12, Cat 6554, October 2011).

[7] ABS Cat 6523, Table 1.1. The ABS updated the mean $938 shown in Table 5 of this paper using CPI. The median is taken from the middle percentile shown in the same table.

[8] Under Division 3, Section 111 of the Radio Communications Act 1992 (https://www.comlaw.gov.au/Details/C2015C00143) the ACMA can make changes to the licence conditions of individual licensees or receive a direction from the Minister through a legislative instrument to make changes.

[9] Schedule 2 of the Act already includes obligations on service providers with respect to operator services, IPND (numbers), directory services and itemised billing. Under section 99 of the Telecommunications Act, the ACMA may make a written determination setting out additional rules that apply to service providers in relation to the supply of specified carriage or content services.

[10] Vertigan's market and regulatory report (Vertigan 2014) termed horizontal equity – "*ensuring households can access a service on similar terms, regardless of where they are located"* and vertical equity as – "*ensuring that irrespective of income level, all households can afford the service"* (p98).

[11] In 2012, the Telecommunications Universal Service Management Agency (TUSMA) became the principal responsible for the USO and entered into contracts with Telstra (Australian Government 2012) to deliver the obligations ($253m p.a. until July 2032). In July 2015, TUSMA was folded into the Department of Communications (Australian Government 2015c).

[12] Ian Martin drew this double marginalisation effect to my attention with his RBS note Telco Services: funding the USO on the NBN (17 June 2011).

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From Universal Service to Universal Communications

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Abstract: The policy of universal service must change. The 1975 world of a government-owned monopoly provider obligated to provide fixed line voice telephony has been replaced by the twenty-first century reality of Australians using fixed, mobile and text communications over a range of communications equipment and services provided by competitive providers. A new universal service must reflect those changed realities, and with it, the changed environment of a national broadband network, with competitive providers offering service and equipment choice.

Introduction

> Australia needs a fundamental re-think of its USO policy in view of the 10 years of experience with competition policy in telecommunications and the need to ensure equity for consumers in national broadband policy (Barr 2007, 31.1)

It is a view shared by the regulator (ACMA 2011, 28), the Department of Communications (DBCDE 2010, 2-4), industry (Optus 2015, section 3), consumer groups (ACCAN 2011, particularly 4-5), academics (for example, Goggin 2010) and the Parliamentary Secretary for Communications (Fletcher (2015, 5)

The concept of government policy mandating the supply of communications infrastructure and services throughout Australia began in the very different world of 1975. It was a world where the basic public switched voice traffic service was provided by the Government-owned, the newly formed monopoly provider, Telecom Australia, to roughly five million telephone subscribers, out of a population of 15.8 million (Davidson Inquiry 1982, 36; Grant & Raiche 2012, 386-395). In today's world, there are more telecommunications services subscribed to than Australians. Over 80% have an Internet connection. Increasingly, communications services are Internet based, and accessed on a computer or mobile device (ACMA 2014, particularly 34-49). They will be provided in a market where there will be a government-owned monopoly provider of transmission infrastructure to the premises, supporting the provision

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of retail services to customers, alongside providers of infrastructure and services for mobile telephony.

The original policy goals for universal service were placed on Telecom Australia to make telecommunications services available throughout Australia, so far as it was, in Telecom's opinion, 'reasonably practicable to do so' (noting the special needs of Australians who 'reside or carry on business outside the cities) in ways that 'best meet the social, industrial and commercial needs' of all Australians (*Telecommunications Act 1976*, s. 6).

Those policy goals are still sound. However, the existing regulatory framework for the Universal Service Obligation (USO) must change to reflect the realities of a different legislative framework and twenty-first century communications. Specifically, the following three elements must be reconceptualised:

- The service that must be provided;
- The provider of both the infrastructure and service; and
- How the costs of providing the infrastructure and services are met.[1]

Service Definition

The original universal obligation was to provide a 'fixed line standard telephone service' that provided automatic connection for local and national calls. (*Telecommunications Act 1976*, s6. See also Raiche (2010) p. 2 for later definitions).

The current definition is far simpler and technology neutral: it is 'carriage service for the purpose of voice telephony (or its equivalent for people with a disability) that passes the 'connectivity text' (*Telecommunications (Consumer Protection and Service Standards Act 1999* (T(CPSS)A) s. 6). Under legislation, both public mobile telecommunications services and Voice over IP (VoIP) services can be supplied in fulfilment of the USO, but only after the customer has agreed to their supply in fulfilment of that obligation (T(CPSS)A s. 6A).

The peak telecommunications consumer body ACCAN's policy position is clear:

> Broadband for all: Policies need to be developed to ensure high-quality, affordable broadband can be accessed by all Australians who want it (ACCAN (2014, p. 2).

Former Communications Minister Turnbull, now Prime Minister, is quoted as saying:

> . . . nobody is suggesting there should not be universal access to affordable broadband as well as voice, so the question then is: how do you define broadband and what is affordable (Fell 2011 , p. 7).

Indeed, the Government recently established a Digital Transformation Office that **assumes** public access to broadband. Quoting the Prime Minister again:

> People need to be able to transact services and access information anytime, anywhere. Like any other service industry, government should design its services in the most user-friendly way. Interacting with government should be as easy as Internet banking or ordering a taxi through an app (Abbott & Turnbull 2015, 1).

The Prime Minister's question needs to be answered: in legislative terms, how should broadband – the service that should be universally accessible throughout Australia – be defined? One of the early definitions of 'broadband' was part of the 'broadband service guarantee', where a 'metro-comparable' broadband service was defined as providing download speeds of one megabit per second down load and 256 kilobits per second upload speed (Raiche 2010, 5).

Since the introduction of the national broadband network (NBN), Governments have adopted policies for the delivery of far greater speeds for Australia. Indeed, the Coalition's election commitment was:

> Our aim is that everyone in the nation should have access to broadband with download data rates of between 25 and 100 megabits per second by 2016, and between 50 and 100 megabits per second by the end of 2019 in 90 per cent of the fixed-line footprint – although it should be noted this goal in part depends on NBN Co delivering its current satellite and fixed wireless solutions on time and on budget (Coalition 2013, 6).

Former Parliamentary Secretary to the Minister for Communications, The Hon Paul Fletcher's speech to an ACCAN conference adds to the discussion:

> To take one example, the service that NBN delivers over the fixed wireless network is a data service. However, most service providers are also offering a voice over IP telephony service. Therefore if the USO were mandated as a data service today, it would in practical terms also mean that the end user was able to receive a voice service.
>
> Now a key question here is cost. If you had asked this question fifteen years ago, it would have been possible to extend the USO to mobile or to data – but that would have involved considerably greater cost. Today that may very well not be true. If the USO is framed in terms of a mobile service or a data service, that conceivably could cost less – on an individual service basis and a system-wide basis – than mandating the delivery of a voice service over the traditional

copper network (Fletcher 2015, p. 6).

There is already a legislative definition. The term 'superfast carriage service', was introduced into the section 142A of the *Telecommunications Act 1997* (the Act) and is defined as a service that:

- Enables end users to download communications;
- The download transmission speed . . . is normally more than 25 megabits per second; and
- The service is supplied using a line to the premises occupied by the end user.

If the third element – the requirement for the use of a line – were eliminated from the definition, the term should be used to redefine the service that must be accessible to the public. It is technology neutral. Its required download speed is that which the Government has already committed to providing. It obviously provides access to both voice and data services. And more recent mobile technology delivers close to if not above those speeds now.

Provision of the USO

While there is a growing consensus on the need to upgrade the 'service' that must be universally accessible, how to ensure its delivery in the changed regulatory environment is a more vexed question.

Since its inception, Telstra has been the provider of last resort for both infrastructure and services to the premises. The implementation of the NBN necessarily changes that arrangement.

Infrastructure Provision

Over time, the NBN will be the provider of transmission infrastructure, taking over the role that, up to now, Telstra has filled. Specifically, the 'Definitive Agreements' between NBN Co and Telstra provide for the transition from Telstra's largely copper infrastructure to the premises, to NBN Co's network. Under the Agreements, NBN Co will progressively take ownership of Telstra's copper and networks, potentially using that infrastructure as part of its infrastructure to the premises.[2]

While there will be other providers of backhaul infrastructure, as well as infrastructure supporting the provision of mobile telecommunications services, in the end, it will be the NBN that provides access to broadband transmission capacity to the premises. Indeed, the Government's stated intention is to legislate to make NBN Co the Infrastructure Provider of Last Resort on an area basis, once NBN Co has a 'well established presence in that area

(Australian Government 2014, 10). At that stage, Telstra will become just another (if still large) retail provider of services to customers and the fixed network infrastructure 'will be fundamentally broadband, not Telstra's copper network (RTIRC 2015, 46).

The transitional arrangements for migration to the NBN, however, complicate development of new structures for a universal service regime.

The Telecommunications Universal Service Management Agency (**TUSMA**) was established in 2012 to administer the provision of 'public interest' services, including the provision of a standard telephone service. In essence, TUSMA would take over oversight of the USO (and other public interest services) from the ACMA (*Telecommunications Universal Service Management Agency Act 2012 (***TUSMA Act***)*, ss 11-13). Three years later, TUSMA was abolished and its functions transferred directly to the Department (*Telecommunications Legislation Amendment (Deregulation) Act 2015*, Schedule 1, Part 2).

In its lifetime, however, TUSMA, on behalf of the Department, entered into a contract for Telstra to provide public services including the USO, for twenty years, at an approximate cost of $6.4 billion over the life of the contract. Part of that contract is for the delivery of a standard telephone service over the NBN, at a current value of $253 million a year, or over the 20 year period, $5.06 billion. Telstra also receives funding to operate and maintain its existing copper network to provide the standard telephone service in areas where NBN will not deploy fibre (Department of Communications 2015).

The outcome looks to be a nonsense. The Government owned NBN Co is charged with implementing Government policy of providing broadband transmission capacity that is accessible to all Australians within a few years. Yet Telstra is charged with maintaining its copper network for twenty years.

Quoting the Optus submission:

> Notwithstanding that the current USO policy arrangements appear to be locked in under contractual arrangements there is a compelling case to review the relevance and appropriateness of the current arrangements against alternative models (Optus 2015, Para 5.2)

The proposed Optus solution: NBN infrastructure should become the 'primary mechanism' for 'ensuring connectivity', and that it takes over Telstra's copper network outside of the fibre footprint, using it when other infrastructure does not provide an adequate service (Optus 2015, Para 5.5).

Prof. Reg Coutts has proposed another model. The universal service to be provided should be 'equivalent (fixed) broadband', but include mobile service as a policy objective. Under his

Stage One of a reformed USO, NBN Co would become the wholesale provider of infrastructure, with the existing mobile 'black spots' program reviewed. The next stage would include mobile services as part of the service to be delivered, with targeted subsidies to achieve policy goals. The final stage would be a converged USO providing broadband for both fixed and mobile services. (Coutts 2015, slide 5).

The RTIRC also report questioned whether the NBN solution for provision of its service to premises is always the most appropriate solution. In indigenous Aboriginal communities, for example, individual access to broadband is better provided by mobile connectivity or WiFi than by satellite services (RTIRC 2015, 34).

Before the Government abolished TUSMA, section 23 of the TUSMA Act required that TUSMA's "public interest'" and other related functions be reviewed. That review should proceed. One of its most important terms of reference must be the goal of only one provider of broadband infrastructure of last resort to all Australians – NBN Co, but with flexibility to provide the most appropriate broadband infrastructure for different communities in Australia.

Service Provision

NBN Co must remain a wholesale only provider of infrastructure; it cannot provide retail services to end users (*National Broadband Companies Act 2011*, s. 9). If, as suggested above, NBN Co is made the universal provider of infrastructure, the next obvious issue is whether there should also be a universal obligation in relation to service provision.

As discussed above, the transmission capacity to support 'superfast broadband' should be accessible throughout Australia. The question of whether the provision of a service should be mandated is a more difficult one. Increasingly, Australians are making different choices for their communications services; the increasing use of mobile services for voice, the use of fixed line services for broadband, or other combinations of technologies and services attest to that.

There may also be room for other categories of providers: a service provider for a specific geographic area, a provider of specialised services for people with disabilities, or a provider of high quality, low cost voice only (or broadband only) services. There should be room for a range of different categories of providers, and customer choice to meet their particular communications needs.

The fact of existing broadband infrastructure in an area does not, however, guarantee that services will be offered on a retail basis to customers there; the business case to do so may not exist.

One solution may be that a retail provider is declared by the Minister to be the universal provider of service to that area, with cost recovery possible under a modified USO levy scheme.

Another possibility would be similar to the former Australian Broadband Guarantee Scheme under which a minimum level of services is provided at a set price, meeting consumer protection requirements, as proposed by the Regional Telecommunications Review (RTIRC 2015, 47-51). It should then be eligible for Government subsidy support (see Raiche 2010, 5). In either case, minimum consumer protections should apply.

Meeting the Cost(s) of the USO

Funding universal service provision (infrastructure and services) is not an issue for Governments in a monopoly provider environment. The monopoly provider (whether Government or privately owned) can cross-subsidise those areas/customers that are difficult and/or expensive to serve with its more profitable services. Once competition is introduced, however, competitors to the incumbent provider target more lucrative markets in terms both of customers and locations (Minister for Transport and Communications 1988 paras 3.29-3.31). Since the introduction of competition in telecommunications in Australia, that issue has been addressed through the universal service levy scheme, with 'eligible' providers providing a proportionate share of their 'eligible' revenue to the USO provider for the provision of loss making infrastructure and service (T(CPSS)A Part 2, Divisions 13-14).

In an NBN environment, the costs of providing infrastructure and services must be considered separately: NBN Co will be the universal provider of infrastructure to premises, but cannot be the provider of services. And clearly, the costs of providing universal infrastructure will be significantly different from those for providing services over that infrastructure.

Loss-making Infrastructure

The Government has begun the process of identifying the costs involved in providing infrastructure, as well as how those costs can be met.

The Bureau of Communications Research (BCR**)** has issued initial and final consultation papers, seeking input on the costs of providing loss-making infrastructure in regional Australia and on cost recovery methodology for recovery of those costs (BCR 2015, 7). Specifically, the paper looks at the cost issues for the provision of fixed wireless and satellite services to regional and remote Australia.

> The fixed wireless and satellite NBN networks are non-commercial largely as a result of the high cost needed to achieve successive government requirements for high-speed broadband to be delivered across Australia. Meeting the required coverage and performance standards requires significant capital investment. Revenue opportunities are limited given the small number of

> customers served, current pricing arrangements and infrastructure competition (BCR 2015, 15)[3]

The RTIRC Report also raised the issue of funding loss making infrastructure and services. Its recommendation was for a new 'Consumer Communications Fund' that would:

> … replace the current USO levy scheme and support 'loss making regional infrastructure and services with scope to include subsidy arrangement for the non-commercial NBN services (Satellite and Fixed Wireless) as well as social equity elements that merit funding…(RTIRC 2015, Recommendation 9 p. 54)

Even confining the BCR's examination of 'loss making areas' to regional Australia, there are significant issues to be decided including the methodology of determining 'loss', the granularity of the loss making areas, the period over to which to determine loss, etc. (Bureau of Communications Research 2015, Chapters 2-5). After the BCR reports to Government in 2016, Government will need time to consider the Report's recommendations as well as recommendations from the RTIRC report and other relevant findings. It will therefore be some time before there is clarity in whether and to what extent NBN's provision of infrastructure will cost, how that cost is determined, and how it is paid for.

Loss-Making Services

Until now, the calculation for determining loss-making services under the USO has included the provision of both the underlying infrastructure and the service. In the NBN regulatory framework, the two must be disaggregated.

The BCR's study is looking at the costs of providing infrastructure and the underlying access services that NBN Co will supply to retail service providers. While clearly those access costs will be a significant component of the overall cost to retail providers of providing services, there will be other costs involved, depending on the services on offer.

As argued above, a minimum level of broadband **service** should be accessible from all Australian premises. It can then be left up to each customer as to the choice of service(s) they subscribe to, including whether the service includes voice, voice and text, or text only, and at speeds that address their particular circumstances.

There may still be areas where service provision is uneconomic. For those areas, there could be a subsidy scheme, similar to the Broadband Service Guarantee scheme. Specifically, providers of broadband services (at a minimum quality level and affordable price) could be subsidised for the provision of the minimum service to areas where it is otherwise not economic to do so.

The Way Forward?

There is no question that the 1997 version of the USO does not reflect the way people communicate, the technology they use or the new regulatory framework.

At the least, a newly imagined universal service obligation must reflect the reality that people make very different choices in the communications equipment and services they use. It must reflect the reality of an NBN world where the provider of last resort for infrastructure is, at law, different from a service provider or providers of last resort. And compensation (a levy scheme, or government subsidy, for example) for the infrastructure provider of last resort must be very different to any assistance given to service providers.

Quoting Fletcher:

> We will not find the answers overnight – and we are keen to hear the perspectives of stakeholders including of course those who will speak at today's conference.
>
> The government does not have a concluded view about what changes, if any, we would like to make to the USO. But we are certainly open to asking the question of whether the USO arrangements could be varied to do a better job of achieving their underlying policy intention: providing Australians reasonable access on an equitable basis to telecommunications services wherever they live. (Fletcher 2015, 5)

The questions have been posed for some time. It is time to develop the answers.

References

Abbott, T; Turnbull, M. 2015. 'Media Release by Prime Minister and Minister for Communications: A Digital Transformation Office'. 23 January.

Australian Communications Authority (ACA). 2002. *Telecommunications Performance Report 2001-2002*.

Australian Communications Consumer Action Network (ACCAN). 2011. *Universal Service Obligation: Legislative Reform for Transition to the National Broadband Network – Discussion Paper*. August.

Australian Communications Consumer Action Network (ACCAN). 2014. Position Statements: Our Broadband Future: What Consumers Want. February.

Australian Communications and Media Authority (ACMA). 2011. *Broken Concepts: The Australian Communications Legislative Landscape*, August.

Australian Communications and Media Authority (ACMA). 2013. *Broken Concepts: A 2013 Update on the Australian Communications Legislative Landscape*, June.

Australian Communications and Media authority (ACMA). 2014. *Communications Report 2013-2014*.

Australian Government. 2014. *Telecommunications Regulatory and Structural Reform,* December.

Barr, T. 2007. Revisiting the USO, *Telecommunications Journal of Australia*, 57:2/3.

Bureau of Communications Research (BCR). 2015. C*onsultation Paper: Non-commercial services funding Options: Final Consultation Paper*. October.

Coalition (Liberal and National Parties). 2013. 'The Coalition's Plan for Fast Broadband and an Affordable NBN'. April.

Committee of Inquiry into Telecommunications Services. 1982. *Report* (Chairman J. A. Davidson (The Davidson Inquiry), Volume 1.

Coutts, R. 2015. 'POTS to PANS: Journey to Future USO', Presentation to ACCAN Conference, 'Rethinking the USO'. 12 March.

Department of Broadband, Communications and the Digital Economy (DBCDE). 2010. *Implementation of Universal Service Policy for the Transition to the National Broadband Network Environment*, October.

Department of Communications. 2015. Telecommunications and Grant Registers: TUSMA Agreement: Telstra, accessed on Department of Communications website: https://www.communications.gov.au/who-we-are/department/funding-reporting/telecommunications-contract-and-grant-registers 9 December 2015.

Fell, L. 2011. 'Malcolm Turnbull: A Feisty interview with the Shadow Minister' *Telecommunications Journal of Australia* 61(1):2.7.

Fletcher, P. 2015.Keynote Address to ACCAN Conference by Parliamentary Secretary Assisting the Minister for Communications: 'Rethinking the USO', 12 March.

Goggin, G. 2010. 'Realising Universal Communications'. Paper Presented at ACCAN Inaugural Conference. 5 July.

Grant, A; Raiche, H. 2012. Consumer Protection and Universal Service'. In Grant, A., Howarth, D., eds, *Australian Telecommunications Regulation*, Communications Law Centre, 386-395

Minister for Transport and Communications. 1988. Statement: Australian Telecommunications Services: A New Framework, 25 May

National Broadband Network Co Limited (NBN Co). 2011. Media Release: NBN Co and Telstra Sign Binding Definitive Agreements', 23 June.

Optus. 2015. *Bringing the USO into the Twenty First Century: Submission to the Senate Environment and Legislation Committee*. February.

Raiche, H. 2010. 'Universal Communications in a Broadband World', Paper presented at ACCAN Inaugural Conference. 5 July.

Regional Telecommunications Independent Review Committee (RTIRC). 2015. *Regional Telecommunications Review 2015*.

Turnbull, M. 2014. 'Government Expectations'. Letter from the Ministers for Communications and Finance to the Executive Chair of NBN Co, 8 April.

Turnbull, M; Cormann, M. 2014. Media Release by Minister for Communications and Minister for Finance: 'NBN Co and Telstra sign revised Definitive Agreements'. 14 December.

Endnotes

[1] There are other important issues that must be addressed to ensure the service is truly 'accessible' to all Australians, such as service quality, disability access and affordability. See, for example, Goggin 2010. This paper will, however, only deal with the three issues listed above.

[2] NBN Co Limited 2011, 1. A summary of the agreements are included in the release and cover NBN Co's use of Telstra's infrastructure, access arrangements, switchover provisions, and NBN's progressive payment to Telstra, expected to total approximately $9 billion. The definitive agreements were updated in 2014 to implement the new Government's policy of an NBN that is a multi-technology mix of fibre, copper and HFC cable to the premises. See Turnbull and Cormann 2014, 1.

[3] The paper notes comments made by NBN Co that the BCR study has limited its inquiry to fixed wireless and satellite services, ignoring the cross subsidies 'likely to be inherent within the fixed line footprint due to geographic pockets of non-commerciality' (BCR 2015, 15).

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Contactability framework for the delivery of universal services

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Abstract: The Universal Service Obligation (USO) ensures access to voice communication services for all Australians. The obligation has changed very little in comparison to the telecommunications market and consumers' use of services. This presents a number of gaps and risks for consumers, as safeguards do not exist for the communications services that are used today, such as data and mobile services. However, updating the obligation to include these services alone will likely fail consumers. Furthermore, focusing on distributing resources does not take into consideration the resulting outcome for consumers; how they utilise the opportunities that they have; or the barriers that they may face. This paper outlines the imperative for action in this area and argues for a new framework based on a principle of contactability. This new framework will have four key areas: availability, affordability, accessibility and service standards. A further two areas; online service delivery and literacy and empowerment, are also needed to fully ensure contactability is achieved.

Introduction

The Universal Service Obligation (USO) guarantees reasonable access to a standard telephone service (STS) and payphones to all people in Australia on an equitable basis, wherever they reside or carry on business (*Telecommunications Act 1999*). The obligation was set out in legislation, but is now delivered by alternative contractual arrangements between the Government and the Universal Service Provider (USP), currently Telstra (*Telecommunications Act 2011*).

There have been a number of changes to the telecommunications market in recent years which make it an ideal time to re-examine how and what telecommunication services are guaranteed to consumers. One of the main drivers is the Government decision to implement the National Broadband Network (NBN), delivered by nbnco (the company), to provide all premises with access to superfast broadband (capable of greater than 25Mbps). This has resulted in a policy of separate network and retail telecommunication services and a desire for competition at each level.

Furthermore, the Regional Telecommunications Review (2015; 44-54) noted that safeguards are needed to expand beyond the guarantee of "increasingly irrelevant" voice services. It recommended that a new Consumer Communication Standard for voice and data be developed. This Standard would be technology neutral and better address availability, accessibility, affordability, performance and reliability issues. It would also be subject to transitional arrangements, with grandfathering provisions (maintenance of the current obligation while the new obligations will apply going forward) to protect consumers who are still reliant on legacy services.

This document will not attempt to provide a history of the USO, summarise all the relevant documentation or outline issues with the current situation in Australia (for the detailed background see Grant & Raiche (2012) and Corner (2012)). Rather it will provide an argument for why there needs to be a change, and how this might look.

Imperative for action

The USO is associated with the principles of availability, accessibility and affordability. Goggin (2010) found that the USO is "well out of date" as it focused on the availability of voice services, which were essential in the 1990s, and not the communication technologies used today. Consumers are now at risk if they are not guaranteed access to the essential telecommunication services of today, primarily data and mobile services. The essentiality of communication services today can be seen by what they are used for (ACMA 2014; 37, 55);

- for personal safety and security in life threatening situations (8.5 million calls were made to Triple Zero in 2014, 67% of which were made from mobile phones),
- for self-progression and personal development (56% of Australians work or study from home),
- to complete essential tasks, e-commerce and economic livelihood, success and well-being (77% of Australians bank and pay bills online, 64% for buying and selling, 49% accessed government websites), and
- for social networking, interaction and communication (94% used the Internet for emailing, 69% of Australians used the Internet for social networking).

However, many consumers are being let down by not being able to access services that they require to perform these necessary activities. Often the service required is not adequately available, particularly for regional and remote consumers. The Department of Communications (2013) stated that 13% of premises had inadequate or no access to fixed broadband services. Accessibility and reasonable affordability are considered to be key aspects of the USO, with some obligations to address these barriers placed on the USP.

However, consumers still face accessibility and affordability barriers, and issues with quality of service standards.

Accessibility

Accessibility of voice services has been traditionally addressed through the provision of accessible equipment – tele-typewriters – to enable people who are deaf or have a hearing or speech impairment to communicate. Telecommunication services, particularly data services, are expected to address many barriers faced by Australians with disabilities. The National Disability Strategy (Department of Social Services 2011; 27) states that the NBN "is capable of enabling Australians with disability and their carers to access a range of benefits including e-health services, remote monitoring for assisted living, interactive learning opportunities, employment opportunities, increased connectedness within the community, and improved access to communication services". Such services come with a hefty price in terms of the cost of equipment and data allowance, support for which is not currently addressed through the obligation or Government support programmes.

Affordability

Affordability is a known barrier for broadband services. Nationally the penetration of households with Internet is currently 83%, with access falling to just 59% for households with incomes in the lowest 20 per cent (ABS 2014). Current indications are that broadband affordability will become an increasing concern, as NBN products last year showed a real price increase of 4.6%, while the cost of other telecommunication services decreased (ACCC 2015). De Ridder (2013) estimates that without entry level retail pricing "there will be 250,000 fewer broadband customers."

The USP is required to have low-income options. However, this does not provide consumers with a choice of providers offering low-income products. Furthermore while some welfare beneficiaries can claim an allowance for the telephone, "most curiously, it is not available to those on the poorest payments such as Newstart and Youth Allowance unless they have dependent children, are over 60 or have limited capacity to work" (SACOSS 2015). De Ridder (2015) demonstrates the potential risk as he estimates that about a million households currently face issues of affordability and are in need of support, but not all qualify for it. The Allowance also only provides for ongoing costs and not the sometimes hefty upfront costs of the devices used for getting connected.

Service Standards

Current connection and repair timeframe guarantees only apply to the delivery of voice services, and service reliability standards do not apply to all networks. Consumers do not have guarantees in relation to service standards for data services. Complaints in relation to fully unusable Internet services and delays in connecting Internet services have increased (45.7% and 41.5%, respectively) in the quarter to March 2015 (TIO 2015). There is a risk to consumers from not having guarantees on these services.

Clearly, there is a gap in the provision of the voice and data services that are required in order to participate adequately in modern society. Some consumers are also at a disadvantage due to affordability and accessibility barriers and due to lacking service and reliability standards.

Updating the current USO model

Since 1991 the Australian telecommunications market has been transformed from a monopoly provider, capable of offering a complete or end-to-end service, to a market with different network infrastructure layers and service providers. When providing a universal service, a number of requirements need to be met, primarily at the network level. It was easier to obligate the provider to offer everyone a service under the old model. The complexity of the market today presents a number of issues which limit the effectiveness of updating the current system.

What is a data service?

The delivery of voice services under the USO is based around a technical standard (CA 2004) which the service must meet. There currently is no similar standard for a data service. The Government initiative of the NBN, to deliver 25Mbps downstream to every premises and 50Mbps to 90% of premises (NBN 2014), only sets out a speed that the network should achieve and not what a data service to every premises should be. This is evident by nbnco selling lower speeds, at 12Mbps downstream. It creates geographical inequity as not all premises will receive the same standard, as the company needs to meet target coverage rates, not to provide everyone with a universal service. The promise to deliver 25Mbps downstream also does not take into consideration what people can do with the connection, which is dependent on other technical features such as upload speeds and latency, which have no set requirements. Minimum technical standards which the services must meet need to be established, to ensure that the services are offered equitably across providers, technology platforms and geographical areas.

At what level, network or retail service, should a data obligation apply?

The purpose and interpretations of what the USO obligation provides varies. Traditional availability addressed the lack of a network, which is the most expensive part of providing a service. Telstra, the current USP, is of the view that “the USO is a retail service provision obligation designed to provide a safety net for customers at a retail level, not a wholesale infrastructure obligation” (Telstra 2015; 11).

Through NBN, legislation, and the carrier licence conditions, every premises will have access to a broadband network which offers services to retailers, on a non-discriminatory basis, at a capped price (Department of Communications 2014). There is no obligation on retailers to provide services over these networks. It is not clear if some premises will have access to a network but not a retail provider, for which an obligation would be required.

What role do mobile services play?

Mobile services are important for safety and convenience, and may be preferred to fixed broadband by many low income consumers. Of households with incomes of less than $40,000, 23% had mobile-only broadband, compared to 9% in households with income over $120,000 (BCR 2015; 55). However, there are large areas of Australia which have no or poor mobile reception. In the first round of the Mobile Black Spot Programme, 6,221 mobile black spots were identified (Turnbull 2015). Mobile services can deliver voice and data services, but an updated USO might not address mobile coverage issues. A provider obligated to provide data services would be able to choose the technology to use and might not address mobile coverage issues, particularly along highways and other non-premise areas.

Is the USO the best mechanism to address all barriers?

There is a myriad of barriers to broadband that a consumer may face. Other countries are increasingly moving away from updating and declaring new services as universal services in favour of using other complementary mechanisms. Ofcom (2010; 4) stated that availability is an issue “but it is by no means the only one and some of the challenges are not easily addressed via the USO requirements”. Placing an obligation on one provider to address all barriers may not be the most effective method. It also removes consumer choice and power. For example, a consumer who needs assistance with special equipment should not be limited to the service provider and plans from which they can choose in order to avail themselves of such equipment. A number of targeted funding programs may be more effective to address barriers such as affordability and accessibility.

With the complexity and the new opportunities that the telecommunications market presents, and the services that are required by consumers, it is time for the USO to be re-examined. The following section will outline a suggested new framework to approach the USO, which would deliver more value to consumers.

A new telecommunications Contactability Framework

Communication services can be seen as an enabler for consumers to perform a variety of functions, rather than delivering value by themselves. Therefore they should be judged on how well they are utilised for the capabilities that they deliver. A contactability framework considers what a consumer can do, based on a theoretical framework, the capabilities approach, developed by Nobel Prize winning economist Amaryta Sen (Sen 1999).

The capability approach was originally used in development studies to understand the causes and consequences of not having opportunities to "do" and "be" what is of value to the individual, due to external causes such as poverty or racism. It highlighted that development should be a method to promote an individual's capabilities, and should be evaluated according to its impact on people's capabilities. For example a programme to teach school children to read should not just be evaluated by its means, e.g. how many children attended class and passed exams, but by how this impacted on these children's capabilities – such as being literate, empowered, connected and later accessing jobs. This approach is useful as it is applicable across political, economic and cultural borders. People can choose to do the things they want to do when they have the resources available, as well as the environmental and personal characteristics that allow them to perform these actions. Garnham (1999; 113-124) argues that a capabilities approach to communications results in a state of 'contactability', the absence of which results in a loss of functions, inhibits participation in social life and the labour market.

For consumers in Australia, contactability means the ability to ensure personal safety, self-progression and personal development, completion of online tasks, e-commerce and economic livelihood, success and well-being and social networking, interaction and communications. Working backwards from this, the level of service required to ensure these capabilities is a voice and data service that offers a minimum level of availability, affordability, accessibility and reliability. The following chart and sections outline each of these key requirements and suggests elements, methods and tools which could be used to improve contactability.

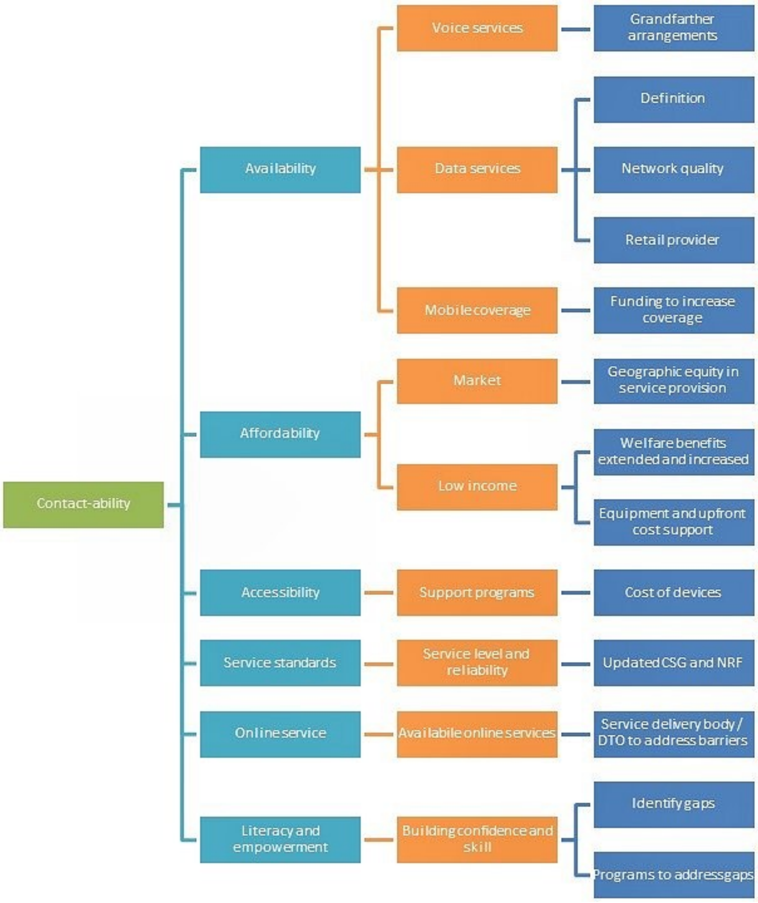

Figure 1: Contactability Framework

Availability

As discussed above, consumers need access to voice and data services in order to perform the many functions which communication services enable. Furthermore, as communication no longer occurs in one place, an element of mobility needs to be included.

a) Voice

The delivery of voice services occurs increasingly through mobile and Internet platforms. Other countries, such as the UK, are currently debating the removal of obligations related to the delivery of voice services through their national legacy network (Telegraph 2015). After the completion of the NBN network rollout, most voice services in Australia will be delivered over Internet applications. However, there may be a number of consumers, particularly during the interim period and for those receiving NBN services over satellite technology, who remain reliant on the delivery of voice services through the legacy network, i.e. the Public Switched Telephone Network (PSTN). The obligation to provide voice services should be grandfathered to protect consumers who continue to rely on these services. It is likely, with time, that this obligation could be removed, once there is evidence that all consumers have access to similar or better alternatives.

b) Data

Definition

The term data service can describe many activities, including voice and video conferencing, emailing, web browsing, accessing government sites and video streaming. A technical minimum level of service appropriate to the required level of data services needs to be established. This would be achieved by examining what the service is required to deliver and designing the standards around it. It could be updated if the level of service needed increased over time. Consumers require a network to meet certain standards to carryout functions, such as minimum speeds for uploading and downloading and latency for voice and video calling. Providing a network that cannot meet these will limit consumers' capabilities.

Quality network standards

As nbnco, or a competing wholesale broadband infrastructure provider, will be connecting every premises, it is logical that quality standards at the network level should apply. It is unlikely, and in some cases not possible, that more than one network will service some premises. Consumers for the most part will not have a choice in the network that is used. Therefore technical standards should apply through legislation or regulations on carrier licence obligations to ensure that a minimum standard of broadband network access performance is available throughout Australia. Ireland's Broadband Intervention Strategy has proposed minimum standards delivered at the wholesale level for: minimum download speed (30Mbps), minimum upload speed (6Mbps), latency (no more than 25ms), jitter (no more than 25ms), packet loss (not more than 0.1%) and network reliability (of at least 99.95% of the time) (DCENR 2015; 19). The strategy aims to promote strong retail competition.

Standards in terms of similar specifications should apply to all wholesale broadband networks in Australia. The level of speeds typically offered by service providers are peak capabilities rather than what is always achieved. Therefore a minimum speed, Committed Information Rate (CIR), per premises is also required.

Retail provider

The provision of wholesale broadband network access in Australia, where retailers must be offered non-discriminatory price-capped access, should be priced to ensure that it is commercially motivating for retailers to offer services in all areas. However, there are other costs to the retailer in supplying services, such as costs to connect to the network (backhaul), which may threaten this. In the first instance nbnco and the Australian Competition and Consumer Commission (ACCC) should address market issues that result in geographic inequities amongst retail providers. A retail provider of last resort for data may be necessary.

Decisions made by retailers can also affect the quality of data services for consumers. However, if network quality standards are met and consumers can make informed decisions regarding which retailer to choose on broadband performance, then a minimum level of service at the retail level should not be required.

c) Mobile coverage

Even where mobile services could be used to fulfil the obligation of delivering data services under a revised USO, it is unlikely that this would result in market-driven increased mobile coverage, as USP providers can fulfil their obligation at a lower cost through other available networks (i.e. Telstra copper and NBN). Therefore mobile coverage is likely to remain an ongoing concern, and it is unclear how long the Mobile Black Spot Programme can continue to be indefinitely funded. As coverage extends further into less populous areas, the cost of extending mobile coverage increases and the potential return to the provider decreases. It is important for the public good that the mobile networks do extend their coverage further, and that a collaborative approach and utilisation of all available infrastructures is used, to reduce the cost of public subsidies. The extension of the mobile networks should ensure open access wholesale mobile coverage, i.e. re-selling a network to other providers. This is in the best interest of consumers, as it provides choice and competition in rural areas. Further targeted funding measures should be used to address mobile coverage gaps particularly along roads.

Affordability

Affordability is a consumer's ability to pay for and use telecommunications without sacrificing expenditure on other essential services and items (Lewin & Milne 2010). It is particularly an issue for those who are vulnerable to higher costs. It should be ensured that affordability is not a barrier to communications services. Existing Government-funded subsidies for low income consumers need to be re-examined to include a wider range of at risk citizens, and updated to reflect the essential role and cost of basic broadband telecommunication services.

The ongoing cost may not be the only barrier or immediate affordability concern. Whether upfront or ongoing costs represent the greater barrier to usage should be examined. A review of the US subsidy scheme for telephone services found that support for initial connection (Linkup) increased penetration to a greater extent than ongoing monthly support (Lifeline subsidy). It was more effective as it encouraged consumers who had no connection to take up services (Ackerberg et al 2013). Furthermore, the low-income households surveyed were found to value higher assistance with upfront costs more than assistance with ongoing costs.

Accessibility

At the moment the Australian USO framework does not address the basic needs of consumers who require additional equipment in order to use data services. Mobile and fixed broadband data services, and the associated equipment, may inherently better meet the needs of consumers with accessibility issues. For these citizens, the cost of the additional devices needed can be significantly more than for average consumers. There are no policies or programs which recognise or provide broadband communication support for these users. If telecommunication services are to be used to address social inclusion issues and to improve service delivery and health, then the equipment supply and the costs of being connected need to be addressed through targeted programs.

Communication Standards

Standards should apply to communication services in terms of reliability, connection and repair timeframes. These standards should apply across all networks as this would ensure that there is consistency in the delivery of services to consumers for telecommunication services.

The implementation of this would take the form of an update to the current standards: the Customer Service Guarantee (CSG), which applies to the connection and repair timeframes for the standard telephone services, and the Network Reliability Framework (NRF), which relates to fault repairs on the Telstra copper network. The new Consumer Communications Standard should ensure that a minimum reliability standard is achieved by networks. Consumers may have no choice about the wholesale network that services them, because it may be an effective monopoly; therefore it is important that these minimum connection, repair and reliability standards apply to all networks. While consumers deal directly with retail service providers, it is important that incentives and accountability apply to the body which is responsible for delivering the network services.

Online service delivery

Telecommunication providers and the NBN will increasingly be relied upon to deliver other services, such as education and Government online services. The latter is seen as a better method to interact with citizens, and produces cost savings to the Government from doing so. However, usually there is not a prior assessment made of the ability of consumers and the network to use and deliver these e-Government services. One suggested approach could be the use of zero rating for Government websites (i.e. data is not charged for using these sites).

However, this would need to apply to all plans and providers, including mobile networks, to ensure equity, which may present a challenge. The Digital Transformation Office (DTO) and the body delivering the service may be best placed to establish systems to deal with the delivery of these services. They are better equipped to know who the relevant people are and the level of service and equipment required. Furthermore, this would require the governmental agencies to design their services with the consumers' ability to use them in mind. If the delivery of online services requires the use of special equipment, e.g. for disabled citizens, then the agency concerned should provide support for the purchase of this equipment. As a further example, the cost of equipment for school age students should be considered and programs to address the affordability of these designed, such as providing an increased child benefit for school age children.

Literacy and Empowerment

Once consumers have access to services, can afford them, and any further accessibility barriers are addressed, then they must have the ability, skill and confidence to utilise the services. Lack of confidence, lesser ability or fear of the technology can be a barrier to its use. This is a complex barrier that is hard to measure or overcome. It is increasingly important that consumers are informed and feel empowered by technology and communication services. It is important that consumers realise the benefits of communication services. Further study is required to identify barriers to usage in consumers' attitudes to communication services. Programs may need to be developed which try to address the gaps and build consumer confidence, both in their user skills and the workings of the technology itself.

Conclusion

Broadband communication services are increasingly the biggest enablers for consumers to be capable of carrying out a large number of essential work, home and lifestyle activities. The benefit from having and using good broadband services can impact on almost every aspect of life. However, consumers in Australia are at risk from not having access to these essential services. The current Universal Service Obligation, tied to traditional telephony services, is not delivering in this area.

The telecommunications market has presented difficulties in terms of delivering equitable broadband data services, whether equitable across geographic areas or over income ranges or age demographics. Therefore a re-examination of the delivery of universal communication services should be undertaken. This paper has suggested adopting Sen's capability framework to better address the needs of everyone to utilise communication services. For this, a number of elements would need to be included, including guaranteeing a defined data service available to everyone, obligating quality standards on fixed networks, extending mobile coverage, targeting funding programs for essential equipment and service costs, ensuring that services delivered online are appropriate, and that consumers are confident users of the enabling technologies. In short, it is important that citizens can achieve contactability.

References

Ackerberg, D. A; DeRemer, D. T; Riordan, M. H; Rosston, G. L.; Wimmer, B. S. 2013. "Estimating the Impact of Low-Income Universal Service Programs", Centre for Economic Studies. Available at: http://www2.census.gov/ces/wp/2013/CES-WP-13-33.pdf

Australian Bureau of Statistics (ABS). 2014. '8146.0 - Household Use of Information Technology, Australia, 2012-13'. Available from: http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/8146.0Chapter12012-13

Australian Competition and Consumer Commission (ACCC). 2015. 'Changes in the Prices Paid for Telecommunications Services 2013-2014'. Available at: https://www.accc.gov.au/system/files/906_ACCC%20Telecommunications%20reports%202013%E2%80%9314_web_2-June-2015.pdf

Australian Communications and Media Authority (ACMA). 2014. 'Communications Report 2013 – 2014'. Available from: http://www.acma.gov.au/theACMA/Library/Corporate-library/Corporate-publications/communications-report

Australian Government, Bureau of Communications Research (BCR). 2015. 'Final consultation NBN non-commercial services funding options.' Available at: https://www.communications.gov.au/have-your-say/final-consultation-nbn-non-commercial-services-funding-options

Australian Government, Department of Communications. 2013. 'Broadband Availability and Quality Report'. Available from: www.communications.gov.au/file/3184/download?token=wROJ-2Uq

Australian Government, Department of Communications. 2014. 'Telecommunications Regulatory and Structural Reform'. Available at: https://www.communications.gov.au/sites/g/files/net301/f/Telecommunications%20Regulatory%20and%20Structural%20Reform%20Paper.pdf

Australian Government, Department of Social Services. 2011. 'National Disability Strategy 2010-2020'. Available at: https://www.dss.gov.au/sites/default/files/documents/05_2012/national_disability_strategy_2010_2020.pdf

Communications Alliance (CA). 2004. Industry code c519:2004; End-to-end network performance for the standard telephone services.   Available at: http://www.commsalliance.com.au/Documents/all/codes/c519

Corner, S. 2012. 'Universal Telecommunication Services: A brief history and analysis of issues surrounding the new Australian legislation on the universal service', *Telecommunications Journal of Australia*, 62(2), 22.1-22.9

Department of Communications, Energy and Natural Resources (DCENR). 2015. 'Ireland's Broadband Intervention Strategy. Connecting Communities. National Broadband Plan.' Available at: http://www.dcenr.gov.ie/communications/SiteCollectionDocuments/Broadband/Strategy%20Reports/Proposed%20Intervention%20Strategy.pdf

De Ridder, J. 2013. 'Entry Level Pricing for Fixed Broadband'. Available at: http://www.deridder.com.au/files/Entry%20Level%20Pricing%20for%20Fixed%20Broadband-FINAL.pdf

De Ridder, J. 2015. 'The future of the Universal Service Obligation (USO)'. Occasional Paper for the Australian Communications Consumer Action Network (ACCAN). Available at: https://www.accan.org.au/our-work/research/1132-the-future-of-the-uso

Goggin, G. 2010. 'Realising Universal Communications'. Working paper for inaugural ACCAN conference. Available at: https://accan.org.au/files/Reports/Realising%20Universal%20Communications.pdf

Garnham, Nicholas. 1999. "Amartya Sen's capabilities approach to the evaluation of welfare: Its application to communications."   Available at: http://www.dlib.si/stream/URN:NBN:SI:DOC-BCMNDPK6/a82d7efb-d39c-4ab5-be30-8489eb609d3f/PDF

Grant, A; Raiche, H. 2012. 'Chapter 7: Consumer protection and universal service', *Australian Telecommunications Regulation*, 4th Edition. Ed: Grant and Howarth. Communications Law Centre, UTS.

Lewin, D; Milne, C. 2010. '*Are telecommunications services universally affordable across the EU? An independent assessment for Vodafone*'. Available at: http://www.plumconsulting.co.uk/pdfs/Plum_Nov2010_Affordability_of_telecommunications_services.pdf

National Broadband Network (NBN). 2014. Shareholder Minister Letter of Statement of Expectations. Accessed from: http://www.nbnco.com.au/content/dam/nbnco2/documents/soe-shareholder-minister-letter.pdf

Ofcom. 2010. 'Joint UK submission from the Department for Business, Innovation & Skills and Ofcom to the European Commission's Consultation on Universal Service Principles in e-Communications.' Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/access/uso_response.pdf

Regional Telecommunications Review. 2015. '*Regional Telecommunications Review. Unlocking the potential in regional Australia'*. Report by the Regional Telecommunications Independent Review Committee for the Australian Government. Available at: http://www.rtirc.gov.au/wp-content/uploads/sites/2/2015/10/RTIRC-Independent-Committee-Review-2015-FINAL-Low-res-version-for-website.pdf

Sen, A. 1999. *Development as Freedom*. OUP, Oxford.

South Australian Council of Social Services (SACOSS). 2015. 'Cost of Living update, No.22 March Quarter 2015. Available at: https://www.sacoss.org.au/sites/default/files/public/documents/Reports/Cost%20of%20Living%20Reports/150520_CoL%20Update%20No22_Telecommunications_final.pdf

Telecommunications (Consumer Protection and Service Standards) Act 1999. Available at: https://www.comlaw.gov.au/Details/C2015C00390

Telecommunications Industry Ombudsman (TIO). 2015. 'TIO complaints down year-on-year, but landline and Internet complaints increase'. Accessed 27 November 2015. Available from: https://www.tio.com.au/publications/media/tio-complaints-down-year-on-year,-but-landline-and-Internet-complaints-increase

Telecommunications Legislation Amendment (Universal Service Reform) Bill 2011. Available at: https://www.comlaw.gov.au/Details/C2011B00220/Explanatory%20Memorandum/Text

Telegraph. 2015. 'BT aims to shut down traditional phone network to help it battle US tech giants'. The Telegraph, 24 June, 2015. Available from: www.telegraph.co.uk/finance/newsbysector/mediatechnologyandtelecoms/telecoms/11696314/BT-aims-to-shut-down-traditional-phone-network-to-help-it-battle-US-tech-giants.html

Telstra. 2015. “Telstra submission to the Bureau of Communications Research NBN non-commercial services further options consultation paper”. Submission to Department of Communications Consultation. Available at: https://www.communications.gov.au/sites/g/files/net301/f/webform/hys/doc/Telstra%20Corporation%20Limited.pdf

Turnbull, M. 2015. ‘Mobile Black Spot Programme to deliver almost 500 new or upgraded base stations with total investment of $385 million’. Accessed 27 November 2015. Available from: http://www.minister.communications.gov.au/malcolm_turnbull/news/mobile_black_spot_programme_to_deliver_almost_500_new_or_upgraded_base_stations_with_total_investment_of_$385_million#.Vlfox79Cxf4

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Not your Grandfather's HAM Radio

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Abstract: Scratch any older electronics or telecommunications professional and there's a good chance you'll find an Amateur Radio operator.

Amateur Radio operators of our fathers' or grandfathers' era typically set-up transmitting stations in sheds down the backyard with wire antennas strung between the trees. Talking to people around the world on HF amateur bands was cool then, as even a phone call interstate was tricky; you needed to book a time with the telephone trunk operator, and it cost a small fortune. The more adventurous amateurs experimented with frequencies above 30MHz, and many pushed the limits of the available technology. In 1947, an Australian amateur (VK5KL) made a two-way contact on 50MHz with an amateur in Hawaii (W7ACS/KH6), a path of 9000 km. That was esoteric stuff - how times have changed!

Introduction

On 12 December 1961, barely four years after the world's first orbiting satellite was launched (Sputnik-1), an Amateur Radio satellite built by a group of amateurs in California was launched successfully, piggy-backed with a few other satellites (Amateur Radio 2015). A later amateur satellite (Oscar 5) was built in the late-1960s by Project Australis, a bunch of radio amateurs who were undergraduate students at Melbourne University. It was launched into low earth orbit (LEO) from Vandenberg Air Force Base in 1970. Oscar 5 operated on its battery power for 46 days and over that time the students compiled tracking reports from hundreds of amateur stations in 27 countries. Not bad for a satellite built on a shoestring budget using a bedspring for the release system and Stanley measuring tape for the antenna! An on-board experiment involved measuring the satellite's case and internal temperatures which, astonishingly, revealed that the engineering algorithm previously used by space engineers to predict a satellite's temperature was in error! Oscar 5's design for a stabilisation scheme was cleverly simple, using on-board permanent magnets that reacted with the earth's magnetic field to stabilise and orient it to obviate signal fading. Oscar 5's stabilisation technology was later widely adopted and adapted by other LEO satellite makers.

http://doi.org/10.18080/ajtde.v3n4.41

Figure 1: A typical "home brew" Amateur Radio station from the 1960's

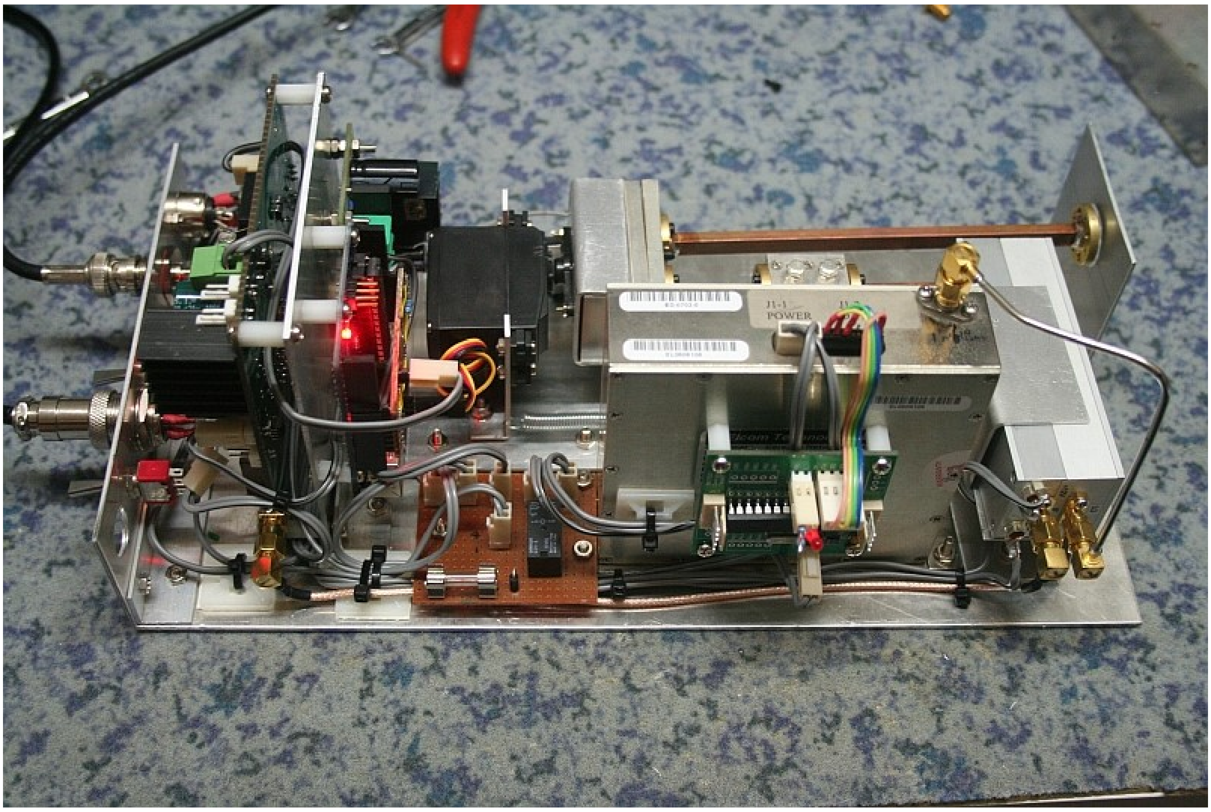

Figure 2: DIY ham microwave gear

Figure 2 shows a 47 GHz transverter that was made by VK4REX. Making your own equipment remains popular with today's radio amateurs, especially on the microwave bands as well as on the low frequency bands at 137 and 474 kHz.

Since 1961, over 70 amateur satellites have been launched. The oldest still operating and relaying Amateur Radio signals, is Oscar 7, launched in November 1974; a collaborative effort between US, Canadian, German and Australian radio amateurs.

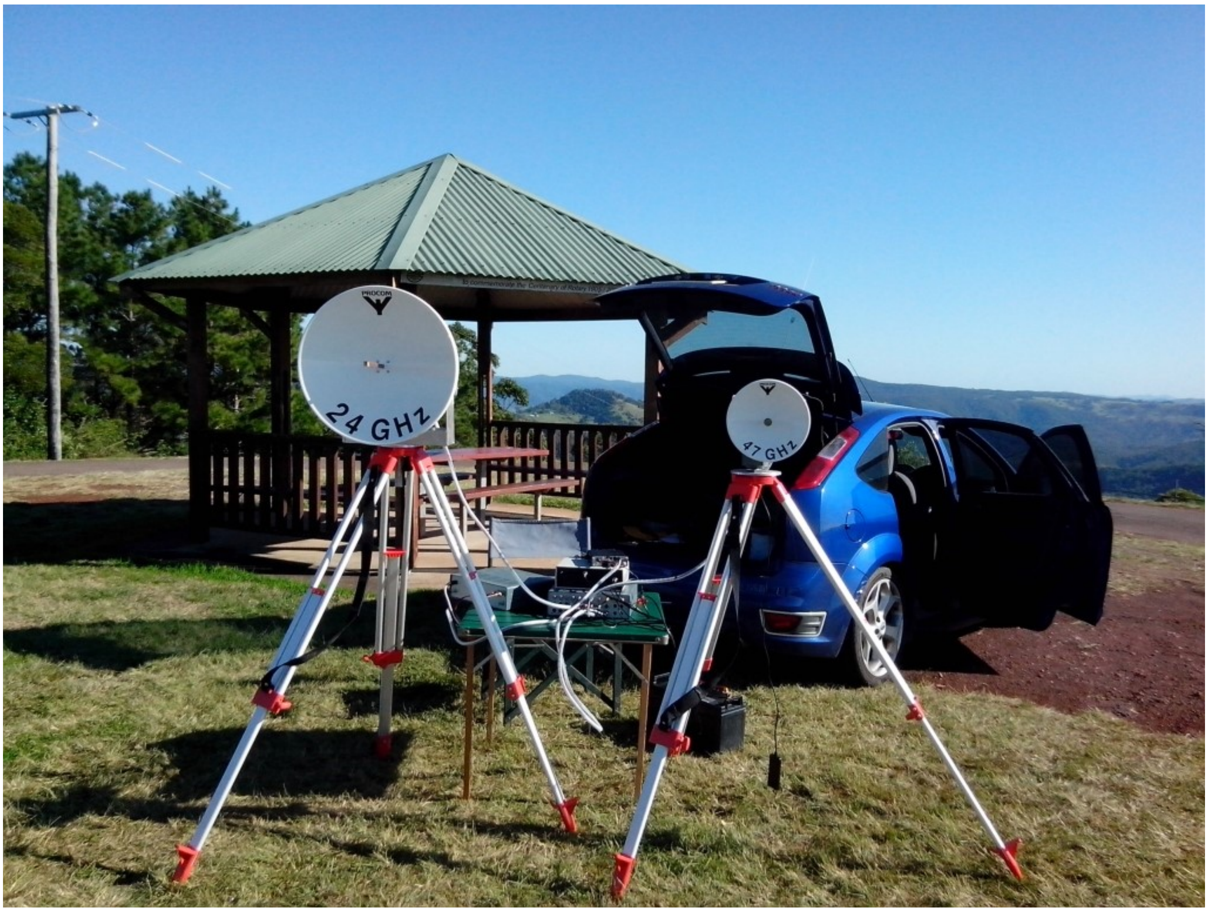

Figure 3: Ham microwave outdoors - VK4REX at Howell's Knob, South East Queensland

Figure 3 shows how operating from geographic vantage points is popular with amateur radio microwave enthusiasts.

The most recent satellite with an Amateur Radio payload is EO-80, a sun-synchronous "cubesat" measuring 10cm x 10cm x 20cm. The primary function of EO-80 is to test systems designed for other cubesats, including

- an Attitude Determination and Control System,
- an Ion and Neutral Mass Spectrometer,
- an Oxygen Flux Probe, Satellite Control Software, and
- the quadpack deployer (a spring device that shoots cubesats out into space from the International Space Station).

The Amateur Radio transponder will be activated following the completion of the various scientific experiments. Meanwhile, the University of NSW's BLUEsat Group, a team of undergraduate students, is active in developing "easy-to-access space technology", which includes Amateur Radio in communications systems. Amsat provides information on all amateur satellites (AMSAT 2015).

Some people are surprised to know that the International Space Station has a permanent Amateur Radio station. It's used to provide some down-time for the astronauts and cosmonauts, and also provides the link for a NASA-sponsored education program, Amateur Radio aboard the International Space Station (ARISS) (2015). To quote NASA:

> "With the help of Amateur Radio Clubs and ham radio operators, astronauts and cosmonauts aboard the International Space Station (ISS) have been speaking directly with large groups of the general public – showing teachers, students, parents, and communities how Amateur Radio energises students about science, technology, and learning" (NASA 2015).

The overall goal of ARISS is to get students interested in mathematics and science by allowing them to talk directly with the crews living and working aboard the ISS. The program's goal is to spark student interest in mathematics and science and inspire the next generation of explorers. Selected students learn about the station, radio waves and other topics, and prepare questions before their scheduled call. Hundreds more listen in from classrooms or auditoriums. Teachers report that the exceptional experience of talking with crew members in space "holds the power to inspire greatness" and "launches dreams".

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Figure 4: International Space Station

The ISS also has an orbiting beacon, amateur data packet repeater and a slow-scan television transmitter. A typical ground station for contacting the ISS station would include an inexpensive amateur transceiver with 25-100 watts of output power, and a steerable antenna system. Public domain software is available to help track when the ISS will be in range of the amateur ground station, and where to point the antenna.

Figure 5: Flight Engineer Sunita Williams Talks with Students from the Zvezda Service Module

Figure 6: Students ask questions of the astronauts during a 10 minute pass of the International Space Station

Although many radio amateurs still simply talk over the radio, or participate in "radio-sport" contests to see how many stations they can work in a set time, a large number of amateurs are now using the very latest technologies to communicate. Radio amateurs have been prolific in developing new data compression techniques, allowing narrower signal bandwidths and far superior noise immunity, and many amateurs now communicate reliably around the world using only flea-power transmitters and low-cost Raspberry Pi computers, extracting information from signals way below the radio noise floor, something impossible only a few years ago (Raspbian 2015).

Other radio amateurs are developing the hardware and software solutions for the new generation of software-defined radios (SDRs) with functionality limited only by their imagination, and their nation's radio regulations, naturally. One such development is the open source CODEC designed by Australian amateur David Rowe (VK5DGR) (Rowe 2015), providing communications quality speech over narrowband/low bandwidth HF and VHF digital radios, and finding application in a number of diverse areas.

So, Amateur Radio has come a long way in the last half-century. It's always been a hobby that just about anyone can get into on a modest budget, and it now caters for a very wide variety of interests indeed. In the age of Facebook and Twitter, it provides an opportunity to learn how communications technologies actually work, and takes followers beyond simply being consumers of packaged technology, into a much more interesting and challenging sphere. It can be combined with many other interests, such as ballooning (HORUS 2015; Linton 2015), orienteering, yachting, four-wheel driving or rocketry, and it might even lead into a lifelong career in science and technology.

The Wireless Institute of Australia

The representative body for Amateur Radio in Australia is the Wireless Institute of Australia (WIA) (2015), founded in 1910. A key role of the WIA is providing training and licence assessment services for people interested in obtaining their amateur licence, particularly young people. WIA appointees participate in the work of spectrum management, consultative and standards bodies, the Australian Radio Study Groups in preparatory work for World Radio Conferences (WRCs), Australian delegations to WRCs, and the Radiocommunications Consultative Council in Australia.

The WIA is a member of the International Amateur Radio Union (IARU 2015), which represents the interests of the amateur and amateur satellite services internationally and is recognised by the International Telecommunications Union. There are over three million Amateur Radio operators worldwide, with over 1.2 million in Japan, over 700,000 in the USA, and about 14,000 in Australia.

Although the WIA currently performs licence assessment and callsign functions under a Deed with the ACMA, ideally, the amateur service would like to have a greater degree of self-regulation. Self-regulation might include issuing licences and determining overseas amateur qualifications equivalency so that visiting and immigrating amateurs can more easily obtain an Australian qualification, and determining the relative privileges of the three licence grades, all within a broad set of regulatory boundaries set by the Commonwealth.

Amateur Radio Spectrum

The Amateur Radio service has either a Primary (exclusive) or Secondary (shared) user status on many amateur bands from 136 kHz right through to 300 GHz and above. VHF and UHF spectrum used by radio amateurs is coming under increasing pressure from existing and emerging telecommunications and entertainment services, particularly at 450MHz, 2300MHz and 3300MHz. The amateur service has recently acquired new spectrum around 136kHz and 475kHz, and WARC-15 has just approved a new international amateur allocation at 5MHz; however, that spectrum is fairly heavily used in Australia and it may be some time before it becomes available for Amateur Radio use in Australia.

Amateur Radio Regulation

The ACMA regulates the amateur services through the Radiocommunications Licence Conditions (Amateur Licence) (1997), which specifies the operating conditions such as frequency bands, permitted power, modes of transmission, methods of station control and many other conditions.

There are three amateur licensing grades in Australia: the Foundation licence (an entry level introductory licence), the Standard grade, and the Advanced grade. The three grades have different operating conditions and require different knowledge assessments in order to obtain the licence.

The Foundation licence has limited privileges, and only allows transmission on frequency bands below 450MHz, analogue voice modes and Morse code, and a maximum of 10 Watts of output power. The Foundation licence is easily achievable with a little study and passing a multiple choice exam along with a practical assessment. Standard and Advanced licensees have access to more frequency bands, digital and image modes, and higher permitted power, up to 400 watts peak for Advanced licensees.

The introduction of the Foundation licence in Australia over 10 years ago has largely offset a natural decline in the number of licensed radio amateurs, mostly due to age. Of the approximately 14,000 licensed radio amateurs in Australia, currently about 17% are Foundation grade, 14% Standard and about 69% Advanced grade. It is expected that the radio of Foundation grade licensees to other grades will continue to grow.

Need for Regulatory Change

As Amateur Radio is adopting new wireless communications technologies and moves into increasingly diverse applications – such as spread spectrum on HF frequencies, very narrow band digital audio techniques, digital television, SDR radio, remote control and telemetry applications – it is rapidly running up against the constraints of the regulation. While the current LCD was demonstrably an advance on its predecessors and generally served the amateur community well during a period of regulatory flux, it is now rather prescriptive and insufficiently flexible in many areas to accommodate emerging technology adaptations.

This is especially true of the Foundation licence (Wait 2014). Although its intended purpose was to improve the attractiveness and accessibility of the hobby and to attract young people with a technical interest, it offers little scope for experimentation and application in any of the new technologies that are likely to attracted young people. Additionally, ambiguities and disparities exist regarding the type of equipment that licensed radio amateurs can possess and operate, including the remote control of amateur stations and connection of amateur stations to the internet.

The WIA has recommended that Foundation grade licensees should be permitted to: transmit digital voice, data and images; connect computers to a transmitter; build their own transmitters from commercially available kitsets; use commercial transceivers which have been modified to transmit on the amateur bands; use unattended and remote control of a transmitter; operate through gateways connected to internet connected repeater networks; have access to additional frequency bands; and use a maximum output power of 25 Watts peak.

The WIA also recommended that the Standard and Advanced grades should have access to more frequency bands and be allowed to transmit higher power levels. Even our closest neighbour, New Zealand, allows its radio amateurs to transmit 1000 Watts peak, more than twice the maximum allowed in Australia. The WIA's proposed changes to the Amateur LCD are intended to both make the hobby more relevant to newcomers, and also to bring the privileges of the higher licence grades into line with other similarly developed nations

Due to the scope of the WIA's recommendations and the fact that the Commonwealth legislation for Amateur Radio was due to "sunset" on 1 October 2015, and had to be "remade" quickly for the amateur service to continue in Australia, the ACMA chose to remake the amateur LCD with only minor amendments. The WIA expects that the ACMA will embark on a public consultation process in response to the WIA's recommendations, and expects further changes to the amateur LCD will be made.

Australian Spectrum Policy and Management Framework Review

The WIA (WIA 2014a) made a submission to the July 2014 Department of Communications review into the Australian spectrum policy and management framework.

The WIA submitted that the Amateur Service has a long history of public service, both through emergency communications and as an educational resource, and that such public use of spectrum has an imputed value which cannot be measured using the same set of tools as a conventional market-oriented valuation approach. The same situation would apply for, say, defence, governmental or emergency services, research, meteorology and safety-of-life services.

The WIA noted that Amateur spectrum usage holds the potential for greater public benefit, especially for non-commercial educational and pure research purposes that might enable innovative developments while still allowing traditional Amateur Radio activities.

The WIA also made the following recommendations, summarised below:

- Simplification of the framework to reduce its complexity and impact on spectrum users and administrators.
- Administrative efficiency through a minimum 5-year licence term for Amateur Radio, and self-administration of the hobby by the WIA (possibly through an Industry Code).
- Improved flexibility.
- Greater resources directed to the ACMA to protect the radio frequency spectrum from interference.
- Removal of the ability for spectrum to be retained by certain licensees (generally commercial, for-profit) indefinitely, regardless of use.
- Encourage new technologies such as cognitive radio, together with regulatory innovation, such as parameter-based licensing, to help maximise spectrum efficiency.
- Achieve a clear distinction between policy formation and policy implementation, which will be best achieved by maintaining both a well-resourced department and regulator.

The WIA (2014b) lodged a second submission to the Department of Communications Spectrum Review Potential Reform Directions Paper, released in November 2014.

The Department of Communications then released its Spectrum Review Report, recommending replacement of the *Radiocommunications Act* with a new Act and reforming the current licensing framework into a single licensing system. The report's recommendations cover new legislation, a single licensing system, user involvement in spectrum management, improved compliance and enforcement measures, government spectrum use and spectrum pricing, among others.

It must be said that the implications for Amateur Radio licensing and the WIA are far-reaching, and the WIA looks forward to exploring the opportunities further.

Conclusion

Amateur Radio has changed significantly over its long history and, these days, Amateur Radio presents a very wide range of opportunities and experiences for its participants. The WIA believes that Amateur Radio has an "imputed" public value which cannot easily be measured. There is an opportunity to increase the public value of Amateur Radio by encouraging the use of Amateur Radio spectrum for non-profit educational and research purposes, naturally with the appropriate safeguards to avoid unwanted interference to other licensees.

The Wireless Institute of Australia, as the representative body for Amateur Radio, is highly engaged with its members and is committed to the Commonwealth's Spectrum Policy and Management Framework Review. The WIA believes there is a window of opportunity for the amateur service to take greater responsibility in the management of Amateur Radio, through self-determination and self-regulation, possibly including the development of an Industry Code. The WIA is keen to take up that challenge on behalf of all Australian radio amateurs.

References

Amateur Radio. 2015. USA Amateur Radio History and Licensing. Accessed online on 1 December 2015 at http://www.ac6v.com/history.htm

AMSAT. 2015. Amateur Radio in Space. Accessed online on 1 December 2015 at http://www.amsat.org/

ARRIS. 2015. Amateur Radio on the International Space Station. Accessed online on 1 December 2015 at http://www.ariss.org/

Australian Government. 1997. Radiocommunications Licence Conditions (Amateur Licence). (1997). Commonwealth of Australia, Legislation. Accessed online on 1 December 2015 at https://www.comlaw.gov.au/Details/F2010C00897

HORUS. 2015. Project HORUS, High Altitude Balloon Project. Accessed online on 1 December 2015 at http://projecthorus.org/

IARU. 2015. International Amateur Radio Union. Accessed online on 1 December 2015 at http://www.iaru.org

Linton, J. 2015. Aussie high altitude flight heads home. Accessed online on 1 December 2015 at http://www.wia.org.au/newsevents/news/2015/20150116-1/index.php

NASA. 2015. Amateur Radio on the International Space Station. Accessed online on 1 December 2015 at https://www.nasa.gov/mission_pages/station/research/ops/research_teacher/ariss.html

Raspbian. 2015. To install Raspbian software on a Raspberry Pi. Accessed online on 1 December 2015 at http://www.raspberryconnect.com/raspbian-packages-list/item/71-raspbian-hamradio

Rowe, D. 2015. Codec 2, Rowetel. Accessed online on 1 December 2015 at http://www.rowetel.com/blog/?page_id=452

Wait, P. 2014, Remake of the Amateur LCD. Accessed online on 1 December 2015 at http://www.wia.org.au/newsevents/news/2014/20140901-2/index.php

WIA. 2014a. WIA makes its submission to Australian Government Spectrum Review. Accessed online on 1 December 2015 at http://www.wia.org.au/newsevents/news/2014/20140901-1/index.php

WIA. 2014b. WIA submits comments on the Government's Potential Reform Directions paper. Accessed online on 1 December 2015 at http://www.wia.org.au/newsevents/news/2014/20141204-1/index.php

WIA. 2015.Wireless Institute of Australia. Accessed online on 1 December 2015 at http://www.wia.org.au

http://doi.org/10.18080/ajtde.v3n4.41