Parliament of Australia
House of Representatives Standing Committee

Inquiry into Wireless Broadband Technologies

Submission by ArrayComm Inc and CKW Wireless

22 May 2002

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1. EXECUTIVE SUMMARY

Thirty years ago, people started making telephone calls 'on the move' rather than being tied to a phone line. They were freed to communicate wherever and whenever they wanted, they were untethered and they were free to move.

This simple concept – mobility – has since created new industries, new technologies, and new companies all focused on the opportunity wireless voice services. Billions of dollars in value has been generated. More importantly, consumers have changed how and when they communicate, businesses have increased efficiency and effectiveness, and, national economies have realised the flow-on benefits in terms of economic growth and expansion. This simple concept – mobility – when applied to data services, will deliver the same radical changes to both industries and countries around the world.

This submission by ArrayComm Inc and CKW Wireless can be summarised as follows:

- Wireless broadband and data services, although still in their relative infancy, have the same potential as mobile voice services to change how we communicate and to generate economic growth. Australians will be able to benefit from these developments and from the freedom to move.

- No single wireless broadband technology will provide all the answers. In reality it will be a combination of wireless solutions that will ultimately deliver consumers the full potential of wireless broadband wherever they live or work.

- There will be some false starts as customers become accustomed to the limitations of various offerings and vote with their feet. These false starts need to be seen by policy makers as part of the natural development of a new industry rather than as limitations in the potential of broadband wireless or areas to be further regulated.

- Comparatively speaking, Australia it is well positioned to take advantage of the growth in wireless broadband services. Spectrum auctions have delivered some sensible commercial outcomes. Service offerings are being developed and some are commercially available. Investments are in place, or being planned for. Early-adopters are already experiencing the freedom of data mobility and the mindset is starting to change.

- The role of government is simply to ensure the broader parameters are in place. These include creating the right investment climate, promoting competition, ensuring efficient spectrum management, supporting technology-neutrality, protecting property rights, and, supporting the development of global standards.

- With these parameters in place, and given the undeniable demand drivers for mobility, the market will decide which wireless broadband solutions are sustainable and which will fail, customers will migrate exponentially to the new services, and Australia will reap the economic benefits of the next wave of mobility.

ArrayComm Inc was incorporated in California, USA in April 1992 and is a leader in smart antenna technology. It develops and licenses software technology to enhance the spectral efficiency and cost effectiveness of voice and data systems. ArrayComm Inc has developed a unique technology called *i-BURST* that will deliver customers a unique and currently unmatched combination of low cost, high speed and widely available wireless broadband services.

CKW Wireless is a 100% owned subsidiary of ArrayComm Inc. CKW Wireless purchased spectrum in the recent Australian spectrum auctions with the intention of deploying a national wireless broadband service called *i-BURST* in all Australian capital cities from October 2002 onwards.

ArrayComm's management team is, for a small company, one of the most experienced groups of veterans of the wireless, telecoms and internet industries. It remains at the disposal of the inquiry for further consultation on the contents of this document.

THE WIRELESS BROADBAND OPPORTUNITY

The Internet and the wireless industries have each experienced unprecedented growth and development. Notwithstanding this, the Internet and wireless markets are still in their early stages of development and their full potential is still to be realised. They are expected to continue the rapid progress with the development of new technologies and applications suitable to consumers, government and business.

2.1 THE WIRELESS INDUSTRY

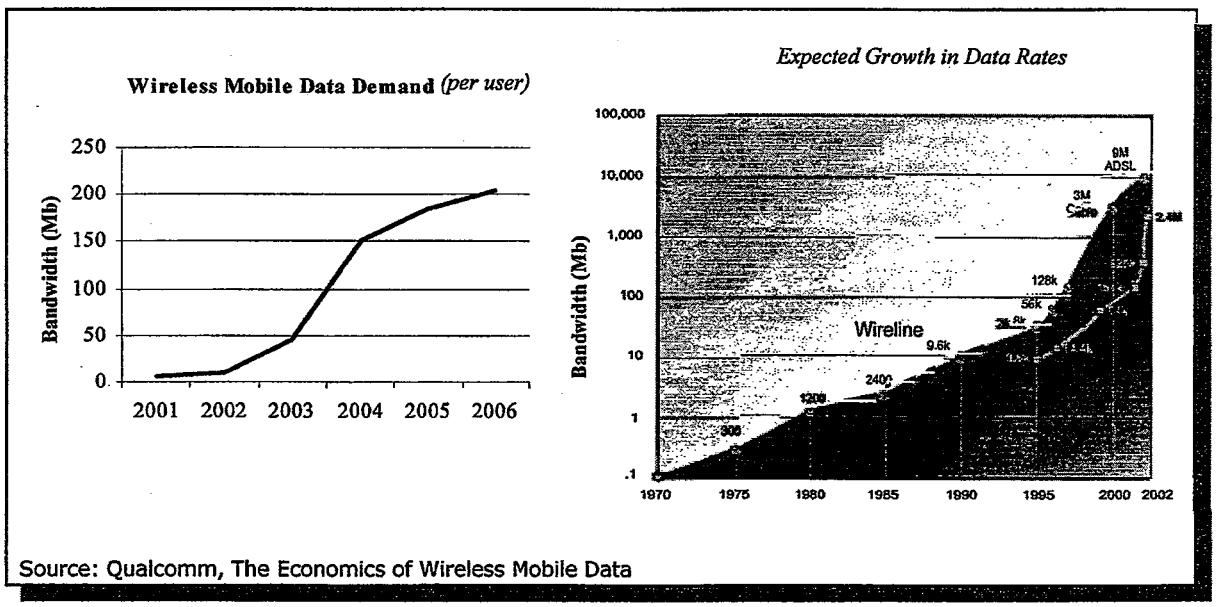
The global wireless voice industry has seen phenomenal growth in recent years. This growth is expected to continue for many years as new wireless voice and data services evolve and offer customers unprecedented value.

Personal communications are increasingly becoming wireless in nature. This trend has been particularly evident in voice communications, where the number of subscribers worldwide to mobile services is currently in excess of 800 million. In North America, mobile penetration has reached approximately 40% and in Western Europe, the most-mature market, penetration has reached 63% of the population and continues to grow. In Asia, penetration rates are above 80% in markets like Hong Kong and Taiwan, 70% in Singapore and over 60% in Korea and Japan – not to mention the world's single largest mobile market in absolute terms, China, with over 125 million subscribers. In Australia the mobile penetration rate has reached 59% (sources: Nomura, U.S. Bancorp Piper Jaffrey, Morgan Stanley Dean Witter, Paul Budde Communication).

Worldwide mobile phone usage is still relatively low with 730 million subscribers at the end of 2000 or a total market penetration of only 12%. We expect the number of global wireless customers will exceed one billion subscribers in the next month. Although some markets are not expected to support high penetration rates there is nevertheless considerable room for growth and the market is expected to have a compound annual growth rate of 31% through 2002.

2.1.1 Wireless Data

Over the past ten years, fixed line data traffic has increased from one megabyte (MB) per customer, per month to 196 MB per customer, per month (source: AT&T Research Labs). This acceleration in usage, which continues each month, has been driven by the technological improvements that have increased data rates, enhanced usability and lowered costs. It is expected that these same factors will drive wireless data usage in the near future and future growth in wireless data rates is expected to mirror the experience with fixed line data rates.



Source: Qualcomm, The Economics of Wireless Mobile Data

2.2 THE INTERNET

Since the conception of the World Wide Web in 1989, the growth in Internet users has been phenomenal, reaching 400 million in 2000 from 500 Internet users in 1984. The number of users and devices accessing the Internet are expected to continue to grow at an average rate of 20% and 28% respectively over the next five years with the number of users reaching almost 1 billion by 2005.

Worldwide Internet User Summary							Figures in million
	1999	2000	2001	2002	2003	2004	2005
Number of Users Accessing the Web	240	400	522	651	775	877	977
Number of Devices Accessing the Web	237	371	509	672	860	1,050	1,284
Users/Total Pop. (%)	5%	8%	11%	13%	15%	17%	19%

Source: IDC, Merrill Lynch Internet research

Internet usage will be driven by the increasing number of products and services available to end customers. The availability of high-speed wireline and wireless Internet services will stimulate further growth. Fixed broadband services are increasingly available in many countries and growth is forecast over the next five years. Content is also expected to develop as broadband becomes widely available. In addition, the Internet is expected to evolve from wireline to wireless, just as voice telephony evolved from desk phones to mobile phones. This will drive demand for high-speed portable Internet services and terminal devices (not just mobile phones, but also personal digital assistants, laptop computers, mini-PC's, pagers, and other portable devices) and is expected to surpass PC-based Internet connectivity over the next 3 to 4 years.

Network operators and service providers are keen to enhance and diversify their revenue streams. Wireless internet services represent a significant opportunity, and anything that can be done to stimulate competition and growth in this market is going to result in an expansion of the business in contrast to the now-maturing and commoditized voice business.

Australia currently has over 4.3 million internet subscribers. Over 50% of Australians use the internet regularly both at work and at home. Increasingly Australians are migrating to broadband solutions as the technology becomes more widespread and the prices fall. In addition to this, there are some 2 million laptop users in the Australian market.

2.3 WIRELESS INTERNET

The arrival of the Internet into the wireless space is expected to emerge as one of the most significant product cycles of the coming years. The growth in wireless Internet access is expected to lead to an ascending cycle of applications driving bandwidth and bandwidth driving applications.

There will be multiple wireless access schemes and services available as the wireless data industry grows and develops. Each wireless technology will deliver their own service variations and their own range of applications. These differences will in turn attract different market segments.

We have included a more detailed description of the various wireless technologies in section [3.0] below.

The expectation is that, in the short term, wireless usage will be driven by demand for voice services but that the convergence of mobile networks with the Internet and the introduction of wireless Internet services will have a significant impact on the growth of the wireless internet business.

Important drivers underpinning the future growth in mobile data services are:

- The proliferation of Internet usage and increased average computer literacy.
- Convenience and ease of use of wireless access.
- Growing demand for speed in accessing the internet and other data services.
- Growing demand by enterprises for remote access to corporate and market data.
- Wireless voice connectivity driving demand for wireless data connectivity.

- Improved wireless and broadband technologies.
- Fixed broadband offerings driving demand for broadband wireless services.
- Improving wireless devices that can support greater use of data applications and solutions.
- Increased adoption of handheld and laptop devices.
- Data connectivity for individuals in the developed world becoming as necessary as voice connectivity.
- Mobile wireless services not only for consumers but for public service, governmental and defence applications.

2.4 THE HYPE

As with all new phenomenon, there is also a lot of hype around wireless broadband services and their potential. From the customers' perspective, there is significant and confusing debate in the industry about broadband generally and about data-rates and bandwidths in particular.

For the consumer, broadband is a meaningless term and the confusing debate is an unfortunate distraction. What is important is the development of communications services that are accessible are 'always-on', are highly affordable, have a wide range, give customers mobility and freedom to move. These are the factors which allow customers to make the best use of their time and money whatever their communication, information, entertainment and business needs.

In this context therefore it is the underlying drivers that are important to focus on because they are the aspects which will drive the deployment of services which will in turn deliver the attributes mentioned above and underpin the ultimate utility needed for widespread deployment of mobile broadband services. These underlying drivers include affordability (ie derived from underlying network economics), availability (ie network reach and capability), security, and the ability to offer portability and mobility.

In Summary:

Wireless broadband and wireless data services, although still in their relative infancy, have the same potential as mobile voice services to change how we communicate and to become an important new generator of economic growth.

This potential will be driven by the continuing growth in the Internet, the desire for mobility and speed, and, improvements in wireless technologies and devices. These drivers are just as relevant in the Australian context as in other markets.

Comparatively speaking, Australia is well served in relation to these trends. Spectrum auctions have delivered some sensible commercial outcomes. Service offerings are being developed and some are commercially available. Investments are in place, or planned for. Early-adopters are already experiencing the freedom of data mobility and the mindset is starting to change – accessing the internet or corporate data is no longer something you have to do from home or work or from a specified room.

Equally, given the tendency of Australians to adopt new technologies and ideas early in their lifecycle, wireless broadband ventures are emerging across the complete spectrum of technologies and beginning to offer services.

Australia therefore has the opportunity to be a leader in the development of wireless broadband solutions, services and applications.

3. WIRELESS BROADBAND AND DATA TECHNOLOGIES

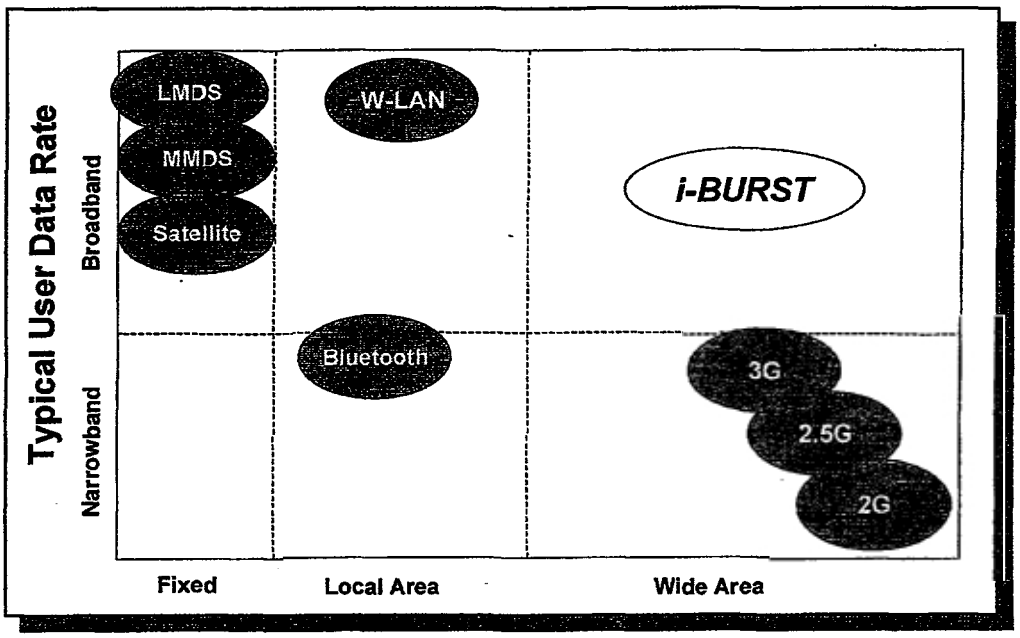
The value of the wireless broadband or data industry is estimated to be in the billions. It is one of the most dynamic areas of industry development in the global communications industry at this point in time. It is characterized by established equipment suppliers (such as Ericsson, Alcatel, Lucent, Kyocera), telecommunications operators (such as Vodafone and Telstra), pure technology companies (such as ArrayComm), and new players (such as Unwired).

New ideas, technologies and services are emerging all the time. The various market participants are approaching the opportunity from different angles. Some examples:

- ArrayComm is leveraging its investments in smart-antenna technologies and cost effective digital processing to provide cost effective, high quality, and wide-area wireless broadband services. It is currently commercializing the technology globally;
- European companies, supported by their governments, have developed the soon to be implemented wideband third-generation (3G) cellular technologies. Despite economic challenges with the development of these systems and operating licenses in Europe, these systems support the delivery of data, and a suite of supported applications, at speeds up to ten times that of traditional dialup connections;
- Asian companies, notably NTT DoCoMo have already deployed extensive mobile data services and have pioneered the standardisation and implementation of 3G W-CDMA based services;
- Qualcomm, a leading American technology developer, has matched European developments with US-centric cdmaOne systems, providing high-speed data to the cellular handset at even fast speeds.

The generic and evolving wireless access technologies can be plotted in a simple diagram reflecting data speeds and area covered.

Wireless Data Technologies



These various technology each offers their own capabilities in terms of affordability, utility and mobility. Outlined below is a brief description of each technology.

Wide Area Narrowband – 1G

- Mobitex: A narrowband, always on, wireless data solution developed by Ericsson using packet switching to deliver an 8 kbps data transfer rate. Spectrum in the 400 to 900 MHz range.
- DataTAC: Wireless data solution developed by Motorola with data transfer rates of up to 19.2 kbps.
- CDPD or Cellular Digital Packet Data: A data transmission technology developed for use on mobile phone frequencies using unused mobile channels (800 to 900 MHz range) to transmit data in packets. Data transfer rates of up to 19.2 kbps operating over unutilised analog voice channels.
- ReFlex: Two-way Paging service offering data speeds of up to 25 kbps for short messages (uplink is 9.6 Kbps, downlink is up to 25 Kbps. Originated by Motorola and is part of the FLEX protocol that includes FLEX (traditional paging) and inFLEXion (Voice paging).

Wide Area Narrowband (2G)

- GSM: Data rates of up to 9.6 kbps on a GSM channel. This is a circuit-switched channel that expends voice capacity even if the user is idle. An appropriate analog in the wired world would be dial-up modems. These systems are predominantly used for voice services, as well as short messaging.

Wide Area Narrowband (2.5 G)

- GPRS or General Packet Radio Service: A new technology designed to deliver high-speed data services over existing GSM networks with data transfer rates of up to 171 kbps. In practice speeds of between 20 and 50 kbps are expected for the first generation of devices.
- EDGE – Enhanced Data Rates for Global (or GSM) Evolution: A standard that builds upon existing GSM and TDMA infrastructure to provide up to 384 kbps peak rate per user. In practice speeds of approximately 32-64 kbps are expected. Primary alterations in air protocol to accommodate higher order modulation. EDGE will require new devices and significant upgrades to the network infrastructure.

Wide Area Wideband (3G Technologies)

- cdma2000: 3G technology that is being supplied as an upgrade to Qualcomm's cdmaOne, IS95 systems. The service claims up to 2.4 Mbps peak rate using the HDR or 1xEV variant that overlays a data-centric network over that of the existing voice network. Actual peak data rates are expected to be comparable to other 3G systems (i.e. 144 kbps for each customers).
- W-CDMA: This is the ITU's version of CDMA that is the upgrade path from GSM aimed at the delivery of true broadband multimedia services. W-CDMA is a service that supplies up to 144 kbps under mobile scenarios. Initial deployments in Japan and the UK will provide no more than 64 kbps.

Local Area Broadband

- Bluetooth: A new standard for short-range wireless communication developed by several multinational companies with current data rates of approximately 722 kbps. The Bluetooth technology is what is known as a personal area network, there are three classes of operation that have ranges of 10, 100, and 1000 cm. Uses unlicensed spectrum at 2.4GHz.
- Wireless LANs: 802.11b. An IEEE standard for short-range wireless communication with theoretical data transfer rates of approximately 11 Mbps (in practice 2-3 Mbps) in local area networks using unlicensed spectrum at 2.4GHz. W-LANs range from 30 to 300 meters, depending on the local environment. Uses unlicensed spectrum at 2.4 GHz. As with any other wireless systems, experienced end-user data rates depend on the nature of the backhaul network. In the case of public access W-LANs, however, backhaul economics for their small cells are particularly challenging. The systems are typically deployed with DSL or T1/E1 backhaul, limiting the cell throughput to a range of 0.3 – 2.0 Mbps. Wireless LANs are ideal for enterprise, residential and some campus locations but cannot scale to provide the wide area coverage

and quality expected from conventional wireless systems. Their application is therefore often referred to as 'hot spot' coverage.

- MMDS: A fixed wireless data service commonly referred to as "wireless cable" in that it provides coverage to residential areas without the need to run cable modem. The service promises rates in the 1Mbps range with range in the order of several kilometers. However, the service requires that the user terminals be fixed, eliminating the portability support both in terms of handoff and in the network side. Frequency of operation is in the 2.5-2.7 GHz range in the US and similar systems have been deployed in a number of countries at the 3.4 GHz.

- Satellite: A fixed wireless data service that uses 11GHz TDMA technology. The return link limits upload speeds to 56 kbps. Download data rates are about 400kbps to the user. While coverage is typically large, systems only support fixed access due to the need for dish antennas and bulky receiver equipment. Such encumbrances are not likely to be eliminated in the future due to technology and architectural constraints.

Wide Area Broadband – *i-BURST*

- Wide area broadband wireless systems are capable of providing continuously connected or "always-on" high speed data services, usually at speeds more than 50 times faster than dialup access rates which support standard applications such as email, web-surfing, remote access, banking and streaming video. Customers may be located at home, in the office, or on the move.
- *i-BURST* complements (rather than competes with) both the 2.5 and 3G systems as well as the wireless LAN systems which are part of the broadband wireless landscape.

In Summary:

No single wireless broadband technology will provide the total wireless broadband solution. This is no different from the situation when we evolved to wireless voice services - customers currently use a range of devices and services to get create a complete wireless voice solution to meet their needs.

Given the number of business development initiatives underway in the Australian market, Australians will have significant choice in constructing their wireless broadband solutions.

In reality it will be a combination of wireless solutions and emerging applications that will ultimately deliver consumers the full potential of wireless broadband and mobility.

Despite the confusion, we trust that the marketplace, rather than product-specific legislation or individual companies, will determine the most effective solutions.

4. THE CHALLENGES FACING WIRELESS BROADBAND

Given the relatively early stage of development in wireless data and wireless internet industry, there are a number of generic issues which are impacting development.

These include:

- Capacity (the number of subscribers that a network can serve at a certain grade of service);
- Coverage (the ability to deliver uninterrupted service uniformly throughout a geographic area);
- Transmission quality (voice and data fidelity at high data rates);
- Reliability and security (the ability of a network to operate continuously over an extended period of time);
- Cost (the ability to deliver capacity, coverage and transmission quality at competitive rates);
- Spectrum availability (essential to deliver broadband wireless services) and spectral efficiency (including the ability of unlicensed spectrum to support commercial grades of service);
- Availability and ease of integration of customer devices.

The priority of these needs may vary over time. When initiating a service, for example, the highest priorities may be coverage and the speed of installation. Later, transmission quality gains importance as a competitive need and, eventually, as a system reaches its limits, capacity becomes critical. Reliability and cost are always important. Equally, the availability of a range of compelling and competitively priced customer devices which allow easy integration, will always be a priority.

4.1 Wireless Broadband - Emerging Solutions

There are a number of solutions emerging as the requirements for more capacity, lower costs per customer and higher quality transmission for mobile voice and data communications lead the wireless industry to seek and adopt new technologies. The key message here is that despite the inevitable limitations of emerging technologies, market forces are such that solutions are soon found and deployed.

The principal examples in recent years are as follows:

Digital Transmission Techniques

Wireless communication systems originally employed analog transmission formats. However, the demand for additional capacity in the face of limited spectrum encouraged the transition to more efficient digital transmission technologies. The resulting gains in capacity derived primarily from the speech compression techniques used in digital transmission systems, rather than from a fundamental improvement in spectral efficiency. In voice systems, capacity can be increased through increased compression (at the cost of some degradation of voice quality).

Multiple Access Techniques

The two principal multiple access techniques have emerged - Time Division Multiple Access ("TDMA" - which is used in GSM, PHS and several other digital standards) and Code Division Multiple Access ("CDMA"). These technologies solved some of the wireless challenges. For example, TDMA allows multiple users to share a given frequency resource by assigning users to timeslots in a round-robin fashion. CDMA allows multiple users to share a given frequency resource by encoding each the users' signals with individual codes.

Cell Splitting and Sectorised Antenna Systems

To increase capacity and provide service in regions of high subscriber-density, operators often split large cells into smaller ones or sectorise them (generally by dividing 360 degree cells into three 120 degree sectors) to allow the re-use of assigned frequencies more often within a large region.

New Wireless Air-interface Standards

Partly in response to the growing demand for data transmission, new so-called 2.5G and 3G wireless air-interface standards such as GPRS, EDGE and W-CDMA are emerging. These new standards provide compatibility with existing digital standards such as GSM and CDMA while enhancing the capabilities for data services.

In general, the technical improvements associated with these new standards are:

(a) packet-switching capability for data transmissions (vs. circuit-switching used historically for voice transmissions) which is more efficient for data transmission and allows an always-on connection; and

(b) the ability to temporarily combine communication channels as necessary to provide higher data-rates on demand to customers that will pay for them and (c) more efficient modulation schemes.

Improved Hardware Technologies

Manufacturers of the components and subsystems of wireless networks are continuously improving the technologies that affect the price and performance of their products. For example:

- Processing power used in base stations and handsets is declining in price;
- Base station amplifiers with higher linearity are permitting more channels to be created from a band of RF spectrum; and
- New wideband transceivers are allowing the fixed cost of radio elements to be shared by more channels.

As a result, system manufacturers are able to deliver base stations and subscriber handsets with improving performance and declining costs.

While further investments in digital transmission, cell splitting and hardware technologies will continue to pay dividends, they will face diminishing returns. Given the limited availability of spectrum, conventional systems will be unable to deliver the capacity, coverage, quality, reliability and cost-effectiveness that operators will require. Importantly, new high-utilisation and low-revenue-per-subscriber services will be difficult to deploy unless RF interference is decreased, spectrum is used more efficiently and network costs are reduced.

The techniques mentioned above are well understood and, today, fully exploited. Significant further advances in spectral efficiency will also come from advanced spatial processing techniques which will drive greater capacities from traditional high speed wireless systems.

Summary:

As with any developing technology or industry, there are a number of issues that need to be solved.

Nonetheless, there is, and will continue to be, a proliferation of emerging solutions created by an active and innovative industry whose participants are all keen to secure a leading-edge in the market.

Despite this, there will be some false starts as customers get to understand the limitations of various offerings and vote with their feet to choose other alternatives.

What is important, is that policy makers see these false starts as part of the natural development of a new industry rather than limitations in the potential of broadband wireless itself or areas to be further regulated or monitored.

5. SPECIFIC ISSUES RAISED BY THE HOUSE OF REPRESENTATIVES STANDING COMMITTEE

5.1 CURRENT ROLLOUT OF WIRELESS BROADBAND TECHNOLOGIES IN AUSTRALIA – CKW WIRELESS PLANS

5.1.1 ArrayComm Inc

ArrayComm was incorporated in California, USA in April 1992 and is a leader in smart antenna technology. ArrayComm develops and licenses software technology to enhance the spectral efficiency and cost effectiveness of wireless voice and data systems.

ArrayComm's core technology, *IntelliCell*®, is the wireless industry's most advanced form of, commercially deployed, smart antenna technology. *IntelliCell* is primarily software that is integrated into wireless equipment, such as base stations.

IntelliCell has been used by ArrayComm to develop three product groups:

- The *i-BURST* wireless broadband system
- Smart antenna technology for cellular base stations
- Smart antenna technology for wireless terminals

Using *IntelliCell* technology, ArrayComm has developed *i-BURST*, which is a complete end-to-end data only wireless system that addresses the portable broadband Internet market and has been designed to leverage the capabilities of the *IntelliCell* technology.

ArrayComm's first licensing partner, Kyocera Corporation ("Kyocera") has deployed more than 100,000 PHS base stations with *IntelliCell* software, primarily in Japan and China and has produced prototype *i-BURST* bases stations as a part of the process of ramping up commercial base station production. Marconi Corporation ("Marconi") has licensed the *IntelliCell* technology for W-CDMA base stations.

Another end-to-end system developed by ArrayComm and manufactured by Kyocera, a wireless local loop (fixed wireless) product was developed. Kyocera recently won an order of over 200,000 subscriber lines in Thailand with this product. This product has at its core the adaptive antenna technology developed by ArrayComm which in turn led to compelling economics and performance.

ArrayComm is extending its *IntelliCell* technology to wireless terminals such as handsets and is currently in discussions with a number of handset manufacturers with a view to embedding the *IntelliCell* product into their handsets.

5.1.2 *i-BURST*

ArrayComm has developed an open-standard wireless data system called *i-BURST*. It addresses the portable broadband Internet market. *i-BURST* is a complete solution, including the air-interface. It supports up to 40 mbps per cell capacity using 10 MHz of spectrum (or 20 mbps per cell using 5 MHz of spectrum) and per-customer data rates in excess of 1 mbps, when in fully loaded, real world, deployments.

It is a 'data only' network. It is designed for packet switching and transparently conveys end-users' Internet Protocol ("IP") traffic. The overall network architecture is a direct extension of that employed in today's wired broadband aggregation and access architectures, including DSL, cable and dialup. The identical provisioning and billing tools, along with much of the wired network infrastructure used by operators to support their wired customers can also be used to support end-customers. It is designed to extend existing, wired, broadband distribution architectures and IP services, reducing barriers to entry by carriers and ISPs alike.

One important element of the design is its time division duplex ("TDD") duplexing technique. The advantages are as follows:

- TDD extracts maximum benefit from the smart antennas because of the highly correlated uplink and downlink propagation environments. In TDD systems, uplink and downlink transmissions occur in the same frequency block separated in time. This is in contrast to frequency-division duplex ("FDD") systems in which the uplink and downlink transmissions occur on widely separated frequency blocks.

- TDD has the ability to more efficiently support asymmetrical data transmission than FDD systems. In a TDD system, the ratio of uplink-to-downlink traffic resources is determined by the relative amount of time devoted to uplink versus

downlink transmissions. In an FDD system, the ratio of uplink-to-downlink resources is effectively fixed by the relative sizes of the (typically equal-sized) uplink and downlink blocks.

- TDD spectrum is typically far less expensive than FDD spectrum.

The radio access portion of a viable mass-market wireless broadband system requires three complementary technical elements, spectral efficiency, packet access mechanism and high peak data rates.

- **Spectral Efficiency.** This is a measure of how well a wireless network utilises radio spectrum. It affects the amount of radio spectrum and the number of base stations required to deliver a given amount of traffic. It is consequently one of the primary determinants of system economics for broadband mass-market applications. Spectral efficiency is measured in units of bits/second/Hertz/cell. *i-BURST* achieves a spectral efficiency of 4.0 bits/second/Hz/cell (GSM, CDMA, 3G are generally accepted to be no more than 0.2 bits/second/Hz/cell). This translates directly into the system's ability to support many customers per cell at high data rate levels and mass market prices.

- **Packet Access Mechanism.** Packet access mechanism gives flexibility in instantaneously dividing and sharing bandwidth across many customers. As opposed to circuit switched voice traffic, data traffic is bursty; hence significant cost advantage is garnered by allocating radio resources instantaneously through the use of packets. Packet access mechanism is a requirement from a system economic standpoint and provides a 10x increase in supportable customers over a circuit-switched mechanism. Together with the gains in spectral efficiency, this means that *i-BURST* offers a factor of 400x increase in capacity over current circuit switched mobile technology, 40x due to *IntelliCell* and 10x due to packet switching.

- **High Peak Data Rates.** These provide end-customers with high-speed access to network resources. As broadband access becomes the norm over the next several years, high peak data rates will be required for wireless applications. Next generation mobile technologies such as GPRS, EDGE and 3G are transitioning existing infrastructure to address the requirement for high peak rates. However, high peak data rates do not necessarily imply high network capacity. Because of the lack of spectral efficiency, customers on those networks are unlikely to experience high peak data rates. *i-BURST* avoids this issue by virtue of its high spectral efficiency and base station throughput.

5.1.3 CKW Wireless

CKW Wireless is a wholly owned subsidiary of ArrayComm Inc.

CKW is an Australian company incorporated in February 2001 to deploy the *i-BURST* broadband wireless network and services in Australia. CKW will use the unpaired spectrum it purchased in the recent auction to provide this service and the current intention is to roll-out the network in the eight State and Territory capital cities during the period from 2002 to 2005. When complete, the network will cover approximately 75% of the Australian population.

Since incorporation, CKW has purchased spectrum in the 3G auction, developed the business and financial model in conjunction with its advisors, made initial appointments to its board of directors and management team and is in the process of soliciting major contract proposals relating to such matters as system integration, site acquisitions, backhaul provisioning, ISP functionality, and software billing.

CKW will continue to develop its operations with relevant strategic investors and will undertake a capital increase to raise the required finance. It is expected that the strategic investor will also be a major participant in the capital increase. Any additional finance required to complete the capital increase will be raised from other investors.

5.1.4 Proposed Network Roll-Out

The *i-BURST* network will be built and deployed over a three-and-a-half year time period beginning in the second half of 2002. Much of the site acquisition, backhaul provisioning and system integration work will commence in the first year.

The network pilot phase will involve the roll-out and trials of 10 base stations in selected CBD, urban and suburban sites across Sydney. This is currently scheduled to be completed by the third quarter of 2002 and will be followed by the roll-out of additional base stations in Sydney to fully cover the metropolitan area. Sydney CBD deployment is planned to commence in the third quarter of 2002. This will be followed by roll-out in the urban and suburban areas with completion of the Sydney network in the first quarter of 2003 and follow-on deployment in other capital cities. It is planned, that the network will be deployed in all capital cities by the end of 2004.

After completion of the network in Sydney, CKW proposes to roll-out the network in Melbourne. This is scheduled to commence in the second quarter of 2003 with a similar implementation plan to Sydney starting in the CBD before progressing to the urban and suburban areas. The final phase of network roll-out will be in the six other cities covered by the spectrum by which time the Sydney and Melbourne *i-BURST* business will have built a substantial subscriber base. This will also be undertaken on a phased basis with the Canberra and Brisbane network roll-out proposed to commence from the fourth quarter of 2003, Adelaide and Perth starting from the second quarter 2004 and Darwin and Hobart scheduled to start from the fourth quarter of 2004.

In Summary:

ArrayComm Inc and CKW Wireless will be rolling out a wide area, high speed wireless broadband network in all capital cities consistent with its spectrum licence during the period 2002 to 2005.

5.2 *INTER-RELATIONSHIPS BETWEEN THE VARIOUS WIRELINE AND WIRELESS BROADBAND TECHNOLOGIES*

Broadband wireless is able to successfully deliver high-speed data and voice services to many customers. Those systems which also offer the added bonus of cost-effective mobility allow their customers to use the service not only within the fixed home or office environment, but also as they move, in the same way that cellular systems can deliver cost-effective telephony services to fixed and moving customers. The ability to deliver always-on high-speed data connectivity can deliver some genuine benefits, not just for the oft quoted 'road warriors', but also for more commonplace customers.

- For example, broadband data services offering mobility allows school and university students to access applications and services which can be cost-effectively delivered via Internet Service Providers both within the school environment as well as when the student is at home.

- For parents trying to work from home while bringing up children, such systems with their ubiquitous coverage and high speed performance, can provide cost-effective connectivity both for the home office, as well as allowing fast email transfers while waiting at school for the children to come out to the car, or while in transit on the train to a meeting.

Clearly, the provision of such wide area services, when it is made cost effective, is ideal for customers who can take advantage of the availability of the system's service delivery while away from the office or the home. Where cellular freed users from the need to make or receive telephone calls from a few key locations, broadband wireless data can free up users from the need to plug into those same key locations.

5.2.1 The Complementary Nature of Wireless and Wired Technologies

Cost-effectiveness is the key as it will ultimately be affordability that is the key to adoption. For customers who are always using data services from fixed locations, such broadband wireless systems can be complemented effectively by moderate cost wired systems including DSL and cable. These fixed wire solutions can offer greater data capacities than wireless systems.

However, while the availability of such systems will continue to gradually increase, there will always be a significant number of fixed customers who will never be within range of such systems (Exhibit 1).

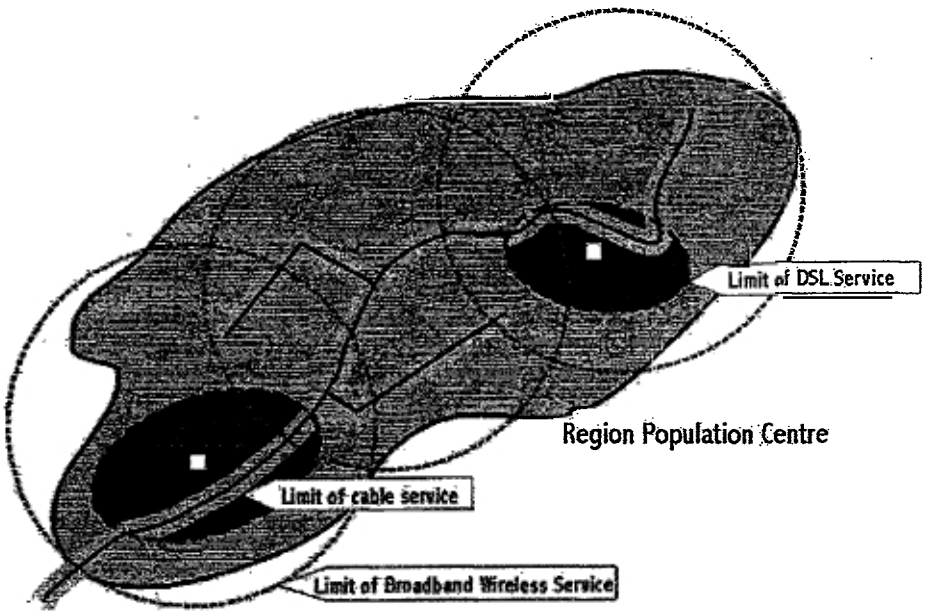


Exhibit 1 : Complimentary Coverage of Different Technologies

Note: Coverage in this figure is illustrative only

In addition, high speed wired capacity from DSL or cable will take some time to be rolled out, even within capital cities in Australia. Once implemented, systems such as cable, can quickly become capacity limited in some areas, preventing the addition of new users.

Wireless can therefore form be a complementary technology to these fixed wired systems. Providing faster deployment, they can offer high capacity and high speeds well prior to the availability of wired systems in many cases. Also, since DSL and cable can never cost-effectively cover every part of an area, there will often be many locations where wireless is the optimal solution. Cost effective combinations of all of these technologies can offer a bright future to the projected high broadband demands of Australians, both within cities as well as within regional and rural locations.

There is one further issue that is worth mentioning in relation to the future relationship between fixed and wireless broadband services. Just as more and more people are now using cellular phones as their only voice service (particularly in the youth and young adults market), so too is wireless broadband likely to evolve to a point where some customers will use mobile wireless broadband offerings as their only data service. In other words, they may well use the same wireless broadband service whether they are at home or 'out and about' and not use a fixed broadband solution at all.

5.2.2 The Complementary Nature of Wireless Technologies

3G cellular systems serve customers with voice as well as data at moderate speeds. By delivering a combination of voice and data across common channels, each service is compromised, to some extent by the other. Since voice calls must be carried with few delays, it often requires preferential access to the network. Delay however is of little concern for many data applications. This allows data to make very efficient use of those same channels. However, each time that data must make way for the time-critical voice calls, efficiency rapidly falls, and overall network capacity and efficiency becomes reduced.

However, customers are becoming increasingly interested in the ability to own a cellular phone that also supports some data services. A single portable device for phone calls as well as for monitoring stock market rates and, periodically, listening to internet radio stations carried via streaming audio, makes sense to most people. When these same customers require wireless broadband services for a laptop or PDA, however, the 3G phone lacks adequate capacity.

For these situations, the use of a specialised wireless broadband service is ideal. The ability to use a specific service to support laptops and computers, and all the standard applications that run on these devices, also makes sense to most customers. Within this context, customers will also have the option of accessing wireless broadband services that are 'local area' in their reach or wireless broadband services that are 'wide area'.

At the same time, neither device is ideal for delivering multiple video channels of broadcast quality, for example, to these same customers. Yet another device, most likely in the form of a low cost set top box, will provide such services.

Through the use of a group of wireless devices – the third-generation cell phone, the wireless broadband modem in the laptop or PDA, and the set top box – customers will be able to achieve wireless connections to, and services from, a multiplicity of complementary technologies and be able to have true mobility. A good analogy here is to consider that, with voice services, customers use a combination of their traditional fixed phone, a cordless phone (with limited range) and a cellar phone (with wide area range). Similar alternatives and options are emerging in the broadband data context.

Therefore, just as in the mobile voice communications environment there are many devices and options, so too will there be a range of services and devices in the mobile data communications environment. What is most important is that the market be free to develop and deploy these options and choices and that customers be given the liberty of choosing which package of services best meets their own needs.

In Summary:

In practice, most customers will adopt a complementary set of wireless and wireline broadband services to meet all their broadband and data needs, particularly in the early years of wireless while some of the issues are still being resolved. The continued deployment of both fixed and wireless solutions will be needed going forward. However, as the need for mobility increases, wireless services may well start to become the only solution for some customers.

5.3 *BENEFITS AND LIMITATIONS OF WIRELESS BROADBAND COMPARED WITH FIXED PLATFORMS*

Key Benefits

- High speed services within the network's coverage
- Many systems provide services well beyond short range last-mile systems, and beyond the range limitations of DSL and cable
- Support standard internet email and web browser systems without modification
- Security - encryption and rigorous authentication processes are features of more comprehensive high capacity wireless broadband systems
- Portable - broadband services can be maintained while moving, or in a variety of customer locations within the network's coverage area
- Always connected - no tedious dial-in procedures
- Cost-effective

Typical Limitations

- Wireless coverage can be limited inside buildings and coverage holes can exist in some parts of the network
- All wireless systems are ultimately range limited
- Cost can be higher than for DSL or cable systems under certain market conditions
- Capacity can be limited by system or spectrum constraints

5.4 *POTENTIAL FOR WIRELESS BROADBAND TECHNOLOGIES TO PROVIDE A 'LAST MILE' SOLUTION, PARTICULARLY IN RURAL AND REGIONAL AREAS*

Delivering telecommunications services into remote rural areas and smaller regional centres with modest populations inevitably costs more per customer than equivalent systems within cities. High startup costs, expensive transmission and, in some cases, inefficiencies resulting from unfilled capacity all lead to these higher per-customer costs.

Most technologies have relatively high startup costs. For wireless technologies, these costs include the establishment of radio base station sites, including towers, and antennas. A factor also critical to the operation of these sites, often not readily observable, is the high cost of transmission - The system which connects the radio base station site and its served customers back to the core of the web.

Lower densities of population often means that system capacity may not be fully utilised. This also leads to the system establishment and operational costs being higher than similar city systems.

Other critical issues in these remote locations include power and site access, particularly when sites are located in difficult terrain or in harsh environments.

Most broadband wireless technologies have been developed for use on relatively high frequency bands. While offering the benefit of greater capacity, the coverage range of these systems is significantly reduced due to the properties of radio waves at these frequencies. This limited range results in the need to deploy a greater number of sites in rural areas, making the economics even more challenging.

One alternative already widely deployed in developing nations is based on the European DECT standard. Across Asia, this has allowed the deployment of cost-effective systems covering up to 55,000 rural customers[1] with a combination of traditional telephony services and medium speed (70 kbps) Internet connectivity. The very low cost of these systems has allowed greater numbers of sites to be deployed. However, such systems fall well short of delivering the necessary high 1 Mbps (or greater) speeds required to support broadband applications.

To overcome such problems, technologies must utilise techniques that deliver greater capacities from traditional high-speed wireless systems. One example is the use of spatial antenna processing. This relies on the use of elegant cost-effective digital processing to deliver services to many users simultaneously on the same channel or frequency. Already well established in the demanding fields of fixed and cellular digital telephony, such methods also have the advantage that much greater ranges can be achieved even with the more demanding higher frequencies available to broadband wireless systems. Rather than a limit of a few hundred metres, which limits the availability of such systems to minimal numbers in most rural applications, such systems can operate successfully over ranges of 20 to 30 km.

These solutions, delivering high speed broadband data to many customers sharing a common infrastructure, can allow rural and remote systems to be operated more cost effectively and covering far greater numbers with the lower customer densities such as those traditionally encountered in regional and rural areas of Australia. Wireless technologies that are based on these characteristics offer an ideal opportunity for providing relatively low cost wireless broadband services in regional and some rural areas that also offer customers mobility.

In Summary:

Wireless technologies that have low cost, wide area coverage capabilities, offer significant potential for providing 'last mile' solutions both in the cities and the regions. Wireless technologies that combine portability and mobility with these attributes will deliver an added value for customers in those areas.

[1] 'Global Wireless' magazine, Nov-Dec 2000

5.5 POTENTIAL FOR WIRELESS BROADBAND TO ENHANCE APPLICATIONS AND CONTENT

The advent of affordable, easy to use and widely available wireless broadband services combined with the continued rapid penetration of fixed broadband services, will have a significant impact on development of the industry and on the growth of new applications and services.

However, just as it would have been impossible to predict the scale and scope of industry and economic change resulting from the advent of mobile voice services, it is equally difficult to do so in relation to mobile wireless broadband and data services.

Nonetheless, as mentioned above, the drivers behind the growth in wireless broadband, and therefore the development of content and applications, are powerful and unstoppable:

- proliferation of Internet usage;
- increased average computer literacy;
- convenience of wireless access;
- growing demand for speed;
- growing demand by enterprises for remote access to data and applications;
- wireless voice connectivity driving demand for wireless data connectivity as the two services converge;
- improving and cheaper wireless and broadband technologies;
- improving and cheaper wireless devices that can support greater use of data applications and solutions;
- increased adoption of handheld and laptop devices;
- data connectivity for individuals in the developed world becoming as necessary as voice connectivity; and
- emergence of a more mature industry which focuses on customer needs and service quality.

Mass-market mobile broadband wireless services will create new markets for existing applications and products, as well as a need for new content and applications. The availability of wireless services with IP transparency and high data rates mean that a separate, "thinned-down" content base will not be required for wireless customers and providers will not need to revise or rewrite their applications or content. These are the types of barriers that need to break down in order to see a proliferation of new applications and services. The immediate benefit of open access wireless architectures which extend existing wired broadband distribution architectures and IP services however, is that customers will get whatever content or applications they can access on fixed broadband services, on wireless broadband services.

Wireless broadband services that offer mobility and portability will see the development of even more applications. Imagine the following as examples:

- the wireless camera that uploads pictures to a favorite digital image processing service as soon as they are taken, from wherever they are taken;
- the remote diagnostic system that lets emergency service personnel immediately transmit vital information to medical personnel from wherever they are;
- the security monitoring system that allows parents to monitor their children at the local day care facility;
- the wireless MP3 player that allows a teen to purchase and download the latest hit song while they are 'out and about'.

As a further example, the table below illustrates some of the wide range of applications that *i-BURST* will support:

APPLICATION	DESCRIPTION
Business Email	Corporate or company server-based email with online and offline client access
Consumer Email	POP3 and IMAP4 email – synchronization with Exchange Server and Domino Server
Synchronization	Synchronization of address book, calendar, tasks, notes and services; business database synchronization, including broadcast sync across entire population of users
VPN	Secure access to corporate networks
Intranet	Access to internal databases, files and information; requires secure network access; HTML interface
Chat/Instant Messaging	Text, audio and video messaging and chat
Web Browsing	Browser client and Internet access
Location Based Info Services	Targeted information based upon location
File Upload and Download	MP3/Short Video/Graphic download; pay per download or monthly subscription
Broadcast/Streaming Audio	Live or pre-recorded audio streamed to audio-enabled players; audio entertainment, news and sports
Broadcast/Streaming Video	Live or pre-recorded audio streamed to video-enabled players
Networked/Internet Gaming	Real-time interactive gaming; software downloads
Remote Video Monitoring	Home and business security; specialized closed-circuit TV markets – medical, child care, etc.
Database	Access to both custom database applications and packaged databases through ODBC
Sales Force Automation	Contact management, sales pipeline and forecast, contract/deal terms, sales activities tracking, etc.
Video Conferencing/ Broadcast Chat	IP-based video conferencing w/computer and specialized mobile devices; also, consumer video conferencing or "chat"

In Summary:

It is not possible to predict today the full gamut of broadband applications that will evolve over the next decade as a result of having affordable, accessible, widely available, always-on mobile wireless broadband capability.

However, what we do know is that most of what we do today on fixed broadband services can be supported by some wireless technologies. Equally, many new applications are already being developed to meet the specific capabilities of some wireless technologies such as 3G.

5.6 COMMENTS ON THE AUSTRALIAN WIRELESS BROADBAND REGULATORY ENVIRONMENT AND THE ROLE OF GOVERNMENT

Australia is well served by its regulatory environment as it relates to the development and evolution of wireless broadband services.

Australia's government agencies are well aware of the specific wireless challenges and, we would suggest, are at the forefront of thinking on these issues globally. The recent draft report of the Productivity Commission and the review of Australia's current radio communications legislation undertaken by the Australian Communications Authority have identified the key issues and proposed solutions. ArrayComm and CKW Wireless support the direction being taken by these reviews and the majority of the recommendations in them.

Nonetheless, there are a number of issues them particularly relate to wireless broadband services, which policy makers need to be aware:

- Spectrum allocation and efficiency;
- Spectrum cost and tenure to ensure certainty of investment;
- Potential for anti-competitive outcomes; and
- The importance of technology neutrality.

Attachment 1 is a testimony to the US Senate by Marty Cooper who is the Chairman and CEO of ArrayComm and a leader in the field of mobile and wireless communications.

He is a leading advocate of the opportunity, and responsibility, of spectrum ownership and efficiency. He is also acutely aware of the critical role wireless developments will play in economic development in the future.

In the context of the challenges outlined above, Marty's testimony to the US Senate outlines the powerful yet appropriate role that government can take in encouraging the development of the wireless industry. Here is a summary:

- *"Empower the [regulators] to re-examine all spectrum allocations, in light of what can be done with new radio technologies and the Internet;*
- *Put the public first.* The wireless industry has been focused on technology (illustrated by the myriad of acronyms such as CDMA, 3G, WAP, etc.), and is driven by delivering voice services. We need to challenge the industry to find the right solutions that will genuinely serve the masses with the Internet'
- *Hold spectrum users accountable.* Many companies will indeed need new spectrum, but we must first ensure that we are all using the spectrum we have to its highest spectral efficiency;
- *Foster new radio technologies with inherently higher spectral efficiency.* New radio technologies have been developed in the past 10 years which are drastically more spectrally efficient than the technologies used in cellular systems today, which are all evolutions of the standards developed 30 years ago;
- *Promote "real" competition at home and abroad.* Without real competition we will not have much in the way of creative new services;
- *Avoid the trap of the "universal solution."* Universal gadgets that purport to do all things for all people do not do any of them well. There is no Holy Grail of solutions. People have different needs. They will need different devices and services to satisfy those needs.

In Summary

The role of government is to ensure the broader parameters are in place to facilitate the development of broadband wireless services.

These broader parameters include creating the right investment climate, promoting a competitive regulatory framework, ensuring an efficient and effective spectrum management and allocation, supporting technology-neutrality, protecting property rights, and, supporting the development of global standards.

With these parameters in place, the market is best placed to decide which wireless broadband solutions are sustained and which are not.

6. SUMMARY

Given the importance of these issues to Australia's future productivity and economic development, the House of Representatives enquiry is both timely and well positioned.

It will ensure that the Australian Parliament, and Government, has a thorough understanding of the potential of wireless broadband services and of the status of the industry and its regulatory framework.

It will also allow the Parliament and the Government to adopt an appropriate role in the development of the industry in this country going forward.

It is our view that the Committee Members will discover that Australia and Australians are well placed to benefit from the development of wireless broadband services in Australia. They will also discover that, while there are challenges, the opportunity inherent in wireless broadband services will ensure that they are solved.

ArrayComm Inc and CKW Wireless are looking forward to playing a significant role in unleashing Australians from their desks, their homes and their work so that they can to take full advantage of the opportunity of wireless and the freedom of mobility.

Testimony of
Martin Cooper
Chairman, CEO and Co-Founder
ArrayComm, Inc.
Before the U.S. Senate
Committee on Commerce, Science and Transportation
Subcommittee on Communications
Hearing on Spectrum Management and Third Generation Wireless Service
July 31, 2001

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear before you today.

I commend you for holding this hearing on spectrum management and Third Generation (3G) wireless – two critical issues facing the wireless communications industry today.

My name is Martin Cooper. I am the Chairman and CEO and Co-Founder of ArrayComm, Inc., a U.S.-founded and based technology company headquartered in Silicon Valley, California. We founded the company in 1992 and now have over 200 employees including many renowned scientists, engineers, and industry leaders in the field of wireless communications.

Today, I would like to present my views on spectrum allocation, including how we can ensure that our nation's scarce spectrum is put to its most valuable use, and the need to encourage new technologies and the timely deployment of these technologies to all Americans.

While these technologies originated in American laboratories and were often paid for by the Department of Defence, ironically, many are more widely deployed abroad than here at home.

Wireless personal communications have contributed importantly to the productivity, safety, and convenience of people in this country over the past 60 years, but especially during the most recent 18 years of commercial cellular service.

I would like to share with the Subcommittee the vision that inspired the creation of cellular service, to express an opinion on how well we have done in fulfilling that vision, and to project that vision into a future that includes the Internet. Specifically, I would like to make two points relative to this Committee and its role in overseeing the Federal Communications Commission (FCC) and the Department of Commerce.

Despite enormous progress in the personal communications industry, that industry is still in its infancy. Future services will require 10 to 20 times the spectrum allocated today. That spectrum just does not exist – *unless* the industry continues to aggressively adopt new technology that *multiplies* capacity of existing spectrum. 3G is one of a number of new personal communications services, each of which will serve different constituencies who have different needs. All of these services need to be accommodated in the fixed amount of spectrum that is available as limited by physical laws.

When we created cellular 30 years ago, we envisioned a personal portable telephone service that unshackled people, all people, from the wires that tied them to their desks, their homes, and their work-places. We knew that wireless technology had the capability of delivering high quality speech, at low cost, with good reliability to all the people. And further, we promised the FCC, which was a crucial participant in the creation of cellular service, that cellular technology was capable of continuously improving spectral efficiency. "Allocate 40 MHz," we said, "and we will grow the service indefinitely."

Despite the enormous strides made by the industry and the FCC – and without question, there has been progress – the cellular vision remains incomplete today. Some segments of the population are served effectively, others, not at all. Data-over-cellular pales in comparison with data over wireline. Despite the obvious convenience of wireless service, those of us who use the service still suffer from the lower reliability and higher cost that characterize wireless compared to wired service. As a result, although over 100 million people in the United States use cellular service, they still, on the average, use old-fashioned wired phones for over 90% of their talking and over 99% of their Internet access.

The initial 40 MHz of cellular spectrum has grown to 170 MHz and here we are, asking for more. Consider that, with today's technology, if the industry proposed to serve all personal traffic, the FCC would have to allocate virtually *all* of the usable spectrum to cellular service to the exclusion every other defense and commercial service. Not to mention, I add, the demand for new classes of data services that will consume, again, with today's technology, far more spectrum than voice services. And that is the real problem faced by this Committee. If we rely on today's technology, the need is not for just another 100 or

200 MHz, the demand is for another 2000 or 4000 MHz and that spectrum simply does not exist.

The *only* answer is new technology that multiplies spectrum capacity. Technology has come to the rescue in the past and, properly stimulated, it will come through in the future. It is that stimulation that is the crucial role for this Committee, Congress, the FCC and the Department of Commerce. There are industry standards for automobile fuel efficiency – why are there not standards for efficient use of the radio spectrum? We have huge reserves of fossil fuels – but only about 2000 MHz of spectrum that *is* useful to connect people.

The message is clear. The demand for more services is going to accelerate. People are learning the value of freedom from the wired tether and that freedom is every bit as important for the Internet a it is for plain old voice service. The only hope for providing this new freedom is continuing technological progress. We must, and will, continue to extract more and more value from the spectrum, just as we have been doing for the hundred odd years since radio was invented. We must ensure that our nation's scarce spectrum is put to its most valuable use, to enable U.S. telecommunications companies to meet consumer demands, and remain competitive globally.

The wireless industry today stands at a crossroads. The momentum of the past 18 years has made mobile connectivity a part of our lifestyle. But, this is just the beginning. The next 20 years offer even greater promise for the American public and the American economy. But the mission has expanded. We started with voice. The technology of the entire communications world is now *data.*

Voice is now just one of many applications that must be served within a limited amount of spectrum and voice is fast becoming a minor part of the demand. The Committee members know, I am certain, that I raise these challenges only because I am confident that solutions exist for all of them and I will touch briefly on those today.

Let us look at the issues that this profound change of mission raises.

A Basic and Scarce Resource: The Spectrum "Sweet Spot" for Mobility Services

There is a "sweet spot" for the frequencies allocated to mobile wireless systems, influenced by the physics of radio-communications, which extends from about 500 MHz to 2500 MHz, or about 2000 MHz in total. The size of this sweet spot cannot be expected to change dramatically over time.

We must accept that there will always be competing interests for this spectrum, all in one form or another important for our country. The decisions made on 3G spectrum must include a comprehensive approach to all spectrum allocation in this range of frequencies or the problems we face today will resurface every few years indefinitely.

Today, the cellular industry uses about 170 MHz of spectrum between 850 MHz and 1.9 GHz, or 8.5% of the 2 GHz sweet spot. Let us assume that an additional 140 MHz (located between 1710 and 1850 MHz) is allocated to the cellular industry, and its share of the sweet spot goes to more than 15%.

Without passing judgment on whether this is an equitable allocation of the sweet spot for this very important industry, it is clear that the amount of spectrum available for commercial mobile wireless cannot continue to increase without limit, given all of the other demands on the spectrum – other commercial, scientific, public safety, aviation and defense interests - which consume a considerable portion of the rest of this frequency range.

New Services are More Spectrally Demanding

Compounding the difficulty is the fact that many of the new services that may be desired by the public and are contemplated by the cellular industry require more bandwidth than today's voice and low-rate data services. The critical issue here is the price at which wireless operators can afford to offer new services to consumers. The techniques that are most effective at using the spectrum better and improving spectral efficiency also reduce deployment and operating costs for the carriers that use them.

Efficient use of the spectrum can lower an operator's costs and bring wireless services to constituencies that would otherwise not be served.

Without adequate spectral capacity, there is a risk that advanced services will not be available to the public at a price-point that most Americans can afford. Congress has already heard from some wireless carriers that spectrum shortages could cause their companies to increase their prices for cellular voice service. Of course, this is true using 30-year old technology. But there are technologies in widespread use today that have the opposite effect and carriers will soon have access to these

technologies – *if* they are encouraged to adopt technologies that use spectrum more efficiently, rather than to solve capacity demands with more spectrum.

There will be no benefit from 3G services to the American economy if they are not affordable.

ArrayComm, Inc.

ArrayComm, Inc. is the global leader in fully adaptive *smart antenna*-based wireless communications. Our technologies are independent of the air-interface. They can work with *every* generation of cellular deployment; in fact, with any personal wireless communication system, and we license that technology to manufacturers of wireless communications equipment.

ArrayComm has created one of the key technologies that will form the basis of the rescue that I just alluded to. Our technology, called IntelliCell, is an advanced form of smart antenna technology that is technically called adaptive array processing. A traditional cellular base station blankets a wide area with radio energy. Our smart antenna technology directs that energy to the person for whom it is intended and avoids putting energy in locations where it could interfere with others who wish to use a radio channel. This technology can be applied to any personal communications system. The result is an increase in the number of users, lower deployment costs, higher profitability, fewer dropped calls, faster data rates and improved customer satisfaction.

There are, today, over 80,000 cellular base stations using this adaptive smart antenna technology serving many millions of people in Asia and the Middle East. In these developments, we have created a nine-times improvement in spectral efficiency over systems that were already using advanced technology. That is effectively multiplying the spectrum used in those systems by nine times. These systems are capable of serving nine times more people than earlier versions that did not incorporate adaptive smart antennas.

Our patented IntelliCell ® technology (also known as a fully adaptive "smart antenna") uses advanced software and antenna arrays to continuously optimize, in real time, the communication channel with every wireless user. IntelliCell dramatically enhances the quality, capacity and overall performance of wireless voice and data networks across all air interface standards. IntelliCell multiplies spectrum re-use by creating multiple spatial channels on top of traditional time-division and code-division multiple access methods used for voice and data transmission, thereby reducing the need for spectrum.

IntelliCell technology is deployed in over 80,000 cellular base stations serving millions of commercial customers principally in China and Japan, as well as other Asian countries. This technology is not a vague future promise – its proven, real, and widely used – but not yet in the U.S.

ArrayComm created a new service, *i-BURST*™, in an effort to demonstrate the principles of our spectrally efficient technology and to offer new services not available today to constituencies that are not served effectively today. *i-BURST* is a wide-area, high-speed, portable, wireless Internet access system. It is very efficient in terms of spectrum use, and can be deployed at significantly lower cost than generic 2G and 3G cellular data systems. *i-BURST* can provide each user anywhere, with an always on, Internet connection at data rates in excess of 1 Mbps per user, even in a fully loaded network.

Operating on as little as 5MHz of unpaired band of radio spectrum and using time division duplex (TDD) transmission technology, *i-BURST* can bring high-speed wireless Internet access to people at far lower cost, by orders of magnitude, than systems designed for other purposes. Perhaps most importantly, its performance and its affordability make it a candidate for an array of applications of immense social value, such as tele-education and telemedicine, which may unfortunately not be served by standard commercial wireless systems.

ArrayComm is also working with U.S. and international standards and regulatory agencies to increase their awareness of how strategic spectrum allocations and the use of technologies like spatial processing can maximize the value of spectrum and enable the wireless industry to meet consumer demand.

On a larger scale ArrayComm is also a charter member of the TDD Coalition, which is a group of like-minded U.S. and international companies, all with applications and services built on the TDD technology platform.

The Coalition was founded earlier this year to:

(1) promote TDD technology for wireless broadband products and services;
(2) promote TDD technology into market and regulatory environments for broadband wireless;
(3) inform the industry about TDD technology, and its benefits to the global broadband wireless industry;
(4) pool promotional resources to develop common marketing approaches as they relate to TDD;

(5) inform and educate international and national regulatory bodies to ensure that technologically neutral rules are adopted to allow economical deployment of TDD technology for broadband wireless access;
(6) create a collaborative industry voice to address issues relating to TDD;
(7) develop implementation guidelines that will allow TDD deployments and insure harmonious coexistence of TDD with other duplexing systems; and
(8) support TDD within global, regional and national standard organizations.

The TDD Coalition believes that policy makers and regulators can benefit from the Coalition's contributions, and perhaps most importantly, appreciate that there are many companies worldwide that are developing leading edge, spectrally efficient applications and services on the TDD technology platform. Commercial deployment of these applications and services will bring Innumerable low cost, advanced data and voice applications and services to consumers worldwide.

What Can The Government Do?

What can the government do in the face of the fundamental limits on mobility spectrum?
I suggest that the government can do the following:

Empower the FCC to re-examine all spectrum allocations, in light of what can be done with new radio technologies and the Internet.

The FCC and the Department of Commerce are currently doing the best that can be done in a very complex situation; handling an impossible task of satisfying so many constituencies. Commerce Secretary Donald Evans and FCC Chairman Michael Powell have demonstrated a commitment to make sufficient spectrum available for advanced wireless services. They have also acknowledged that time is needed to study options to develop a new 3G allocation plan that best serves the public. As they reexamine the issue, I encourage them to develop a more unified approach to spectrum management that offers long term solutions for serving *all* Americans with a wide variety of voice and data services more efficiently.

Just as the Subcommittee did under the Chairmanship of Senator Inouye and the leadership of Members like Senators Hollings, Stevens and Burns, nearly 10 years ago when it carefully reviewed the feasibility of auctioning radio spectrum, so too should it carefully explore spectrum allocation and encourage the efficient use of spectrum by licensees.

Put the public first. The wireless industry has been focused on technology (illustrated by the myriad of acronyms such as CDMA, 3G, WAP, etc.), and is driven by delivering voice services. We need to challenge the industry to find the right solutions that will genuinely serve the masses with the Internet, which is a compelling matter for the telecom industry today. This will define an inclusive approach; to serve the elderly - the disabled – teenagers - the police-rural America. To serve all of the billions of people in the world who do not fit the profile of the traditional cellular subscriber.

Hold spectrum users accountable. Many companies will indeed need new spectrum, but we must first ensure that we are all using the spectrum we have to its highest spectral efficiency. After all, there are fuel efficiency standards for cars, and planes, why should there not be efficiency standards for spectrum use – a finite national resource? According to what I call Cooper's Law, there could even be spectral efficiency timed goals. For instance, the reason we provide more spectrum fast has little to do with international standards, but much more to do with potential demand. Like with any infrastructure requirement, when the demand is here, you do not start a new technology, you do more of the same *(e.g.*, when traffic jams become widespread, county authorities will first widen the road, and at some point prepare for mass transit). The most obvious thing to do, however, is to make sure that we – the industry – use as efficiently as possible the spectrum we have been allocated.

Foster new radio technologies with inherently higher spectral efficiency. New radio technologies have been developed in the past 10 years, which are drastically more spectrally efficient than the technologies used in cellular systems today, which are all evolutions of the standards developed 30 years ago. Built from the start to accommodate the Internet Protocol, they are eminently suited to carrying very affordably the new services that the public requires. ArrayComm is just one company that has developed technologies that can increase spectral efficiency. Neither Congress nor the FCC should be in the business of mandating technology or services.

However, they can very well define guidelines to foster or specify minimum levels of spectral efficiency in radio systems. Suitable allocations of TDD spectrum in the overall 3G allocations would foster their quick adoption and deployment.

Promote "real" competition at home and abroad. Without real competition we will not have much in the way of creative new services. Other countries are stimulating innovation and rolling out new mobile services because they have allocated spectrum for these services. We too would like many of these services at home. But to do so, the U.S. must allocate spectrum for these new services. Since this has already been done overseas, in one sense we are already behind.

Avoid the trap of the "universal solution." Universal gadgets that purport to do all things for all people do not do any of them well. There is no Holy Grail of solutions. People have different needs. They will need different devices and services to satisfy those needs. Future Americans will have lots of choices for their personal communications devices and services but all of them will interconnect. There will not be a universal network. Some networks will be optimized for voice and some for data. Some will be for travelers who need to communicate all over the world. Some will just service a neighborhood or small community.

Chairman Powell and the FCC have been supportive of the initiatives regarding spectral efficiency, TDD and new systems to serve the public. The FCC has provided ArrayComm with experimental licenses to test its technologies. If 3G allocations occur, as they have elsewhere, they will embrace both FDD and TDD spectrum and this

will provide for the competition that is crucial to successful consumer services.

The Future

Despite the fine progress in cellular and other personal communications services in recent years, we have experienced only a glimmer of the impact that these services will have in the future.

Delivering bandwidth to people has always increased their awareness of the world. Making high interactive bandwidth available at very low cost will have a profound effect. The practice of medicine, for example, will be very different, and far more effective, when a doctor can diagnose a patient remotely and immediately when the patient is sick – not when the patient can make an appointment. The days of delivery of music by CD, by cardboard and plastic, are numbered. Someone will develop a way to pay the artists and distributors and their choice of music will be delivered to people when they want it. The workplace will expand to be anywhere that the worker wishes to be and instant collaboration, enhanced by the ability to see and hear (and why not touch, smell and taste), will be a way of life.

The Internet will be truly meaningful to people only when it can be delivered wirelessly, at low cost, and with broad bandwidth. Efficient spectrum use will make that possible and will make the Internet a tool for everybody beyond the early adopters and "techies" who use it today.

Bandwidth Is Awareness And Mobile Bandwidth Is Freedom.

I thank the Chairman and Members of the Subcommittee for this opportunity to express my views today.