A New Look NBN

Submission to the Senate Select Committee on the National Broadband Network

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0. Preface

The National Broadband Network (NBN) is Australia’s largest ever infrastructure project and it is important that this Government-initiative delivers the needs of the Australian public. Under the Labor Government’s plans, the NBN was to become a nationwide wholesale-only open access network where *Access Seekers* or Retail Service Providers and deliver services through to every premises in Australia through three primary technology types: Fibre to the Premises (93%), Fixed Wireless using 4G TD-LTE technology (4%) and Ka-band satellite for the remaining 3%.

The Coalition Government has proposed a new look NBN, incorporating a greater mix of technologies including DSL-based technologies and reusing the existing HFC networks from Telstra and Optus in order to deliver the NBN "faster, cheaper and more affordably". The *NBN Strategic Review* explores options available for the Government to meet its objective and is part several review which aim to assist the Coalition in determining a new NBN model.

NBN Co Limited is a Government Business Enterprise (GBE) – wholly owned by the Government. NBN Co Limited was established on the 9th April 2009 tasked to design, build and operate the Government's National Broadband Network.

1. Summary

This submission examines a number of key concerns, including:

- assumptions made in the *Strategic Review*, in regards to:
  - Multi-Technology Mix (MTM) NBN
    - Technology and deployment issues with FTTN/dp/B
      - Guarantee of service under FTTN/dp/B
    - HFC contention and upgradability issues
      - Guarantee of service under HFC
  - revised forecasts
- decreased levels of transparency in NBN Co
- effect on emerging retail service providers
- impact on future generations
- why is the NBN so important?

2. Key concerns

2.1 Multi-Technology Mix (MTM) NBN

The recent *Strategic Review* initiated by the Minister for Communications, Malcolm Turnbull and completed by NBN Co together with external consultants proposes a new preferred *Optimised Multi-Technology Mix* model for the rollout of the National Broadband Network.

A summary of the MTM can be found on page 15 of the *Strategic Review*:

> *There are many ways for NBN Co to deliver a multi-technology approach. In this scenario, NBN Co selects which technologies will be rolled out on an area-by-area basis, in a way that minimises peak funding and maximises long term economics, while delivering 50Mbps to a significant proportion (~90 percent) of the fixed line footprint by end of CY19 (covering all areas, both broadband-served and –underserved). The technology selection by area takes into account:*
>
> - *The earliest available technology that provides a certain speed for that area;*
> - *The relative cost position (build Capital Expenditure, ongoing Capital Expenditure and Operating Expenditure) of the various technologies;*
> - *The constructability in relation to neighbouring areas;*
> - *The implications on future revenue realisation; and*
> - *The potential future upgrade path.*

The Multi-Technology Mix incorporates three technology groups for the fixed-line footprint, namely:

- **Fibre to the Premises (FTTP):** for 26% of premises
- **Fibre to the Node/Distribution Point/Basement (FTTN/dp/B):** for 44% of premises
- **Hybrid fibre-coaxial (HFC):** for 30% of premises

while suggesting the possibility of a reallocation for FTTN technology for part of the planned fixed wireless footprint and roughly retaining existing plans for the long-term satellite.

I am extremely concerned with NBN Co's preference for a mixed-technology approach, which limits network capabilities based on locality. Both FTTN/dp/B and HFC networks are limited and are unable to provide NBN-grade services experienced by end users today. Current FTTP, Fixed Wireless and the Ka-band Long Term Satellite services are designed to provide a guaranteed NNI to UNI capacity. This is done by:

- Suitable contention ratio splits with the optical splitter for GPON over fibre
- Sufficient signal strength and suitable contention ratio over fixed wireless
- Suitable contention ratio over the Ka-band Long Term Satellite service

I am concerned with both FTTN/dp/B and HFC networks and their capabilities to provide "guarantees" to network speeds between an access seeker's NNI and the end user's UNI – which the current network provides. Such guarantees cannot be made for those two technologies, as outlined in the two subsections below.

2.1.1 Fibre to the Node/Distribution Point/Basement

Fibre to the Node and Distribution Point architectures relies on the existing Telstra Copper Access Network (CAN) to provide network connectivity for the last mile using various DSL technologies such as VDSL2+ as canvased in the *Strategic Review*.

At the time of the *Strategic Review* and this submission, there has yet to be a comparable commercial deployment of a Vectored VDSL2+ network. Furthermore, there has been little experience rolling out VDSL technologies over 0.4mm gauge copper which is commonly used in Telstra's CAN.

Copper is susceptible to environmental factors such as water ingress and signal interference especially at high frequencies. Collectively, these environmental factors cause modulated signals transmitted down a copper line to have significant attenuation (signal loss) over distance and copper condition.

2.1.1.1 Vectoring technology

Vectoring is a technology designed to minimize "noise" and cross-talk between the copper lines. However, there are inherent limitations of vectoring including the need for all lines originating from the same DSLAM to be vectored, otherwise performance may be adversely affected.

2.1.1.2 VDSL Central Line Filters

Central line filters are required to be installed by qualified technicians on the end user premises if the end user wishes to have PSTN co-exist with their VDSL connection. This is what's currently being trailed by NBN Co in their Fibre to the Building pilot deployment where NBN Co contractors are required to enter into the end user's premises to install a new wall plate and line filter.

If NBN Co opts for a no-disruption, self-install model for their mass deployment as suggested by the Coalition's NBN Proposal prior to coming into government – no POTS service can co-exist with the VDSL connection in order to avoid installing a central line filter. This means that their POTS line will need to be terminated at the time of NBN connection to avoid interference of the phone line with the VDSL service. Consequently, there would be a disruption in the end user's phone service. The service provider would need to port their existing PSTN phone number to a VOIP service, a process that currently takes several business days to complete. The provider will also need to provide an ATA (analogue telephone adaptor) or a VOIP phone to the end user to receive the new service. The provider will also need to provide the new CPE (VDSL2+ modem) for the end user to obtain the Internet and phone service.

The following is a rough list of activities required to deliver a phone and Internet service under a "no-disruption" model:

1. NBN service ordered by the retail service provider
2. Retail Service Provider needs to port over existing phone number prior to copper cutoff
3. Retail Service Provider needs to provide an ATA or a Voice-IP phone capable of configured to connect to the VOIP service
4. Retail Service Provider needs to provider a VDSL2+ modem to the end user
5. NBN Co cuts off existing copper line in order to avoid installing central line splitter
6. NBN Co provisions VDSL service to end user
7. End users will wait for the porting of phone number to complete that could take a week under normal operations and potentially much longer if incorrect details are provided by the end user (such as service number, provider name, etc…)
   - **Possible issue:** During a delay, if the end user is disconnected from the copper network, the end user will be unable to receive any phone calls from their fixed line
   - **Possible issue:** This process favours Telstra as the preferred service provider due to the current process for porting. Telstra, who services the majority of Australian fixed-line telephone services, will not be required to undergo the same porting procedures as competing service providers.
8. End users will configure and test VDSL2+ CPE provided by the Retail Service Provider
   - **Possible issue:** If there is a fault or misconfiguration on the CPE, or by the RSP or NBN Co on the network, there will be no existing Internet or phone line service is available for the end user to diagnose the fault with their RSP. This will result in disgruntled end users who are left without any internet connection or phone line connection
9. End users can then set up their VOIP service once their number is ported.

As stated above, this process highly favours Telstra as the preferred service provider eliminating the complications of telephone service porting.

Furthermore, until all end users connected to the same node are connected with a Vectored VDSL2+ connection and compatible CPE, vectoring technology cannot be used as stated above. In the case where an end user does not wish to obtain an Internet connection:

- Vectored VDSL can not be deployed unless all end users are connected to VDSL with Vectoring-compatible modems or CPEs
- Customers may potentially be forced to purchase an expensive Vectored VDSL2+ compatible modem, endure service disruption during porting, install an unused Internet connection for the purposes of delivering a phone line service only.

- If NBN Co elects to continue to jumper or pass through POTS service to end users who do not wish to have an internet connection, Telstra will continue to be the primary provider of voice services. This will advantage Telstra and will hamper the rollout of Vectored VDSL due to incompatibility.

There are many potential issues that may cause the deployment of a "no-disruption" FTTN service to be of more disruption than a new infrastructure rollout such as FTTP. There is severe disadvantage to customers who do not wish to obtain an Internet service.

2.1.1.3 Worldwide comparison of "speed guarantees" on VDSL

DSL deployments (including current ADSL, ADSL2+ deployments in Australia) are known to provide "up to" speeds. For example, British Telecom's VDSL2 network advertises their BT Infinity 2 product as 76/19 Mbps (down/upstream). Real life performance, however, is known to vary based on distance and copper line condition.

Like the current NBN deployment of Fixed Wireless in semi-rural regions, NBN Co may not be able to deliver the same quality of service to all premises within a FTTN/dp/B footprint. For Fixed Wireless, NBN Co currently undertakes signal strength tests prior to installation to determine if the premises are suitable for connecting to the NBN Co Fixed Wireless network. If it fails to meet the required signal strengths, the premises are removed from the footprint and are unable to receive the Fixed Wireless service.

Since DSL-based technologies are not necessarily able to provide a minimum speed like Fixed Wireless due to factors such as copper quality and distance from the node (collectively the factors cause attenuation of signal along the copper pairs), a similar scheme should be conducted to determine whether it's feasible for the end user to connect to the FTTN network. If an end user fails to meet the set minimum target (say 25Mbps downlink) "peak speed", the service should *not* be provided in order to stay consistent with service obligations currently practised in the Fixed Wireless network.

In the above scenario, "Peak speed" refers to the maximum speed achievable where network contention is not a factor. This is comparable to the Fixed Wireless network where contention may reduce network performance, however, peak speeds of 25/5 remain achievable at all times when there is no contention.

2.1.1.4 Limitations of download/upload ratio (symmetry)

The symmetry of VDSL services are also set on a DSLAM basis, rather than on a per user basis. This means that end users connected to an FTTN network who wish to obtain a service with higher upload speeds in proportion to download speeds would need alternative arrangements such as a fibre-on-demand product due to lack of flexibility to control upload/download ratios on a per-line basis.

2.1.1.5 CPE/VDSL2+ modems

VDSL2+ modems are also presumed to be a BYO device, or as provided by the Retail Service Provider. This also limits the ability for smaller start-up RSPs to provide products such as a preconfigured CPE (VDSL2+ Modem) and may require end users to manually configure the devices. This favours larger retail service providers who also have larger purchasing power due to a larger customer base.

2.1.1.6 FTTB trial

Fibre to the Basement (FTTB) trials for MDUs are already being planned by NBN Co. The shorter loops within the buildings of large MDUs and the relatively more shielded environment of the copper allows for more reliable speeds to be delivered to end users.

However, quality of service cannot be guaranteed due to the unknown quality of the copper within the building and the inability to remediate without acquisition of the copper asset. In addition, the same limitations to CPE (VDSL 2+ Modems) detailed above apply here.

2.1.2 HFC

Hybrid Fibre-Coaxial is commonly used for broadband in urban areas in Australia through the DOCSIS 3.0 specification. These services are currently provided through both Telstra and Optus' HFC network.

The current DOCSIS 3.0 specification the Optus and Telstra HFC networks to provide speeds of up to 100 Mbps upstream and 2 Mbps downstream to end users. Currently, each Telstra HFC node has maximum capacity of:

- 445 Megabits per second upstream,
- 123 Megabits per second downstream;

which is shared across the users serviced by that particular node.

However, unlike copper, Hybrid Fibre-Coaxial is a shared medium, resulting in high contention over the network during peak times. The current average contention ratio is commonly cited as 1:200 for Telstra HFC (that is, one node to every 200 end users) and is substantially higher for Optus HFC, without real figures.

The current contention ratio for the GPON FTTP network has an optical 1:32 passive split (current design specifications reserve 12 splits for growth, resulting in a current split of 1:20). However, each split has a capacity of:

- 2,500 Megabits per second upstream
- 1,250 Megabits per second downstream

The discrepancy in actual capacity between the HFC and FTTP network makes interpreting the contention ratio without accounting for the total throughput at the point of contention of the physical network ineffective. The following table illustrates the contention in relation to the respective NBN Co AVC profile:

Figure 2-1: Contention per AVC profile using current Telstra HFC vs NBN FTTP

AVC Tier	Telstra HFC (~1:200)		NBN FTTP (1:32 at max)	
	445 Mbps	*123 Mbps*	*2500 Mbps*	*1250 Mbps*
1000/400 Mbps AVC	N/A*	N/A*	1:13	1:10
100/40 Mbps AVC	1:45	1:65	1:1	1:1
50/20 Mbps AVC	1:22	1:33	> 1:1	> 1:1
25/10 Mbps AVC	1:11	1:16	> 1:1	> 1:1
12/1 Mbps AVC	1:5	1:2	> 1:1	> 1:1

^ 1:*X* where *X* is rounded to the nearest whole number
* N/A is where service cannot be provided even at 1:1 contention due to lack of bandwidth from point of contention

The table above demonstrates the actual contention experienced by the users if all users connected to each physical point of contention elected to connect to the particular AVC profile.

Evidently, the current HFC network is incapable of delivering NBN-grade services from the aspect of contention. The current GPON FTTP network deployed by NBN Co is able to deliver almost 1:1 contention at 100/40 Mbps compared with the 1:125 contention for the Telstra HFC Network. This greatly degrades the quality of service available to end users connected to the network.

However, NBN Co does indicate that they will increase the capacity of the HFC network, by:

> *The Review assumes that to increase capacity on the HFC network, NBN Co:*
>
> - *Reallocates the unused portion of downstream spectrum (14x8 MHz); (1)*
> - *Reallocates the DOCSIS 1.1 capacity to support additional upstream and downstream capacity on DOCSIS 3.0; (2)*
> - *Upgrades upstream channels to 64QAM; (3)*
> - *Upgrades downstream channels to 256QAM; (4) and*
> - *Splits nodes (5).*

2.1.2.1 Upgrading Telstra's HFC Network

Based on these assumptions provided by NBN Co in their *Strategic Review*, as the author of this submission, I've determined that the following can be achieved using the Telstra HFC network only:

1. Presumed that this is an additional *14 x 8 Mhz* for reallocation.
2. Re-allocation of DOCSIS 1.1 capacity to Downstream and Upstream
3. 64QAM; already assumed in above scenarios
4. 256QAM; already assumed in above scenarios
5. Split nodes (further analysis below)

In the review, NBN Co canvases a hypothetical band plan for the HFC network:

> *In a hypothetical band plan for a NBN HFC network, it would be possible to allocate 7x6.4MHz channels at 64QAM for upload, allowing up to a 1:3 ratio of upload to download speed (for example 40Mbps upload to 120 Mbps download, more commonly described in reverse as 120/40 Mbps).*

Based on these assumptions provided by NBN Co in their *Strategic Review* and the hypothetical band plan, the upgrades should theoretically be able to achieve a maximum of 1168 Mbps downstream / 215 Mbps upstream per node - assuming channels can be redistributed without limitations.

Figure 2-2a: Potential throughput of an upgraded Telstra HFC Network

Upgrade Conducted on Telstra's HFC Network	Additional Downstream channels per node	Additional Upstream channels per node	Additional Downstream throughput*	Additional Upstream throughput^
Original EuroDOCSIS 3.0 capacity	8 x 8 MHz	4 x 6.4 MHz	445 Mbps	123 Mbps
+ Additional 14x8 Mhz for reallocation	14 x 8 MHz	-	+778 Mbps	+0 Mbps
+ Re-allocation of DOCSIS 1.1	1 x 8 MHz	1 x 6.4 MHz	+56 Mbps	+31 Mbps
Sub-Total	*23 x 8 MHz*	*5 x 6.4 MHz*	*993 Mbps*	*154 Mbps*
Total spectrum available for redistribution	*216 MHz*			
Example re-distribution for 7x6.4Mhz	21 x 8 MHz	7 x 6.4 MHz	**1168 Mbps**	**215 Mbps**

* Calculated at *n* x 8Mhz = *n* x 55.62 Mbps; ^ Calculated at *n* x 6.4 Mhz = *n* x 30.72 Mbps;

However, this calculation does not demonstrate 1:3 upload to download speed (1168 Mbps / 215 Mbps is closer to 1:5) as proposed, this suggests that the calculations conducted by NBN Co may demonstrate that they have less available spectrum than calculated above. An alternate explanation to the difference in could be a higher-than-normal upload speed per channel, or lower-than-normal download speed per channel was assumed.

A more evenly distributed band plan, which tries to match the 25/10 Mbps AVC, is demonstrated in the following calculation:

Figure 2-2b: Potential throughput of an upgraded Telstra HFC Network

Upgrade Conducted on Telstra's HFC Network to the 25/1 Mbps AVC up/down ratio.	**Additional Downstream channels per node**	**Additional Upstream channels per node**	**Additional Downstream throughput***	**Additional Upstream throughput^**
Original EuroDOCSIS 3.0 capacity	8 x 8 MHz	4 x 6.4 MHz	445 Mbps	123 Mbps
+ Additional 14x8 Mhz for reallocation	14 x 8 MHz	-	+778 Mbps	+0 Mbps
+ Re-allocation of DOCSIS 1.1	1 x 8 MHz	1 x 6.4 MHz	+56 Mbps	+31 Mbps
Sub-Total	*23 x 8 MHz*	*5 x 6.4 MHz*	*993 Mbps*	*154 Mbps*
Total spectrum available for redistribution	*216 MHz*			
Example re-distribution for 25/10Mbps AVC	18 x 8 MHz	11 x 6.4 MHz	**1001 Mbps**	**337 Mbps**

* Calculated at *n* x 8Mhz = *n* x 55.62 Mbps; ^ Calculated at *n* x 6.4 Mhz = *n* x 30.72 Mbps; N.B. redistribution calculated by custom-built program linked in the appendix to provide a 25/10Mbps down/up ratio.

The table below compares the contention for the current NBN Co AVC profiles on an upgraded HFC network based on the 25/10Mbps AVC band plan (Figure 2-2b) and the current NBN Co GPON FTTP network.

Figure 2-3: Contention per AVC profile using upgraded HFC vs NBN FTTP

AVC Tier	**Upgraded HFC (~1:200)**		**NBN FTTP (1:32 at max)**	
	1001 Mbps	*337 Mbps*	*2500 Mbps*	*1250 Mbps*
1000/400 Mbps AVC	1:200	N/A*	1:13	1:10
100/40 Mbps AVC	1:20	1:24	1:1	1:1
50/20 Mbps AVC	1:10	1:12	> 1:1	> 1:1
25/10 Mbps AVC	1:5	1:6	> 1:1	> 1:1
12/1 Mbps AVC	1:2	> 1:1	> 1:1	> 1:1

^ 1:*X* where *X* is rounded to the nearest whole number
* N/A is where service cannot be provided even at 1:1 contention due to lack of bandwidth from point of contention

An upgraded HFC network without node splitting is again, incapable of delivering NBN-grade services from the aspect of contention. The current GPON FTTP network deployed by NBN Co is able to deliver almost 1:1 contention at 100/40 Mbps compared with the 1:24 contention for the Telstra HFC Network. This greatly degrades the quality of service available to end users connected to the network.

In order to meet the current FTTP network's contention ratio at 100/40Mbps, each present optical node would need to be split into 24 additional nodes further down the field.

Similarly, to meet the 1:1 contention as per the 50/20Mbps AVC profile (note, the GPON FTTP network exceeds 1:1 contention at the 50/20 AVC profile), NBN Co needs to split each individual optical node into 12 additional nodes further into the field.

Assuming that the number of homes to be serviced is 3.4 million premises as per the *Strategic Review*, the total number of nodes required to achieve on the network to achieve the 1:1 AVC contention as per the present GPON FTTP network would be:

- **408,000** optical nodes to achieve the 100/40Mbps contention
- **204,000** optical nodes to achieve the 50/20Mbps contention

Both figures, however, includes the number of nodes presently operational in the field. After exhaustive research from public data, Telstra does not appear to have provided an updated number of nodes since 2001. In *Exhibit 6-3* of the *Telecommunications Infrastructures in Australia 2001* paper, 279 nodes are cited as part of the Telstra HFC network (see Appendix 2.1.2A). Presumably, the number of nodes has increased since that document was produced.

In the optimal scenario where all 408,000 nodes are built as part of the NBN Co HFC upgrade, a 100/40 Mbps connection can be attained between an access seeker's NNI and the end user's UNI. However, this does require a node splitting of 24 nodes per present node – an upgrade which is unlikely to be conducted due to cost. The current spectrum availability on the Telstra HFC network and the limitations of the DOCSIS 3.0 specification means that NBN Co is unable to deliver 1,000/400 Mbps AVC products as the theoretical maximum uplink speeds do not reach 400Mbps connection speeds even on a 1:1 node contention – i.e. one node per household.

In reality, however, the upgrade will most likely not include all 408,000 nodes that will provide attainable 100/40 Mbps connections. The HFC network becomes inherently limited with various levels of contention beyond the access seeker's NNI. I'm concerned that within the HFC footprint, network modifications conducted by NBN Co will be insufficient in providing quality of service to its customers (access seeker) and their customers (the end users).

However, neither the amount of node splitting being proposed nor the estimated investment required for the HFC upgrades have been disclosed in the *Strategic Review*. It is concerning how many nodes would theoretically need to be built to deliver NBN-grade services to those in the HFC footprint. Yet, the review neglects to provide such crucial detail in its costings.

Note that the analysis conducted above is for the Telstra HFC network and does not include the Optus HFC network. However, spectrum availability on both networks would be similar at present.

2.1.2.2 Future Upgrade Options

The *Review* proposes two potential upgrade paths for the HFC network:

- *Building out the network from 750MHz to 1 GHz, providing access to another 30 8MHz channels (adding 1.5Gbps at 256 QAM). This could be done concurrent with upgrading to DOCSIS 3.1, expected in 2017, to allow expansion of upstream capacity concurrent with expansion of downstream capacity.*
- *In relation to the Telstra HFC network, should Foxtel agree at some point in time to move off HFC, this would free up another ~30 8MHz channels.*

DOCSIS 3.1 uses channel bonding of multiple channels of a smaller width. While upstream and downstream capacity will be achievable, should the network be built from 750MHz to 1GHz, NBN Co would need to consider potential interference of mobile communications that utilize the same frequencies. The recent selling of the 700MHz TV whitespace for future 4G network expansions, as well as current utilisation of the 850MHz and 900MHz frequencies by phone carriers Telstra, Optus and Vodafone are within the HFC network's proposed upgrades. Of particular concern is the potentially damaged or unshielded coax lead ins and in-premises wiring which may lead to interference within the end user's premises.

These issues could need to be addressed prior to mass deployment of DOCSIS 3.1 technology, at substantial cost to NBN Co or house owners.

2.1.2.3 Moving Foxtel off HFC

Note that the analysis conducted above is for the Telstra HFC network including the bandwidth allocated for Foxtel's PayTV channels. Assuming all of the additional 30 x 8MHz channel can be redistributed for EuroDOCSIS 3.0 if Foxtel agrees to move off HFC:

Figure 2-4: Potential throughput of over HFC without Foxtel

Upgrade Conducted with Foxtel off HFC to the 25/1 Mbps AVC up/down ratio.	Additional Downstream channels per node	Additional Upstream channels per node	Additional Downstream throughput*	Additional Upstream throughput^
Original EuroDOCSIS 3.0 capacity	8 x 8 MHz	4 x 6.4 MHz	445 Mbps	123 Mbps
+ Additional 14x8 Mhz for reallocation	14 x 8 MHz	-	+778 Mbps	+0 Mbps
+ Re-allocation of DOCSIS 1.1	1 x 8 MHz	1 x 6.4 MHz	+56 Mbps	+31 Mbps
+ Foxtel Channels	30 x 8 MHz	-	+1669 Mbps	+0 Mbps
Sub-Total	*53 x 8 MHz*	*5 x 6.4 MHz*	*2531 Mbps*	*154 Mbps*
Total spectrum available for redistribution	*456 MHz*			
Example re-distribution for 25/10 AVC ratio	38 x 8 MHz	23 x 6.4 MHz	**2114 Mbps**	**707 Mbps**

* Calculated at *n* x 8Mhz = *n* x 62 Mbps; ^ Calculated at *n* x 6.4 Mhz = *n* x 30.72 Mbps; N.B. redistribution calculated by custom-built program linked in the appendix to provide a 25/10Mbps down/up ratio.

Using the 38 x 8MHz and 23 x 6.4 MHz band plan as calculated above, a substantially higher theoretical bandwidth throughput would be possible on the HFC network, hence lowering contention:

Figure 2-5: Contention per AVC profile using upgraded HFC (w/o Foxtel) vs NBN FTTP

AVC Tier	Upgraded HFC w/o Foxtel (~1:200)		NBN FTTP (1:32 at max)	
	2114 Mbps	*707 Mbps*	*2500 Mbps*	*1250 Mbps*
1000/400 Mbps AVC	1:95	1:113	1:13	1:10
100/40 Mbps AVC	1:9	1:11	1:1	1:1
50/20 Mbps AVC	1:5	1:6	> 1:1	> 1:1
25/10 Mbps AVC	1:2	1:3	> 1:1	> 1:1
12/1 Mbps AVC	1:1	> 1:1	> 1:1	> 1:1

^ 1:*X* where *X* is rounded to the nearest whole number
* N/A is where service cannot be provided even at 1:1 contention due to lack of bandwidth from point of contention

An upgraded HFC network without node splitting is again, incapable of delivering NBN-grade services from the aspect of contention. The current GPON FTTP network deployed by NBN Co is able to deliver almost 1:1 contention at 100/40 Mbps compared with the 1:11 contention for the Telstra HFC Network. This greatly degrades the quality of service available to end users connected to the network.

In order to meet the current FTTP network's contention ratio at 100/40Mbps, each present optical node would need to be split into 11 additional nodes further down the field.

Similarly, to meet the 1:1 contention as per the 50/20Mbps AVC profile (note, the GPON FTTP network exceeds 1:1 contention at the 50/20 AVC profile), NBN Co needs to split each individual optical node into 6 additional nodes further into the field.

Assuming that the number of homes to be serviced is 3.4 million premises as per the *Strategic Review*, the total number of nodes required to achieve on the network to achieve the 1:1 AVC contention as per the present GPON FTTP network would be:

- **187,000** optical nodes to achieve the 100/40Mbps contention
- **102,000** optical nodes to achieve the 50/20Mbps contention

This "future upgrade" scenario would allow for much higher capacity with less optical nodes (node splitting) required to deliver NBN-quality AVC products. However, substantial build out of the current HFC network would still be required. Since this is canvased as a future upgrade, it is unlikely that NBN Co will be able to deliver such throughput per node at launch – nor the same level of build out. It would be unwise to conduct an upgrade of a network based on an assumption that Foxtel will move off the HFC network in the future to deliver present service.

A similar scenario could theoretically be achieved if Optus' cable TV services were moved off their network.

2.2 Decreasing Transparency at NBN Co

I am concerned with the decreasing levels of transparency at NBN Co, especially regarding information available publically.

Since the change in Government, NBN Co has stopped publishing a number of documents previously publicly available. These files are now released exclusively to Access Seekers who have entered into a non-disclosure agreement with NBN Co. These files include the:

- **Monthly Ready for Service Plan** *(RFS Plan)* which provides the expected ready for service date (when service is expected to become available) for all rollout regions in the Brownfields Fibre, Greenfields Fibre and Fixed Wireless footprints where construction has commenced
- **Monthly Point of Interconnect Rollout Plan** *(POI Plan)* which provides a list of 121 NBN Points of Interconnect, the number of premises serviced by each Point of Interconnect, their respective Connectivity Service Area (CSA), and expected commissioning dates.
- **Rollout Boundaries** which consists of a ZIP archive of MIF files (MapInfo Document) indicating the network boundaries for the Brownfields Fibre, Greenfields Fibre and Fixed Wireless footprints where construction has commenced
- **Disconnection Commencement Date** which provides a list of dates in areas where NBN service is available of when Telstra's PSTN network is disconnected

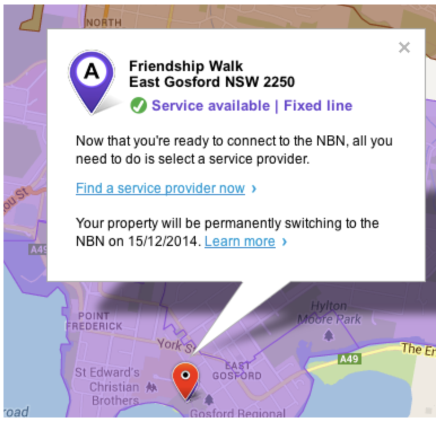
- **Proposed Footprint List** in both XLSX and XML files, provides a list of addresses at least 6 months in advanced where service is expected to become available

Removal of such files from the public has hampered public efforts to track the progress of the project, especially the removal of the Monthly Ready for Service plan, which limits the ability of individuals within rollout regions to finding out when they can expect to have service available in their area.

Furthermore, NBN Co has since removed areas where Work had commenced (where the first mobilisation payments were made to contractors along with the initial Contract Instruction to commence the production of the Detailed Design Document) but where Build had not commenced (the Contract Instruction to commence the build process) from their rollout plans and the online interactive map. I understand that this reflects NBN Co's position in terms of ability to issue build instructions, as per the interim Statement of Expectation issued by the Minister for Communications and the Minister for Finance:

> *"Any further build or remediation instructions should not ordinarily be issued pending further analysis and discussion."*

While this does limit NBN Co's ability to issue Build Instructions, areas where build had not commenced continues to have groundwork continuing such as roping and rodding. To this respect, these areas should continue to be marked as "Work commenced" to indicate where initial work had commenced and still continues to occur. It's NBN Co's responsibility as the network builder to make sure that such construction activity known to the community.



The NBN Co rollout map is located in the section of the website known as "When do I get it". However, none of the information provided in that section answers this question. NBN Co could further improve its rollout map tool by providing the expected ready for service date in areas where build had commenced. There are evidently no technical limitations to making such information being available as the Disconnection Commencement Date is already available on the map (see screenshot).

It should be noted that NBN Co has also started releasing its weekly rollout statistics as part of the Interim Statement of Expectations. Such efforts should be commended, however, provide little detail in terms of the actual rollout and its expected availability.

2.3 Conservative Estimates

I am concerned with the NBN Co's *Strategic Review* costings in relation to the current NBN plan (known as the Revised Outlook within the *Review*), which has been framed as being a "conservative approach" (page 35, *Strategic Review*).

On page 63 of the *Review*, NBN Co states that they do not expect to have productivity improvements and efficiency savings except in financial years 2017 and 2018:

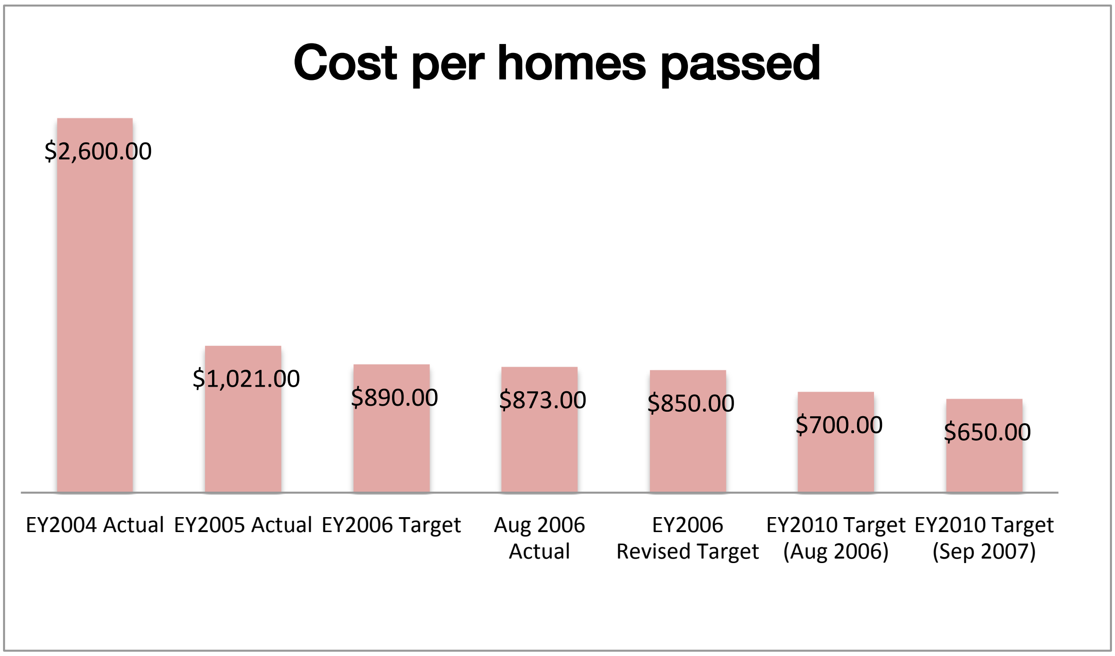
> *Productivity improvements and efficiency savings of 2.5 percent in FY17 and FY18 only (compared to every year in the Corporate Plan), reflecting the intrinsic complexity of the*

> *project, the poor capability base of both NBN Co and its Delivery Partners, and the heavily interdependent relationship with Telstra*

Verizon's FTTP deployment in the United States demonstrates the costs savings possible from improvements and efficiencies. The costs in the deployment of Verizon's FiOS network dropped from US$2,600 to US$1,021 per homes passed in 2005 (reduction of 60.7%), and dropped further to US$873 by August 2006 (further reduction of 14.5%).

In contrast, however, NBN Co's *Strategic Review* forecasts a 78% increase in LNDN costs per premises – from $1,123 to $1,997 per premises passed. NBN Co only predicts a **2.5%** efficiency savings between FY17 and FY18, in contrast to Verizon's 60%. This prediction is contrary to international trends, which is what the *Review* bases much of its other scenarios on.

Figure 2-6: Graph: Verizon FiOS cost per homes passed over time (collated) [1][2][3][4][5]



[1] The *NBN Strategic Review*
[2] "Verizon provides FiOS update": http://www.networkworld.com/news/2006/092706-verizon-fios.html?page=2
[3] "Copper pricing and the fibre transition – escaping a cul-de-sac": http://www.etno.be/datas/publications/studies/plumreport-costing-dec2011.pdf
[4] "Fiber for All! When? Why?" http://www.localret.cat/revistesinews/broadband/num18/docs/10num18.pdf
[5] "FiOS - Verizon's long-term vision to the 10+ gigabit home – ZDnet" http://www.zdnet.com/blog/ou/fios-verizons-long-term-vision-to-the-10-gigabit-home/571

Furthermore, it suggests that cost savings achieved by certain design optimisations have been halved:

> *Business cases for ~$1 billion of potential savings have been completed and implementation of some of these improvements is underway. These could be achieved over time, but allowing for the time to introduce these concepts and other risks, it is prudent to adjust the amount by 50 percent.*

The halving of the savings seems unjustified, citing only time required for implementation and "other risks". While it may be prudent to adjust the savings amount by 50%, such prudency is evidently not being applied to scenarios other than the Revised Forecast. For example, in determining the amount of remediation necessary for VDSL deployments:

> *The Australian Communications and Media Authority (ACMA) reports the current fault rate for telephone services on the entire copper network at ~17 percent. […] Given uncertainty about quality of Australian copper, the Strategic Review assumes that half of reported faults are in the local access network and will require remediation.*

It seems rather imprudent to only assume that 50% of the faults reported would require remediation. Furthermore, the report seemingly ignores the need for remediation for copper lines that have not been reported, or have not yet materialized. For example, lines requiring remediation as a result of the minimal shielding of the copper which becomes more prone to cross-talk due to high frequencies of VDSL.

2.4 Effect on emerging Retail Service Providers

Because of changing rollout strategies from policy decisions, there is evidently high instability within the telecommunications industry – especially with the emerging market of small retail service providers.

The lack of rollout stability and forward planning due to limitations in build instructions being issued (as limited by the interim statement of expectations) has led to wasted expenditure by Retail Service Providers especially for marketing.

For example, several emerging Retail Service Providers had begun marketing strategies in fibre serving areas that were scheduled to be activated before the end of CY2013 (as per the Expected Ready for Service date on the August 2013 Ready for Service plan). However, since the change in Government, the lack of Build instructions being issued for that area has led to the removal of that area from the current rollout plan. While there are inherent risks in forward-looking statements as described in the disclaimer of the document, the revoking of areas from a rollout plan presents new risks for emerging Retail Service Providers who are unable to be assured of adequate customer base.

The changing technology types, such as the MTM model, also limits the speed tiers able to be offered by Retail Service Providers to their customers.

The inability to provide guaranteed AVC due to attenuation and contention for FTTN/dp/B or contention for HFC also presents a certain level of instability for Retail Service Providers. For example, it limits the ability for business-grade services to be delivered over certain types of networks such as FTTN/dp/B or HFC. Multicast technology is also unable to be delivered over FTTN/dp/B, while multicast over HFC would be limited by the channel capacity assigned and may remain exclusive to Foxtel. It is also unlikely that a viable multicast product can be provided over HFC due to the likely preference to use additional spectrum for DOCSIS to provide Internet connectivity.

2.5 Impact on future generations

(opinion) The present intentions for the rollout of the National Broadband Network by the Coalition Government is short-sighted and does not account for the needs of future generation. The investment in the NBN is huge and should be used to provide a long-term solution for our future broadband needs for the decades to come.

As a young individual, I'm appalled to see the elected Government take the risk of acquiring old network infrastructure to deliver short-term broadband benefits. Using DSL technologies to deliver high speed broadband using existing copper lines provides such short-term goals, which makes sense for incumbent telcos who own the existing phone lines. It is common knowledge that optical fibre (glass) has a much longer life span than copper within phone lines, and is not prone to same level of deterioration when exposed in the environment. It shouldn't be simply about meeting demands in terms of bandwidth capacity in today's terms – the NBN should be building a robust infrastructure that can be used for the next several decades.

While it may well be that "new technologies" may arise in later decades to meet the demands of future generations, I worry that the same would be said in the future when the demand is there. Australia will inevitably be left behind in its global competitiveness – especially for our future generations. Upgrades should be conducted with forward thinking, not just to meet current demand. Telecommunications infrastructure should incorporate a stable technology with proven upgrade paths – not theoretical untested technologies that may arise in the future. A GPON FTTP network is a proven and well-established technology with proven upgrades to other PON technologies like XG-PON capable of delivering 10 Gbits down, 2.5 Gbits upstream at an optical-split level. The DSL technologies which NBN Co are proposing to use such as Vectored VDSL2+ and proposed upgrades to G.fast are still experimental technologies which have not been widely or commercially deployed. Yet, these upgrade paths being proposed are unable to provide the same capacity or the same quality of service even when compared to the current NBN FTTP GPON fibre network.

If an FTTP GPON network were to be rolled out now as per previous plans, the future upgrade to G.fast would not be needed since it has the capacity to deliver an even higher speeds or bandwidth without the need to upgrade anything.

I struggle to see any advantages for future generations in deploying a short-term fix network. Purchasing the Telstra copper network and potentially the Hybrid-Fibre Coaxial is an unnecessary expense that will need to be continually remediated and upgraded due to the lack of forward thinking. Inevitably, the network will need to be replaced – and it will need to be done by future generations because past Governments failed to use their funds with the future in mind.

2.6 Why is the NBN so important?

The text below is an extract from my blog post: http://jxeeno.com/blog:why-is-the-nbn-so-important

(opinion) There has been a lot of argy-bargy the benefits and the purpose of the National Broadband Network. But many forget, or are unaware of why we needed to build NBN Co (the company) and the new network in the first place.

Up until 1996, Telstra was a Government Business Enterprise (or GBE) owned wholly by the Australian people — exactly what NBN Co currently is. This government enterprise ran, amongst many other things, the copper network which connects the majority of premises in Australia. The troubles began in the 1996 election, when then-opposition leader John Howard announced the Coalition policy to sell one-third of Telstra. After being elected by the Australia public, 33.3% of Telstra was sold to the public sector with an additional 16.6% in 1999.

Approaching the 2007 federal election, the Coalition government sells another 31% of Telstra in late 2006 — ending the public majority ownership in the corporation. At this stage, the Howard Government had successfully sold off 81% of Telstra to the private sector. The company that runs the most crucial fixed-line communication network in Australia becomes completely privatised.

Why was privatisation a bad idea?

Looking at the state of the copper network today, it's pretty easy to see the damage caused by the privatisation. Telstra began laying off their own staff — opting for contractors paid per job, rather than per hour leading to corner cutting exercises. The company had become so focused on returning the greatest profit for its shareholders (which is what private companies do) that the infrastructure that the entire Australian population relies on begins to rot slowly but surely.

Then there's the monopoly. The majority of Telstra's fixed-line copper network was built while the company was in the hands of the public — all using tax-payer dollars. This gave a private Telstra a definite monopoly, charging atrocious prices with consumers having no other choice but to continue using and paying for the services.

NBN Co is rebuilding Telstra from scratch

Essentially, the National Broadband Network is rebuilding the Telstra copper-network from scratch — but keeping it in the hands of the Australian public. For too long, Australia has been crippled and limited by the Telstra monopoly of fixed-line communications. (At least mobile networks have three main competitors; Telstra, Optus and Vodafone.)

Telstra only has to provide a working PSTN service to households (that is, a phone line). Many city dwellers as well as us in the country have been controlled by Telstra, connected to a pair-gain system which wasn't compatible with any DSL broadband service. City dwellers became stuck on a congested 3G network, while others in the country are trapped in satellite hell while others across the road was surfing at 24Mbps ADSL2+.

ADSL pricing ranged greatly between exchanges, with "on-net" providers such as TPG or Dodo able to undercut Telstra by significant margins to provide cheap and affordable internet to a minority — primarily city dwellers (which weren't bound by pair-gain systems). The rest were left for Telstra to service with the ability to resell Telstra Wholesale. For other competitors to stay even slightly competitive "off-net", margins are often stripped to the bone.

While the speed (bandwidth) and reliability of the NBN is definitely important and very enticing — it's the publicly-owned monopoly that Australian consumers want and need. Australians should not have to suffer under the mismanagement and underinvestment of Telstra in maintaining their crucial copper network.

Realistically, we need a new network far from the hands of the private sector. A network which will remain the hands of the Australian people knowing that their network will properly function. A network which is no longer bound by Telstra's inflated and atrocious pricing for the price of a half-rotten network.

3. Conclusion

The National Broadband Network is the largest national infrastructure project in Australia – so it's crucial to get it right the first time. The original plan derived by the Labor Government's statement of expectations provides Fibre to the Premises to 93% of premises in Australia, with the remaining percentages either on Fixed Wireless or the Long Term Satellite services.

NBN Co and the Coalition Government should look to stabilizing the industry by selecting technologies that are not limited in capacity and will not require substantial upgrades within the next two decades. Issues like contention in the HFC network and deteriorating copper conditions will continue until the technology is replaced. While the 93% FTTP objective originally set by the previous Government might not be met, NBN Co should look to maximise the percentage of FTTP built to reduce the need to upgrade and reinvest in the near future.

NBN Co should also look to increase its overall transparency in its operation and continue its efforts to stabilise the industry after the change in Government.

4. Appendix

Appendix 2.1.2A

Exhibit 6-3: HFC Network Rollout

Operator	Coverage	Investment*	Infrastructure	Capacity
C&W Optus	Urban areas in Sydney Melbourne Brisbane	$3bn	• 30 nodes covering 2m households • 21,000km coax cable • 5500km cable	5-65MHz (up link) 85-700MHz (down link)
Telstra	Urban areas in Melbourne Sydney Gold Coast Brisbane Adelaide Perth	$4bn	Nodes = 279 Hubs = 4172 40,000km cable (covering 2.5m homes)	5-65MHz (up link) 85-750MHz (down link) • 64 Analogue TV Channels • 200MHz Digital Services • 768Kbps (up link) • 30MKbps (down link)
Neighbour hood Cable	Mildura, Ballarat, Bendigo (c), Albury-Wodonga (c)	$8m	140 nodes 250km cable (120,000 homes)	768Kbps 30MKbps
Austar (Windytide)	Darwin		• covering 27,000 homes	
West Coast Radio (iiNet)	Perth (Ellenbrook)		• covering 10,000 homes (planning)	

(c) = constructing
* estimates

Source: https://www.accc.gov.au/system/files/Telecommunication%20Infrastructures%20in%20Australia%202001.pdf

Appendix 2.1.2B

HFC reallocation calculator: This file has been shared on the file sharing service *Dropbox* as the committee does not accept submission of XLSX files. This calculator can be used as reference for some calculations conducted in this submission.

https://www.dropbox.com/s/nuvve6kesfod0df/HFC%20Calculator.xlsx

5. Glossary of Key Terms

The following table of key terms is sorted by the order in which the terms appear in the submission.

Key Term	Definition
NBN	National Broadband Network, a wholesale-only network operated by the Government Business Enterprise NBN Co Limited.
TD-LTE	Time Division Duplex Long Term Evolution – a 4G LTE wireless variant that uses time division technology to transmit data
DSL	Digital Subscriber Line – a group of technologies which delivers broadband through a copper pair (e.g. VDSL)
HFC network	Hybrid-Fibre Coaxial Network – refers to a network of coaxial cables currently operated by Telstra and Optus to deliver broadband, phone and PayTV services to consumers.
MTM	Multi-Technology Mix – a new deployment strategy proposed in the NBN Co Strategic Review
FTTP	Fibre to the Premises – a network where fibre is connected into each premises
FTTN	Fibre to the Node – a network where fibre is connected to a node in the street, and copper pairs deliver the final service to premises using DSL technologies
FTTdp	Fibre to the Distribution Point – a network where fibre is connected to a distribution point close to the premises than a node, and copper pairs deliver the final service to premises using DSL technologies
FTTB	Fibre to the Basement (or Building) – a network where fibre is connected to the building and the final connection into individual unit blocks is delivered through existing cooper pairs using DSL technologies
Contention ratio	The ratio at which an end user shares its bandwidth with other users of the same network. A 1:200 contention ratio indicates that each end user within a subsection of a network will share the finite bandwidth with 200 other users. The higher the contention, the more congested the network is during peak times.
GPON	Gigabit-capable Passive Optical Network – an optical-access technology that incorporates an optical split where premises are able to share a common fibre to transmit and receive data without an active network component in the field.
NNI	Network-to-Network Interface – a physical port at the Point of Interconnect which Access Seekers purchase from NBN Co to connect their network to the NBN
UNI	User-Network Interface – a physical port at the end-user's premises which allows end users to connect to the NBN.
CAN	Copper Access Network – refers to Telstra's copper network
VDSL2+	A DSL technology commonly deployed in FTTN network around the word to deliver high-speed broadband to end users
Vectoring	A technology that minimises cross talk interference between the copper pairs in a VDSL network to deliver more reliable connections.

Attenuation	A phenomenon whereby energy in electrical signals are lost, commonly due to distance or damage to transmission medium (such as copper).
BYO	Bring your own […]
CPE	Customer-premises equipment – equipment which resides within an end user's premises such as DSL modem or a network router
DOCSIS	Data Over Cable Service Interface Specification – a standard which allows broadband to be delivered to end users using a coaxial cable network
AVC	Access Virtual Circuit - The bandwidth allocated to the end-user premises.
RFS	Ready for service – when 90% of a Fibre Serving Area Module is passed, the module is declared ready for service
POI	Point of Interconnect – where an Access Seeker connects its network to the NBN to deliver services to end users
DCD	Disconnection Commencement Date – the date where, in agreement with Telstra, its copper network is switched off and premises within the Fibre Serving Area Module will need to migrate to the NBN Fibre network to continue to receive fixed-line services
Proposed Footprint List	Contains a list of premises where NBN Co expects to deliver services, no less than 6 months before its expected completion date
Work commenced	Where initial contract instructions and first mobilisation payments are issued to NBN Co construction partners to commence work on designing and building an FSAM
Build commenced	A new metric where the second contract instruction is issued to NBN Co construction partners to commence to the build process in an FSAM
DDD	Detailed Design Document – the final document produced by NBN Co construction partners and approved by NBN Co to which the delivery partners build the fibre network in accordance.
LNDN	Local Network Distribution Network – section of the NBN Co fibre network from the Fibre Access Node to the last multiport or network access point closest to the customer's premises
G.fast	An experimental DSL technology which delivers higher speeds to end users compared with its predecessors