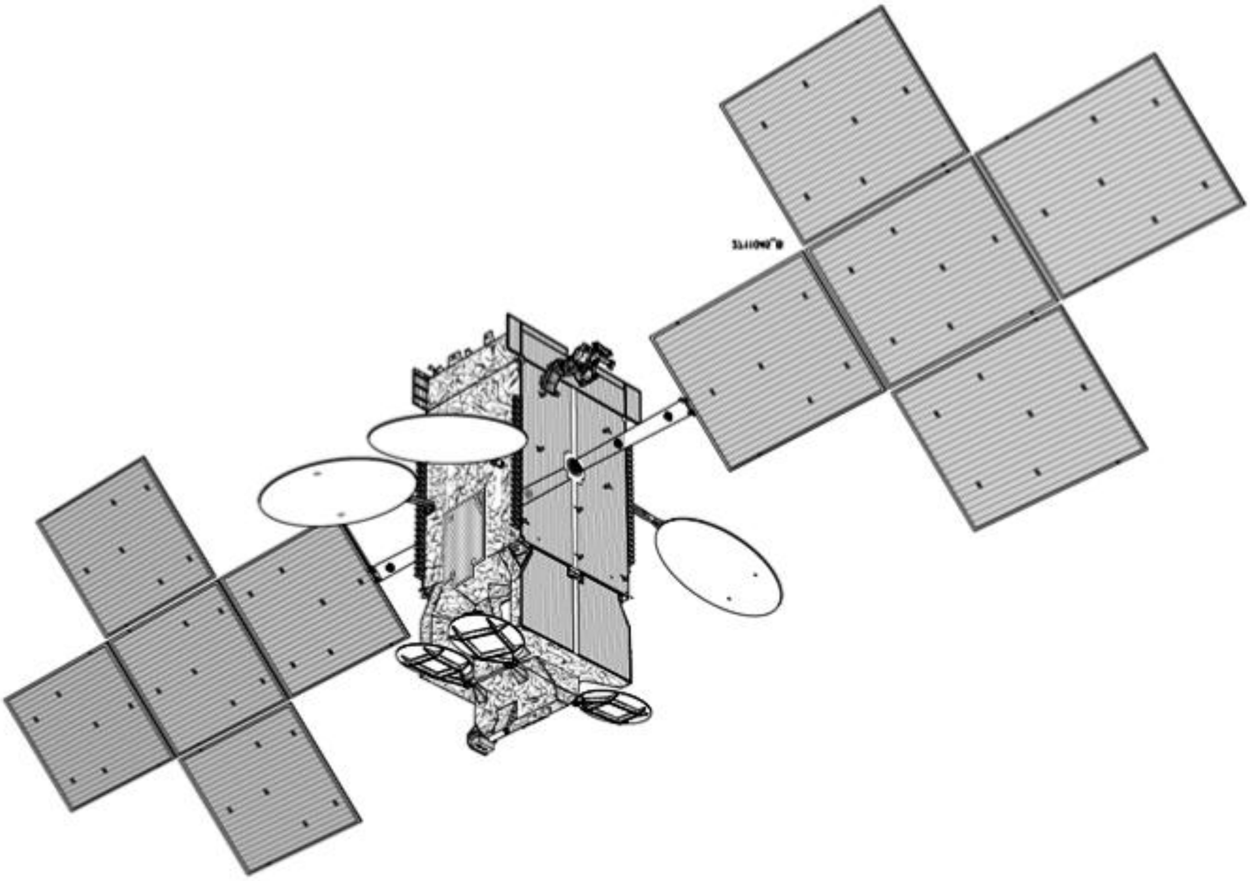
A Brief Overview of

Civilian Satellite Communciations in Australia



KaComm-1 On Station

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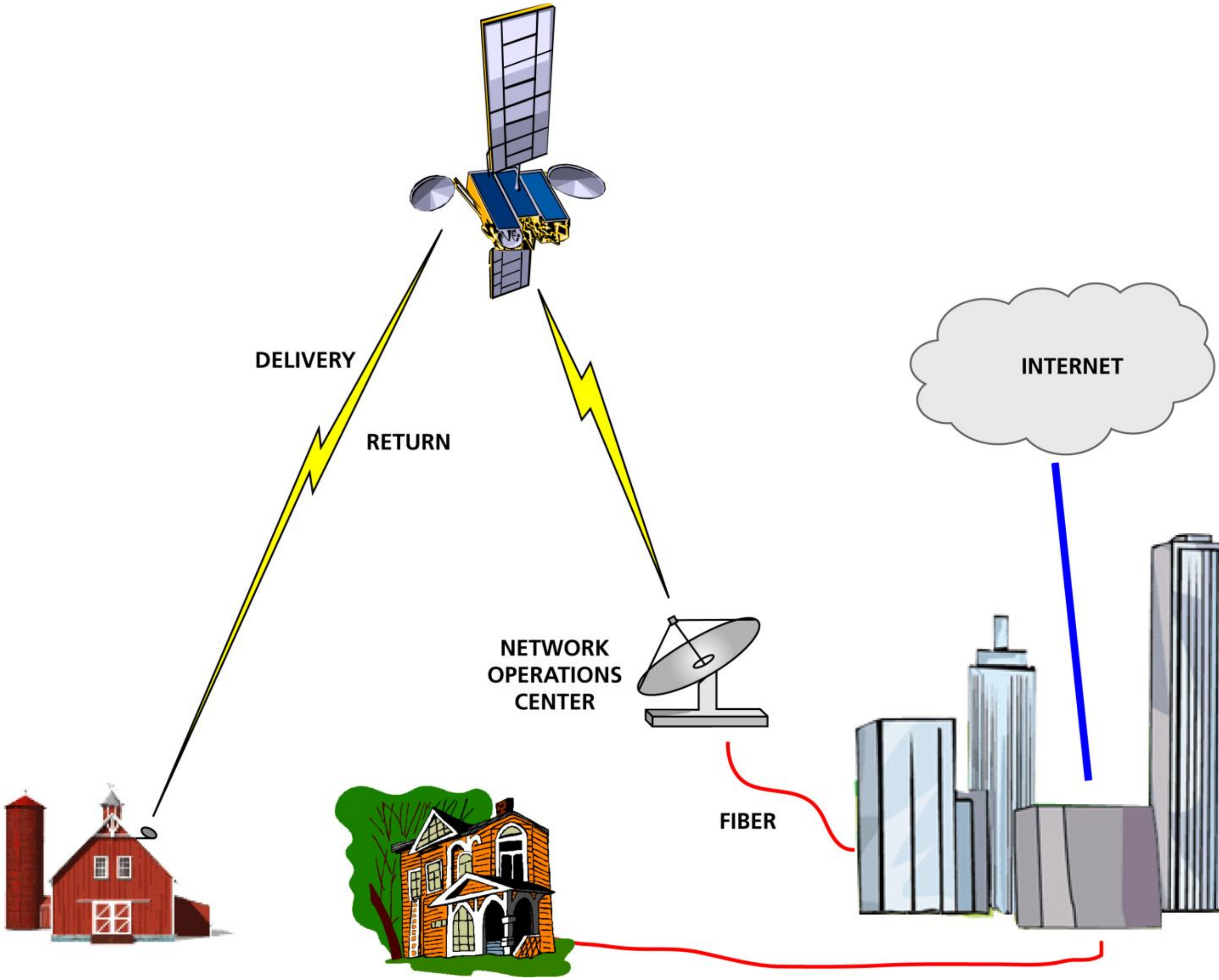
Executive Summary

1.0 Satellites Have Provided "Network Extension" Data Access Since the 1980s



2.0 Evolution of Satellite Technology for Network Access

Satellite technology has evolved through two generations of data network access capability since the 1980s and will evolve to the third generation in the next few years.

Each succeeding generation has improved performance and reduced costs.

The earlier deployments of satellite technology for connectivity to the telephone network in remote, unwired locations were based on analog technology and pre-Internet Protocol (IP) digital technology both of which were subject to bandwidth and quality limitations due to such artifacts as echo and excessive delay (latency).

By combining the increased bandwidth available on newer, higher capacity satellites with the advanced processing surrounding the transmission of IP data, these artifacts have been greatly reduced, throughput and quality have been increased, and costs have been reduced.

In the next few years, third generation technology will extend these improvements so that NBN-compatible performance, i.e., ≥12 Mb/s download speeds, can be achieved for Australians located beyond the practical reach of wired FTTN solutions

The following sections chronicle this evolution through three generations of technology and demonstrate the resultant benefits for Australians.

3.0 "First Generation" Satellite Broadband VSAT Systems

From the 1980s to present, first generation satellite broadband systems had the following characteristics.

- 56 kbps – 256 kbps throughput per user
- Primarily business networks for corporate users with dispersed operations
    - "Point of Sale" transaction verification for retail companies
    - Corporate LAN extension to all locations

- Characterised by bursty data usage with limited need for continuous, real-time circuits
- Early systems deployed before general availability of Internet and designed with proprietary, non-IP-based standards
- Typically used a portion of a transponder on a satellite shared among many customers and applications
- Enabled by satellite modem and terminal technology from companies such as Hughes Network Systems, Gilat, ViaSat, others
- "Business grade" VSAT terminals costing US $5,000 – US $10,000

4.0 "Second Generation" Satellite Broadband VSAT Systems

Second Generation refers to systems launched 2005 – 2007 and can be defined by the following charateristics.

- 256 kbps – 3 Mbps throughput per user
- "Born of the Internet Age" to extend Internet connectivity and feature-rich applications to underserved users
- Majority of current customers are consumers and small businesses
- Largest systems use dedicated satellites (IPSTAR, Wildblue, Spaceway) and are migrating from Ku-band to Ka-band to increase system capacity and user throughput via high-gain spot beams with frequency re-use
- Enabled by integration of IP routing technology and IP Quality of Service (QoS) management with software-defined modems and advanced coding and modulation schemes yielding smaller, more capable "consumer-grade" VSAT terminals costing ~US $500
- Introduced advanced latency-management technology
    - Compensating for latency-sensitive TCP/IP protocols via Protocol Enhancing Proxy (PEP) to allow TCP/IP transmission over satellite links at arbitrarily high data rates
    - Accelerating latency-sensitive applications via pre-fetching of subsequently requested and commonly requested information to reduce response time

- Prioritizing traffic to meet timing and jitter requirements
- Compressing IP headers and payloads to reduce transmission time

5.0 "Third Generation" Satellite Broadband VSAT Systems

Third Generation systems are planned for launch starting in 2010 and will have the following advanced characteristics.

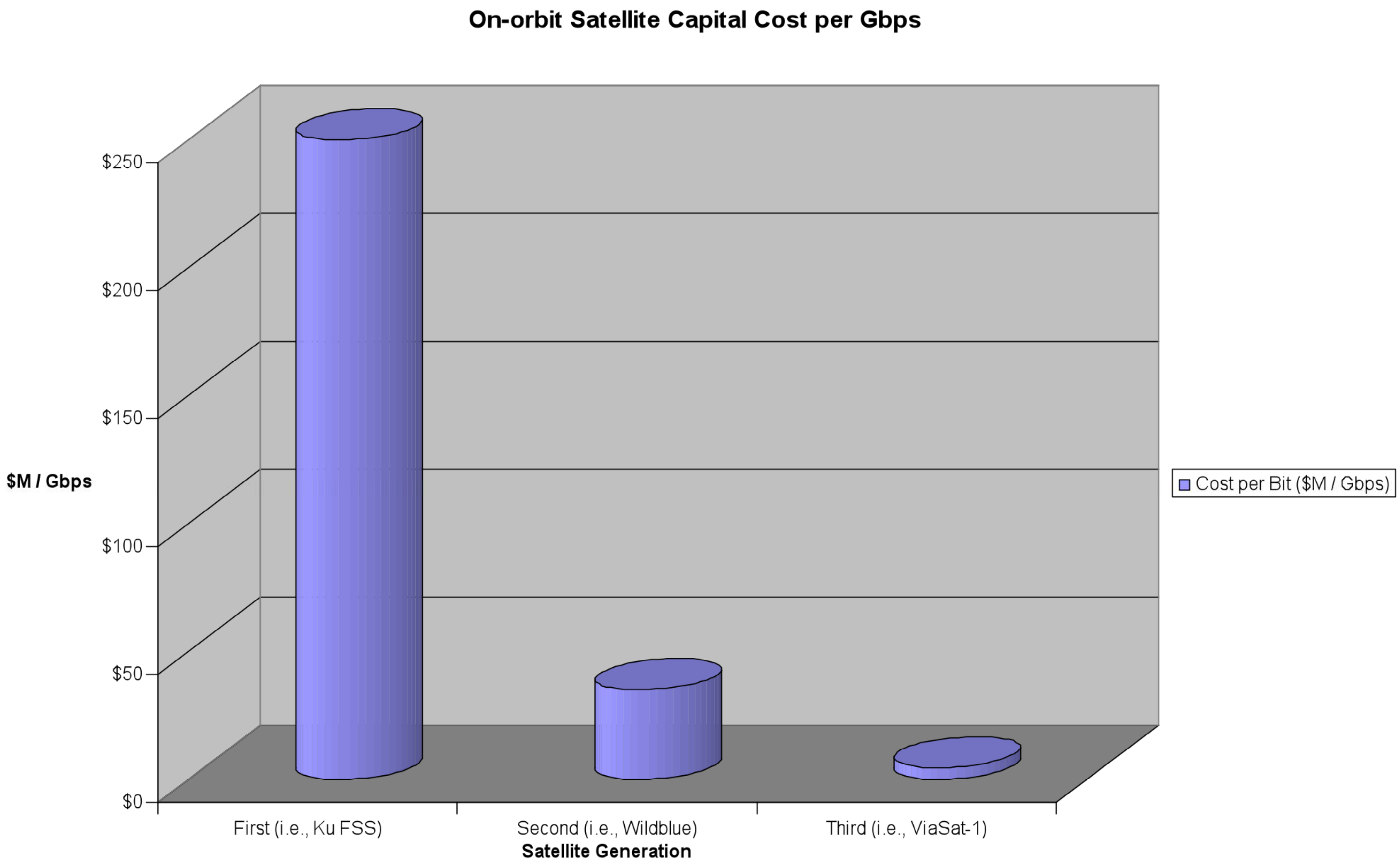
- Throughput per user compatible with ADSL2+ ≥12 Mbps
- Designed to deliver video-driven capacity requirements of the next generation Internet applications
- Will use dedicated satellites with ~100 Gbps capacities that are 10x "second generation" system capacities of ~10 Gbps
    - Each satellite can serve 2-3 million users
    - The instantaneous throughput per user can be >20 Mbps
- Enabled by high power Ka-band spot-beam satellites with efficient frequency re-use and next-generation terminal modems that increase physical layer capacity 10x from ~50 Mb/s to ~500 Mb/s in VSAT terminals costing under US $500 with a clear trend towards even lower prices
- The first third-generation satellite systems KA-SAT and ViaSat-1 will be deployed in 2010 and 2011 to serve Europe, the United States, and Canada

6.0 Cost Reductions Across Three Generations of Satellite Technology

Third generation satellite and terminal technology is increasing the per satellite capacity by as much as a factor of 10x, and thereby reducing the cost per bit and increasing the average throughput per subscriber. For example;

- The bandwidth per spot beam will be increasing from ~50 MHz to ~500 MHz

- The data receiving capacity of user VSAT terminals will increase from ~80 Mb/s to ~800 Mb/s while keeping cost < $500


On-orbit Satellite Capital Cost per Gbps
$M / Gbps
$250
$200
$150
$100
$50
$0
First (i.e., Ku FSS)
Second (i.e., Wildblue)
Third (i.e., ViaSat-1)
Satellite Generation
Cost per Bit ($M / Gbps)

7.0 Evolution of Three Generations of Satellite Broadband Systems

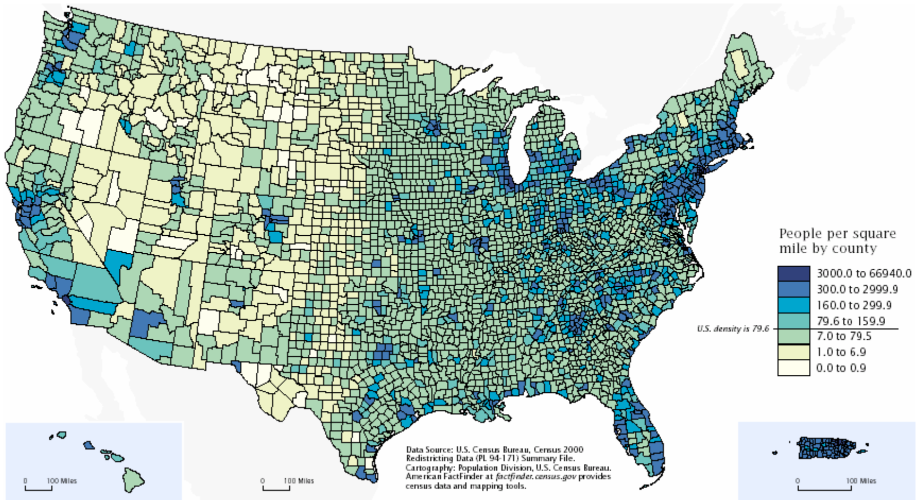
Characteristic	First Generation	Second Generation	Third Generation
Timeframe of Operation	1980s to present	mid 2005 to present	2010+
	Increasing Satellite Capacity		
Satellite Capacity	1 Gbps	10 Gbps	100 Gbps
	Increasing Data Rate per User (Improved User Experience)		
Typical Data Rate per Terminal	56 kbps - 256 kbps	256 kbps - 3 Mbps	2 Mbps - 30 Mbps
	Increasing Number of Subscribers		
Maximum Number of Subscribers per Satellite	100,000 - 500,000	750,000 - 1,000,000	2 million - 3 million
Satellites	All FSS satellites; Example: Hughes leases 126 xpnders worldwide	IPStar; SES ASTRA2Connect; Eutelsat TooWay; Wildblue; Telesat; Spaceway	ViaSat-1; KA-SAT; KaComm; SpaceWay 4
Satellite Payload Characteristics	24 Ku-band transponders w/ regional coverage & 36 - 72 MHz bandwidth	Ku-band & Ka-band spot beams w/ 36 - 72 MHz bandwidth	Ka-band spot beams w/ ~500 MHz bandwidth
Major VSAT Terminal Suppliers	Hughes, Gilat, ViaSat, iDirect	Hughes, Gilat, ViaSat, iDirect	Hughes, Gilat, ViaSat, iDirect
Cost of VSAT Terminal	\$5,000 - \$10,000	\$500 - \$1,000	< \$500
Typical Applications	Point-of-sale transactions	Broadband access for enterprise & consumer	Broadband access for enterprise & consumer
Data Protocol	Proprietary and non-IP based	IP based	IP based
Connection Type	Bursty; Non-real-time data	Continuous; VoIP & video streaming capable	Continuous; VoIP & video streaming capable

8.0 Status in North America: Spaceway, Telesat, and Wildblue

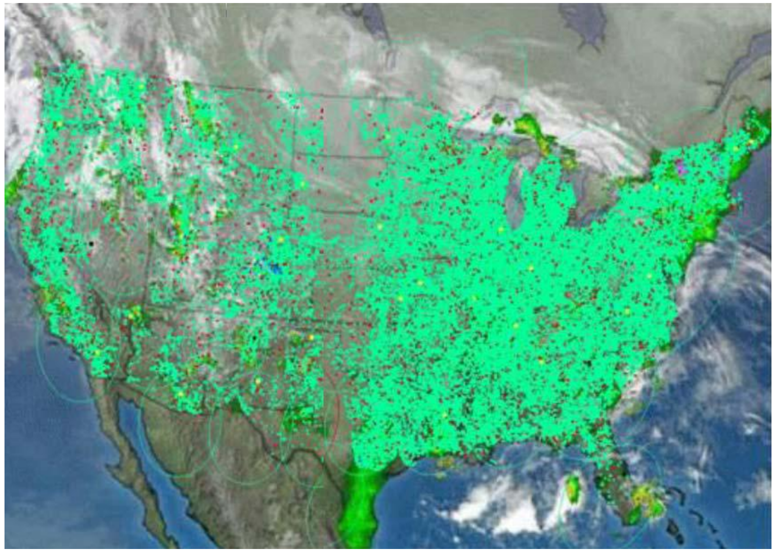
These three North American suppliers have amassed ~900,000 subscribers in 2-3 years of service time (with Hughes incorporating legacy DirectPC customers)

- Hughes and Wildblue adding 15,000 subscribers per month each
- Approximately 5 million U.S. homes will be unwired for broadband in the very near future.

Satellite Broadband subscribers follow the population



U.S. Population Density



Satellite Broadband Subscriber Distribution

9.0 Third Generation Satellite Broadband Systems Will Bring the Benefits of the National Broadband Network to All Australians

Within the five-year roll-out timeframe of the NBN, third-generation broadband satellite systems will be online delivering ADSL2+ compatible (>12 Mbps) broadband services ubiquitously to all users throughout the satellite footprint

KaComm Communications Pty Ltd, an Australian company, in partnership with Space Systems/Loral and Loral Space and Communications, seeks to use third-generation satellite broadband to extend the NBN to all residents of Australia, especially those in rural and remote areas

- KaComm has access to four excellent Ka-band orbital slots for the service
- Space Systems/Loral built the IPSTAR and Wildblue satellites, and is currently building the third generation ViaSat-1 satellite to service the USA
- Loral has successfully managed several space-based programs and is 2/3 owner of the fourth largest global satellite services company, Telesat
- Third-generation terminal technology is in near production development for the KA-SAT and ViaSat-1 programs

KaComm's service will provide a baseline capability of 12Mbps downlink and 6Mbps uplink. Less demanding users can access a 4Mbps/2Mbps package whilst premium enterprise and institutional will have access to 30Mbps/15Mbps and up to 100Mps packages.

The KaComm service will support classic "Triple Play" content (ie www, standard definition video on demand and voice over IP), HD Video download and HD video conferencing.

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1.0 Introduction - Australia's History with Satellite Communications

Australians began using satellites for international telephony many years before the introduction of the modern cable systems. The International Telecommunications Satellite Organisation (INTELSAT) first gave Australia reliable access to satellite communications in 1966 via its Overseas Telecommunications Commission (OTC est. 1947). The first OTC earth station was built at Carnarvon in Western Australia. The next at Moree (est. 1968), Ceduna (est. 1969) and then in the late eighties at Gnangarra (est. 1987) in the northern suburbs of Perth and also at Oxford Falls (est. 1987), a north eastern suburb of Sydney. The INTELSAT satellites operated in the C-band frequencies of 4Ghz to 6Ghz.

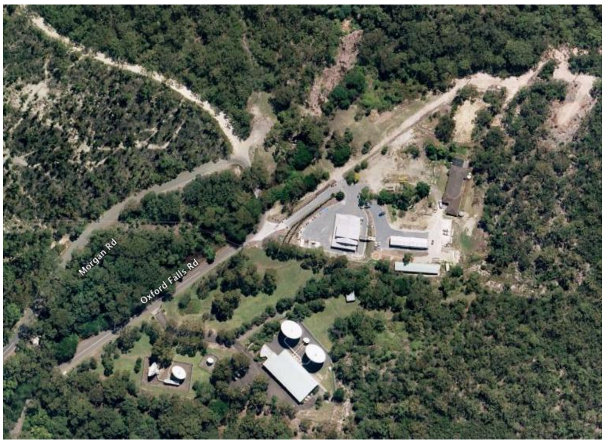


Figure 1: Oxford Falls Earth Station

Figure 2: Gnangara EarthStation

Australia's domestic awareness of satellite technology grew considerably with the establishment of AUSSAT, Australia's national satellite company at the beginning of the 1980s.

AUSSAT was introduced to own and operate a network of satellites and ground stations to deliver broadcast quality television services to the rural and remote regions of Australia. This service was known as the Homestead and Community Broadcast Satellite Service (HACBSS) consisting of ABC and SBS programming content.

To provide the service, AUSSAT purchased 3 spin stabilised HS376 satellites from Hughes Space and Communications group. These would be called the A series satellites and the first two were launched by the Shuttle program and the third by Arianespace from French Guiana. The ground stations were built by Mitsubishi Electric of Japan and were located in each of the Australian capital cities. The Control centre for managing the network was located at Belrose in Sydney. A back-up earth station was built at Lockridge, WA.

Figure 3: Belrose Earth Station

Figure 4: Lockridge Earth Station

Since those early days, many satellite operators have established earth stations (gateways) on Australian soil in places like New Norcia, Kalgoorlie, Meekathara, Broken Hill, Dubbo, Brisbane, Adelaide and Mt Isa

To facilitate its national obligations, AUSSAT secured 4 ideal orbital locations (slots). These provided it with excellent coverage and access across the Australian and New Zealand continents.

A Series

Early spin stabilised satellites like the A Series, although leading edge technology 30 years ago, were quite low in power by today's standards and were also limited by the capability of the onboard electronics of the day. The A series used Ku-band frequencies and 12W to 15 W transponders. This first series of Aussat satellites provided Radio and Television to outback communities as well as providing a new means of delivering the School Over The Air (SOTA) service.

Despite its limitations, the success of the A series analogue broadcast service became the development platform for the Aurora digital service and Pay Television as we know it today.

B Series

In the late eighties, a more powerful B Series of satellites was launched. These were 3 axis stabilised HS 601 satellites. The B series was designed for a life span of 10 years but actually lasted for more than 15 years. The onboard electronics, although improved, were still a limiting factor. The B series used Ku-band frequencies and 50W transponders. The higher transponder powers enabled the beginning of the use of Very Small Aperture Terminals (VSATs) for the delivery of enterprise based services.

Each B series satellite also carried an L-band payload to provide the Mobilsat service. Mobilsat provided voice and low speed data across Australia and 200 kms off shore.

C Series

Capacity on the B series was consumed quickly with demands from the broadcast industry and the realisation that satellite was the most efficient way of delivering pay television regardless of metropolitan or country location.

Optus, in conjunction with the Australian Department of Defence, launched the Optus C1 satellite in 2003. This was the largest commercial and military satellite of its time. This complex satellite was built by Space Systems/Loral and was launched by the most powerful launch vehicle in the market the Ariane 5. It carried a commercial payload of 24 110W Ku-band transponders and a complex military payload of Ka, X band and UHF.

The C series demonstrated the advance in Satellite technology and launch vehicle capability as the C series carried 16 antennas, weighed 5 tonnes and spanned 25 metres in space when deployed and provides 10Kw of power. The original A series satellite that weighed just 650Kilos and was 2m in diameter.

D Series

The two D series satellites were deployed to replace the B series which were approaching end of life. D1 designed as a Fixed Satellite Sservices (FSS) satellite with 30 transponders and D2 a combination Broadcast Satellite Services (BSS) and FSS satellite with 32 transponders. D1 was launched in October 2006 and D2 a year later

These satellites have a mass of approximately 2.3 tonnes and carry transponder powers of 105W and 112W.

The third D series, D3, is a custom Direct To Home (DTH) design for Foxtel and is expected to be launched in mid 2009.

1.1 Other Ku-band Satellites over Australia

Other than the Intelsat and AUSSAT/Optus series of Ku-band satellites, today, Australia is also illuminated by Ku-band satellites owned by AsiaSat, Thaicom (IPStar), New Skies Satellites, Russian Satellite Communications Company, Measat and SAT-GE. It is important to note that today, of all these satellites, only one was specifically designed to transmit sufficient energy onto the ground to facilitate a useful and reliable broadband service. That is the IPStar satellite that was designed nearly ten years ago and is expected to run out of life before 2018. Ku-band typically defines the radio frequency range of 12Ghz to 14Ghz.

1.2 Satellite Services

The satellite industry in Australia today supports not only the rural and remote broadcast services but also the ever increasing demand of pay television in Australia and New Zealand. In addition, a number of vital industries including Air Services Australia, the Victorian Fire Brigade, and distance education (including School of the Air) are serviced to name but a few.

From the history outlined above it is clear that satellite communications technology was and still is heavily focussed on the broadcast industry. Satellite power and size restricted the services that could be offered.

Ground stations were large, often with antenna sizes 11 metres or more to achieve the required level of service reliability.

Today satellites are much larger and their power capability has increased 10 fold. Modern electronics has vastly improved the efficiency and sensitivity of their transponders. This technological evolution has enabled two-way small dish services (VSAT – Very Small Aperture Terminal) with low cost terminals and dish sizes as small as 50cm. Internet service delivery via satellite became a reality.

However, the typical internet download speed offered by many of the satellite delivered service operators today is restricted to 512Kbps and there are significant restrictions on the total monthly downloads.

IPSTAR, using more modern technology designed in conjunction with Space Systems/Loral, is offering internet service which achieves speeds of up to 4 Mbps download, but we can do better than that.

1.3 Voice

The perceptions of satellite quality created by the early technology left a lasting stigma from which it has taken a long time to recover. Where much of the quality issues were blamed on the overall physical delay created by the signal travelling 35,786kms to and from the satellite, the real issue was the poor echo cancellation performance of early analogue implementations.

Today with the modern digital encoding techniques and echo cancellation the quality surpasses that of most mobile phone services.

The focus on IP (Internet Protocol) has created large scale development for Voice over IP (VoIP) and enabled effective quality IP voice communication on small low cost VSAT terminals. However, just as with terrestrial connections, VoIP works best when the service return link has adequate bandwidth. Service plans offering only 512kbps downlink and 64 or 128kbps returnlink are unlikely to offer a useable VoIP service unless coupled with generation 2.5 or 3 modem technology.

1.4 Internet and Data

Data and Internet via VSAT uptake in Australia was relatively slow compared with the USA and Canada. The USA and Canada had adopted the technology out of frustration whereas Australia with a single telecommunications provider didn't present the same issues as in the US where multiple network providers would often be required to provide a customer network.

The demand for Internet in Australia and the inability to gain access beyond the cities created the incentive for the Federal Government's Broadband Guarantee Program (HIBIS). A subsidy of $2,500 for each service was provided to premises that have no metro equivalent ADSL access.

1.5 Quality and Perceptions

The Federal Government program created an enormous growth in VSAT implementations around the country. However, a number of the service providers profiteered from the growth and massively oversubscribed the amount of bandwidth they used, resulting in poor service quality.

Again, this created a poor perception of satellites as a means to provide the service. The term Contention Ratio was coined to describe the degree to which the bandwidth was oversubscribed. For example, it is common practice today for low cost telecommunications resellers to heavily oversubscribe capacity purchased in bulk at wholesale prices from the primary carriers such as Telstra, Optus and Vodaphone. A high contention ratio will lead to reduced capacity per user, slower service speeds and poorer service quality.

[Need to explain “contention ratio here.]

1.6 New Technology

None of the current satellite coverage over Australia, by any of its satellite providers, is capable of meeting the 12Mbps Internet download requirements for all the underserved users unable to be served viably by fibre as specified by the Government. Technical “tweaking” could provide this speed to a very much reduced number of these users, but not to all. Here the effect of contention ratio is felt because each satellite has a fixed total capacity which can be divided into many small portions or only a few large portions.

A step change in technology is required to deliver 12Mbps or more capacity to all of Australia’s underserved population.

Such capacity and speed can only be met by the next generation of specifically designed broadband satellites and their supporting gateway earth stations and user terminals.

Third generation purpose built broadband satellites like those being developed by KaComm, deliver multiple high power, wideband Ka-band spot beams optimised to population densities. These high powered beams will provide sufficient capacity to ensure the service quality demanded by corporate, small business and private users alike. Ka-band typically defines the radio frequency range of 20Ghz to 30Ghz.

This technology is advanced but is available today and has already been proven by Space Systems/Loral with its design and delivery of specific broadband satellites for the US market.

Exactly as computer technology has improved over the years, so the end user VSAT terminal equipment has improved with a number of the major manufacturers already producing terminals capable of the 12Mbps download to meet the demands of the Ka-band markets in the USA and Europe.

As with the satellite and user equipment, the Gateway Earth Station technology has also improved dramatically over the years. With KaComm, a centrally managed network of gateway earth stations will distribute the broadband services through the Government’s planned fibre network to the service providers, thus offering a quality of satellite delivered service never before seen in Australia.

1.7 Ideal Orbital Location

The appropriate orbital location of an operator’s satellite is essential to the success of the business because it determines the elevation angle of the user dish. The higher the elevation angle the less chance there is of blockage by adjacent buildings, trees or natural terrain.

KaComm has secured access to four key Ka-band orbital slots for service coverage in Australia. These locations provide excellent elevation angles ensuring high visibility of the satellites wherever the user is located in Australia.

2.0 Satellite Technology Evolution

In this section, the reader will find a usefully comprehensive table of satellite technological evolution that starts at a developmental point that could be described as one at which the Thaicom IPStar satellite currently resides. That "point" is often referred to as Generation 2.

Just as our home and office computers improve in accordance with the process that we today call Moore's Law, so does the Customer Premises Equipment (CPE). This is not a great surprise because frequently our computers and the CPE have the same or similar Central Processing Units (CPUs) as, in fact, does the earth station equipment (referred to as Hub equipment). After all, the CPE and Hub equipment are computers that run specific software and hardware that enables them to process and manage all the digital data that we send over the airwaves today. It is important to grasp that concept because it means that CPE and Hub equipment design is not static.

Another important concept to grasp addresses the notion that we are not simply speaking about a satellite with some ground based CPE and Hub items. The efficiency gains necessary to deliver an effective satellite broadband service requires the engineers to develop a highly integrated system comprised of well matched space and ground elements. Again, that does not imply stagnancy. Today, a satellite will be launched with a designed life expectancy of 15 years. Over that same period of time, the ground based equipment may have evolved as many as 3 to 4 times. The system space segment must, therefore, be designed to, as far as possible, accommodate the evolution of the system ground segment.

The table in 2.1 below, therefore, deals with the evolution of a number of the key satellite broadband system parameters that would need to be considered by the system engineers. It is not an exhaustive table although it is quite extensive.

2.1 Comparison of Current Generation Satellite, and Next Generation Satellite Network Systems

Characteristic	Current Generation Satellite Network System (Ku-band Satellite w/ 2nd Generation Terminal Technology) Feature / Functionality	Next Generation (2.5G) Satellite Network System (Ka-band Satellite w/ 3rd Generation Terminal Technology) Feature / Functionality	Third Generation (3G) Satellite Network System Feature / Functionality	Third Generation Benefits Relative to Current Generation Satellite Network Systems
System Technical Parameters				
• Satellite User Downlink Beam	Full geographic coverage via multiple **large** satellite beams.	Partial to Full geographic coverage via multiple **small** satellite beams	Full geographic coverage via **multiple** small and large satellite beams shaped, located and containing a variable number of carriers with variable bandwidth based on population distribution	-Beams more specifically shaped and focussed to meet customer demand and performance while utilizing satellite resources efficiently. -Provides higher bandwidth to users and user capacity where needed geographically
• Frequency Reuse	**Low** frequency reuse, typically 2 times	Medium frequency reuse, typically 20 times in ~50 MHz spot beams	High frequency reuse, typically 20 times in ~500 MHz spot beams	-High frequency reuse results in higher capacity and bandwidth per beam-better user performance.
• Estimated Subscriber Capacity	Maximum of 100,000 to-300,000 subscribers per satellite with few to none having high downlink rates. Very slow speeds during peak hours.	Maximum of 300,000 to 1 million subscribers per satellite with a moderate percentage having high downlink rates. Slow speeds during peak hours.	Maximum of 300,000 – 400,000 subscribers per satellite (600,000-800,000 total system) with all users having higher downlink rates with guaranteed QoS.	-All Australians living in rural (unwired) areas and 2% - 4% of Australians living in metro/regional (wired) areas will have the option of accessing cost-efficient ADSL2+ equivalent broadband via satellite
• Total Downlink Satellite Throughput Capacity	1-10 Gbps per satellite (~10-25kbps per user daily average)	Up to 40 Gbps per satellite (~30-40kbps per user daily average)	40+ Gbps per satellite (80+ Gbps total system) (~50-100kbps per user daily average)	-Satellite capacity matched to best meet subscriber distribution and throughput requirements -High satellite capacity allows true broadband for more subscribers by making sufficient uplink and downlink data throughput available for each user with ubiquitous coverage.

Characteristic	Current Generation Satellite Network System (Ku-band Satellite w/ 2nd Generation Terminal Technology) Feature / Functionality	Next Generation (2.5G) Satellite Network System (Ka-band Satellite w/ 3rd Generation Terminal Technology) Feature / Functionality	Third Generation (3G) Satellite Network System Feature / Functionality	Third Generation Benefits Relative to Current Generation Satellite Network Systems
• User Data Rate	Maximum beam capability per user given no contention: 5 Mbps down / 256 Kbps up	Maximum beam capability per user given no contention: Up to 30 Mbps down / 1.6 Mbps up	Maximum beam capability per user given no contention: Up to 100 Mbps down / 12 Mbps up	-System can provide required 12Mbps minimum downlink to all customers which is over double the speed of current satellite platforms. - Enterprise or special application satellite customers can have much higher throughput capabilities for large throughput applications. - Much higher uplink capability allows remote sites to be server locations, content providers, multimedia sources, video teleconferencing participants and corporate headquarters.
• Bit Error Performance	10-8 downlink; 10-6 uplink	10-10 downlink; 10-7 uplink; Adaptive Coding and Modulation (ACM) only on the downlink	10-10 downlink; 10-10 uplink; Adaptive Coding and Modulation (ACM) on the downlink and uplink.	-Customer experiences higher throughput and less delay due to less retransmissions. - ACM on uplink and downlink maintains performance during rain conditions
• Latency	Little latency-management techniques; no data compression, little web page caching and pre-fetching, 1st generation web acceleration, no SIP acceleration, little to no QoS or application enhancements.	Some latency-management techniques; 2.5 generation data compression, 2.5 generation web acceleration, SIP acceleration, application aware enhancements	Advanced latency-management techniques with more applications optimized for delay with application aware QoS: -Protocol Enhancing Proxy (PEP) for TCP/IP transmissions at higher arbitrary data rates -Pre-fetching to reduce response times -Prioritized traffic to meet timing and jitter requirements -IP header and data compression to reduce transmission time	-Third generation acceleration techniques minimize the inherent satellite link transmission delay and thus provide optimized end-to-end services for better user experience.

Characteristic	Current Generation Satellite Network System (Ku-band Satellite w/ 2nd Generation Terminal Technology) Feature / Functionality	Next Generation (2.5G) Satellite Network System (Ka-band Satellite w/ 3rd Generation Terminal Technology) Feature / Functionality	Third Generation (3G) Satellite Network System Feature / Functionality	Third Generation Benefits Relative to Current Generation Satellite Network Systems
• Availability (annual average which includes environmental conditions, planned outages and maintenance activities)	90.0% -No adaptations for rain conditions to ensure connectivity (i.e. coding and modulation)	>99.6% (for critical applications such as VoIP, http, email) -Adaptive coding and modulation for rain conditions on downlink only. -Adaptive power transmission. - High availability provided only to those areas within the narrow spot beams. Limited geographic coverage.	99.7% (for critical applications such as VoIP, http, email) -Adaptive coding and modulation for rain conditions on downlink and uplink. -Adaptive power transmission.	-Customers experience similar availability as 2.5 generation systems while using a mix of wide and narrow beams. This mix of beams provides ubiquitous coverage with a more efficient satellite. -Much higher tolerance to rain than current systems allowing more connection time to the user and better experience. -Next generation systems prioritize applications to maintain minimum resources during periods of congestion to provide customers with best performance
• Customer Premises Equipment (CPE) Cost	$500-$1000 USD	$500-$1500 USD	$300-$500 USD	-Customers pay lower CPE costs and gain access to a better performing satellite platform.
• CPE Dish Size and Equipment	Low link margins requiring CPE dish ~1 meter in diameter	High link margins requiring CPE dish ~0.65 meter in diameter	High link margins requiring CPE dish ~0.65 meter in diameter	-Smaller and less obtrusive dish on customer premises or line of site location, simplifying installation. - 2–3 times more bandwidth per dish size using better equipment and advanced transmission techniques.
• CPE Deployment	Fulfilment of subscriber by fast installation of satellite dish at premises. Instant availability of satellite service to the user.	Fulfilment of subscriber by fast installation of satellite dish at premises. Instant availability of satellite service to the user.	Fulfilment of subscriber by fast installation of satellite dish at premises. Instant availability of satellite service to the user.	-Customers located anywhere in Australia gain access to ADSL2+ equivalent broadband
Subscriber Experience Parameters				

Characteristic	Current Generation Satellite Network System (Ku-band Satellite w/ 2nd Generation Terminal Technology) Feature / Functionality	Next Generation (2.5G) Satellite Network System (Ka-band Satellite w/ 3rd Generation Terminal Technology) Feature / Functionality	Third Generation (3G) Satellite Network System Feature / Functionality	Third Generation Benefits Relative to Current Generation Satellite Network Systems
• Overall Subscriber Experience	Comparable to dial-up Internet access.	Comparable to DSL Internet access	Comparable to ADSL2+ Internet access	-Customers are offered increasingly better service experience involving audio, video and file transfer. The service experience matches that of terrestrial service experience. -Most applications, outside real-time highly interactive gaming, perform comparably to terrestrial networks based on user perception. -Guarantee the retailer's SLA and thereby promote the options and experience of a user.
• Data Compression	None	Yes – 2.5 generation data compression	Yes – 3.0 generation data compression	-Compressing message headers, and in some cases the body of the message, before transmission over the satellite conserves the bandwidth usage and delay, thereby increasing effective data throughput and improving customer experience. - Third generation systems significantly reduce the bandwidth required for VoIP traffic by eliminating extraneous and redundant protocol information; improving delays over satellite and improving the customer experience.
• Data Compression Benchmarks	1Mb inbound file transfer – approx. 180 seconds (No Protocol Enhancing Proxy (PEP))	1Mb inbound file transfer – approx. 135 seconds (PEPv3)	1Mb inbound file transfer – approx. 9 seconds (PEPv3.5 with V.44 packet payload compression)	- Advanced PEP and compression techniques provide improved performance and better user experience with higher satellite efficiency.
• VoIP Codec	First Generation Codec (MOS <3.2)	Second Generation Codec (MOS 3.2)	-Third Generation Codec (MOS 3.4)	-Delivers voice quality comparable to cellular resulting in better user experience

Characteristic	Current Generation Satellite Network System (Ku-band Satellite w/ 2nd Generation Terminal Technology) Feature / Functionality	Next Generation (2.5G) Satellite Network System (Ka-band Satellite w/ 3rd Generation Terminal Technology) Feature / Functionality	Third Generation (3G) Satellite Network System Feature / Functionality	Third Generation Benefits Relative to Current Generation Satellite Network Systems
• Video Resolution	Standard Definition	Standard Definition	High Definition enabled through increased data throughput for both uplink and downlink to the users	- Increased data throughput, especially on the uplink, and advanced compression and error correction techniques will allow symmetric high definition video services. -Capability to support new applications, over ALL-IP network, with guaranteed user experience.
• Web Browsing	Web Acceleration generation 1.0	Web Acceleration generation 2.5	Web Acceleration generation 3.0	-Substitutes multiple sequential 'get' operations of non-cached web objects over the satellite link with pre-fetching of web objects at the satellite gateway utilizing proxy and then delivering to the satellite user using push techniques. -Results in faster web page loading over the satellite link.
• Web Browsing Benchmarks	Average time to fully open a set selection of web pages = >50 seconds (No PEP, no compression, no web acceleration)	Average time to fully open a set selection of web pages = 17.03 seconds (PEPv3, compression on, no web acceleration)	Average time to fully open a set selection of web pages = 11.89 seconds (PEPv3, compression on, advanced web acceleration- pre-fetch, caching)	- Advanced web acceleration techniques provide improved performance and better user experience- fast browsing, high efficiency, high throughput.
• TCP/SIP	TCP Acceleration No SIP Acceleration	TCP Acceleration SIP Acceleration	TCP acceleration SIP Acceleration	- SIP (Session Initiated Protocol) Acceleration is used for voice/video/other signalling over the ALL-IP network. Utilizing a SIP proxy server, the satellite gateway replaces multiple sequential SIP client operations over the satellite link to a single or lesser number of operations over the link and thereby increases the speed of SIP operation, resulting in faster response times and improved user experience.

Characteristic	Current Generation Satellite Network System (Ku-band Satellite w/ 2nd Generation Terminal Technology) Feature / Functionality	Next Generation (2.5G) Satellite Network System (Ka-band Satellite w/ 3rd Generation Terminal Technology) Feature / Functionality	Third Generation (3G) Satellite Network System Feature / Functionality	Third Generation Benefits Relative to Current Generation Satellite Network Systems
• QoS Management	Not Applicable	Application aware enhancement	Application aware enhancement Application Aware QoS Generic End-to-End QoS (MPLS) User QoS to Retailer QoS Mapping	-Application Aware QoS recognizes the application by inspecting the IP packets and applies the QoS relevant to that application. The QoS guarantee is then applicable within the Satellite Access Network, and thus last mile rather than just at the gateway nodes, thereby extending the performance benefits of QoS management directly to the user. This is most beneficial to interactive services providing improved user experience. - Through End-to-End QOS management, the end user's experience is guaranteed to be acceptable for present and future applications. - Generic End-to-End QoS (MPLS) has the additional advantage over 'Application Aware QoS' by minimizing the delay introduced due to packet inspection and therefore minimizing response time. - User QoS to Retailer QoS Mapping results in better subscriber experience by way of retailer's SLA guarantee and promoting the increase of retailer and application service providers - Examples of various QoS and access scheme capabilities the system can support include but are not limited to: multilevel IP QoS with VoIP prioritization, Bandwidth on Demand (BoD) as needed, Constant Bit Rate (CBR) for guaranteed QoS applications, application-triggered BoD/CBR and CBR reallocation.

2.2 Why Ka-band over Ku-Band

It is useful, at this point, to briefly explain the advantages of Ka-band over Ku-band frequencies. Perhaps we should first explain the difference between Ku-band and Ka-band. The term K band comes from World War II Germany and was called the Kurtz or short radio frequency band. Ku or Kurtz unter usually refers to the 12Ghz to 14Ghz frequency range. Ka or Kurtz above usually refers to the frequency range 20Ghz to 30Ghz.

Radio frequency signals are electromagnetic radiation and as such are waves. The wave has a length and an oscillation frequency and the two are interrelated in proportion to the speed of light. The term hz is an abbreviation for Hertz (not the rental firm) which means one oscillation cycle per second. In the simplest terms, each oscillation of the signal per second can carry at least one "bit" of data per second. As the signal oscillates faster, it can carry more data within a given time. Hence Ka-band can deliver more than twice the data rate compared to Ku-band.

Ku-band has been used for satellite communications since the late seventies because of its good compromise of excellent data carrying rates and acceptable penetration through weather. Manufacturers have produced Ku-band equipment for both terrestrial and space based applications for many years and it has become cheaper and more efficient. However, the extensive use of Ku-band has also made the spectrum scarce. Scarcity in the frequency world usually means that higher frequency bands begin to be used. Ka-band is the next block of spectrum to be allocated for satellite communications use and equipment has become both economically available and made in accordance with today's high efficiency and reliability requirements.

This means that today, it is possible to build a Ka-band satellite for about the same price as a Ku-band satellite that has less than half the capacity. In terms of capacity density per orbital slot and cost of system space system deployment, Ka-band is a far more cost effective option for today's high capacity broadband demands. It is for this reason that third generation satellites are now operating in the Ka-band.

[In addition, there is more Ka-band spectrum available at each orbital slot. Hence, the use of Ka-band provides a 4-5x increase in available basic communications capacity at a given orbital slot.]

2.3 Latency, the long and short

The effects of latency are discussed later in this paper but first let us describe what latency means and how it is addressed. Because the geostationary orbit is at 35,786km above the earth's equator, the radio signals travelling at light speed still take 250ms for the journey from the earth to the satellite and back. This time lag is known as a communications property called "Latency". This property is governed by the laws of physics but its impact on communications in the past has been at best annoying and at worst disruptive.

Latency in the signal travelling time is one thing but when it is added to the overall system processing delay, the summed delays can change a 250ms delay to over a second. Humans can comfortably tolerate a 250ms latency but when it goes over a second, it then becomes annoying. Add to this the problem of "echo" effects and the use of satellite communications for services such as voice became unpopular.

This pesky fact of physics coupled with the processing delays of 1980s vintage computers bedevilled satellite communications in the past, earning many expletive encrusted titles in the process.

Today however, computer processing in the modems and transmission equipment is so fast that processing delay may add only a small amount of additional time. Advanced echo cancelling technology means we hear our voice only once as we speak. Quality of service is so good that many people that have used satellite phones, for example, claim that the quality is better than their cellular phones. Data services are equally improved and new IP based data transmissions operate smoothly and seamlessly.

In summary, latency is no longer a significant issue for satellite communications.

3.0 Network Technology

In the late eighties, it was believed that the fastest data rate achievable over copper telephone lines would never exceed 9600bps. Today we know that even with dial-up internet connections we can reasonably expect 56,000bps. The limitation to data rate in the eighties was the speed and efficiency of the available electronics and thus, the sophistication of the methods used to MOdulate and DEModulate (or MODEM) the information. Superimposed upon the modulation schemes were methods used to encode more information into the same signals. These are referred to as coding schemes. The combination of modulation and coding schemes are sometimes referred to as Waveforms. Because these Waveforms are effectively software algorithms, their useful sophistication is directly dependent upon the available speed of the processing electronics used to implement them.

It is no surprise, then, that because all our data is transmitted by some form of electrical or light based waveforms, as electronics improved, so did the speed of data transmission rates. Consider the office Local Area Network (LAN). In the eighties and early nineties, data rates went from a few hundred kilobits per second to 10 megabit per second in the first stage of Ethernet (10baseT). Ethernet then stepped up to 100Mbps and today we have 1000Mbps.

Why we would choose a light signal over an electrical signal (ie optical fibre rather then copper wires) becomes obvious when we realise that we send the data over modulated oscillating signals. As we mentioned in section 2.2, each oscillation carries at least one “bit” of information. The more cycles, the more bits that can be sent. Light has vastly higher cycle rates than radio signals so light can carry more information. This makes optical fibre an ideal choice for high density data trunks.

This comparison led many, in the early eighties, to believe that optical fibre would render satellites redundant. However, that simplistic extrapolation failed to understand the shear cost, complexity and time required to lay optical fibres over millions of kilometres of mountains, valleys, across rivers, lakes and even oceans. Hence, even with today’s technological sophistication, there is still a strong argument for both satellites and optical fibres to complement each other in the process of delivering information. Satellites today still offer the simplest, fastest and often cheapest method of distributing information from one point to many widely distributed points simultaneously.

[In addition, satellite communications is impervious to terrestrial disaster such as fire or flood, making it the medium of choice in time of emergency.]

3.1 Considerations of the 3rd Generation - The KaComm Network solution

The capability and the capacity of 3rd generation Ka satellite broadband systems is impressive and represents a cost effective way to bring the benefits of broadband to rural and remote subscribers, but the technology is only part of the story. Converting the technology into a service requires the entire end-to-end system to be carefully engineered and integrated to achieve the optimum balance between service performance and service affordability. To arrive at optimal performance/availability it is necessary to address:

- Regulatory considerations both as they relate to space, to determine suitable satellite orbital slots (and therefore coverage), frequencies and as they relate to the ground, including issues such existing terrestrial frequency users, and regulatory or political limitations on satellite hub locations or network operations centres.
- Understand the subscriber distribution, both current and future, in order to determine satellite beam patterns.
- Determine the types of services the subscribers will want to consume in order to determine system performance characteristics, availability of subscriber services, and throughput.
- Determine overall system availability, which influences factors such as the total number of satellites or the phasing of satellite launches.
- Balance the performance of the Customer Premises Equipment (the dish and modem installed at the subscriber’s residence), the satellite, and the satellite hubs, in order to determine system power requirements, dish sizes, and the number of hubs.
- Specific satellite hub siting considerations to determine where hubs can be located, including the civil and site engineering considerations, and access to terrestrial telecommunications infrastructure.

- The nature of the retail service providers to ensure that the satellite system is sympathetic to their business model and gives them the best chance of success.
- Determine the most efficient way to manage the technical and business operations of the system as a whole.
- Determine an appropriate procurement and ongoing management model.

Fully understanding these factors requires a balanced team with expertise in satellite engineering, ground equipment engineering, internet protocol engineering, internet service provision, project management and operations. Additionally, these factors are not discrete but need to be considered in parallel since the system as a whole needs to be optimised, and many decisions have interdependent technical, business and operational consequences.

The considerations mentioned above are discussed in more detail below. Regulatory issues are discussed in section 4.0.

3.2 Subscribers.

Determining the location and numbers of the subscribers is an essential consideration for system designers. At the highest level the general distribution of subscribers effects the selection of satellite slots. As a rule of thumb, a particular orbital slot can practically service about a quarter of the earth's surface. While it is possible to 'see' one third of the surface, subscribers at the very fringes of the coverage need to have their satellite dishes pointed almost parallel with the ground in order to acquire the satellite signal, meaning the geographic features such as hills, buildings and even tree cover become limiting factors.

Conversely, simply because an observer on the ground can 'see' a satellite doesn't mean that they are able to receive services from that satellite. As described below, satellites are engineered with specific beam patterns that define their service areas. This can be visualised in the same way that you might shine the beam of a flashlight on the floor. By analogy, those people in the beam receive signals and those in the dark do not. Both could see the flashlight (satellite) if they looked up. A satellite can shine many beams to suit the population density and geographic shape of the land the population occupies.

Larger subscriber populations require larger capacity satellites. While larger subscriber populations generally allow the costs to spread more widely and therefore the end service to be cheaper, in some instances even relatively small subscriber populations may be commercially viable. For example the Canadian Telesat satellite broadband service supports just 50,000 subscribers but is commercially viable because the satellite itself is actually mostly devoted to other purposes, with the broadband payload 'piggybacking' on the satellite.

The distribution of subscribers is also an important consideration. Using the flashlight analogy from above, older generation satellites were the equivalent of a handful of dull flashlights bundled together in space, with each beam providing a relatively low capacity service to a large number of subscribers. Modern 3rd generation satellite systems are the equivalent of tens of bright flashlights, each providing high capacity to a smaller number of subscribers. The combination of high power and tightly focused beams has allowed 3rd generation satellites to significantly improve the quality of the services they provide to each subscriber. Key to this improvement is the beam pattern, which in most commercial systems is fixed when the satellite is built.

However over the life of the satellite system subscriber distributions are not static. Subscriber populations grow as populations grow and recede as terrestrial systems increase their geographic coverage. Servicing subscribers in high rainfall areas requires the allocation of additional power in the satellite architecture, additional power in the ground equipment, larger antennas, or a combination of all three. The size, location and capacity of each beam needs to be planned early in the satellite design. Factors such as satellite power, the number and frequency range of transponders, the number of antennas, and antenna size and shape are based on the subscriber distribution.

The number and distribution of subscribers also influences the breadth of radio frequency spectrum that needs to be allocated to the system. While modern spot beam designs allows frequencies to be reused in different spots across the same subscriber base, ultimately the maximum number of subscribers in a particular geographic area that can be serviced depends on the total radio frequency spectrum that has been allocated to the satellite. The total spectrum available to be used by a satellite is limited by regulatory constraints managed by the ACMA in accordance with ITU requirements. The limited spectrum must be allocated amongst the beams, which in turn defines the maximum subscriber density that can be serviced in any given beam.

Finally, the likely take up rate of services by subscribers also needs to be considered. Satellites generally have a useful life of 15 years. The economics of the satellite system depends heavily on how quickly the satellite will be filled to capacity. In some instances it may make more economic sense to launch two satellites, with the second being launched as the first is filling. Staging the launches allows better tuning of the beam pattern of the second satellite to reflect the actual subscriber take up of the first satellite. Capacity can be reduce in regions where take up of satellite services has not been as quick as projected and reallocated to provide additional capacity in areas of high demand. It also allows for the introduction of more modern spacecraft technology on the second satellite.

Accommodating the Australian subscriber distributions in the system design is especially challenging for engineers. Large parts of the country have very low population densities while some areas, especially those surrounding the state capitals, have very dense subscriber populations. It is non-trivial to develop a beam pattern that maximises the number of subscribers that can be serviced with a fixed spectrum allocation, especially when frequency reuse and interference issues are considered. Figure 3.2-1 shows a representative beam pattern developed for the Australian population.

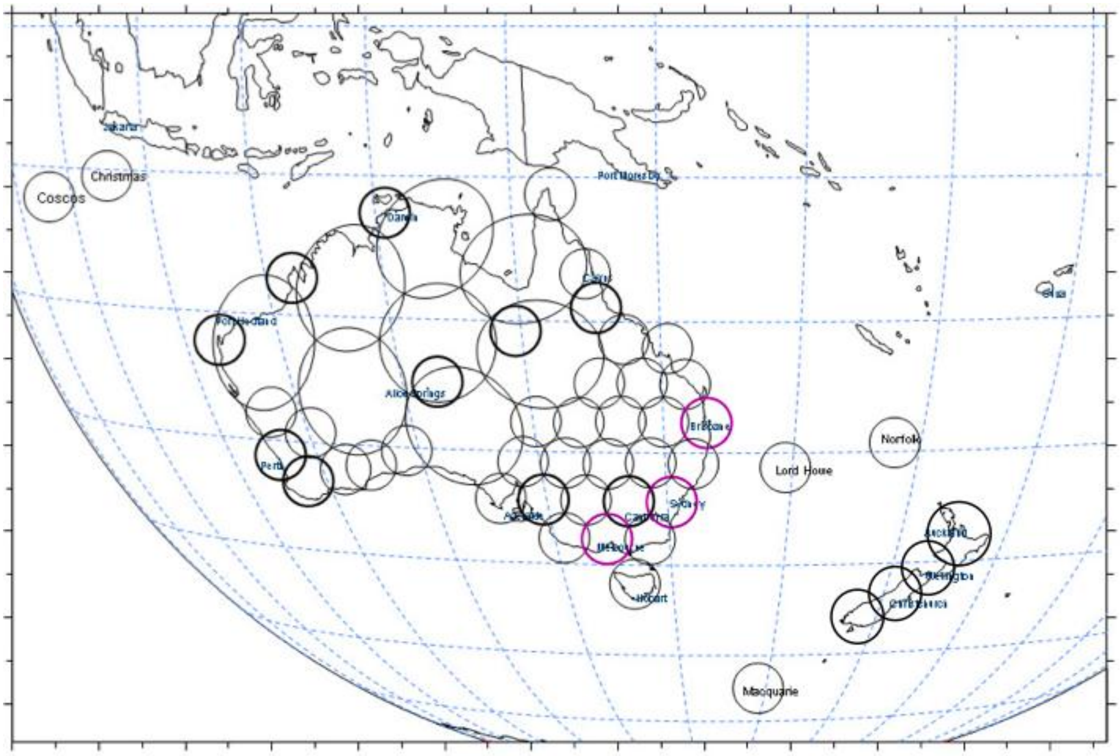


Figure 3.2-1: A 3rd Generation Satellite Beam Plan for Australia (NZ is optional)

3.3 Service Characteristics

The types of services that subscribers will consume needs to be considered as part of the system design. The types of service can influence:

- System availability (the percentage of time the service can be used as intended).
- Modem technology.
- Customer Premises Equipment design.
- Architecture of satellite hubs.
- Network management features.
- Satellite and constellation architecture.

Of course, everyone prefers that their 'service' is highly available, but determining what this means, what this will cost, and what it is reasonable to invest to achieve 'high availability' can only be done in relation to a particular service. Consider a traditional ADSL service. If the subscriber is only able to achieve dial-up speeds, is the service 'available'? Even concepts like '99% availability' can be misleading. There are examples of ISPs quoting availability over unrealistically long timeframes so it behoves the user to clarify the terms under which such availability is determined.

Weather tends to be the most significant cause of satellite system availability degradation. Modern 3rd generation systems are built with excess power that can be dynamically allocated to what are termed 'disadvantaged' terminals. This sophisticated power management is designed to ensure that a level of service is always maintained, even in the heaviest weather. The question asked by the engineers is which 'service' should be maintained. Is it all, some or only one?

Typically high bandwidth, time sensitive services are the most difficult and therefore expensive to support. Lower bandwidth or less time sensitive services are easier to support, and therefore can be made highly available for less cost.

For example, a highly available email service is relatively easy to provide because short term disruptions do not matter, and the volume of data being sent and received is relatively low. Live-streaming, high-definition (HD) television is less tolerant of interruption and is very bandwidth intensive, and therefore more expensive to support. Conversely, an HD video-on-demand service that relied on movies being stored on a customer's set-top-box could be engineering as highly-availability relatively cheaply even though the total data content would be higher than the streaming HD example, simply because the service is tolerant of delay.

The types of services demanded by customers may also impact the design of the satellite modem (a satellite modem is analogous to the DSL modem that is deployed in support of terrestrial broadband internet services). Many functions can be undertaken in hardware or software, or a combination of both. A typical example is support for voice. Some manufactures offer modems with integrated circuitry dedicated to the support of voice or VoIP across a satellite link. Other manufactures employ generic processors and implement their voice handling in software. Some manufacturers take the view that VoIP and similar services are add-ons that are best handled by a separate box that needs to be purchased by the subscriber, or by software on the subscriber's home computer. No approach is necessarily more correct than the other, but each does produce different quality of service, different levels of system flexibility, and different costs. And voice is just one example. Web acceleration technology is another example but there are many.

The symmetry of the service likely to be received by the subscriber also needs to be determined early in the design. The term 'symmetry' refers to the ratio of download speed to upload speed. Subscribers are perhaps more familiar with symmetry ratios (perhaps more correctly 'asymmetry' ratios) when they are expressed as 512/128kbps. In this example the ratio is 4:1 but many terrestrial IPS services are provided at symmetries of 8:1 and higher. Incidentally, the 512/128kpbs service package is currently the most widely subscribed package of all internet packages in Australia.

Some services, such as web surfing are highly asymmetric. A small request for data is generated by the subscriber which results in a large volume of data being served down to the subscriber. Other services, such as video teleconferencing, tend to be more symmetric because a picture and sound needs to be transmitted in both directions simultaneously. Still other services, hosting web servers for instance, are highly asymmetric but in the opposite direction. Small volumes of data are sent to the subscriber's web server which response with large volumes of data back up the link. While it is currently unusual for a subscriber to host their own website at home, peer-to-peer protocols such as BitTorrent may exhibit this highly inverse asymmetry where the subscriber is a significant source of content but not a significant consumer.

The symmetry of the service has impacts beyond the design and power of the Customer Premises Equipment and the hub equipment. For example it may be prudent to deploy caching servers in the satellite gateway to reduce the outgoing traffic across the satellite links in systems where subscribers are hosting significant volumes of content on their home computers. Caching servers are data storage sites that copy huge portions of the most popular internet content so that they may be accessed locally to reduce network load.

Symmetry also impacts the radio spectrum allocation plan. Emulating highly asymmetric services such as ADSL over satellite requires that most of the spectrum be allocated for forward links. Moving to more symmetric services means that more spectrum must be allocated to the return link. In general, the more symmetric the service the fewer subscribers can be supported in the same size spot beam. To support the same number of subscribers spot beam sizes must be reduced with some increase in satellite complexity and cost. Allocation of additional frequency to the communications between the satellite and the gateway in systems with more symmetry may also be required, complicating some gateway siting considerations (discussed in more detail below).

In addition to 'traffic' services there are other services that may or may not be integrated into the Customer Premises Equipment (CPE). These influence the system design and CPE cost and performance. Chief amongst these is the level of internet protocol routing that should be incorporated into the modem. Should the modem include a router at all? Perhaps subscribers who wish to support more than one computer on the link should be required to buy their own separate router, as is the case for most terrestrial ISP services.

Clearly, the more features that are built into the modem the more expensive it will be. But also additional features mean additional support complexity and therefore the requirement for larger and better trained Level 1, 2 and 3 technical support teams, and more intelligent troubleshooting tools. Highly featured solutions tend to drive up the overall cost of the system while distracting attention away from providing an underlying high level of service.

The services likely to be demanded by the subscriber also impact the design and complexity of the satellite hub. The phrase 'hub' refers to the electronics employed within the ground stations/gateways. The satellite hub and the CPE can be likened to the two cans at either end of a string in a simple child's toy telephone. Complexity or services integrated at one end needs to replicated at the other end. For example, circuitry to support voice calls in the CPE is also likely to be replicated in the hub. This also holds for various web compression technologies, encryption technologies and a number of routing functions that may be built into the CPE.

As an aside a single gateway may employ multiple hubs, depending on the hub manufacturer's architecture, with each hub services a specific subset of subscribers.

The nature of services that the satellite provider provides to the Retail Service Provider (RSP) also affects the complexity and cost of the system. This issue will be addressed in greater detail below. It suffices to say at this stage that the satellite service provider can provide the RSP everything from a very low service 'dumb pipe' to the customer, to fully replicating all ISP services (including management of IP address, authorisation services, access control services, accounting services, email and web hosting services, etc) and simply allow the RSP to brand and sell the service. Clearly there are costs and benefits of both approaches, and many variations in between, all of which impact the overall quality of the subscriber's service.

The nature of services offered to the subscriber directly impacts the architecture of the satellite and the system. Consider a mix of broadcast and uni-cast (ie point-to-point) services. Scheduled content broadcast services such as pay TV are easy to support hence the already high penetration of satellite pay TV into most markets across the world. Non-scheduled (ie on demand) high definition video is more challenging if viewed as a satellite broadband problem because the satellite needs to have both high power and a generous radio spectrum allocated. However the rapidly falling cost of hard disk storage means that North American operator such as DirecTV are making use of broadcast services to cache content on subscriber's set-top-boxes to outcompete terrestrial video-on-demand providers. In the DirecTV instance, the satellite is engineered so support broadcast services, but the system is able to provide high quality, cost effective uni-cast services. Additionally traditional scheduled content (such as free to air television channels) can be encapsulated in satellite broadcast IPTV to provide a rich consumer experience (already in operation in North America). Broadcast services can be cheaply and easily bundled into satellite broadband services, providing the system as a whole (including the satellite, Customer Premises Equipment, and hubs) has been designed to accommodate the features.

3.3.1 System Availability.

Single satellite systems have one obvious single-point-of-failure, that being the satellite itself. However all modern satellites are designed to survive reliably for the full duration of their mission. While satellites are often perceived as being modern technology the satellite industry is over fifty years old, with the first active telecommunications satellite being launched in 1962. Satellites have high levels of redundancy built-in as a matter of course. In fact, it is very uncommon for satellite missions to fail because of technical failure. A satellite's useful life is normally determined by its ability to accurately keep its station (ie its position in the sky) which is a function of the amount of on-board station keeping thruster fuel. Never-the-less satellites systems are vulnerable to total failure of the satellite, either through launch failure or a catastrophic failure in space such as space junk strike. To mitigate against these types of failures it is necessary to consider the launch of more than one satellite.

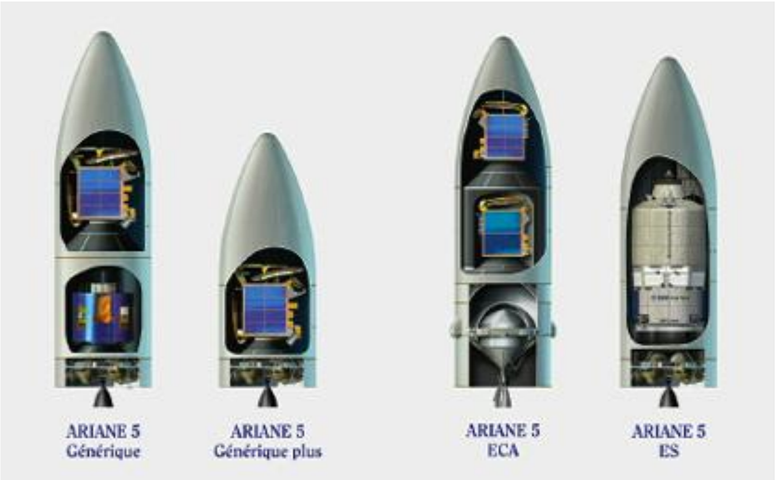
Where system resilience is achieved through the simultaneous deployment of more than one satellite the configuration of the constellation becomes important. If the satellites are too far apart in space it will not be possible to communicate with both satellites through a single antenna therefore requiring the re-pointing of ground based dishes in the event that the primary satellite fails. On the other hand widely separated satellites will make frequency planning far less complex and may allow either more subscribers or faster download speeds to be supported. If adjacent orbital slots are available, additional satellites could be located closely, perhaps removing the need to re-point in the event of failure. It may even be possible to stack more than one satellite in the same orbital slot. But in either case careful frequency planning needs to be undertaken to ensure that the two satellites do not interfere.

Radio frequency signals are electromagnetic radiation and, as such, can be polarised. Signals in free space at the same frequency but at opposite polarisations do not interfere. The polarisation of the signals is often used to provide separation between redundant satellites but this requires the Customer Premises Equipment to be able to switch polarisation in the event of the failure of one of the satellites. In some systems polarisation can be switched electronically by remote control. In other systems it is necessary to physically access the satellite dish, unbolt a portion of the radio frequency equipment and re-bolt it in the new orientation. The electronic re-pointing is more expensive, but is likely to be much cheaper than manual re-pointing in the event of a failure.

Another consideration in a two satellite constellation is business consequence of the permanent failure of one satellite. Such a failure may mean that the overall system remains operational, but capacity for most subscribers will halve as the subscriber base of the remaining satellite doubles. At the very least the implications for the business plan of an instantaneous, long term 50% capacity reduction needs to be considered. From a purely commercial perspective the failure of one of a pair of satellites may cause business failure even if a level of service is maintained for all subscribers.

An alternative to two satellites in orbit is to employ only one satellite in orbit and to keep a spare on the ground, ready for launch in the event of a failure. Such an approach may be a reasonable trade off between system availability and cost. While the cost of a second satellite is significant, the cost of satellite launch and launch insurance is also substantial, and avoiding incurring the cost of the second launch may be enough to close the business case. Conversely, if the satellites themselves are light then it may be possible to launched both simultaneously, reducing the total launch cost but increasing the risk of total system failure.

The ‘dual constellation’ and the ‘ground spare’ approach also have direct impact on the cost of the ground equipment. A second satellite will inevitably mean more hub equipment and more hub complexity. The ground spare approach will require less investment in ground infrastructure. A hybrid approach may be to plan for a dual satellite constellation but delay the launch of the second satellite, and therefore the cost of the launch and additional hub equipment until part way through the life of the first. This approach may also make the business case easier to justify, in that it spreads the cash commitment across the life of the system.



Regardless, of the approach, decisions regarding system availability have impacts right across all parts of the system.

3.3.2 End-to-End System Optimisation

The availability of a particular customer service defines what is known as the ‘link budget’. The link budget is an engineering term for the sum of the total power gains and losses in the entire end-to-end system. In order to ‘close’ the link for a certain service it is necessary to achieve a certain quality link budget. The engineering problem that needs to be solved is optimising the gains and losses through the system in the most cost effective way to meet the link budget for a particular service.

For example, the effects on the link budget of doubling the size of a Customer Premises Equipment power amplifier or increasing the radius of a subscriber's satellite dish by 40% are approximately the same, but have quite different cost impacts across the life of the system.

Other examples of potential link budget tradeoffs include deploying smaller CPE dishes with a more powerful satellite, reducing satellite power by deploying larger gateway dishes or larger amplifiers, or leaving the gateway dishes unchanged but instead employing higher quality electronics. Additionally, while it is normally cheaper to buy off-the-shelf equipment, manufacturers only offer equipment in steps of size and performance, each at a certain cost. Consequently, providing the proposed subscriber base is large enough, it may actually be cheaper in terms of the overall system to custom develop some items rather than buy off the shelf.

When designing satellite systems it is important to separate the concepts of 'bandwidth' from 'throughput'. Using the analogy of a water pipe, bandwidth is the width of the pipe, throughput is the volume of water that can pass through for a given pump. In this analogy, the CPE and hub equipment are the pumps. While bandwidth and throughput are related to each other, they are not the same.

In satellite systems bandwidth tends to be a function of the radio frequency spectrum allocated to the system and the speed and quality of the electronics employed in the various components of the system. Throughput is partially defined by the electronics and partially defined by the power of the system (the link budget), but also influenced by the sophistication of the encoding algorithms used across the satellite link. This is especially the case in satellite broadband systems that employ Transport Control Protocol/Internet Protocol (TCP/IP).

The laws of physics mean that satellite systems unavoidably incorporate approximately 250 milliseconds of delay. TCP/IP was designed to operate over terrestrial networks where delay was interpreted to be caused by traffic congestion. The solution to traffic congestion was to reduce the speed of communications until the congestion cleared. In a satellite system the delay is inherent in the system and has nothing to do with traffic congestion.

Modern satellite systems have solved this problem. Second and Third Generation satellite systems employ a technique called "protocol enhancement proxy" (PEP) that ensures the transmission of arbitrarily high data rate TCP/IP packets over satellite links with latency, unlike first generation systems that did not employ PEP and therefore experienced limits on data throughput rates

In addition to dynamic allocation of satellite power, frequency reuse, and spot beams, 3rd generation satellite systems employ highly efficient protocols in their hubs and modems that convert TCP/IP into a satellite friendly protocol for transmission across the link. The performance of this compression technology varies from manufacturer to manufacturer, and it is not possible to mix and match manufacturers at either end of the link. If manufacture A is used in the hub then manufacturer A must also be used for the Customer Premises Equipment modem.

The choice of the modem and hub manufacturer is also a major driver of overall system performance, and needs careful consideration in relation to the cost/benefit of their technology, the level of support they can provide, their commercial viability, their ongoing technology development roadmap, the maturity of their interface into monitoring, operational support and business support systems, and the commercial implications of locking them in for the life of the system.

The architecture and extent of the satellite gateways depends upon the power of the satellite, the radio frequency bandwidth allocated to the system, the number of subscribers, and their allocated bandwidth and throughput, and sometimes upon the location of the satellite slots. The more powerful the satellite, generally the fewer satellite gateways are required. However this needs to be balanced against the demands on the scarce radio spectrum.

Communications between the satellite and gateway hub must be accommodated within the same radio frequency spectrum allocated to support communications between the subscribers and the satellite. Depending on the subscriber distribution it is often preferable to locate gateways in low population density locations because relatively little of the spectrum is employed supporting subscribers so relatively more of the spectrum can be used for communications with the gateways. Similarly the subscriber population being serviced by a satellite can be maximised by extensively re-using frequencies in many narrow spot beams.

This, in turn, may drive the requirement for more, but lower capacity gateways depending on the topology of the terrestrial backhaul network and the distribution of the subscribers.

3.3.3 Gateway Siting Considerations

A medium capacity 3rd generation satellite broadband system will need between six and ten gateways to support a typical subscriber base, depending on the spectrum allocated to the system. The siting of these gateways is non-trivial. As discussed earlier, satellite gateways are potential sources of interference to other terrestrial users and possibly other satellite systems. Consequently they generally need to be sited way from urban areas. The characteristics of the beam patterns used to link the satellites to the gateways mean individual gateways supporting a single satellite often need to be separate by up to as much 750 km. Also since the communications between gateways and the satellite consume frequencies that might otherwise be used to support subscribers, the gateways themselves should be located in areas of low population density.

In Australia, these siting considerations mean that the gateways for 3rd generation systems need to be located primarily in northern and western Australia. These areas bring their own challenges. Firstly the remoteness of the potential sites adds to complexity and cost of construction and maintenance. Satellite dishes at gateway sites are large and susceptible to strong winds. Siting in northern and western Australia makes many potential sites susceptible to cyclone activity which requires additional engineering to strengthen the structures. Northern Australia especially is also susceptible to high rain fall, including monsoonal rains during the wet season. Measures need to be taken to ensure that the gateways are engineered to operate during severe rain.

Satellite gateways need good connectivity to the internet. The nature of access to internet and the cost of backhaul in Australia are significant cost drivers associated with locating gateways in remote areas. Australia, being an English speaking county, sources most of its internet content from North America. This content is delivered into Sydney by submarine cable. Locally produced content is primarily hosted in Sydney, with the rest from Melbourne and to a lesser extent Adelaide. Getting this content to gateways located in northern and western Australia requires extensive use of long distance backhaul services.

Most potential gateway locations are serviced by Telstra alone. The fees for access to the backhaul network in these areas are prohibitive. And regardless of the price, for many potential sites such as Exmouth, Broome, Alice Springs or Mt Isa, there simply is not enough capacity within the existing terrestrial fibre networks to support gateway traffic volumes. Using satellite for backhaul is not practical. The factors that drive the satellite gateways to remote regions in the first place also apply to teleports used for satellite backhaul systems.

When examining the business case for a satellite broadband service, the siting and operational expenses associated with the gateway locations are a significant factor in the feasibility of the system business case. In order to avoid backhaul costs it may actually be more cost effective to service a smaller customer base if this means fewer gateways in remote locations.

3.3.4 Retail Service Providers

The 3rd generation satellite system proposed by KaComm for Australia will be based on a wholesale business model. Consequently the success of a satellite broadband service depends heavily on the success of the Retail Service Providers. RSPs are responsible for developing packages that meet customer needs, reaching customers, and provisioning and operating the services. RSPs schedule and manage the installation of the Customer Premises Equipment, provide first level technical support, billing, and invoicing. With the exception of the installation and a few other minor issues, these activities are little different for a satellite broadband service or a traditional terrestrial ISP.

As most customers of terrestrial ISPs would appreciate, the ability of RSPs to undertake these varies considerably from RSP to RSP. This needs to be overlaid on the fact that the satellite broadband wholesaler is only servicing a relatively small but geographically diverse market and, therefore, may not always attract the largest or most capable RSPs to provide services across their network. It is more likely that the majority of RSPs providing satellite broadband will be niche suppliers specialising in either rural customers or satellite broadband services.

Many smaller RSPs typically have informal processes, low staffing levels, struggle to attract and retain skilled employees, and do not have the resources to invest in sophisticated systems to provision and manage their customer base.

A review of the comments on internet forums of customers of existing Australian satellite broadband RSPs indicate that a significant proportion of the issues associated with the provision of satellite broadband relates to the performance of the RSPs rather than any intrinsic performance of the various systems. Typically issues include delays in installation, poor installation, poor technical support or poor response times, and failures of ISP type services such as email.

This can be seen in comments where forum participants recommend one RSP over another, even though both use the same satellite service provider and the same Customer Premises Equipment. While this behaviour is one of the benefits of the wholesale/retail model, bad experiences with satellite broadband impacts on the reputation of 'satellite' as a whole, and the satellite broadband wholesale provider in particular. In fact it is common to read comments where RSPs deflect issues that clearly relate to the 'ISP-type' aspect of the services onto the satellite systems provider. Technically non-literate customers are left to accept the explanation as given.

Regardless of the allocation of blame, the customer just wants the problem fixed. Therefore it is in the interests of the satellite broadband service provider to engineer their system such that RSPs are given the best chance of providing a high quality standard of service.

There are two extreme models of wholesale satellite Internet Service Provider (ISP). The first is the so-called 'white labelled' ISP. In the white label ISP model all aspects of the service – the provisioning systems, internet address allocations, authentication, access control, and accounting, calculating and rendering invoices, collecting and processes payments, the provision of services such as email and web hosting for customers – are all provided by the satellite ISP. RSPs simply pay a fee to access the system. The white label ISP models allow the RSP to concentrate on customer facing activities such as sales, installation and technical support. While the white label ISP model has many attractions including common levels of service provision and quality assurance across the satellite broadband service, it increases the complexity and cost base of the satellite broadband provider, forces all RSPs to adopt similar product lines, and stifles innovation and competition. In the both the Australian terrestrial and satellite broadband market the white label model has never taken off.

The alternative to the while label ISP model is the do-it-yourself (DIY) model. In this model the satellite broadband service provider is responsible for ensuring the continuity of the satellite link and providing the RSPs with access to monitoring systems that relate to their own customers, but all other aspects are managed by the ISPs themselves. The DIY model is overwhelming the model adopted by Australian terrestrial and satellite ISPs.

These two models represent the extremes and there are variations between the two.

The choice of RSP model determines the complexity of the satellite hubs, operational support and business support systems, the choice of Customer Premises Equipment and hub equipment suppliers, aspects of the terrestrial network that needs to be provided to support the system, staffing and skill levels of the satellite broadband service provider, cost and price points for delivering the service, and potentially the success or failure of the system as a business. Decisions regarding the RSP model should be made early in the development in conjunction with a number of the technical engineering decisions to ensure that the system is RSP friendly, and ultimately customer friendly and successful.

3.3.5 Technical, Operational and Business Support Systems

Three distinct management systems are typically fielded to support telecommunications systems, these being:

- Network Management System.
- Operational Support System.
- Business Support System.

The Network Management System (NMS) is the system that deals with the instantaneous technical 'health' of the network, and also providing historical trend data relating to network health. The large screens that stereotypically adorn the walls of Network Operations Centres and show the network in green, amber and red, are normally displaying output from the NMS. The level of NMS resolution and fidelity depends partially on the quality of tools, but also on the technical decisions made during the system design.

For example, a system based on the DIY RSP model supporting a wide variety of broadcast and uni-cast customer services, that includes hardware based voice circuitry in its Customer Premises Equipment, would need significantly different features and functions compared to a pared down, white label system featuring basic CPE functionality. Feature sets related to the performance of specific applications in the first example would require not only an NMS capable of displaying these features, but CPE capable of generating the raw monitoring data, and features allowing this data to be provided to multiple RSPs in way that allowed them views of their own subscribers but not their competitors. The features of the second system, and the volumes of data that needed to be processed and stored, would both be reduced allowing for the deployment of a cheaper NMS.

Operations Support Systems (OSS) are the tools that support operations, fulfilment, assurance (i.e., high order NMS type functions), billing, customer relationship management, resource management and supplier and partner management. The RSP model and therefore the technical feature the CPE, hubs and other parts of the end-to-end system are important considerations during the design phase and matched to the features and capabilities of the OSS.

The accompanying Business Support System (BSS) which support marketing and offer management, service development, resource development, supply change development and management, infrastructure and product life cycle management and aspect of corporate strategy is also significantly impacted by the nature of the technology and the business model.

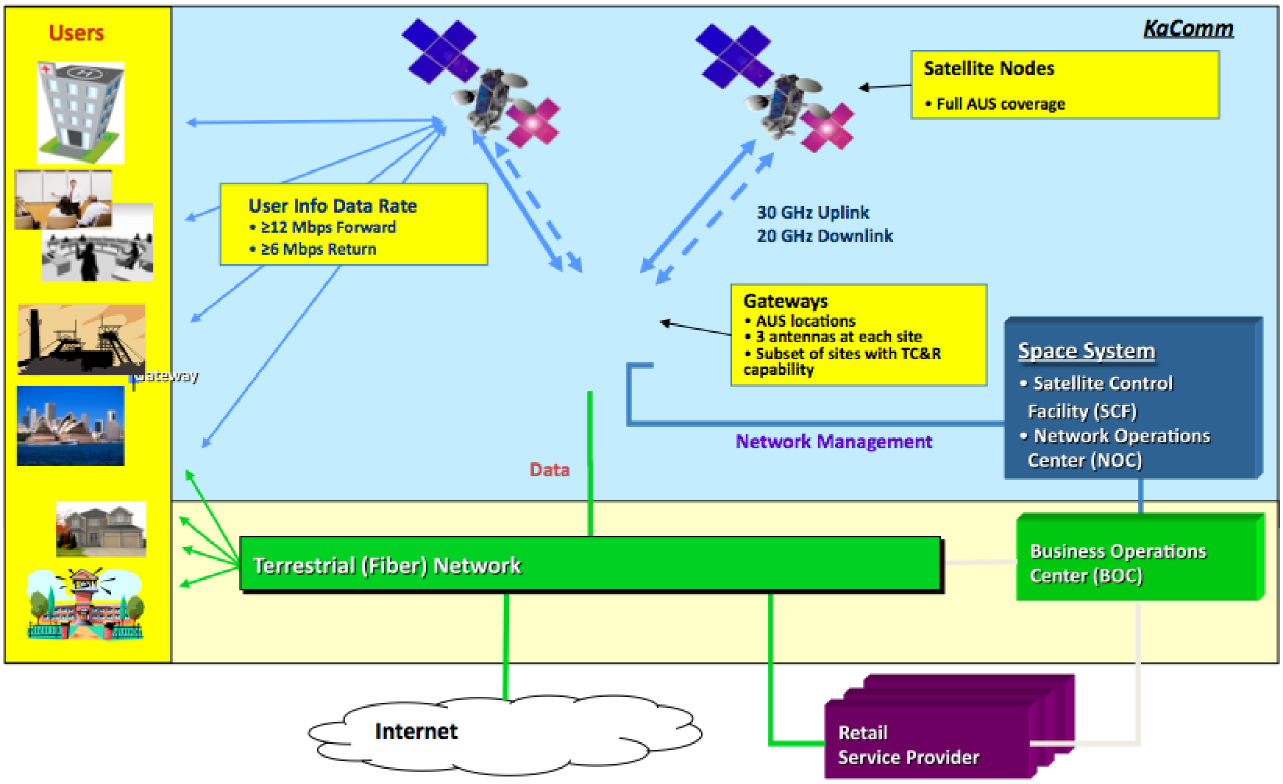


Figure 3.3.5-1: An example of the KaComm operations architecture

3.3.6 Procurement and Management Models

Tradition satellite communications services such as those provided by established international providers such as Intelsat are not designed or procured as end-to-end systems. In these systems many of the issues discussed above are either not a factor or are far less important than in the development of the satellite broadband. This is because:

- Focus is on trunk communications rather than the last mile.

- Wide coverage beams rather than spot beams.
- Low usage of TCP/IP.
- Less demanding performance/price optimisation challenge.

Traditional communications systems have been developed to support the Wide Area Network (WAN), not the last mile to the subscriber. In traditional systems there are no individual subscribers on the network. Instead each network node represents a high capacity WAN interface. Many of the complexities described in the discussion above relate directly to providing services to large numbers of residential subscribers and linking them to a small number of satellite gateways. In a traditional satellite WAN the users of the network often own the satellite gateways and individual subscribers don't exist, and therefore much of the broadband complexity simply does not exist.

Secondly, traditional systems depend on wide coverage beams, not spot beams. These wide coverage beams often cover several countries, and sometimes whole continents. And while the satellite designer cannot be ignorant of the location of potential subscribers, a high degree of accuracy is not important. On the other hand spot beam systems introduce high complexity. Potential subscriber populations need to be identified, beam patterns designed, frequencies chosen to maximise capacity while minimising interference, and satellite power, transponder design and antenna geometry adjusted accordingly.

Traditional satellite systems do not have to deal with the full complexity of TCP/IP. Overcoming the limitations of TCP/IP in satellite broadband systems has required equipment developers to invest in specific web acceleration technologies that remain closely guarded intellectual property. This requires the Customer Premises Equipment to be matched to the hub equipment, and limits the employment of open standards. Traditional systems do not have this problem and therefore open standards for modem operation can be defined, allowing a modem from manufacturer A to communicate with a modem from manufacturer B. This is not the case in satellite broadband systems.

The success of traditional satellite communications systems stemmed from their ability to leapfrog terrestrial infrastructure. This was done for reasons of economy where the terrestrial telecommunications market was dysfunctional, for reasons of necessity where terrestrial services were not available, or for reasons of convenience particularly where mobility was valued. The user of the service had a need that could only be satisfied by satellite and therefore price was less important.

Satellite broadband systems are as much about delivering a social good as they are about the economics of telecommunications. Satellite broadband customers themselves tend to be far more price sensitive because even if they don't have a terrestrial option for broadband they always have the option of not buying broadband services at all. While not having broadband access clearly puts them at a disadvantage in the modern economy, for many potential subscribers of satellite broadband services there is not an overwhelming need that compels them to purchase the service regardless. For this reason the challenge of optimising price and performance is of greater concern in broadband satellite systems than is has been traditionally.

As a result of these factors, satellite broadband systems must be designed as end-to-end systems, with a single entity controlling the project and with the responsibility and authority to balance the system-wide tradeoffs that maximise performance and minimise cost. This allows the Customer Premises Equipment, satellite design, spot beam design, hub design, hub location and terrestrial system design, management, operational support and business support systems, and the Retail Service Provider model to be aligned and optimised.

Similarly, it makes sense for the system to be operated by a single entity in a wholesale service provision model. Uncoordinated changes of various configuration or setting across the system would quickly lead to reduced performance. Across the life of the system components will be required to be upgraded or replaced. Ensuring system coherence during this process requires end-to-end system management control.

4.0 Regulatory Environment

Geosynchronous satellites need to orbit the earth at 35,786 km over the equator. At this altitude, they appear to remain fixed above their given longitude in the sky. This orbit is know as the Clark belt after Arthur C. Clarke the English science fiction author who proposed the suitability of this orbit for satellite communications in 1945. While the Clark belt itself is very large, the physics of radio waves means that the location of communications satellites must be carefully managed to ensure that radio waves meant for one satellite do not interfere with the operation of those adjacent to it.

The International Telecommunication Union (ITU) regulates the locations of satellites in orbit (known as their 'slot') and the frequencies that can be used to communicate between the satellite and the ground to ensure that satellites do not interfere with each other. As part of planning a satellite broadband network, it is necessary to apply for a slot for the satellite and frequencies for their use. In Australia, these functions are coordinated by the Australian Communications and Media Authority (ACMA).

Without ITU and ACMA approved access to orbital slots and the chosen frequencies at those orbital locations, a satellite may not be operated under both Australian and International law. Hence it is imperative that any satellite proposal has approved matching orbital slots and frequencies before it can be pursued.

In addition to the space locations and frequencies, ACMA also coordinate the radiating elements of terrestrial systems. Similar to the interference considerations of space, there are interference considerations on the ground. The same frequency bands that are used for satellite communications may also support ground-based users of terrestrial communications and radar systems. Additionally, Australia is already covered by many satellite systems supplying services such as pay TV, communications, television back haul, military applications and satellite mobile telephony.

Frequencies and locations of facilities for all these users must be coordinated to ensure the scarce radio spectrum is distributed fairly and efficiently. Potential builders of satellite systems must coordinate their designs through the ACMA to ensure that they do not impact the operations of existing users. The frequencies, satellite slots and limitations on the location of ground equipment constrain the performance of the system as a whole and are key engineering and commercial considerations for the system designers.

Hence, before an aspiring satellite broadband service provider can deploy its satellite and services, it must make application to the ACMA for its desired orbital slot, satellite operating frequencies and basic performance specifications. If the application is accepted by the ACMA, the authority submits an Advanced Publication Information (API) notification to the ITU. In the course of preparing such a notification, the aspiring provider will have needed to research the existing users of orbital slots and frequencies adjacent to its own desired locations. This in itself is a complex process that requires a clear understanding of the international coordination process as well as the engineering skills necessary to understand satellite and network design.

Once the API is submitted, a period of 6 months is allowed for other users of the spectrum and near orbital slots to register contention and the need for coordination.

The next step in the process is to submit to the ACMA and ITU, detailed satellite frequency use plans and design details for the final satellite system design (referred to as a C-Notice). The C Notice can only be accepted by the ITU after a minimum of 6 months from its receipt of the API. Once the C-Notice is received and published by the ITU, coordination between satellite operators can commence to bring about agreement in design and operational characteristics to permit co-existence between the various satellite operators. Once coordination is reached with all satellite operators who originally requested coordination, the satellite system can be notified on the ITU's Master Register and has the right to commence service.

KaComm is very advanced with its developmental status and has already submitted the APIs and C Notices for four Ka-band orbital slots ideal for servicing Australia. The process to get to the state enjoyed by KaComm is a long one and has taken several years to achieve.

5.0 Demographics

Australia is sometimes referred to as a doughnut because its population is primarily located around the coast line and there is very little population in the country's expansive and harsh interior. Not surprisingly, it is that very problem of distance and remoteness that has driven the need for a better solution for the internet connectivity needs of Australia's rural population. In response to the need for a better internet solution for the rural communities, the Australian Government established the Australian Broadband Guarantee (ABG) to subsidise the high cost of service delivery to remote users.

Postcode Counts - GNAF Premises in ADSL Blackspots			
Category	**NoADSL**	**ADSL4+km**	**Total**
Metro	35,071	160,623	195,694
Regional	211,550	249,437	460,987
Remote	17,586	10,225	27,811
Total	**264,206**	**420,285**	**684,491**

CCD - 2006 Census Counts		
Category	**Population**	**Dwellings**
Metro	16,405,847	5,904,126
Regional	3,353,066	1,210,806
Remote	94,343	28,448
Total	**19,853,256**	**7,143,380**

The ABG has been largely successful although, as mentioned earlier in this White Paper, some RSPs have exploited the process and given satellite based services a tainted reputation.

Although rural and remote users are most normally underserved with the internet, it often comes as a surprise that many metropolitan users are also underserved.

Table 5.0-1 on the left shows that the demographics of the underserved are not confined to remote users. In fact, the majority are in the regional and metropolitan areas.

Whilst it is reasonable to assume that the metropolitan and a large percentage of regional underserved will be "saved" by the proposed NBN, it is equally reasonable to assume that a percentage will not. This means that satellite broadband service provision must account for the regional and metropolitan underserved as readily as it will for the remote users.

This real outcome can be seen in the United States where the resultant density of satellite broadband users closely matches the normal population distribution and comes as a surprise to many analysts.

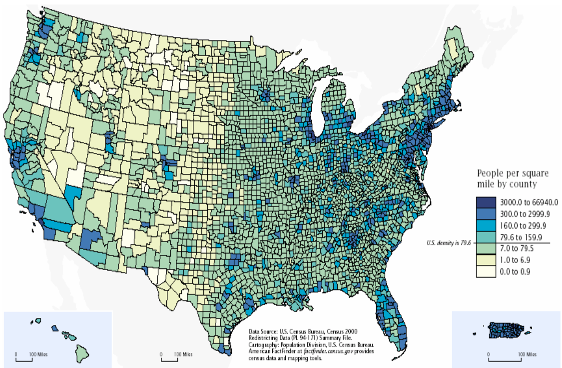


Figure 5.0-1: USA Population Density by post Code

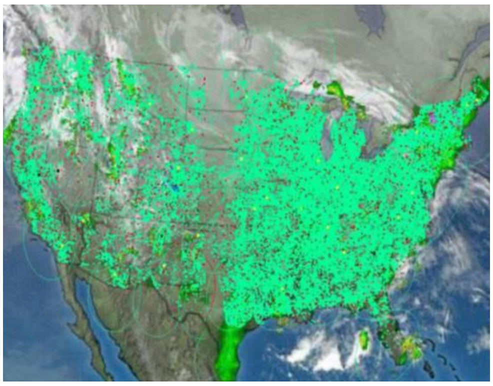


Figure 5.0-2: US Satellite User by Post Code

Observing the two figures above, it becomes clear just how closely the population and user densities have mapped to each other in the USA.

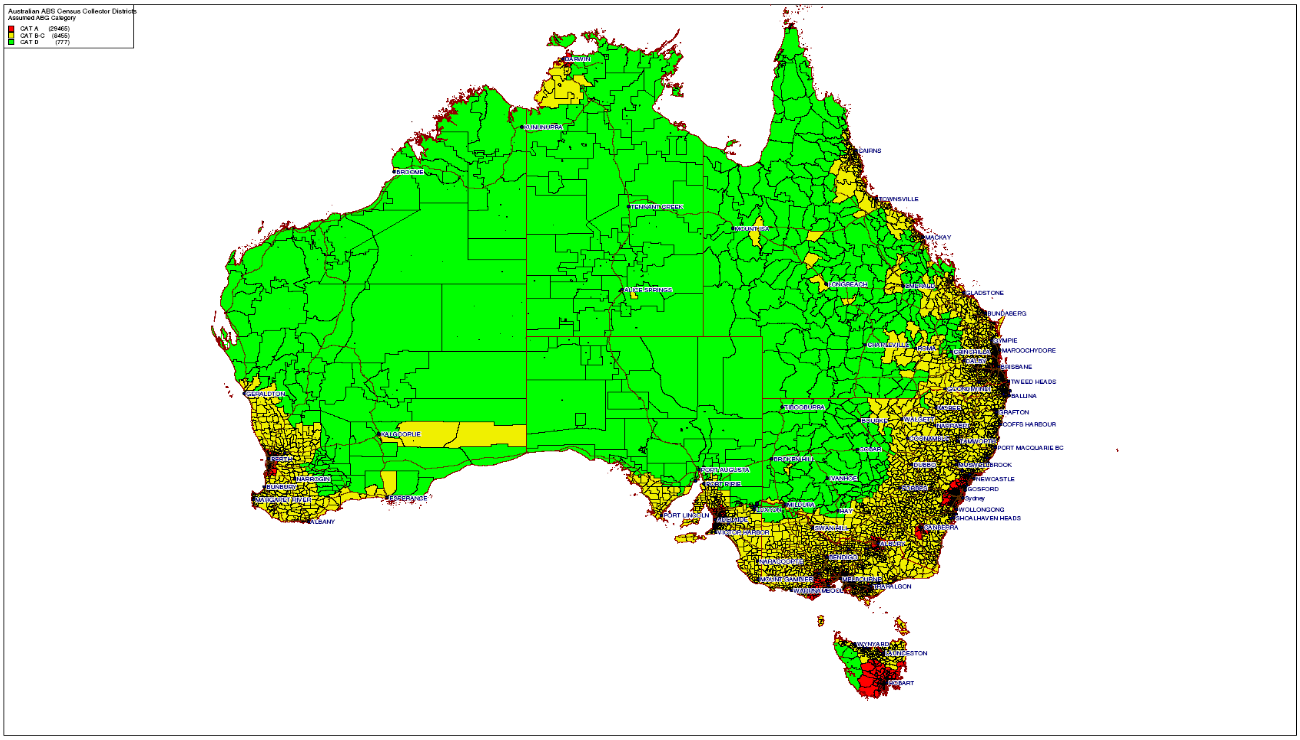


Figure 5.0-3: above shows Australia's population distribution by post code.

It may be reasonable to assume that Australia will see a similar take up of usable satellite broadband services to that seen in the USA.

It is important to note here that KaComm's satellite broadband solution will address 100% of Australia's territorial population. That means all those on the mainland as well as all those on Australia's Island Territories and even down to the north coast of Antarctica.

6.0 Product and Pricing Trends

Satellite product and pricing packages have come a long way since the 1980's.

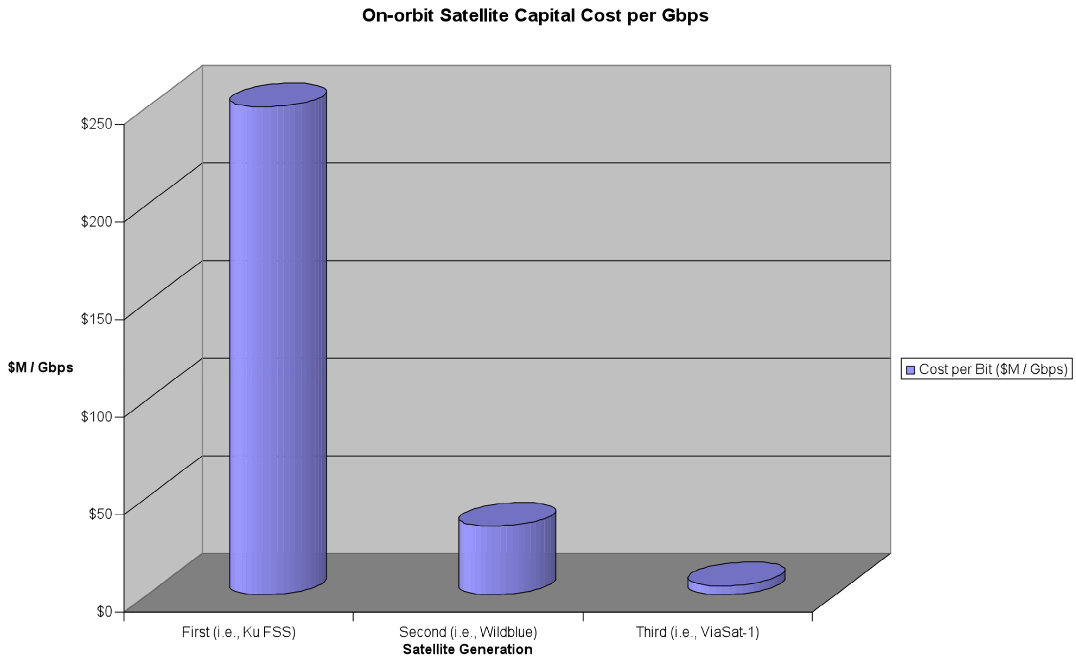


Figure 6.0-1: On-Orbit Capital Cost per Gbps

The figure above demonstrates how the cost per bit of data transmitted by satellite has dramatically reduced since the 1980's. Below is a table that outlines examples of current satellite broadband internet delivery plans, all of which remain dependent upon the ABG. The sub-table on the right is that for a current 2nd Generation satellite serving Australia.

Examples of current satellite plans. All dependent on current ABG						
Traditional plans				Unlimited Speed plans		
Speed	Data	Price per month		Speed up to	Data	Price per month
256/64kbps	1GB	$39.95		4/2Mbps	500MB/1GB	$39.95
512/128	1GB	$49.95		4/2Mbps	1GB/2GB	$49.95
1024/128kbps	1GB	$59.95		4/2Mbps	2GB/4GB	$69.95
512/128kbps	3GB	$66.00		4/2Mbps	3GB/6GB	$89.95
1024/128kbps	2GB	$83.00				
512/128kbps	5GB	$98.00				
1024/256	3GB	$113.00				
1024/256	3GB	$151.00				

Table 6.0-1: Traditional and Current Satellite Broadband Plans

These plans could be compared directly to current terrestrial ADSL2+ plans and it would be clear that those served by terrestrial systems are better off both with the available speeds as well as the download limits

The KaComm 3rd Generation Satellite Broadband service will offer much higher download and return speeds as well as increased download limits all for more competitive wholesale rates. This wholesale pricing advantage should translate to more competitive pricing by the RSPs. The end user will benefit from this.

There are currently 16 certified providers of satellite broadband under the ABG. These include but are not limited to the following.

- Australian Private Networks
- Elders
- Harbout IT
- Orion Communications
- Amcom
- Ocean Broadband

- Internode
- Westnet
- Westvic Broadband
- Wideband Networks
- Optus
- Telstra
- Skymesh

In addition, there are a number of organisations providing broadband services to government and enterprise outside of the ABG.

7.0 Overview of KaComm Services

The KaComm satellite broadband service will be available to 100% of Australia and its Island Territories, including the northern shores of Australian Antarctic Territory. Delivered as an entirely wholesale service, KaComm satellite broadband will offer a nominal capability of 12Mbps downlink speed with a return of 4-6Mbps. The KaComm service is designed to address underserved users, wherever they may be and in a manner that will be totally complementary to the roll out of terrestrial FTTP services.

Retail Service Providers (RSPs) may choose to offer reduced packages such as 4/2Mbps for less demanding users but will also have the option to offer higher capacity packages such as 30/10Mbps, 50/25 Mbps and even up to 100 Mbps for premium enterprise users.

Content over this bandwidth will include World Wide Web, Standard Definition Video on Demand (VoD) and Voice over Internet Protocol (VoIP). This is typically referred to as “Triple Play” service. High Definition video content will also be available, delivered using caching techniques, possibly incorporated into the user terminals. In addition, High Definition video conferencing services will also be supported.

The ubiquitous nature of the service coverage means that anyone in Australia will be able to receive the same services and content. Delivery will not depend upon the user’s proximity to a telephone exchange or a town. An anticipated consequence of these qualities is that the retail cost of the service should be largely invariant from region to region and this will both drive competitiveness between RSPs as well as offer metro comparable pricing to all regions.

Third generation satellite and terminal technology has increased the capacity per satellite by a factor of approximately ten times. This has also reduced the cost per bit whilst increasing the average throughput per subscriber. KaComm satellite broadband will also ensure that full services will be available to the home user, SOHO, dispersed corporate offices and government wherever they are located.

End users will utilise 3^{rd} Generation satellite modem equipment that will be compatibility certified by KaComm. A typical user installation will include an approximately 0.85m diameter offset feed antenna dish and 4W TxRx feed assembly, transmit and receive cabling from the dish to the modem, a 3^{rd} generation modem coupled with a VoIP convertor and a wireless bridge. Each modem will facilitate at least two ethernet ports.

The low power consumption of these devices make them easily compatible with remote location, independent power generation and, almost certainly, mobile homes and recreation vehicles.

KaComm satellite broadband is the perfect complement to the terrestrial services of Australia’s National Broadband Network.

KaComm Communications Pty Ltd.