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SUBMISSION TO THE STANDING COMMITTEE ON INFRASTRUCTURE AND COMMUNICATIONS' NEW INQUIRY INTO THE NATIONAL BROADBAND NETWORK

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I wish to thank the Committee for seeking my view on the capacity of the National Broadband Network (NBN) to contribute to a number of important points.

I wish to state that I have expressed my view on these points to my best ability. Some of the opinions are based on my expertise in telecommunications and computer networks, assistive healthcare, education, and IT industry; some are based in my interest as an ordinary Australian who is keen to see the NBN properly realized for the benefits of all Australians.

I am willing to be called before the committee, if necessary, to elucidate any of the points expressed below.

The NBN will revolutionize Australia in an unprecedented way as it allows all Australians to be connected anywhere, anytime through an Internet-enabled device. It creates a unique information infrastructure covering the whole continent with necessary capacity for people to live, to work, and to do business. Most importantly, it opens up opportunities for Australia to develop new services, especially services that improve quality of life of its citizens and that create wealth for the country.

However, to fulfil its potential the NBN must be provisioned **properly in terms of upgradable capacity, points of interconnect, security of the infrastructure, end-to-end quality of service, and integration of wireless, satellite, and fibre networks.**
With this preamble, I have to stress that all the affirmative points that I express below are conditioned upon how the NBN is realised and services to be developed..

Below are my views on specific points sought by the committee on the capacity of the National Broadband Network to contribute to

A) the delivery of government services and programs

The NBN main objective is to provide a direct connectivity to every Australian household. Clearly, it enables an effective means for direct delivery of government services and programs as it allows necessary information to be reached, delivered, and exchanged between the government and its citizens. However, how efficiently the services are delivered depends partly on how they (services) are designed and implemented through third party providers over the NBN. The government, the NBN Co and the business community will play main roles in making the best use of the NBN.

- Reaching all premises*
- Allowing dialogues in both directions

B) achieving health outcomes

The current model for healthcare is built around hospitals, doctors, nurses and other medical personnel. This model has, up to now, well served the needs of developed countries with relatively young and healthy communities. However, if we continue with this expensive model the healthcare system will be stressed to the point of collapse for a number of reasons:

* The phrases in the text box capture the NBN's contributions

- Healthcare is becoming too expensive to deliver. For example, the US Congress, already overburdened with an annual healthcare bill of more than $1.5 trillion, fears that the healthcare system will be unable to deal with the increase of potential patients [1].
- Changing population demographic. The worldwide population of people over the age of 65 is increasing rapidly. The Australian Bureau of Statistics states that in 1998, most people aged 65 years or more lived in private dwellings (91%) and 6% lived in hostels or nursing homes [2]. This implies that preventive and/or assistive care must remove the expensive components of healthcare. Hospital visits and face-to-face consultations with medical personnel are required only where absolutely necessary.
- Home care preference. Many people prefer their living in their own home rather than being in a hospital or nursing home, provided there are satisfactory means for assisting them with homecare and/or selfcare services.

Alternative solutions need to be developed to reduce healthcare costs whilst preserving or enhancing the quality of life of a country's citizens. We urgently need an Assistive Healthcare infrastructure for eliminating/minimising the expensive components of the conventional healthcare system, providing better healthcare services to an increasing aged-population, and reducing the overall healthcare cost. This assistive infrastructure is generally based on three innovative concepts of (1) mobile sensing and actuating for health monitoring, (2) unified electronic medical record (EMR) for holding personal health data, and (3) collaborative information infrastructure such as Grid and Cloud [3, 4] for sharing and collaborating on specific EMR.

Without the NBN, the communities (aged, rural, disadvantaged, and indigenous communities) that need help most cannot be reached electronically and as a consequence, even with good wills, clever ideas, and strategic plans, no useful, assistive and preventive health services can be done for these communities. The quality of life of these communities will be worsened and the ultimate costs to look after them are astronomical.
With the NBN, a modern, integrated healthcare system can be realised that improves the quality of life of all citizens, including the above-mentioned communities, at affordable costs. For example,

a) When the unified Electronic Medical Record (EMR) is realized, the NBN can be used extensively to deliver needed data, treatment and management of patients, and government health programs to targeted communities efficiently and effectively. All concerned parties (patients, relatives, clinicians, hospitals, insurance companies, health authorities, and governments) can share and collaborate on a targeted patient through his/her EMR.
b) New services that improve the quality of life of citizens can be developed by the governments. More importantly, these health services are themselves business opportunities that can be delivered by private enterprises. This creates a whole new industry associated with the NBN-enabled health services:
   - Various forms of telemedicine services can be developed
   - Activity monitoring services can serve well the aged community
   - Various forms of collaborative consultation services can be developed
   - Expensive demonstrations of medical operation can be shared online across teaching institutions, etc.

The NBN is absolutely necessary as the foundation of this assistive healthcare infrastructure

- Enabling assistive healthcare infrastructure
- Reducing the costs of national healthcare systems
- Improving quality of life of citizens

C) improving the educational resources and training available for teachers and students
I believe that we must see education as one of the most important investments for our future; otherwise our education system will always be disadvantaged.
Furthermore, as an advanced society, collectively we endeavour to provide equal access to opportunities to all. This implies that our education system must be improved to give equal access and opportunity to all people regardless whether they come from rural, urban, lower socioeconomic regions.

Without the NBN, delivery of educational resources and training over the Internet is often impractical either due to the network bandwidth limitations that prevent the exchange of large amount of multimedia data or the network slow responses (both download and upload) that prevent proper interaction between users. These limitations defeat the purpose of online education!

Clearly, with the NBN, the above limitations can be overcome and educational resources and training can be made available to all, including rural and disadvantaged areas. For example, distance learning can be made accessible to all with little costs; training materials can be shared all over the world; mobile and multimedia interactive classes can be conducted; etc.

- Allowing equal access to information to all
- Promoting active learning

D) the management of Australia's built and natural resources and environmental sustainability
With the advance of wireless sensor networks, smart phones, and Smart Grid (just to name a few), Australia's built and natural-resources can be managed efficiently.

Wireless sensors can cheaply and easily capture environmental data such as temperature, wind directions and speeds, moisture, salinity, water levels, etc. The data can be collected, stored, and analysed to extract valuable information that ultimately can help us to manage our environment in a sustainable manner. With well-informed information farmers are more likely to grow their crops with greater yields and manage their water resources efficiently.
Sensors and mobile phones allow us to detect critical events such as bushfire, tsunami, and flood and provide early warnings that may save lives as well as the environments.
Smart Grid with its web of smart meters allows us to manage and minimise our energy consumption and emit less carbon to the environment.
These new developments require a constant collection and transportation of extremely large amount of data from the sensors over the network to various data centres.
The NBN will clearly play an important role in providing the infrastructure for collecting and transporting massive amount of data generated by these sensors, phones and networks.
Furthermore, with the NBN, intelligent schemes can be developed and implemented as control loops to sustain our environment through sustainable developments.

- Enabling ubiquitous sensing and monitoring
- Supporting the control and management of sustainable developments and resources

E) impacting regional economic growth and employment opportunities
On this point, I am not an expert to provide detailed responses. However, I believe that with the construction of the NBN over the next 7 years, there will be a sizable growth in the NBN-related employment in the areas of construction, training, managing and maintaining services.
It can also be envisaged that many new business opportunities associated with the development and operation of new applications and services over the NBN will be generated for both small

and medium businesses and large enterprises such as possible establishment of data centres in regional areas or possible creation of new businesses for managing local products globally.
Other impacts may include a possibility of decentralization of the population to regional areas due to reduction in the cost of living.

- Improving the quality of life of people in regional areas

F) impacting business efficiencies and revenues, particularly for small and medium business, and Australia's export market

The NBN is, however, only a necessary condition for our wealth-generating information economy, it is up to us to take advantage of the infrastructure to move ahead of the rest of the world by developing innovative use of the NBN.
Many revenue-generating services that are vital to our economy such as e-commerce, online banking, mobile health, online entertainment, etc., can be generated and managed efficiently by small and medium businesses (SMBs).
The cost of establishing viable SMBs can be reduced as they now can exist away from expensive urban areas. SMBs can also run their chains of business remotely and thus further reduce their operating cost. Many new services can now be developed from premises and be delivered directly to customers connected to the NBN.
As mentioned previously, with education as an investment, people do have choices in the way they invest in their education. With the NBN, it is quite possible that a new form of education-industry be created to satisfy the needs of different communities including international communities.
All these possibilities may open up Australia's export market in many new areas.

- Creating new business opportunities
- Expanding Australia's export market

G) interaction with research and development and related innovation investments

The recent Excellent Research for Australia (ERA) initiative has affirmed that on the whole the research quality of Australian institutions are above the international benchmark, however, research collaboration amongst them and with international partners is insignificant. One possible reason for the lack of collaboration is the limitation of the funding model that does not really encourage collaboration. Another reason can be contributed to the lack of an information infrastructure that facilitates inter disciplinary and cross-institutional collaboration.
With the NBN, the funding issue may remain but the distance barrier between institutes/organisations is no longer an issue as the network infrastructure provides adequate bandwidths for just-in-time collaborative environments and fast response times for real-time interaction at minimal costs to the institutions (compared to the current situation). Furthermore, the NBN provides abundant bandwidth to support the transfer of massive amount of data often required by the collaboration that may involve multiple parties.
Clearly, the NBN will alter the way research collaboration is conducted and innovation service developments are conceived and invested.

- Collaborative research is much easier through adequate support of real-time multimedia interaction and tools
- Data can be collected and transported from remote locations through sensors and sensor networks and made readily available for collaborative research.
- New areas of advanced research may flourish as the NBN allows complex intensive computations to be distributed over geographically separated data centres. These may include research in Cloud computing, and Quantum computing, Security, and Information Visualization.

- Numerous innovative services in E-health, M-health, education, entertainment, games, and many others will be developed by the collaboration between relevant research communities and their connected industries.
- With close collaboration among institutions and industries, technology transfer can be done more effectively and commercialization of research outcomes can be facilitated

- Stimulating collaborative research
- Advancing Australia research capability
- Facilitating technology transfer

H) facilitating community and social benefits

The National Broadband Network is the single most important project as it provides the infrastructure that is absolutely essential for

- delivering our modern education system,
- implementing our affordable healthcare system and,
- creating revenue-generating and useful services for all Australians.

As such, the NBN clearly has an enormous capacity to facilitating community and social benefits. On social benefits, the NBN provides equal access to information, enhances social interaction, and offers new opportunities for the whole population. It also facilitates policies and measures for improving the quality of life of all Australians including the aged communities, the indigenous communities, and the disadvantaged rural communities.

- NBN is about social benefits just as it is about technology and economy.

I) the optimal capacity and technological requirements of a network to deliver these outcomes

As far as I can see, the NBN with its fibre to the premise (FTTP) can be provisioned with extensible capacity and technological requirements to deliver the outcomes mentioned above for a number of reasons:

i) *Fibre transmission medium is a foolproof technology for the lifetime of the NBN and beyond.* This point requires further explanation:

Wireless transmission medium has a fixed capacity due to its spectrum limitation. This capacity is dictated by Shannon's law that states that the capacity of a transmission channel is a function of its spectrum bandwidth and the signal to noise ratio. Both factors are constrained regardless of the design of the transmitters and receivers. Furthermore, wireless medium is a shared medium and hence the quality of service of a connection is affected by other users as well as unwanted unpredictable interferences sharing the same medium.

With a fixed amount of spectrum allocated, the capacity of the wireless channel can only be increased by increasing the power of the transmitted signal (as not much can be done to reduce the noise that is inherent in any systems); however the power of the transmitted signal cannot be increased beyond a certain limit or else it will interfere with the environment and cause health hazards.

Fibre capacity for all practical purposes is limitless for the following reasons:

- Each fibre channel can provide an extremely large bandwidth capacity, more than the total capacity of all wireless channels put together (for the amount of spectrum allocated),
- The capacity of fibre can be upgraded to accommodate future demands as follows.

- Additional fibre channels can be provisioned and multiplexed if needed (in the future) on to a single fibre wire using dense wavelength division multiplexing (DWDM) techniques.
- Additional fibre wires can be provisioned within a single bundle of fibres, and
- Multiple bundles of fibre can be accommodated within a single duct.

Wireless technology, however, is indispensable as it allows user mobility and covers locations that are inaccessible by wired communication lines including fibres. Wireless technology is thus essential in the overall design of the NBN for both mobility and reachability (rural and remote areas unreachable by optical fibres).

ii) *Fibre capacity can be provisioned to provide necessary quality of service (QoS) for applications.*

One of the main factors that affect the QoS of an application is traffic congestion over the network. Congestion, however, always occurs when the traffic demand is greater than the available capacity resource.

- FTTP NBN can be provisioned to cope with the projected demand and reduce network congestion over its lifetime. As it is possible to predict with some degree of certainty the traffic demands from the projected Australian population over the next fifty years, the core of the NBN (the backbone with long haul trunks) can be provisioned with adequate capacity accordingly.
- Congestion often occurs at the points where fibres from homes (buildings) merge. It is important to provision adequate fibre channels to provide the guaranteed bit-rates for the customers and accommodate unpredictable future demands (Point to point Ethernet and multiple fibres may be necessary for small home businesses and multiple dwellings).
- Congestion may still occur **in the future** at the network termination point (the interface between the premise and the access network) if the total demand from all applications and services within the premise exceeds the specified 100Mbps from the premise to the NBN exchange. This is because the applications and services within the premise have to share amongst themselves the specified capacity. Provisioning of 100Mbps is adequate for now but it is impossible to predict exactly the traffic demand of emerging applications and services in the future. The NBN must provision for emerging and future demand from the premise up to a conservative estimate of more than 10 times the current specified bit rate.

Summary

In summary, the NBN is a visionary project that can deliver all the mentioned benefits to all Australians regardless of political parties in the Government for a number of reasons:

- Fibre technology is the best and future-proof technology for the purpose
- Business enterprises will never realize such a project as it is costly to their shareholders to provide fibre to the premise and connectivity to rural areas.
- Only the Government initiated and supported NBN can subsidize the costs, implement the infrastructure, and provide equal access to all Australians.
- More excitingly, *the NBN provides an unprecedented opportunity for business community to develop new revenue-generating services* as the network bottleneck constraint is eliminated.

However, the NBN must be provisioned and implemented properly. We have made a big investment in the NBN and we have only one chance to do it right. We must do it right!
I urge the NBN Co to pay attention to the following points:

- ***The capacity of the NBN core must be provisioned adequately so that even with the growth of Australian population and the change in the distribution of the population over the next 50 years and beyond, the congestion within the network would be acceptable for all predicted emerging critical and real-time applications.***
- ***The capacity of the feeder fibres must be adequate to cope with an increase in the number of premises sharing the same feeder. Otherwise, point-to-point Ethernets should be provided to premises.***
- ***The capacity of the drop and distribution fibres from the premise to the spitter should be provisioned to cope with more users and more emerging applications within a premise in the future.***
- ***It must be provisioned with adequate points of interconnect (POIs) so that service providers can operate and compete to provide better services for their customers.***
- ***The NBN must implement strong security mechanisms to protect both layer 1 and layer 2 from all types of malicious intruders.***
- ***It must ensure that emerging applications and services can be integrated without altering the design of the NBN.***
- ***The NBN must ensure that the wireless portions and the satellite portions of the network can be integrate seamlessly without creating bottlenecks at their interfaces with the optical fibre portions.***
- ***The NBN must ensure that acceptable end-to-end quality of service (between any end users of the network) in terms of delay, jitter, and throughput for critical and real-time applications.***

References.

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