

High Capacity Broadband: an Economic, Environmental and Social Imperative for 2009

A Discussion Paper

by

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“Jobs, knowledge use and economic growth will gravitate to those societies that are the most connected with the most networks and the broadest amount of bandwidth because these countries find it easiest to amass, deploy and share knowledge in order to design, invent, manufacture, sell, provide services, communicate, educate and entertain. Connectivity is now productivity.”

Thomas Friedman.

The Lexus and the Olive Tree. (London. Harper Collins. 2000)

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Abstract

This discussion paper outlines the tangible economic, environmental and social benefits associated with the provision of high capacity broadband infrastructure. It also provides the context in which the current debate about network speeds has developed. Whilst it is recognized that there are certain contentious difficulties associated with the arrival of this new infrastructure it was a conscious decision by the author to allow others to elaborate upon this aspect of the debate. The word imperative implies a sense of urgency. It is the author's view that the magnitude of the challenge in 2009 to recover from the current global economic meltdown and to create a carbon neutral future clearly establishes that sense of urgency.

For the purposes of this paper, high capacity broadband is defined as the level of communications capacity to a single dwelling or commercial unit that is capable of delivering contemporary entertainment and communications services to the occupants. In the near future this will mean several IPTV channels and multiple simultaneous high definition video phone calls. For technology that will arrive in the next few years 50 -100 Mbps will constitute high capacity broadband.

Serious bandwidth in telecommunications has only been a matter of real and growing significance for the last ten years

Technological breakthroughs in recent decades have changed fundamentally the scope and nature of services provided by telecommunications carriers. In the late 1990's normal household access speeds to the Internet in Australia were in the range of 128-256 Kbps. By 2007 the majority of Australian's were enjoying connection speeds above 1.5 Mbps. Globally, many communities are already enjoying connections speeds of 20-30 Mbps and developing infrastructure for speeds of up to 100Mbps. Connection speeds seem to be doubling every 15-18 months.

Designing and building the "hard" telecommunications infrastructure is the foundation upon which a contemporary connected community can be established. Providing "soft" infrastructure is however the most important step in delivering a resilient future, global competitiveness, sustainability, strong community capacity and a real return on investment in telecommunications hardware. Global and local competitiveness will ultimately depend upon the genius and creativity applied to harnessing the power of high capacity broadband.

1. The Historical Context

“Communities, states and companies which plan for the Information Age will be in a key position to reap its rewards”

John Naisbitt Megatrends 1985

During the last thirty years with few exceptions, governments, of all complexions at all levels (national, provincial and municipal) have greatly underestimated the significance of the Information Technology sector of the economy. At best the industry has simply been taken for granted. For a variety of reasons it has never been understood or recognized by policy makers and bureaucrats alike. After riding on the sheep's back for almost two centuries many Australian's have found it difficult to look beyond "Rocks and Real Estate" as the engines for economic growth.

What is clearly not understood in the contemporary world by the same policy makers and bureaucrats (or their successors) is that the ICT Revolution is scarcely half way to maturity.

For the sake of some clarity, a modicum of explanation concerning acronyms and terminology is probably helpful. Since the late 1970's IT or (Information Technology), IT&T (Information Technology and Telecommunications) and ICT (Information and Communications Technologies) are acronyms which have been widely used interchangeably to refer to the convergence of computing and telecommunications. Today we use ICT as the industry tag to describe this convergence in addition to the evolution of whole forms of new media services. In the early 1990's it was the IT Industry.

In conceptual terms there has always been a vertical and a horizontal dimension to the definition of the IT industry. The vertical dimension involves the traditional somewhat narrow definition of the IT industry as including those businesses whose main function is to produce hardware, software and/or deliver services to install those IT products. This was the original IT Revolution which followed the development and spread of the micro processor in the 1970's and 80's.

The horizontal dimension of the IT Industry takes into account the role of Information Technology as an enabling technology.....a powerful set of tools that can be used , in almost any industry and part of any strategy for economic and community development. In most countries of the world the impact of IT as an enabling technology far exceeds the value and impact of the traditional hardware and software sectors. This was of major significance during the 1990's and the first decade of the twenty first century. During the 1980's and 90's the all embracing impact of the ICT revolution was recognized and writers and observers in many quarters began to describe what they were witnessing as a "New Economy". There were tags aplenty. Initially the new economy was called the Online Economy, then the Digital Economy, the Information Economy and subsequently the Knowledge Economy and even the Creative Economy. All these efforts were associated with an enthusiasm to describe the impact of the generation, manipulation and distribution of massive volumes of information at great speeds over great distances because of the new ICT Infrastructure. Only time will tell how economic historians will best describe the period.

The massive level of investment in IT infrastructure on a global basis during the 1970's and 80's probably rivaled in real terms the outlays for armaments in World War Two. As a result our society and our economy were beginning to change in fundamental ways. Simultaneously, international deregulation had occurred on a massive scale, freeing up trade, freeing up capital markets and deregulating internal markets for goods and services. What amounted to a worldwide movement to deregulate and restructure the telecommunications industry in many respects became the leading example of global deregulation. In hindsight Australia's fumbling of this challenge has cost us dearly. While numerous other countries restructured their Telcos and moved on to invest heavily in the high speed infrastructure for

the Broadband Economy we have squabbled for more than a decade over who should own our national carrier and how it should be controlled via regulation.

The IT Revolution which was well underway by the end of the 1980's began to have a direct impact on how we learn, where and when we work, how we communicate, how we take our recreation, how we market, buy and sell things and how we organize our lives. This period of dramatic change also featured the emergence of new industries and organizations and the demise of many traditional organizational structures. None of us understood all the implications at the time but we were experiencing a very basic paradigm shift; from market place to market space, from passive media to interactive media and from closed networks to an internet-worked world.

By the early 1990's the quality of Telecommunications Infrastructure had been identified as one of the critical criteria determining where and when corporations made decisions about relocating business activities or simply investing in new operations. Normally such decisions were determined by issues such as political stability, availability of skilled workforce, availability of raw materials, transport infrastructure and the cost of labour. In a survey of global corporations undertaken by the Gallop Group in 1994 the quality of Telecommunications Infrastructure appeared on this list for the first time. It was deemed to be the third most significant factor after political stability and skilled workforce. Economists were at the same time beginning to expand the sacred list of the factors of production to include Information. The reality was emerging that plentiful supplies of land, labour, capital and enterprise would not guarantee global competitiveness if information services were second rate.

The basis of the now famous IT Revolution of the 1980's was a matter of speed, cost reductions, energy requirements, miniaturization and reliability. The speed of calculation and recall improved at a phenomenal rate. Cost reductions were quite extraordinary and made it possible for small businesses, schools and householders to own computers.

Energy requirements were very low and the new wonder machines were economical to run. Large cumbersome mainframes in air conditioned chambers were challenged by the arrival of PC's and laptops. The elimination of valves and wiring made computers virtually faultless. The explosive growth of the Telecommunications Industry had been based on major technological innovation, deregulation and globalization of business.

From 1985 to 1995 the volume of voice line activity around the globe had grown from 15 billion minutes to 60 Billion minutes.¹ Of perhaps greater significance was the use of a global telecommunications system designed for voice traffic to transmit data. As a foundation plank of the digital revolution, in the USA in 1997 for the first time the volume of data traffic surpassed the volume of voice traffic. That happened in Australia in 1998. The demise of distance as the key to the cost of communications turned out to be one of the most significant economic forces shaping the last twenty years. The cost of transmission became virtually location independent. The unit cost of Trans Atlantic Telephone Traffic between 1960 and 1995 was a classic illustration.² In 1960 the estimated cost of a Trans Atlantic telephone call was \$US 4.60 per hour. By 1990 that cost was approximately 7 cents per hour and by 1995 it was approaching 1US cent per hour. It is interesting that charges for long distance calls remained in place for many years after this technological breakthrough.

Except in those parts of Australia mesmerized by the resource industry boom it was clear that revolutionary technological developments in IT were going to have a major impact on the shape of Australian society and the competitiveness of our economy.

The Long Wave Theory of Technological and Economic Development suggests in terms of "time" we are about 35 years into a 60 year phenomenon. It is the view of the author that the

¹ Source: TAT Cables World Telecommunication Development Report 1997.

² IBID.

world has just passed the half way mark for the ICT revolution and that high capacity broadband will be the infrastructure that facilitates the full flowering of the revolution in the next two or three decades. Carlota Perez and her colleagues at SPRU (The Science and Technology Policy Research Unit) at the University of Sussex (UK) have contributed in a major way to the understanding of the historical context of the ICT revolution. Perez is a champion of the Long Wave Theory of development and in her latest book on the subject³ she points out with great expertise that the ICT revolution is the fifth major technological revolution to have determined the shape of the last two hundred years. Each of these great surges of economic development was based upon quite remarkable technological breakthroughs. All of the surges lasted for more than 50 years. The First Industrial Revolution dates from 1771 with Arkwright's Mill. The second revolution (The Age of Steam and Railways) dates from 1829. The third revolution (The Age of Steel, Electricity and Heavy Engineering) dates from 1875. The fourth revolution (The Age of Oil, Automobiles and Mass Production) dates from 1908 and the ICT revolution dates from the release of the microprocessor in 1971.

Perez points out that each and every one of these revolutions has passed through four phases, two great periods and a turning point

- **Phase One (The Irruption Phase)** follows the big bang and the gestation period. It features new products, new industries, explosive growth and fast innovation.
- **Phase Two (The Frenzy Phase)** delivers a full constellation of new industries technologies and systems associated with new infrastructure.

These first two phases Perez describes as the installation period or first half of the revolution.

In all five of the technological revolutions spanning more than two hundred years, this period is capped off by a great bubble featuring manic behavior and the inevitable crisis or crash.

This causes a turning point which usually involves new forms of regulatory intervention by government. The second main period of the revolution follows the turning point and is described by Perez as the deployment period comprised of phases three and four.

- **Phase Three (The Synergy Phase)** is characterized by a time for production, full expansion of innovation and market potential.
- **Phase Four (The Maturity Phase)** Features the last of the new products and industries followed by market saturation (maturity) for many of the earlier products.⁴

There is little doubt at the time of writing (Feb 2009) that we have reached the turning point of the ICT revolution. The world's financial systems are described in all quarters as being broken and discredited. Governments of the world are currently working on strategies to ensure that the excesses of the last 5-6 years "never happen again". The fundamental infrastructure for the next two phases of the ICT revolution (high capacity broadband) is being rolled out and the foundations for the next great technological revolution are being laid. There is also little doubt that ICT technologies are a vital key to identifying, unlocking and harnessing the awesome potential of the Twenty First Century associated with Nanotechnology, Biotechnology, Renewable Energy, Green Chemistry and Regenerative Medicine.

2. High Capacity Broadband

For more than a hundred years after the world's first telephone call in 1876, bandwidth was not an issue of any significance for residential connections because traditional

³ Perez, Carlota. *Technological Revolutions and Financial Capital* Edward Elgar. UK 2005

⁴ Perez, Carlota *Technological Revolutions and Financial Capital* Edward Elgar. UK 2005

telecommunications infrastructure was designed and built to handle voice traffic. With the switch from the use of analog to digital technologies in the 1980's the flow of data traffic increased dramatically. Also during the 1980's, optical fibre technology moved beyond the laboratory to the telecommunications industry. In most advanced economies the volume of data traffic surpassed the volume of voice traffic by the late 1990's.

Internationally, the public gained access to the Internet with the launch of the World Wide Web and the Mosaic web browser in 1993-94. Prior to that, the Internet had been available on a limited basis in universities and defence establishments since the 1970's.

During the 1990's what had been developed as a telephone system was handling a greatly increased volume of data applications. Narrowband services were placed under heavy pressure. From its beginning in the early 1990's Internet activities were very much governed by the availability of bandwidth. Throughout that decade modem speeds grew from 9.6Kbps to a very exciting ISDN link of 128Kbps. In terms of general public usage for most of the first decade of its life the Internet was delivered as a dial up narrowband service over copper wires.

The word Broadband really only entered common usage at the end of the 1990's when the demand for online delivery of video and graphic intensive images became substantial. What had been originally developed as a telephone service was by then expected to carry voice, data, and video traffic. The demand for high definition, interactive video for business, professional and recreational purposes has clearly emerged as the key application which now drives the demand for high capacity broadband infrastructure.

Definitions of Broadband are many and varied. Some experts define Broadband by speed and others by functionality. Conventional definitions of broadband tend to focus on what it is not, rather than what it is.⁵ There is general agreement that today's distinction between narrowband and broadband is the transmission capacity equal to or above 256 Kbps. There is however no upper limit placed on what broadband can become, and there is widespread evidence to suggest that broadband speeds and its performance/price ratio are doubling every 15-18 months.

Broadband is also defined as a service that is always on, which is distance independent and which is basically available without limitations on capacity use. A third important aspect of broadband is that it is neither fixed nor mobile but both. In a High Capacity Broadband Network or Next Generation Network the term broadband refers to the quality of the access environment and the possibilities this allows, rather than whether a user is connected to a fixed line or wireless environment at any particular time.

In this paper high capacity broadband is defined as the level of communications capacity to a single dwelling or commercial unit that is capable of delivering contemporary entertainment and communications services to the occupants. In the near future this will mean several IPTV channels and multiple simultaneous high definition video phone calls. For technology that will arrive in the next few years 50-100 Mbps will constitute high capacity broadband. This range of capacity will be capable of delivering the following services

Capacity	Technology	Indicative Applications
1 Mbps	ADSL, WiMax	Internet access, games etc for half the Australian population
10 Mbps	ADSL2+, cable,	Movie downloads. 90% coverage in 5

⁵ D'Costa and Kelly. "BB as a platform for economic development". OECD Conference on Innovation and Sustainable Growth in a Globalized World. Paris Nov 2008

	NBN	years time
100 Mbps	VDSL2, FTTH (PON)	HD IPTV, tele-presence
1 Gbps	FTTH (future)	Multiple simultaneous HD video channels
10 Gbps	FTTH (future)	
100 Gbps	Fibre trunks	Download US Library of Congress contents in 1 hour
1 Tbps	Fibre trunks	

The highest levels of capacity provided for public consumption by telecommunications service providers in the world at the beginning of 2009 appears to be about 40 Mbps and this represents the current benchmark. It will not stay that way for long given that available bandwidth is doubling every 15 to 18 months.⁶

To access the vast range of continuously emerging new online products and services, households and businesses will be looking for connection speeds exceeding 50 Mbps.

A sobering reality about future demand for bandwidth is that the main users of broadband will not necessarily be humans but increasingly machines and objects that are interconnected and controlled in a ubiquitous network.

In Australia the original official definition developed by the ACCC in 2002 was “...Any high speed connection to the Internet greater than 200Kbps in the last mile over a mix of media....”

At the end of the December Quarter 2007 the Australian Bureau of Statistics reported that there were in Australia;

- 7.1million connections to the Internet.
- 2 million still using dial up access.
- 1.6 million had speeds up to .5Mbps.
- 1.2 million had speeds between .5Mbps and 1.5 Mbps.
- 1 million had speeds between 1.5 Mbps and 8 Mbps.
- Only 1.3million enjoyed speeds > 8Mbps.

The Australian Federal Government’s program to deliver a Fibre to the Node National Broadband Network for 98% of households and businesses still involves wireless or copper for the last mile and is seriously limited in capacity (download speeds of 12 Mbps and upload speeds of 1.5Mbps). Assuming a roll out period of 5-6 years this capacity limit has been strongly criticised as falling a long way short of what is needed.

⁶ Interview with Rob Cook of Pangalax (Queensland Australia) January 2009.

During 2008 in both Singapore and New Zealand national governments committed to programs to deliver FTTH operating at a minimum of 100Mbps. Given the rapidly evolving nature of telecommunications infrastructure an exciting but achievable target for Australia would be to provide 50 -100Mbps at home, 1-10 Gbps at work and wireless all around.

The Internet has become an indispensable communications tool and information resource for businesses, governments, community organizations, individuals and families. During this first decade of the twenty first century the proliferation of broadband access to the Internet has changed business practices, consumer behavior, the nature of entertainment, types of employment and the basics of education and research and health service delivery.

By 2008 more than 180 economies worldwide had launched broadband services. Globally the number of subscribers had surpassed 500 million (including fixed and mobile broadband subscribers).⁷

The incremental benefits of high capacity Broadband over the current generation of broadband flow directly from the enhanced user experience and services it can support. These in turn are heavily influenced by the key attributes of high capacity networks such as:

- Higher download and particularly higher upload speeds and lower unit costs.
- Reduced waiting time for information.
- A significant reduction in faults.
- Greater consistency of bandwidth across users.
- The ability to cannibalize other services Eg: live TV and traditional telephone services.
- Lower latency, lower error rate and freedom from radiofrequency interference.⁸

There are very real economic, environmental and social advantages to be achieved by rolling out High Capacity Broadband infrastructure.

3. Economic Benefits of High Capacity Broadband

Globally, high capacity broadband is the infrastructure on which Twenty First Century business will be built. Top quality telecommunications services are important to businesses of all sizes , from large manufacturers managing their global supply chain, to mid sized retail and service based businesses connecting to customers, to the home based consultant or individual eBay business.

High capacity broadband infrastructure is poised to become the driver of great significance that will be the stimulus for a sustained upturn and the next long term wave of development in the global economy.⁹ This phase of the ICT (information and communications technology) Revolution is comparable to the impact of steam and rail technology (1820's), steel and electricity (1870's), and automobiles, oil and mass production after 1908.

⁷ Source: ITU World Telecommunications Indicators Database. 2008

⁸ Report for the Broadband Stakeholder Group June 2008: A Framework for Evaluating the value of Next Generation Broadband.

⁹ D'Costa and Kelly. "BB as a platform for economic development". OECD Conference on Innovation and Sustainable Growth in a Globalized World. Paris Nov 2008

In the past, technological breakthroughs of such significance have been described as General Purpose Technology (GPT) enablers, responsible for long waves of innovation and economic growth frequently lasting for 45 -60 years.

As the technology continues to evolve and bandwidth increases, the scope for broadband to act as an enabler of structural change in the economy expands.

Broadband does not act on the economy in isolation, but as a complement to other information technologies. It has become the critical enabler for the use of computer-based applications that need to communicate. Many of these applications change the behavior and productivity of both firms and individuals.

Telecommunications infrastructure has become an integral part of almost every aspect of the knowledge economy.¹⁰ Public infrastructure increasingly depends on broadband communications networks for significant functions including traffic light control, control of sewerage systems, air traffic control as well as maritime and rail transport and logistics management systems. Many aspects of business are already taking place over broadband networks, such as supply chain management, fleet management, e-procurement, e-invoicing, online recruitment, customer service, call centres, online payment systems, ecommerce, co-ordination of fragmented production processes and the connection of tele-workers to their employers. Consumers have also made great use of broadband networks for e commerce, online payment systems, online reservations, online auctions, and online entertainment services.¹¹

The links between the existence of high capacity broadband and the performance of the local, regional and national economy are well documented, and include;

- Opportunities for innovation
- Increased productivity growth
- Role of eCommerce
- Impact of Telework and Tele-presence facilities
- Effect on SMEs

3.1. Opportunities for Innovation

Amongst experts in the field of innovation there is a significant consensus that broadband infrastructure has had a major beneficial impact on innovation. Broadband in association with other key ICT's has made it easier to uncover and develop good ideas and easier to create new products and services.

- The most direct way in which ICTs boost innovation is by giving researchers more powerful tools for doing research. Broadband is the infrastructure that adds value to the tool box and facilitates the vital forms of interaction in effective innovation.
- Virtual product development at geographically dispersed locations now allows researchers to model the operational properties of a product without having to build expensive prototypes.

¹⁰ OECD Ministerial Background Report: for the Ministerial Meeting on the Future of the Internet Economy. Seoul Korea: June 2008

¹¹ OECD Ministerial Background Report: for the Ministerial Meeting on the Future of the Internet Economy. Seoul Korea: June 2008

- Whereas once R&D was virtually the sole preserve of large corporations, computers and the Internet have made it practical for SME's to participate and compete.
- The ICT tool box has made it possible for a wide range of users and customers to become involved in development, design and product innovation.
- Broadband has become the world's knowledge conduit, making it possible for innovators to learn faster than ever before what other innovators are doing and what level of opportunity the market offers.
- Global knowledge management has become a reality rather than a theoretical possibility as a result of broadband infrastructure and a whole new generation of knowledge management tools and technologies that enable collaboration.
- Broadband has made it practical and more cost effective to run a network of geographically dispersed facilities to enforce standards of operation, branding and all other aspects of successful marketing.
- Broadband also enables concurrent R&D on multiple projects in different locations.
- Broadband has made it possible for companies of all sizes to efficiently access talented people on which so much of innovation hinges.
- Innovation through the development of new applications and the diffusion and further development of existing innovation is greatly facilitated by broadband.¹²

In his soon to be published book on Broadband Economies Robert Bell very vividly suggests that..... *“Broadband has become to innovation what fertilizer is to farming: a heady booster of performance.....”*¹³

3.2. Increased Productivity Growth

Productivity growth, which is the increase in the amount of output produced by workers per given unit of effort, is generally regarded as the most important determinant of economic performance. The ICT revolution incorporating broadband infrastructure was and continues to be responsible for the lion's share of the post 1995 rebound in productivity growth amongst developed economies. The implications of this view are significant given that the roll out of high capacity broadband infrastructure is still in its infancy. The switch to broadband services has produced massive cost savings at the level of the firm. At the same time the new networks have had beneficial impacts on process efficiency, work organization, procurement costs, product quality and customer service.

The primary contribution of ICT's (incorporating broadband) in boosting productivity within the firm is by making employees more productive and thereby enabling the same number of employees to produce more products and provide more services. Sophisticated telecommunications networks together with other information technologies boost productivity by;

- Enabling employees to do more things at the same time.
- Allowing routine tasks to be automated and remotely managed where appropriate.

¹² IBID

¹³ Robert Bell, “Broadband Economies. Creating the Community of the 21st Century”. (Intelligent Community Forum. NY)

- Enabling firms to restructure their supply chains.
- Facilitating more productive self service.
- Allowing bits to be substituted for atoms.
- Enabling the creation of markets and market signals where before there were none.
- Helping markets to be more efficient by expanding consumer information

Information and Communication Technologies not only enable the creation of larger markets, they allow companies to achieve greater economies of scale and exert greater competitive pressure on firms to boost performance. They also give managers better tools by which to make decisions. Shorter product cycles, rapidly changing economic environments and a multitude of new competitors means that decision makers must make decisions faster and with more accuracy than ever before.¹⁴

As broadband spreads throughout the economy transformations are taking place in the way business is done, work is organized and resources are allocated. These effects are most noticeable in the service sector of the economy in areas such as; financial services, business services, transportation, real estate, travel and tourism, retail and communication services.

3.3. The Role of eCommerce

eCommerce had its origins in the 1980's with a phenomenon known as EDI

(Electronic Data Interchange), involving computer to computer exchange of electronic documents for contracts, forms, purchase orders, and invoicing. It was early technology, involved vendor lock in and proved to be expensive, not particularly user friendly and clumsy. As a result eCommerce stalled in the mid to late 1980's.

1993-4 proved to be a major watershed with the development and release of the World Wide Web and the Mosaic and Netscape web browsers. Suddenly there was an attractive, user friendly interface for the Internet. The public was aroused. The first Internet business transaction occurred in 1994.

Modern telecommunications services and technology were therefore at the heart of eCommerce from its inception. eCommerce emerged and grew in a phenomenal way after 1994 on the basis of narrow band dial up connections to the Internet. A very rudimentary form of broadband appeared in 1998 with the release in North America of DSL (Digital Subscriber Line) technology and the rapid growth of eCommerce followed.

One of the oldest and most practical definitions of eCommerce used in the early 1990's was "...the application of the latest forms of communications and computing technologies to the five basic stages of the commercial process.....namely;

- Choosing goods and services
- Ordering goods and services.
- Delivery of goods and services.
- After sales service.

¹⁴ Atkinson and McKay: "Digital Prosperity" (IT and Innovation Foundation.) March 2007

- A payment system.¹⁵

During the first decade of its existence four major categories of eCommerce developed; Business to Consumer Commerce (B2C), Business to Business Commerce (B2B), Consumer to Consumer Commerce (C2C) and Consumer to Business Commerce (C2B).

Despite the initial significance of B2C by far the most significant form of eCommerce today is Business to Business Commerce. This is also the field which is expected to experience most explosive growth in the future with the roll out of High Capacity Broadband Infrastructure.

The most readily identified benefits or advantages of eCommerce which will be further enhanced by the development of High Capacity Broadband are that companies;

- Become more efficient and flexible in their internal operations.
- Are able to work more closely with their suppliers.
- Can be more responsive to the needs and expectations of their customers.
- Can select the best suppliers regardless of location.
- Can sell to an expanded global market.
- Can benefit from better management systems across different organizations.

Whilst eCommerce still represents only a minor percentage of total commerce, high capacity broadband is expected to introduce the next dramatic chapter in the development of eCommerce.

3.4. Economic Impact of Telework and Tele-Presence Facilities

Telework is another significant economic phenomenon directly linked to telecommunications infrastructure. The earliest telework initiatives associated with “home based work” date back to the 1960’s and 70’s. Like many of the important outcomes of the ICT revolution Telework had a long gestation period. Apart from pioneering efforts, serious telework programs did not get underway until the 1990’s.¹⁶

As with eCommerce, telework arrangements emerged in association with narrow band infrastructure in the first half of the 1990’s and accelerated substantially with the arrival of early stage broadband in 1998. Future implications for telework with the development of high capacity broadband are expected to be of major significance.

Reference to the environmental and lifestyle benefits of Tele-working are made at a later stage of this paper. Comments here are confined to the economic impact of the phenomenon.

There are different interpretations of the concept of Telework. In this paper Telework is understood to mean work that relies on ICTs especially telecommunications infrastructure to be carried out from remote locations. Worldwide it is generally accepted as a work arrangement in which an employee regularly works at an alternate worksite such as the employee’s home, a tele-commuting centre or other alternate site.

¹⁵ This definition was developed by the team that built Australia’s first online community in 1994 in Ipswich in Queensland known as Global Info Links.

¹⁶ Dr Wendell Joice “The Evolution of Telework in the Federal Government” (US Office of General Services Administration) 2000

Although a great deal of discussion has focused on the differences between telework, telecommuting and flexiplace, for the purposes of this paper these terms will be treated as synonymous.

Tele-presence facilities are contemporary videoconferencing systems and services that use virtual reality techniques to much more closely emulate real face to face interactions. The concept has been developed to provide high-definition video, spatial audio and a physical setup designed to link two separated rooms to resemble a single conference room. The facilities commenced as single point to point operations but have developed into multipoint facilities. Worldwide they have become an attractive alternative to global business travel and are a classic indicator of future business opportunities and changed business practices made possible by the availability of high capacity broadband.

The amount of work carried out “in the field”, the types of contractual arrangements and the technology applied, vary greatly from place to place and amongst different sectors of the economy.

Broadband connections are greatly increasing flexibility and productivity of tele-working employees. Prime examples include situations where people make phone calls and check emails while traveling or while waiting. Companies are also starting to save costs on office space and office overheads as the design of office space changes to reflect the new more flexible working arrangements. Other tangible, widely recognized economic benefits of effective tele-working include;

- Reduced costs associated with staff relocation and recruitment.
- Improved motivation of the workforce.
- Retention of key skilled employees.
- Multi disciplinary teams can be assembled irrespective of geography.
- Greater organizational resilience in the face of external disruptions.
- Enhanced customer service, beyond normal working hours.
- Reduced costs associated with travel time.
- Reduced traffic congestion.
- Wider employment/work opportunities
- Greater access to work for people with specific difficulties.

In contemporary terms the essential enabling technologies required by tele-workers include laptop computers, mobile phones, broadband Internet connections, and access to the company’s network. There is increasing evidence to suggest that in the foreseeable future the “must have” technology (which highlights the importance of high capacity broadband) for tele-workers will be the IP Virtual Private Network (VPN) which replicates the office environment at a remote location.

3.5. Impact on Small and Medium Sized Enterprises

SMEs are in many respects regarded as the engine room of all economies other than planned economies. They represent a very high proportion of all businesses, provide employment opportunities for more than 65% of all employees, and are an invaluable training ground for business operators across numerous aspects of the economy. Many small and medium sized

businesses were slow to adopt ICT's in the 1990's for a range of reasons. However by the turn of the century the vast majority of Australian SMEs were online and were beginning to realize the benefits of the Internet Economy, albeit via very ordinary connection speeds.

Across a significant number of sectors of the economy SME's are deriving a range of very important benefits of broadband connectivity:

- Evolving supply chain management with partners who demand on-line integration.
- Introducing new collaborative working tools to enhance efficiency.
- Providing flexible working arrangements to retain key employees.
- Improving Customer Relationship Management to meet and exceed customer expectations for sales and support.
- Outsourcing activities to save costs.
- Aggregating content to achieve efficiency gains.
- Linking the mobile workforce with the company and its data resources.

As with so many other parts of the economy, the introduction of high capacity broadband will enable SMEs to save valuable additional time, do more of selected important things and engage in a whole range of new activities.

4. Environmental Benefits of High Capacity Broadband

In recent years major international studies have demonstrated the links between high capacity broadband telecommunications networks and the ability to significantly reduce greenhouse gas emissions. It appears that the greatest potential for greenhouse reductions are to be found in eCommerce applications, telecommuting, teleconferencing and paper reductions.¹⁷

Broadband infrastructure has emerged as a critical element as governments of all complexions strive for a low carbon future. Links between serious bandwidth and changes to the way people and businesses live, shop, travel, work and use products are an important part of the immediate future. The consumption of oil and other fossil fuels has created a serious air and water pollution challenge. At the same time the human population of the globe is increasing and the planet's biodiversity is dwindling. ICTs (especially Broadband networks) are making a major contribution to our understanding of the natural environment and humanity's impact upon it.

As scientific effort become more sophisticated the demand for bandwidth increases.

In a substantial numbers of fields, critical collaboration and remote management of data gathering and distribution (made possible by increasingly sophisticated broadband infrastructure) are helping to mitigate today's pressing environmental issues.

4.1. Tele-commuting, De-centralized Workplaces and Tele-conferencing

Telecommuting and telework were defined earlier. The de-centralized workplace is a variation on teleworking and is the ability of people to work not at home but close to home at a telework centre.

¹⁷ Joseph P Fuhr. Broadband Services Report (American Consumer Institute) Oct 2007

Access to such a facility can significantly reduce commuting distances, travel time and transport emissions. The concept of the De-centralized workplace may involve the use of multi- occupant business centres or regional offices for larger businesses. In other cases whole departments of government can be moved to regional centres. Success of this model hinges on the ability to move large volumes of data, voice and video between regional centres, suburbs and cities. The richness of the experiences will increasingly be enhanced by higher end services such as “in service” quality conferencing services and is directly linked to the quality and extent of the broadband services.¹⁸

The use of personal vehicles accounts for a significant proportion of greenhouse gas emissions, as well as similar effects on toxic water and air pollution. The major gain to the environment from tele commuting is the decrease in the number of automobile trips. Savings for the environment from tele-work and telecommuting activity can be immense.

Vast numbers of electronic documents are now generated daily that were once printed on paper. Newspaper circulation is declining in large part due to competition from electronic forms of news. These trends are likely to accelerate in the future.

Teleconferencing has similar implications. With ordinary bandwidth teleconferencing has been a poor substitute for conference attendance for the last 15 years. Now, long distance, short duration business travel can be replaced with “in person” high quality online conferencing facilities that are significantly more efficient in terms of cost, time, energy and emissions.

Aviation greenhouse emissions are rapidly increasing with increases in air travel. By 2020, emissions from aviation may have doubled since the protocol baseline year of 1990.¹⁹ There is a clear disharmony between the rapid growth of the aviation sector and the pressure for carbon reductions. The alternative to aviation travel for many aspects of business is high definition, high bandwidth video conferencing.

4.2. eCommerce

The definition and evolution of eCommerce was also explained earlier in this paper with the emphasis on commercial benefits. eCommerce is also environmentally friendly. Compared to conventional shopping eCommerce has been found to generate 36% less conventional air pollutants, 23% less hazardous waste and 9% less greenhouse gases.²⁰ eCommerce also reduces retail and warehouse space requirements, which in turn reduces energy requirements to build, heat and cool such space.

Another feature of eCommerce activity which produces considerable environmental savings is the incidence of Internet based research for products, services, prices and location by potential buyers. This may lead to an online transaction or it may lead finally to a visit to a bricks and mortar establishment.

Online commercial behavior also has significant implications for supply chain management. As traditional manufacturing and commercial companies put the supply chain online and reduce inventories, overproduction, unnecessary capital expenditures, paper transactions and mistaken orders, they achieve greater output with less energy consumption. Once again the effectiveness of this online activity will be determined by the quality and extent of the broadband services.

4.3. Substituting Bits for Atoms

This is referred to as dematerialization in some quarters and means replacing high carbon products and activities with low carbon or no carbon alternatives. Substituting face to face

¹⁸ Telstra Climate Risk Report: Towards a High-Bandwidth Low Carbon Future 2008.

¹⁹ Telstra Climate Risk Report: Towards a High-Bandwidth Low Carbon Future 2008.

²⁰ Cited by Joseph Fuhr in the ACI Broadband Services Report. Oct 2007

meetings with videoconferencing or paper with e-billing can play a significant role in reducing emissions. The trend towards the sale and distribution of music and DVD's online is similarly important in the entertainment world.

Like ecommerce, e-government could have a major impact on reducing emissions through the transformation of public service delivery. Many paper based services can be moved into the digital environment. There are also major energy efficiencies to be achieved in the governmental supply chain. Although a credible start has been made on the implementation of government systems and services, the poor quality and limited extent of broadband infrastructure has been a mitigating factor in the take up of this concept.

4.4. Intelligent Buildings and Smart Homes

The origins of Intelligent Buildings and Building Management Systems both have roots in the industrial sector in the 1970's, from the systems and controls used to automate production processes and optimize plant performance. The concepts and applications were then adapted, developed and modularized during the 1980's, enabling transferability of the technology to the residential and commercial markets. The next chapter in the life of Intelligent Buildings opens in a major way with the roll out of high capacity broadband infrastructure to provide for sophisticated networking and remote monitoring and management.

The essence of Intelligent Buildings lies in the control technologies, which allow integration, automation and optimization of all the services and equipment that, manages the environment of the buildings concerned. Later developments in commercial and residential applications were based on distributed intelligence microprocessors. The use of these technologies allows the optimization of various site and building services, often yielding significant cost reductions. With increased awareness of energy use, energy efficiency is fast becoming part of real estate and facilities management, and operations strategies. The concepts are now making rapid inroads into the domestic residential sector.

With the widespread adoption of digital technologies (and now high capacity broadband) there has been a profound change within homes in respect of how people shop for goods and services, conduct business, manage resources, find entertainment and maintain independence and autonomy as they enter old age. As the perception of banks, shops, universities, communities and cities change in response to new technologies such as high capacity broadband, homebuilding management systems are taking on a new importance.

Services and equipment that utilize these networks include; security, home theater and entertainment, telephones, door phones and intercoms, PC and Internet networks, surveillance cameras, driveway vehicle sensors, communication thermostats, motorized blinds and curtains, entry systems and irrigation systems.

4.5. Intelligent Power Grids

Any electricity grid is a collective of wires, transformers and infrastructure that transports electricity from power plants to users. Most conventional networks are huge inefficient grids that lose power in transmission and require an over capacity of generating capability to cope with unexpected demand. Power networks without ubiquitous high capacity bandwidth are blind and are unable to determine where their losses are incurred. Normally communication is one way only, from producer to consumer. In all but a few countries selling power back to the grid is impossible.

An intelligent grid has a minimal amount of waste and a highly efficient use of power. It is an electricity network that uses energy resources and advanced communication and control technologies to deliver electricity more cost effectively, with lower greenhouse intensity and in response to consumer needs. Intelligent grids aim to achieve interactive energy generation and distribution, in which a proportion of the electricity generated by large conventional plants can be displaced by distributed generation from renewable energy sources, which include

wind turbines, solar panels, micro turbines, fuel cells and co-generation. Such a system aims to generate energy closer to the point at which it is needed and seamlessly integrate intermittent renewable sources into the wider network.²¹

If the quality and extent of broadband infrastructure is available to make the system run smarter it is possible to reduce transmission losses, reduce wastage and make the overall supply itself greener.

4.6. Intelligent Transport Logistics

In a modern economy the physical transportation of goods has become a sector of massive importance (of even greater importance because of globalization). The logistics of the transport industry, involving packaging, transport, storage, consumer purchasing and waste management are traditionally inefficient. Currently one third of the billions of kilometers traveled annually by Australian freight vehicles are without loads. Network-enabled vehicles and load monitoring systems that reduce unladen and under-laden trips can now be created. Intelligent Logistics comprising a range of ICTs have been developed that enable companies to monitor, optimize and manage operations with a view to;

- Reducing storage needed for inventory.
- Reducing fuel consumption.
- Reducing kilometers driven.
- Reducing the frequency of vehicles traveling empty or partially loaded.

In Australia the road freight sector is responsible for 36% of the transport sectors emissions and 5% of the nation's total emissions.²² What is clearly needed for this industry is a Real-time Freight Management System which goes far beyond typical in house conventional freight management systems. Stepping up to such a system would involve mobile data networks to enable freight brokers to identify loads, vehicle locations, destinations and load status in order to offer freight to empty or partially laden vehicles. The technologies that are essential to make the system work include, broadband networks, messaging platforms, telematics, supply chain software, real time route optimization software, base management platforms and forecasting and replenishment planning systems.

4.7. Personalized Public Transport

Serious and reliable broadband networks provide the foundation for a public transport service on demand. Personalized Public Transport allows the user to order public transport provided by an integrated network of multi-occupant taxis, minibuses, buses and trains which start at the front door. The objective of the PPT system is to exceed the efficiency of using the private car with faster speeds door to door, greater flexibility and lower costs. Other opportunities have been identified with the potential for web-based intelligence to increase car pooling and therefore the net efficiency of car use.

The net effect of Personalized Public Transport is;

- Increased flexibility for the customer.
- Reduced waiting times for the customer.

²¹ Intelligent Grid Research Cluster. (Australia) www.igrid.net.au/

²² Telstra Climate Risk Report: Towards a High-Bandwidth Low Carbon Future 2008.

- Increasing the use of public transport within the catchment.
- More frequent services
- Higher speed arterial services.
- Increased commercial viability of all transport suppliers

4.8. Intelligent Transport Systems

The introduction of intelligent transport systems where vehicles communicate with their surroundings including other vehicles is expected to be widespread within the next 10 years. Intelligent transport systems provide the opportunity for more efficient use of road infrastructure and energy. Cars can be managed to optimum road speed to suit conditions, traffic lights and pedestrian crossings can be managed more effectively. Electric vehicles can be managed to optimise use of charging stations.

Many of the tools employed to tackle major environmental challenges in today's world are Information and communications based products and services. Since the advent of broadband, communication networks have added serious value to the work of computers. Extra-ordinary developments in the capabilities of communications technology have in effect been a "quiet revolution".

Together computing and communications technologies enable a wide range of other technologies to address air and water pollution, understand global warming and aquatic ecosystems facilitate re cycling and achieve more efficient use of energy. The planet's response to climate change will increasingly involve highly sophisticated communication networks and super computing power. High capacity broadband infrastructure is vital at the global, national, regional and local level.

5. Social Impact of High Capacity Broadband

Since the general public gained access to the Internet in 1993-4, firstly by narrowband dial up access and since 1998 by very ordinary – so called broadband speeds (generally less than 1Mbps) a Social and Cultural Revolution has been underway.

In the last fifteen years, individuals, families and communities have experienced quite extraordinary changes in respect of how, when and where they live, work and play. With access to high capacity broadband, in the next fifteen years the same individuals, families and communities will experience a paradigm shift in terms of the way they communicate, live their lives, earn their living, enjoy their retirement, access services and select their entertainment.

Fixed line applications at home, at the work place and in community facilities and ubiquitous mobile devices handing speeds of more than 50 Mbps will usher in a new era of collaboration and interaction based on real time, high resolution and ultimately 3D interactive services.

Everyone with access will benefit from a range of very fundamental choices including,

- The option of no longer having to do many time consuming and routine tasks.
- Being able to do many selected traditional tasks faster, more effectively and at more convenient times.
- Choosing from a kaleidoscope of enriched new functions and activities.

Most of the enhanced existing services and new services will involve lifestyle benefits for individuals and families, and, benefits associated with the delivery of community services.

5.1. Home Based Entertainment

Whilst the business world and government agencies will comprise a very important part of the demand for Next Generation Systems the real breadth and depth of the demand for high capacity broadband will come from home users.

Technology from radio and record players to television and DVD's has a long history of opening up new forms of entertainment. However it is the broadband revolution that is now defining exciting possibilities to improve, expand and enhance recreational and entertainment experiences. The availability of high capacity broadband is redefining consumers relationships with traditional media. Top quality broadband is improving the quality of entertainment, offering more choices in entertainment, allowing more control of the media and enabling consumers to participate in creating media.

Demand for consistent and higher speeds and higher upstream capacity is growing as new web services and the uploading and downloading of video in particular increase in usage. To put the time frames in perspective, Flickr photo sharing was launched in 2004, You Tube video sharing in 2005, Facebook in September 2006, Gmail in 2007, BBC iPlayer in December 2007 and Apple TV "Take Two" in January 2008. The consequent growth in traffic over the last few years has been dramatic. You Tube for example currently consumes as much bandwidth as the entire internet required in 2000.²³

Growth to date has largely been unconstrained by price signals, as broadband operators have tended to offer flat rate unlimited usage packages to consumers. In early 2008 Cisco forecast 42% annual growth to at least 2011 for global Internet consumer traffic.²⁴

Perhaps the most challenging aspect of the growth in demand for increased bandwidth from the home will be simultaneous use of bandwidth hungry applications such as, home based business operation, videoconferencing, real time online gaming, distance education experiences, social networking and remote health monitoring.

5.2. Tele-medicine and eHealth

Health care systems worldwide are under great and increasing pressure associated with escalating costs, changing disease patterns, the aging of the population and increasing mobility of patients and professionals. The power of information and particularly communications technologies have been harnessed in creative ways in recent years as health care professional and administrators strive to deliver better and more efficient healthcare services.

Many future improvements in health care will originate not from better drugs or better doctors but from better managed information. Some experts in the field believe the world is on the cusp of a paradigm shift in the nature of managing and delivering health care services because of the potential of next generation networks.

In practical terms the concepts of eHealth and telemedicine basically date from the late 1990's.

In the Journal of Medical Internet Research²⁵ G Eysenbach defined eHealth as long ago as 2001 as *".....an emerging field at the intersection of informatics, public health and business, referring to health services and information delivered or enhanced through Internet and related technologies....."* In most instances eHealth features networked services such as electronic messaging between hospitals and other health care participants for

²³ Report on Next Generation Broadband for the Broadband Stakeholder Group: by Plum Consulting. London. June 2008.

²⁴ Cisco. 14 January 2008 "The Exabyte Era"an exabyte is a billion gigabytes.

²⁵ Volume 3 of 2001.

communication of clinical and administrative data and telemedicine such as telepathology services and teleconsultations. Broadband deployment has led to quite revolutionary developments in telemedicine especially in respect of the ability to make diagnoses and provide treatment for patients via high speed two way voice, data and video transmission.

The principal areas of healthcare in which access to broadband has made a significant difference include:

- Reduced health care costs.
- Increased access to health information.
- Improved quality of health care.
- Superior access to health care.
- Greater prevention of illness.
- A shift from hospital care to primary and home care.
- Providing better citizen centered health care.

Access to high capacity broadband will produce even greater strides and achievements in these areas.

5.3. Education Services and Life Long Learning

Education systems are confronting challenges not altogether dissimilar to their counterparts in the health service, especially with regard to escalating costs. As in health, the power of information and particularly communications technologies have been harnessed in creative ways in recent years to assist educational professionals and administrators to deliver better and more efficient education services. The availability of greater and more reliable bandwidth since the late 1990's has had a major impact. In the foreseeable future secondary, primary and early childhood education services will feature fibre to the classroom and quite conceivably, fibre to the desk as a key feature of contemporary facilities. Ubiquitous high speed wireless systems will also be part of the mix.

At the post secondary level of education, distance education is perhaps the most obvious but certainly not the only educational use of bigger pipes. With a large proportion of post secondary students living off campus there is an ever increasing need for extra bandwidth to ensure that such students receive the same quality of educational experience as students on campus. Many smaller regional campuses are turning to high capacity broadband to enable them to provide their students with the same quality of instruction as larger institutions. Education for the young and the not so young is no longer confined to sitting in a classroom and taking notes (chalk and talk).

Increasingly the learning journey at all levels of education involves internet based research, online collaboration with fellow students, videoconferences with remotely based experts and celebrities and real time video based exploration.²⁶

In other aspects of education;

- High quality video is providing meaningful two-way, interactive, real time learning experiences.

²⁶ Atkinson and Castro: Digital Quality of Life (ITIF) Washington October 2008.

- Education and gaming technologies are beginning to merge into learning based simulations that are demanding massive bandwidth.
- Parents are able to use the Internet to monitor their children's academic progress.
- Companies are using sophisticated online technologies to save on workforce development costs.

Increasingly, the ability to expand access to education and cater for multiple learning styles depends on the extent and quality of the broadband infrastructure.

5.4. eGovernment Service Delivery

Part of the foundation of any successful community is its system of government and community services, which involve the collection and dissemination of information. Successful communities also have strong bonds between their members and with other communities.

Effective and reliable telecommunications infrastructure has made possible a new era of online communities which are distinct from traditional geographical communities. Online systems and services now make it possible for citizens of smaller and remote communities to have access to products and cultural opportunities that were previously only available in large cities. In recent years communities of interest have become very important to people irrespective of whether they live in urban, suburban, rural or remote locations.

Because ICTs (especially broadband infrastructure) facilitate the collection, analysis and distribution of information the technology is central to the functioning of all community agencies irrespective of size or location.

Government departments and community agencies have been prime beneficiaries of the major breakthroughs in the provision of broadband services in a number of ways including;

- The transformation of complicated legacy systems into customer friendly systems.
- Making government more efficient.
- The provision of data required for various forms of problem solving.
- Promoting government transparency and accountability.
- The provision of "access" to important data outside business hours.
- Reducing the costs of service delivery.

In our increasingly complex world the sophistication of the data that can be reliably transmitted by government and community agencies to people depends on the extent and quality of the broadband infrastructure.

5.5. Personal Security and Public Safety

In many parts of the world the last twenty years has seen a major shift in concern about personal security and public safety. The level of concern does vary significantly however from country to country.

Householders and individuals are increasingly turning to state of the art ICTs to;

- Secure homes from crime and other hazards
- Make vehicles safer
- Reduce auto theft.
- Prevent accidents
- Respond to emergencies

It is hard to overstate the importance of broadband technology in ensuring public safety. Fast, interactive, content rich services that are the fundamentals of high capacity broadband in times of emergencies are now relied upon to simultaneously deliver voice, high speed data and high quality video for a range of strategies. Beyond local emergencies, at a national or regional level broadband infrastructure is essential for real time interagency coordination, monitoring and mobilization. Ultimately it makes good sense to develop the infrastructure in a way that features multiple carriers, disaster back up services, multiple facilities and decentralization. Top quality, broadband infrastructure has made a significant difference in a range of key activities designed to protect public safety and include;

- The use of biometric screening
- Enhancing remote surveillance
- Better understanding complex weather systems
- Replacing traditional mail services with electronic mail services
- Facilitating remote working stations (Telework)
- Transferring large data and image files at high speed
- Facilitating the involvement of mobile robots in hazardous situations
- Providing accurate information for off site managers dealing with emergencies

The effectiveness of Public Safety strategies always rely heavily upon having the right information, delivered to the right people at the right time. A large range of sophisticated IT products and services can now be made available via broadband infrastructure to more effectively manage responses to natural disasters and national emergencies.

In Conclusion.....Why an Imperative?

It is a perfectly reasonable question to ask why the roll out of High Capacity Broadband should be described as an imperative.

The word imperative implies a sense of urgency. It is the author's view that the magnitude of the challenge to recover from the current global economic meltdown (2009) and to create a carbon neutral future clearly establishes that sense of urgency. At present there is more than a modest sense of economic and environmental urgency confronting the communities, nations, corporations and governments of the world.

In the first decade of the Twenty First Century we find ourselves entering the vital Third Phase of the ICT Revolution that began in the early 1970's. Interpreted simply this implies we are about half way through the impact of the ICT Revolution.

The essential infrastructure that will enable the world to fully exploit the second half (The deployment period) of this revolution is High Capacity Broadband. High quality, high speed broadband is as vital to the contemporary economy as railway lines, assembly lines, power lines and black top highways were to previous revolutions.

The ICT Revolution is one of our best hopes for economic recovery from the current recession and one of our best hopes for the next long term wave of prosperity, if we invest in broadband infrastructure.

The ICT Revolution is one of our best hopes of delivering a low carbon future and tackling the challenges of Climate Change, if we invest in broadband infrastructure.

The ICT Revolution is one of our best hopes to identify, unlock and harness the awesome potential of the Twenty First Century associated with Nanotechnology, Biotechnology, Renewable Energy, Green Chemistry and Regenerative Medicine, if we invest in broadband infrastructure.

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