

National
Broadband
Network

Fixed Wireless and Satellite Review

Final Report
May 2014



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1

Executive Summary

1 Executive summary

1.1 Background

NBN Co is chartered to provide wholesale access to high speed broadband across 100 percent of addressable Australian premises, including the 'non-fixed line footprint' (the premises outside the 'fixed line' footprint) which forms the focus of this Review.

NBN Co has already commenced operating fixed wireless and interim satellite services in the non-fixed line footprint. Over ~10,000 fixed wireless end-users have been activated to date, with ~280 base stations in service as at March 2014. The interim satellite offering, which is out of scope of the Review, has ~44,000 end-users activated. The two long term satellites are around two-thirds of the way through their build process.

For the non-fixed line footprint, the Corporate Plan 2012–15 allowed \$3.5 billion capex for 2011–2021 for two long term satellites, ~1,400 fixed wireless towers, a capital expenditure budget for the ISS, and ██████████ for additional base stations and associated spectrum in areas where NBN Co did not own any spectrum. The fixed line Strategic Review in 2013 did not focus on satellite and fixed wireless, but noted that even on the premises counts given, there would likely be a capacity gap, and that extra costs of more than \$1 billion in capex would likely be required to 2021.

The Fixed Wireless and Satellite Review describes current and expected progress on serving the non-fixed line footprint, and options going forward for NBN Co to meet a broad mix of policy objectives (total funding, rollout timing, download/upload speed, risk).

The Review has used the NBN Co Corporate Plan 2012–15 (August 2012), which represents the most recent Government approved plan, as the basis for financial and operational comparisons. This is also in line with the Strategic Review 2013, which similarly used the Corporate Plan 2012–15 as a basis for comparison.

1.2 Approach

The Fixed Wireless and Satellite Review 2014 was undertaken by NBN Co over a period from 3 February 2014, concluding with the submission of a draft report on 9 April 2014.

The Fixed Wireless and Satellite Review was conducted by NBN Co's Board, under the sponsorship of NBN Co's Executive Chairman.

NBN Co mobilised a cross-divisional team of internal employees to undertake a review of the architecture, rollout options, products and service delivery models for fixed wireless and satellite, as well as to review industry partnership options and revenue. Following a tender process, NBN Co appointed The Boston Consulting Group to provide an independent assessment and support the internal team.

The Review was completed under the direction of NBN Co's Chief Strategy Officer.

1.3 The footprint and technologies planned

The Corporate Plan 2012–15 estimated that NBN Co's non-fixed line footprint would account for ~1 million premises by 2021. Given that Australia has a highly urbanised population, many of those premises are located in metro fringe and regional areas rather than truly 'remote' parts of the country.

The challenges of geography and population density mean that outside of city centres, NBN Co has planned a combination of interwoven fixed line, fixed wireless and satellite technologies.

Over ~600 fixed line 'islands' are located in high density areas outside major capitals, such as major country towns. This Review focuses on areas outside those fixed line 'islands', which are to be served by either fixed wireless or satellite.

Based on the best currently available data the Review estimates there will be ~1,020,000 premises in the non-fixed line footprint by 2021, being ~8 percent of the then total of 12.7 million premises.

NBN Co's fixed wireless network uses TD-LTE technology, with current specifications designed for the 2.3GHz spectrum band. To completely cover a geographic area, NBN Co needs more towers than a notional radius and typical mobile network operator (MNO) grid suggest because although towers have a theoretical range of ~14km, line-of-sight (LOS) is required to all premises. On average, each tower is only able to reach about 20 percent of the area within that 14km radius. The specific location of towers is a critical decision and moving them as little as a few hundred metres can make a large difference to the number of premises they can reach.

NBN Co's satellite program is based around both an interim satellite service and a long term satellite service. The Interim Satellite Service (ISS) currently in place involves NBN Co leasing capacity from IPSTAR and Optus Satellite. In the meantime, NBN Co is developing its Long-Term Satellite Service (LTSS) by building two identical satellites to provide broadband services. Both satellites are scheduled to launch in CY15. The two satellites will work on the Ka band, a high-frequency spectrum particularly suited to telecommunications. They will cover the entire Australian mainland and islands through 101 dedicated 'spot beams'. Each satellite beam has a different capacity in terms of maximum bandwidth, which is split across all end-users in the beam, and cannot be changed. The highest-capacity beam can serve ~15,000 premises, while the 20 lowest-capacity beams can serve an average of ~700 premises each.

1.4 Key issues highlighted by the Review

The Review has identified a set of critical issues with the performance to date of the Fixed Wireless and Satellite Programs:

1.4.1 Based on the Corporate Plan 2012–15 infrastructure and revised take-up estimates, ~200,000 premises will not be able to be served in the non-fixed line footprint

- The Corporate Plan 2012–15 provided a budget of \$3.5 billion capex to 2021 to build 1,400 fixed wireless towers, launch 2 satellites and install end-user premises equipment. The plan anticipated a 22–25 percent take-up rate and predicted connections to ~230,000 premises (with some additional capacity available)
- The Review believes that take-up will likely be 2–3 times higher and that between 440,000–620,000 connections will be required across the footprint. The capacity constraints of the satellites and the coverage restrictions of fixed wireless towers mean that at the proposed specifications, the Corporate Plan 2012–15 would not be able to provide all the necessary infrastructure to meet the Government's objectives. While fixed wireless towers can accommodate some of the higher demand, at the higher take-up expected, ~200,000 premises would not be able to be served by NBN Co.

1.4.2 NBN Co does not currently hold spectrum rights in urban-fringe areas, which drives ~80,000 of the coverage shortfall of ~200,000 premises

- Although NBN Co holds 2.3GHz and 3.4GHz spectrum rights in regional areas, Optus holds the same spectrum in metro areas and the surrounding metro fringe which extends a significant distance from each city. As alternative spectrum has not been secured, NBN Co has a spectrum gap in the urban-fringe zone around Canberra and the five mainland State capital cities
- The Corporate Plan 2012–15 did include a provision of [REDACTED] for additional base stations and spectrum in these areas, but to date the spectrum has still not been secured
- If these areas had to be served with FTTx due to ongoing lack of spectrum, premises would likely be delayed access to fast broadband until late in the fixed line rollout, with extra deployment costs to NBN Co in the hundreds of millions of dollars.

1.4.3 The timeline in the NBN Co satellite program has a substantial level of risk, meaning that the service commencement is expected to be in early CY2016 or sooner, rather than Q3 CY2015

- Any satellite launch carries an inherent element of risk, with delays of between three and six months being common. The Review believes the NBN Co spacecraft build and launch has very little remaining contingency time available, relative to what other satellite programs would typically have at this stage of the build. It identified eight key delay risks
- The Review expects the service commencement date is more likely to be in early CY2016 or sooner and this will only be achieved if the proposed mitigation actions are executed effectively. If they are not executed effectively the service commencement date could be later in calendar year CY2016.
- Longer delays are unlikely, but could materialise even if the proposed mitigations are implemented effectively, due to the inherent risks in any complex Satellite program.

1.4.4 The LTSS needs a more robust product construct

- Higher demand than anticipated was observed with ISS. The Fair Use Policy (FUP) in place at the time, and how NBN Co was able to enforce it, was not sufficiently proactive to guide RSP behaviour. The selling of anytime plans with data usage above the Fair Use Policy by RSPs, caused the degradation of service to all end-users. This did not generate fair and equitable outcomes for end-users, and created significant issues for NBN Co in terms of managing satellite capacity.

1.4.5 The fixed wireless program is currently behind the targets set out in the Corporate Plan 2012–15 and there is significant risk of not meeting end of FY14 activation targets

- While improvements are being seen, NBN Co has not been able to activate towers in a predictable workflow.
- The cost of tower construction is higher than expected based on benchmarks.

1.4.6 NBN Co's functional siloed organisation has inhibited visibility and effective decision-making across fixed wireless and satellite

- Given the complexity of the technology choices in the non-fixed line footprint, decision-making needs to be cross functional. In addition, consideration needs to be given to how to ensure all premises in a given geography have access to at least one NBN Co technology

- Decisions on multiple critical issues have been made in functional silos and, at times, at too low levels in the organisation. Decisions have often been delayed, placing unnecessary pressure on implementation timelines and critical paths
- NBN Co could also be more proactive in approaching industry partners.

1.5 Comparative evaluation of alternative scenarios

The Review proposes a range of actions to address the fundamental issues summarised above. These actions are described broadly in Section 1.6 and detailed throughout this report.

However, in order to address the capacity and coverage issues highlighted, and to ensure that all premises in the non-fixed line footprint can receive a service, the Review also considered a number of scenarios for how NBN Co should deploy infrastructure. These scenarios model the impact of specific changes in addition to the 'base' of proposed actions across both fixed wireless and satellite programs.

- **Scenario 1: All premises served** – This scenario assumes two satellites as per the Corporate Plan 2012–15, and determines the number of fixed wireless base stations required to serve all premises in the non-fixed line footprint
- **Scenario 2: Build FTTN** – This scenario assumes FTTN is available in the non-fixed line footprint. The use of FTTN is subject to meeting minimum requirements of copper loop lengths and delivering a 25/5Mbps service, as well as economic considerations relative to alternative technologies. In select distribution areas, deployment costs can be held stable while giving end-users a product that is superior to satellite and superior to, or on par with, fixed wireless. In addition, the availability of FTTN increases the flexibility of, and decreases the risks associated with, a rollout where the availability of spectrum is not currently guaranteed everywhere
- **Scenario 3: Third satellite** – This scenario assumes that NBN Co constructs and launches a third satellite at the end of CY20. This mitigates the need to build some fixed wireless base stations and FTTN distribution areas. The capacity of this satellite will only be partially required [REDACTED] to meet NBN Co's needs
- **Scenario 4: Third satellite in partnership** – This scenario mirrors Scenario 3, but assumes that NBN Co enters into a partnership with an external party to access only the required capacity on a third satellite [REDACTED] rather than building and owning it outright.

All scenarios assume that NBN Co implements a standard product construct with a network capacity allocation per end-user of 150kbps on satellite when the network capacity is contended, given the limited capacity on the satellite. Note that network capacity allocation refers to the average of all data downloaded across all end-users in a satellite beam. It is quite different to peak speed and is consistent with a headline peak speed of 25Mbps. The proposed product construct is based on latest current thinking and on performance estimates provided by the satellite manufacturer.

As the LTSS platform cannot be field trialled until the first satellite is deployed, NBN Co may need to revise the marketed performance levels and network capacity allocation per end-user to match the reality of what is delivered. Further, NBN Co has an unbudgeted contingency plan to expand the footprint of the terrestrial technical solutions.

Relative to other commercial satellite broadband service providers around the world, the LTSS will be one of the most advanced, offering significantly higher broadband speeds and download capacities than these operators currently have in the residential market. Most operators globally are offering standard speeds of 1-5 Mbps download, with higher speed tiers available up to 5-20 Mbps. It should be noted, however, that as with all satellite services, there are still constraints of latency and capacity that need to be much more carefully managed than with fixed line services, to ensure that a high quality of service for all users is maintained.

Upgrade options would be available within satellite capacity limits for an average capacity allocation across the satellite beam of 200kbps per end-user. RSPs could be expected to sell ~20GB/month plans using this wholesale product in an anytime plan and higher in 'peak/off-peak plans'. For fixed wireless, the Review proposes a network capacity allocation of between 400–500kbps per end-user.

The exhibit on the next page sets out the relative financial outcomes of the modelled scenarios. As with the Strategic Review 2013, undertaking financial modelling over a 30 year time frame presents numerous challenges in deriving absolute numbers. The analysis below should only be used to guide high-level strategic decision-making rather than granular operational decisions.

Exhibit 1-1: Financial outcomes

Highlight of main change
to previous scenario

	Corp. Plan	Fixed Wireless and Satellite Review 2014			
	Corporate Plan 2012–15	Scenario 1 All premises served	Scenario 2: + build FTTN	Scenario 3: + third satellite	Scenario 4: or + third Satellite in partnership
Number of Satellites	2	2	2	3	2 + 1 by JV
FTTN availability	-	-	25/5 service	25/5 service	25/5 service
Number of Fixed Wireless base stations	~1,400	~2,900	~2,700	~2,000	~2,000
Technology mix in non-fixed line footprint in FY21					
Fixed Wireless	39%	60%	57%	52%	52%
Satellite	57%	40%	40%	47%	47%
FTTN	0%	0%	3%	1%	1%
Premises not covered of 1.02m premises	~200,000	-	-	-	-
Non-fixed line footprint cumulative FY11–21					
o Revenue	\$0.4bn	\$0.9–1.0bn	\$0.9–1.0bn	\$0.8–1.0bn	\$0.8–1.0bn
o Operating Expenditure	\$1.0bn	\$1.5bn	\$1.5bn	\$1.4bn	\$1.4bn
o Capital Expenditure	\$3.5bn	\$4.6–4.7bn	\$4.5–4.7bn	\$4.8–4.9bn	\$4.4–4.5bn
o Operating cash flows	-\$4.0bn	-\$5.3bn	-\$5.2bn	-\$5.3–5.4bn	-\$4.9–5.0bn
Non-fixed line footprint steady state (FY28)					
o Revenue	\$130m	\$240–300m	\$240–310m	\$240–300m	\$240–300m
o Operating Expenditure	\$140m	\$270m	\$260m	\$220m	\$220m
o Capital Expenditure	\$200m	\$280–290m	\$280–290m	\$260–270m	\$260–270m

It should be noted that the above scenarios have been modelled assuming:

- The technology mix is designed to allow for take-up rates which exist at the high end of the range (~65% for satellite, ~55% for fixed wireless by 2021). However, all financials are shown assuming both a low and high take-up and ARPU. This allows for a situation where the network is designed for a high take-up, but the resulting demand is lower than expected
- Satellite throughput is set at 200kbps per AVC to allow for the proposed standard product (specified at 150kbps) with headroom for upgrade options including for public interest premises in satellite only areas
- Spectrum is obtained for the urban-fringe areas at a cost of [REDACTED]
- The overall number of premises does not include a 10% error margin (i.e. there are 1.02 million premises in 2021), however, on the capacity constrained infrastructure (satellite) a 10% buffer is modelled
- A fixed wireless service qualification failure rate of 7% is in place, such that 7% of all premises in any given fixed wireless coverage area must instead be served by satellite
- For small, remote FTTN deployments comparable to fixed wireless, the Review assumed that microwave backhaul can be used to connect FTTN distribution areas to the transit network
- The cumulative capex figures (including the Corporate Plan 2012–15 numbers stated) are all exclusive of contingency. Contingency will be added in overall NBN Co financials, equal to the 20% of capex suggested in the Strategic Review 2013
- FTTN costs include a PSAA payment and duct rental payments
- Capex and opex for FTTN deployments was estimated based on the assumptions as the Strategic Review 2013, adjusted for the particulars of remote and rural geographic distribution areas. Premises with copper loop lengths of over 1,000m which cannot reliably receive speeds of 25/5Mbps have been excluded from consideration and are assumed to be served via satellite or fixed wireless.

The exhibit shows that:

- Scenario 1 introduces incremental cumulative capital expenditure (FY11–21) of ~\$1–1.3 billion relative to the Corporate Plan 2012–15, to serve all premises in the non-fixed line footprint. This cost is largely driven by a doubling of the number of fixed wireless base stations required. The need for additional base stations and the associated capital requirements was identified in the Strategic Review 2013, and is now detailed to be ~2,900 base stations
- Scenario 2, which introduces FTTN in the non-fixed line footprint, reduces the number of fixed wireless base stations by ~200 relative to Scenario 1. Cumulative capex reduces by ~\$100 million relative to Scenario 1.

- Scenario 3, by adding a third satellite while using some FTTN, adds an incremental \$200 million in cumulative capex relative to Scenario 2, while also increasing the number of premises dependent on a satellite product that is more capacity constrained than fixed wireless or FTTN. The Review estimates that only ██████████ of the capacity of a third satellite would be utilised. The remaining capacity could then be commercialised, either by NBN Co or a third party. However, there are limited opportunities for NBN Co to monetise the spare capacity in its third satellite, as the majority of bandwidth supply is unlikely to be met with significant market demand from potential corporate end-users. This scenario also reduces the need for base stations and therefore reduces long term operating expenditure.
- Scenario 4's use of a partnership to access capacity on a third satellite results in a cumulative operating cashflow \$200–300 million lower than Scenario 2, while still maintaining the relatively stronger long-term financials realised in Scenario 3. As with Scenario 3 though, Scenario 4 leads to ~70,000 more end-users on a satellite service in FY21 than Scenario 2. In this Scenario, a JV partner would have a greater opportunity to monetise spare capacity outside of Australia. The JV partner's involvement in the build of the satellite and the ground segment allows for a spacecraft design that directs the capacity where it can be best monetised.

Lower take-up and average revenue per user (ARPU) growth, represented by the low range figures, has little impact on the short-term economics of any given scenario, but does drive a marked difference in long term economics. Note that 'lower take-up' is the low end of a possible take-up range that is still at least twice as high as that assumed in the Corporate Plan 2012–15. The Review believes that take-up will be at the high end of the range.

Irrespective of revenue trajectories, all scenarios have challenging long term economics with marginal EBITDA (some slightly positive, some slightly negative) and negative cashflows beyond FY21.

Scenario 2 estimates cumulative capex of \$4.5–4.7 billion which is ~\$1 billion higher than the Corporate Plan 2012–15, and is broadly in line with the high level assumptions made about the non-fixed line footprint in the Strategic Review 2013 'Scenario 6'. It should be noted that the 2,700 base stations described in scenario 2 do not entirely overlap with the originally planned 2,400 base stations. Around ~500 of the 2,400 base stations would no longer be constructed, and instead ~800 new base station locations would be required.

Assuming NBN Co is able to engage the installer industry to lift installation capacity, Scenario 2 would connect the last end-user that requests a service at the time of the rollout, two years ahead of Scenario 4.

In contrast to cumulative revenues (FY11–21) for the non-fixed line footprint of \$0.4 billion in the Corporate Plan 2012–15, the scenarios above estimate revenues of \$0.8–1.0 billion over this period, mainly driven by the increase in take-up.

Given the complexities and uncertainties, NBN Co should continue to include a 20 percent contingency which would be in addition to the capex values referred to here. This is in line with the assumptions that were included in the Strategic Review 2013 'Scenario 6'.

1.6 Overall proposed direction and financial implications

The Review proposes that NBN Co implement a deployment in the non-fixed line footprint that is based on a considered use of FTTN, and optimises the mix of fixed wireless and satellite

technologies to relieve congestion in oversubscribed beams, minimise cost and maximise the average product available to all end-users without any missing out.

Both Scenarios 2 and 4 will achieve this objective, although they require a trade-off of ~\$200-300 million in cumulative operating cashflow to move ~70,000 premises from satellite to less capacity-constrained technologies.

If NBN Co pursues Scenario 2 to minimise the number of premises using satellite, the Review's initial assessment suggests the mix of technologies in the non-fixed line footprint in 2021 may be:

- Fixed wireless to 57 percent of premises
- Satellite to 40 percent of premises
- FTTN to 3 percent of premises.

If NBN Co pursues Scenario 4 to minimise capital expenditure, the Review's initial assessment suggests the mix of technologies in the non-fixed line footprint in 2021 may be:

- Fixed wireless to 52 percent of premises
- Satellite to 47 percent of premises
- FTTN to 1 percent of premises.

The Review proposes that NBN Co decide in the next 3–6 months whether to pursue an accelerated fixed wireless roll-out (Scenario 2), or a satellite partnership (Scenario 4). Given the trade-offs highlighted, the Review has a preference for Scenario 2.

NBN Co and the government have an option to decide on a different network capacity allocation per end-user for the standard satellite product. This implies trading off financial outcomes for capacity allocation. This would have implications for the number of base stations required and overall peak funding. For each increase or decrease of 50kbps in satellite throughput allocated per AVC, this would drive ~500-700 more/less base stations and ~\$500–700 million in peak funding respectively, as shown in exhibit 1-2 below. These examples assume that NBN Co utilise the two long-term satellites as currently planned. If NBN Co were to build and launch a third satellite, at 250 kbps (initial capacity allocation per satellite end-user for standard product) fewer fixed wireless towers would be required. However, the delta in cumulative capex to cover all premises would be similar at ~\$600m, and the delta in peak funding would also be similar at ~\$1bn.

Exhibit 1-2: Outcomes based on different satellite capacity allocations

<i>Initial allocation per satellite user for standard product</i>	100kbps	150kbps	200kbps	250kbps
<i>Capacity allocation across all users</i>	150kbps	200kbps	250kbps	300kbps
<i>Delta in cumulative capex (\$m) to cover all premises</i>	- \$300m	-	+ \$300m	+ \$600m
<i>Delta in peak funding (\$m) to cover all premises</i>	- \$700m	-	+ \$600m	+ \$1bn
<i>Total satellites</i>	2	2	2	2
<i>Total base stations</i>	~2,000	~2,700	~3,400	~4,000
<i>Premises in fixed wireless 'area'</i>	48%	57%	63%	67%
<i>Premises in FTTN 'area'</i>	2%	3%	4%	5%
<i>Premises in satellite 'area'</i>	50%	40%	33%	28%
<i>Premises not covered (of 1.02m premises) with Corporate Plan 12-15 Infrastructure</i>	~110,000	~200,000	~260,000	~320,000

In order to successfully execute any of these scenarios, it is critical that NBN Co incorporate both the fixed wireless and satellite technologies, as well as the non-fixed line geographic footprint into the Multi-Technology Mix (MTM) planning for 100 percent of addressable premises in Australia. This means creating a set of business rules that balance fast deployment of broadband with better economics.

NBN Co should put in place protocols to ensure that the use of scarce satellite capacity is actively planned and 'owned' by a specific function within the company. In addition, the various functions within NBN Co must not rely on satellite technology as a 'back-stop' for other access technologies without the explicit agreement of the function which oversees its capacity. These rules should expressly address the impact of potential changes in the fixed line footprint boundaries in relation to scarce satellite capacity per beam.

Once the basic set of rules are in place, consideration should be given to how to deal with exceptions (e.g., Public Interest Premises, complex premises etc.). In addition, NBN Co should consider potential alternatives for managing special situations, and where private and community organisation funding may be appropriate.

To successfully execute this plan, a specific set of further actions will be required. These are laid out in detail in Appendix 1. In summary, these include:

- Expediting the work of NBN Co's Spectrum Taskforce which coordinates the work of senior commercial and technology representatives with the ACMA and commercial licence holders on spectrum matters
- Executing 14 specific actions that will help to further de-risk the satellite program including, for example, engaging experienced specialists in specific areas, and engaging with the installer industry more than 12 months in advance of the LTSS commencement to provide surety and enable them to ramp up their field forces

- Implementing two additional actions will help to mitigate overall risk with timeline changes, including exercising the option to change the timing of the second satellite launch to 12 months after the first instead of 6 months (understanding that this may need to be negotiated with the relevant counter-parties), as well as considering extending the current ISS contracts
- Implementing six changes to the satellite product instruments including the creation of a standard product with a specific network capacity allocation per end-user (150kbps) with upgrade options possible
- Further investigating the possibility for RSPs to complete their own installs as well as looking at other incremental revenue opportunities
- Implementing five actions to stabilise the Fixed Wireless Program and reduce cost including, for example, NBN Co committing to release sites into the planning process further in advance and in greater volume
- Further considering the option to use existing fixed wireless infrastructure in the current fixed line footprint
- Working closely with mobile operators and other third party tower owners to identify opportunities for further collaboration and reciprocal tower sharing.

In executing Scenario 2, the total cumulative operating cash outflow FY11–21 will be ~\$5.2 billion. This is ~\$1.2 billion greater than the Corporate Plan 2012–15 in order to provide adequate coverage and services to all end-users, including those that would not have been covered under the Corporate Plan assumptions. This level of cash outflow is in line with the Strategic Review 2013 'Scenario 6'. Scenario 2 of this Review does not have a significant impact on overall peak funding, which remains at \$41 billion in 2021, nor on IRR, which is estimated to only change from 3.1–5.3 percent to 3.2–5.5 percent.

1.7 Evaluation of additional options proposed by industry

The Review undertook a preliminary evaluation of a series of potential options proposed by companies in the mobile network operator (MNO), tower operator and satellite operator industries. These include:

- **Implementing fixed wireless in the fixed line footprint** – both the Strategic Review 2013 and industry have suggested that NBN Co could make better use of its planned fixed wireless base stations to serve premises in the previously specified 'fixed line footprint'.

With the relaxing of the constraints from the previous Statement of Expectations dated 17 December 2010, the Review proposes NBN Co make use of its existing and planned fixed wireless base stations to provide fast broadband to premises in base station coverage areas where the addition of equipment at marginal cost is cost and time effective. Pursuing either of the options below requires working with industry to lift installation capacity to 12,000–15,000 premises per month.

The Review proposes that NBN Co pursue this opportunity in one of two ways.

- NBN Co can use fixed wireless to accelerate network deployment, serving future FTTN premises temporarily with wireless until the FTTN build. This enables NBN Co to connect up to ~350,000 (potentially underserved) premises ~2 years earlier

and bring forward revenues, at incremental capex of ~\$150–200 million (not included in the Scenarios modelled in this Review); or

- NBN Co can use fixed wireless to fully substitute for fixed line build in areas where satellite capacity is sufficient to serve the small share of premises unable to receive a wireless signal. This would add ~200,000 premises or more to the fixed wireless footprint. Such premises could receive service earlier by fixed wireless than by fixed line. Depending on whether NBN Co is obliged to make PSAA payments, NBN Co could save between [REDACTED] in avoided FTTN and FTTdp build costs.
- **Fixed wireless partnership opportunities** that have been suggested by industry include increased sharing of passive tower infrastructure with third parties (either NBN Co using more third party towers, or vice versa to improve mobile coverage), sharing of active and passive equipment, and establishing broader open access mobile roaming operations.

The Review believes that NBN Co could pursue partnership opportunities such as these proactively with industry, while noting that these are often in areas where direct benefits for NBN Co appear limited. The Review believes there is an opportunity for NBN Co tower locations to support increased MNO mobile coverage in some (although far from a majority of) locations. The number of such locations will increase if MNO investments are subsidised and/or the government directs NBN Co to lower rental payments in specific geographic areas.

- **Satellite partnership opportunities** that have been suggested by industry include NBN Co selling the satellite network while leasing back capacity, or for the government to sell the satellite network along with the government obligation to ensure broadband coverage in satellite areas.

The Review believes that at this stage in the satellite program, given the risks and timelines involved, negotiating and executing any such deal is not feasible. NBN Co could, however, work with interested third party providers to investigate ways to commercialise any spare capacity in NBN Co's undersubscribed beams. Going forward NBN Co should communicate to the market that it is open to partnership proposals, and then ensure that it considers each on its own merits and risks.

1.8 Next steps

The Review highlights substantial issues in NBN Co's implementation of the current approach to deliver broadband to the non-fixed line footprint. It suggests a number of major changes, including more pro-active co-operation with industry partners, different product constructs and a significant expansion of the fixed wireless build program. Last, but not least, the Review highlights inherent uncertainties that NBN Co will need to adapt to as time passes. A static plan will not be sufficient.

The legal and regulatory implications of the recommendations in the Review will need to be considered as these recommendations evolve, and prior to a decision on whether they are to be adopted and implemented.

It should be noted that NBN Co has already commenced a large scale Transformation Program with initiatives that may address some of the issues highlighted.

Next steps include:

1.8.1 Make organisational and capability-building interventions

- Ensure clear accountabilities, transparency and scrutiny at the Executive Level and below to address the issues laid out in the Review to ensure:
 - That every premises for any given geography can access at least one NBN Co technology
 - That all elements in the technology value chain for each given technology will be in place to serve regional and remote end-users
 - Appropriate provision of product is made for Public Interest Premises
 - That scarce satellite capacity is actively planned and 'owned' by a specific function or individual
- Develop financial and management information to provide visibility of the build and forecast user activations relative to target, both by technology and geography
- Create a dedicated team within the COO function to manage the operational scale-up of both the fixed wireless and satellite network operations.

1.8.2 Execute operational actions immediately, with senior executive leadership

- Pursue multiple pathways to secure spectrum for outer metro areas
- Stabilise the fixed wireless build program and realise cost reductions
- Work with industry to identify tower sharing opportunities
- Implement a set of additional actions to mitigate risks in the satellite program
- Clearly define the details of the product construct – first for satellite and rolling out to other technologies (with different parameters)
- Work with industry to expand installation capacity to 12,000–15,000 per month by the start of 2016
- Work with the government to secure a better base of geographic premises data, prioritising (non-fixed line footprint) areas of limited satellite beam capacity

1.8.3 Prepare for medium term decisions that will be required in the course of 2015–17

These decisions include whether to:

- Proceed with the build of more than 1,600 base stations (excluding the ~400 base stations in 'no spectrum' areas)
- Take up extension options for the ISS contracts until indicatively 30 June 2017 in Q1/Q2 2015 based on the then known status of the satellite program for [REDACTED]
- [REDACTED] release the ~400 tower sites in the areas currently without spectrum, as soon as possible but by [REDACTED] as the worst case timetable
- [REDACTED]

- [Redacted]
- [Redacted]
- [Redacted]

2 Objectives and context for the review

2 Objectives and context for the Review

2.1 Objectives of this Review

NBN Co is chartered to provide wholesale access to high speed broadband across 100 percent of addressable Australian premises. The Strategic Review 2013 outlined a broad strategic direction for the fixed line footprint. The Fixed Wireless and Satellite Review 2014 aims to expand upon this by focusing on premises within the non-fixed line footprint.

Specifically, the Review seeks to understand the current and expected progress of serving the non-fixed line footprint, as well as provide options going forward for NBN Co to meet a broad mix of policy objectives (speed, time, cost, risk) including:

- Provide access for all Australians to fast broadband by 2020, with a 25/5Mbps product available through RSPs
- Create an economically viable NBN Co within the broader government funding envelope

The Government policy objective of 25/5Mbps is a higher aspiration than the Statement of Expectations dated 17 December 2010 of the former government, which stipulated a minimum of 12Mbps.

This Review is not intended to be read as a standalone document, but rather to supplement and extend the findings of the Strategic Review 2013. Where the scope of the Strategic Review 2013 was limited to the fixed line footprint, the Fixed Wireless and Satellite Review 2014 focuses on the non-fixed line footprint in order to inform and refine NBN Co's ongoing planning and implementation processes.

2.2 Where is the 'non-fixed line footprint'?

The concept of a 'non-fixed line footprint' originates in the Statement of Expectations dated 17 December 2010 of the former Government which previously required NBN Co to provide:

- Fixed line technology to 93 percent of premises by the end of the rollout period (minimum 90 percent); and
- Wireless and satellite for the remainder of premises (effectively the 'non-fixed line footprint').

It is important to note that the 'non-fixed line footprint' is not a contiguous, demarcated part of the country. It is also not synonymous with remote or even regional Australia as these terms are commonly understood.

- Many premises in 'remote and regional Australia' will be served by fixed line technologies
- Fixed wireless and satellite will, in many cases, serve metro fringe areas of Australia

The need for a 'non-fixed line footprint' reflects Australia's heterogeneous population density.

In general, Australia is highly urbanised – 74 percent of Australians live in areas with a population density of greater than 1,000 persons per km² compared to only 48 percent of residents in the UK. In addition, three-quarters of Australian premises are located within 50 kilometres of the central business districts of the nation's 20 most populous cities (and concentrated on 1.5 percent of the nation's land area). However, a sizeable collection of regional and remote premises exist at different points across the vast Australian continent. Serving these dispersed premises with broadband is one of NBN Co's key challenges.

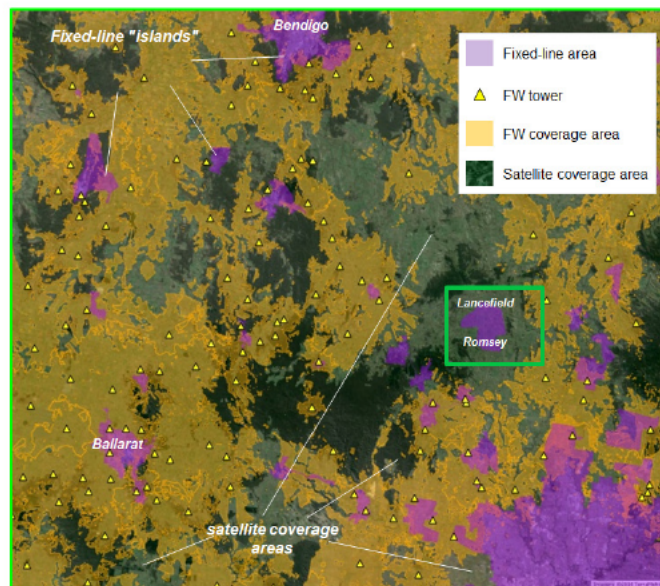
Given this heterogeneity, there is no cost-effective one-size-fits-all solution to provide all addressable Australian premises with access to high speed internet. Instead, the country is served by an interwoven pattern of different technologies.

Typically, fixed line technology will serve premises within the major capital cities and their surrounding metropolitan areas as well as ~600+ much smaller pockets of premises (individual fixed line 'islands') across the country. The existing Corporate Plan 2012–15 assumes that by 2021 these fixed line areas will cover ~25,000 km² across the country (or 0.33 percent of the nation's land area) and ~92 percent of premises in 2021 (11.7 million premises of an estimated 12.7 million), which is within the 90-93 percent range of the former Statement of Expectations dated 17 December 2010.

For the remaining ~8 percent of the premises outside of cities, the Corporate Plan 2012–15 assumed a mix of fixed wireless and satellite. These premises are located in a range of geographies:

- At the edge of cities where the deployment of fixed line technology is difficult
- In metro fringe areas and the outskirts of country towns
- In the middle of truly 'remote' Australia.

Exhibit 2-1: Example – regional and rural Australia often a combination of interwoven fixed-line, fixed wireless and satellite technologies

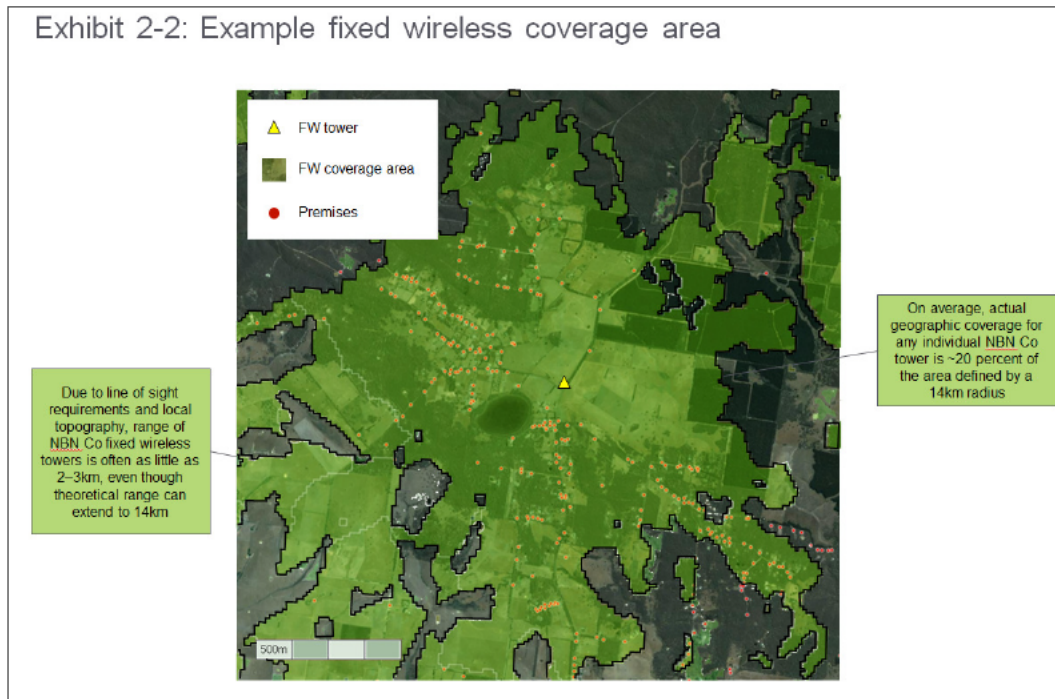


Location: Romsey and Lancefield, Victoria (north-west of Melbourne)

The resulting pattern of technology rollout is a combination of interwoven fixed line, fixed wireless and satellite coverage areas, as shown in Exhibit 2-1. The boundaries between technologies may not always be intuitive because they are based on the economics of service and limits of the technology. For example, in Romsey there is a direct boundary between fibre and satellite coverage areas, meaning that one neighbour may be served by fibre, while the next is served by satellite (see green box in Exhibit 2-1).

In addition, NBN Co's offer of a headline speed of up to 25/5Mbps and use of the 2.3GHz (and potentially 3.4GHz) spectrum band place quite specific requirements on the potential location of fixed wireless base stations. These factors result in the need for line-of-sight from the tower to the

premises, as well as an external Wireless Network Termination Device (WNTD). For this reason, it is clear in exhibit 2-2 below (for a different location) that although coverage in this example extends as much as 14km from the base station in some areas (marked in green), its range comes down to as little as 3km in other areas.



2.3 Number of premises in the non-fixed line footprint

For planning purposes, NBN Co uses data from each Geocoded National Address File (GNAF) as a proxy for number of premises. This data, provided by PSMA Australia, uses recognised address sources from State and Territory Government land records, as well as address data from Australia Post and the Australian Electoral Commission. This data is then 'washed' to remove phantom or redundant addresses to arrive at a refined count of premises.

NBN Co's definition of premises, as per the Statement of Expectations dated 17 December 2010, includes any location within Australia which satisfies one or more of its criteria:

- It is an addressable location currently used on an ongoing basis for residential, business (whether for profit or not), government, health or educational purposes;
- It is a school as defined by the Department of Education;
- It is within a new development at an addressable location for which NBN Co is the wholesale provider of last resort; and/or
- It is a standard telephone service which has been activated in compliance with the USO

At March 2010, the GNAF data had 12.6 million physical registered addresses in Australia, each tagged with a latitude and longitude. The 'washed' premises count was 10.9 million premises, and of these, 839,000 premises were considered to be within the non-fixed line footprint.

The Fixed Wireless and Satellite Review 2014 used the GNAF count taken from the PSMA and washed by NBN Co in September 2013. This number was further adjusted for variances based on satellite imagery. For the purposes of the Review, the total number of premises for the non-fixed line footprint in 2012 was taken as 906,000. An error margin of 10 percent is included in sensitivities to mitigate any GNAF inaccuracies.

Based on ABS and census data, the Review assumes a growth rate of 1.3 percent p.a. in the non-fixed line footprint between 2012 and 2021. This leads to a count of ~1,020,000 premises in 2021.

This definition excludes non-addressable locations such as payphones, traffic lights and bus stops. However, it includes Public Interest Premises (PIPs) which include aged care facilities, hospitals, schools, and universities. There are approximately ~20,000 PIPs in Australia, of which ~3,500 are within the non-fixed line footprint. These include ~3,000 schools, ~200 hospitals, ~150 aged care facilities and ~15 universities. Approximately 1600 PIPs are within the Review's defined satellite footprint comprising ~1,400 schools, ~120 hospitals and ~50 aged care facilities.

It should be noted that the number of premises in the non-fixed line footprint is also driven by potential variations in the boundary of the fixed line footprint. Since the commencement of the rollout of the fixed line network, more detailed planning has been completed on an area-by-area basis and more information about the local conditions is gradually discovered. As a result the geographic boundaries that define which specific premises receive a fixed line service as opposed to a non-fixed service (fixed wireless or satellite), may change due to technical, practical or economic reasons. NBN Co has historically varied these boundaries substantially, and the net effect of this thus far has been to add a substantial number of premises into the non-fixed line footprint. As the detailed planning and construction of the fixed line proceeds, there is a risk that more premises may be moved into non-fixed line areas without careful consideration of the consequences, especially on satellite capacity by beam.

2.4 Broadband quality in the non-fixed line footprint

In February 2014, the Department of Communications published its *Broadband Availability and Quality Report*, a comprehensive analysis of broadband availability and quality in Australia. The report assigned a rating for both Availability and Quality on an area-by-area basis, with A being the highest and E the lowest rating.

Unsurprisingly, given geographic challenges, areas in the non-fixed line footprint are less well served than the future fixed line footprint.

For example, ~50 percent of premises in the non-fixed line footprint are currently within Bands D or E (versus ~10 percent in the fixed line footprint). In Bands D or E, at most 2 out of 5 premises have access to a broadband technology, typically ADSL.

2.5 Background to the fixed wireless and satellite programs

NBN Co's original corporate objective was to provide long term broadband services to the non fixed line footprint from around 2,400 base stations and 2 satellites. The basic offering was 12/1Mbps which was extended to 25/5Mbps in a subsequent 2012 review.

To meet short-term demand for satellite while building its long-term solution, NBN Co launched its Interim Satellite Service (ISS) in 2011 relying on leased capacity to serve ~44,000 connections. The ISS promised a headline speed of 6/1Mbps with ~10GB per month usage limit, which allows end-users to download a reasonable amount of content and receive faster web browsing than the previous Australian Broadband Guarantee (ABG) service.

Over time, as more end-users were added, the service degraded and customer satisfaction scores fell from [REDACTED] January 2013 to [REDACTED] July 2013. As a result of high demand for the service, NBN Co reached capacity on a beam-by-beam basis and subsequently stopped selling the service.

Since then, NBN Co has determined technical designs for both fixed wireless and long term satellite services, selected vendors, and placed contracts. Approximately 285 wireless sites (as at 14th March 2013) are now on air. NBN Co's two Long Term Satellites (LTSS) are scheduled for a 2015 launch.

NBN Co has regularly reviewed the location and boundaries between the FTTP, fixed wireless and satellite footprints using the latest available information to match demand to capacity. Based on these reviews, in late 2012, NBN Co introduced a fluid fixed wireless deployment model to maximise the utility of the LTSS by using fixed wireless to progressively cater for areas subject to congestion of the satellite beams. This flexible deployment model spread the original target 2,400 base stations (covering 4 percent of premises) as follows:

- 1,600 base stations during the Initial Wireless Build (IWB) phase (ending FY16)
- 800 base stations during the Augmentation Wireless Build (AWB) phase (between FY 2017 and FY 2023). These would be deployed reactively to high satellite demand areas based on FTTP rollout decisions, the availability of spectrum and the take-up of fixed wireless and satellite services.

The Corporate Plan 2012–15 forecast a total capital expenditure of \$3.5 billion for FY2011–21 for the non-fixed line footprint (excluding contingencies, transit, and indirect/corporate costs). It should be noted that the Plan as written stated \$3.232 billion was set aside for the non-fixed line footprint, assuming that ~1,400 fixed wireless base stations would be constructed in addition to the two satellites, and a capital expenditure budget was allocated for the ISS. The Plan also included approximately [REDACTED] which was set aside for NBN Co to acquire spectrum in areas where they did not currently own spectrum rights. In addition to this, elsewhere in the Corporate Plan 12-15 (but explicitly indicated for the non-fixed line footprint) was [REDACTED] for additional base stations in areas with no spectrum and another [REDACTED] for incremental fixed wireless replacement capex, bringing the total to \$3.451 billion.

2.6 Characteristics of fixed wireless technology

NBN Co's wireless network is designed as a 'fixed' wireless network dimensioned to provide predictable and consistent service levels to subscribers. It is designed to provide the following business requirements which mirror other NBN Co technology offerings:

- Ethernet Bitstream Service (Layer 2)
- Design speed of 25Mbps down and 5Mbps up
- Four Product Components (UNI, AVC, CVC, NNI)
- Two Traffic Classes to select performance for applications (Voice, Best-efforts data)

The network uses TD-LTE (Time Division) technology and NBN Co's current specifications use the 2.3GHz spectrum band. Its Cell Coverage Area is defined as being where a single end-user can achieve a Layer 2 information rate of at least 25Mbps downlink and 5Mbps uplink with 95 percent probability.

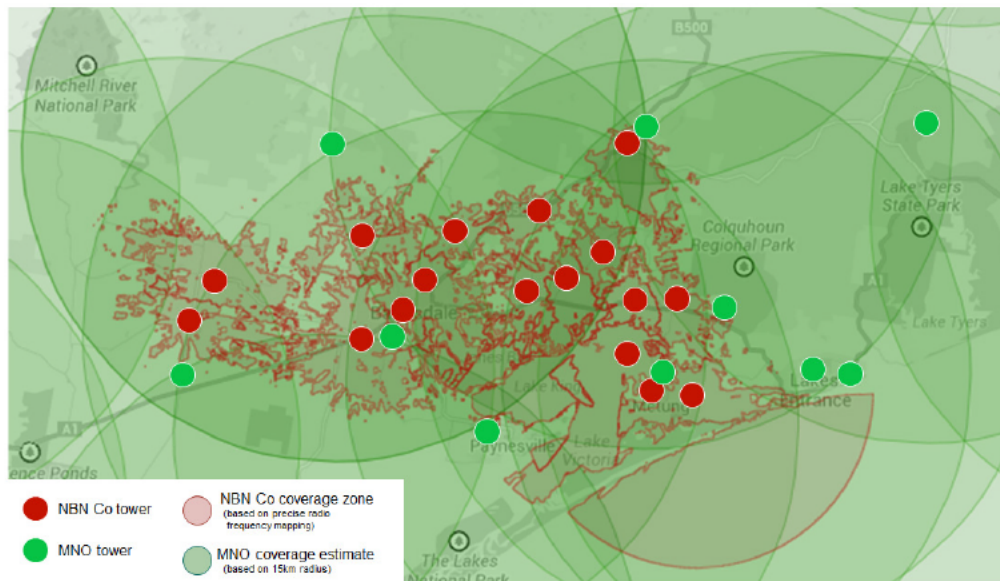
Ericsson supplies the network infrastructure and equipment, while NBN Co provides the fibre spurs for interconnectivity between the Hub sites and the FAN/POI sites and the transmission between the FANs, POIs and core network elements. Microwave hops are used to interconnect base stations sites to the Hub sites. At the end-user premises, an Indoor and Outdoor unit make up the WNTD and requires near Line-Of-Sight (LOS) towards the base station.

NBN Co holds 98MHz of spectrum licences for the majority of areas in the 2.3GHz band with lesser amounts in regional WA and NT. NBN Co has further access to unused spectrum in the 3.4GHz band. All of NBN Co spectrum holdings are in regional and remote areas and NBN Co is yet to secure access to suitable spectrum in mainland capital cities and surrounding areas. The NBN Co deployment of NBN Co's TD-LTE network is impacted not only by the geographic limitations of spectrum holdings, but also by interference between adjacent networks (such as Optus) which must be managed with stringent practices.

The unique requirements of NBN Co's fixed wireless products for high Committed Information Rate (CIR), and the line of sight issues that result from the spectrum being used (2.3GHz), result in a very different tower placement strategy, and much denser concentration of towers, relative to how a typical mobile network would be designed (i.e. using 700–850MHz, with less demanding performance requirements and more flexibility regarding line of sight).

In exhibit 2-3, the varying tower placement approaches become apparent. NBN Co towers (in red) are generally placed in town centres, close to premises, while MNO towers (in green) are placed in city outskirts and cover towns from the outside. NBN Co also requires substantially more towers to cover the same number of premises than an MNO would require (17 NBN Co towers versus 10 MNO towers in this region).

Exhibit 2-3: NBN Co requires much denser concentration of towers to cover the same areas, compared to MNOs



2.7 Characteristics of satellite technology

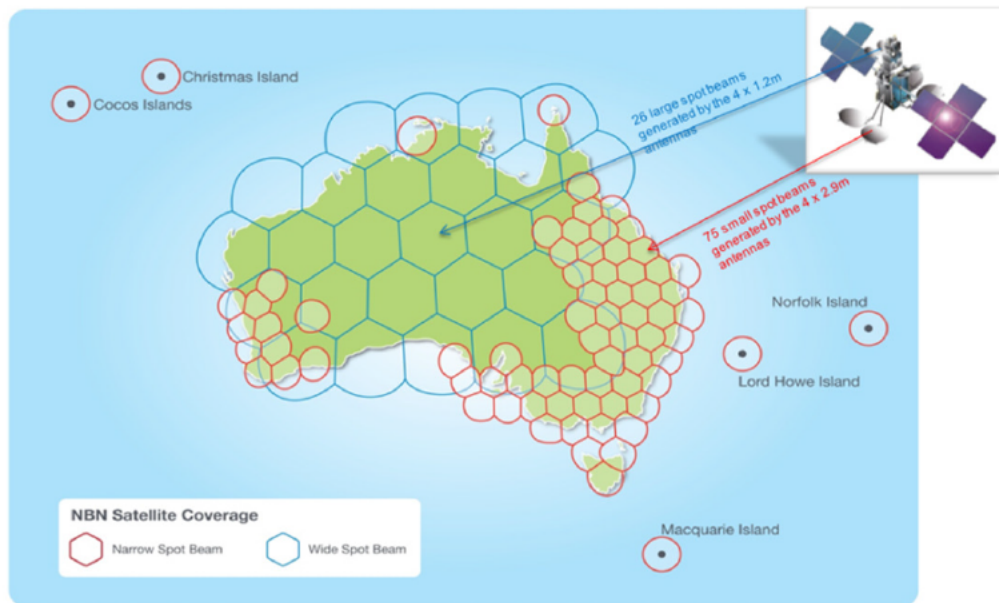
NBN Co's Long Term Satellite Service (LTSS) consists of two Ka Band multi-spot beam spacecraft. These satellites will be supported by 10 geographically dispersed Ground Stations and 2 Central Data Processing Centres (located in NSW and Victoria). The Ground Stations are designed in a 9 + 1 configuration, with the 9 located to maximise spectrum re-use, which is required for NBN Co's product specifications. The additional ground station is designed to act as a Disaster Recovery site, capable of completely replacing one of the primary Ground Stations should the need arise.

The satellites will be located in geostationary orbit and operate at 140°E and 145°E with an expected 15 (+ 1 contingency) years of on-orbit mission life. NBN Co chose spectrum in the higher frequency Ka band (26.5–40GHz) as it allows high capacity broadband satellites to be designed and built.

To cover Australia and offshore islands, 101 user beams were designed per satellite to provide broadband services to end-users using 80cm diameter home dishes. Capacity is fixed on a spot beam by spot beam basis. This means that certain spot beams may experience congestion while others have spare capacity. Capacity cannot be redirected between beams.

Exhibit 2-4 below highlights the beam design. Each beam has a distinct capacity ranging from ~500 to ~15,000 premises. The beam design is composed of narrow spot beams where most capacity is needed, and wide spot beams to cover the remaining parts of the country. The capacity allocation is now locked in and the capacity per beam is a fixed resource for each geographic area.

Exhibit 2-4: NBN satellite coverage



NBN Co has chosen Space Systems / Loral (SSL) as the spacecraft manufacturer and has chosen ViaSat to provide the gateways and end-user premises equipment. Launch services are contracted to Arianespace with NBN Co recently entering into an agreement with Optus Satellite to manage Telemetry Tracking and Command (TT&C) and flight operations (via 2 ground stations).

Currently there are no Ka band satellites operating over Australia capable of providing a residential broadband satellite service. 17 satellites provide broadcast and data coverage operated by local and international companies. A market scan of these providers suggests there is capacity to serve ~90,000 premises with a 30/10kbps throughput broadband service, in addition to the existing ISS. However, much of this capacity is direct-to-home broadcast which has ubiquitous coverage and is therefore expensive to deliver residential broadband services.

Internationally there are several prominent examples of Ka band broadband satellites in operation. For example, in the United States, ViaSat has operated 'ViaSat 1' successfully since 2011, and in Europe, Eutelsat has operated 'KA-SAT' since 2010. These satellites provide retail broadband to residential areas over a Layer 3 network and offer services with ~100kbps mean busy hour throughput per user.

Part A

Satellite

3

Satellite:

Overview of issues

3 Satellite: Overview of issues

Chapters 1 and 2 described progress with the rollout of the satellite and fixed wireless programs. This chapter sets out the critical issues which NBN Co needs to address specifically with the Satellite program:

The timeline in the NBN Co satellite program has a substantial level of risk, meaning that the service commencement is expected to be in early CY2016 or sooner, rather than Q3 CY2015

- Any satellite launch carries an inherent element of risk, with delays of between three and six months being common. The Review believes the NBN Co spacecraft build and launch has very little remaining contingency time available, relative to what other satellite programs would typically have at this stage of the build. It identifies eight key delay risks.
- The Review expects the service commencement date is more likely to be in early CY2016 or sooner and this will only be achieved if the proposed mitigation actions are executed effectively. If they are not executed effectively the service commencement date could be later in calendar year 2016.
- Longer delays are unlikely, but could materialise even if the proposed mitigations are implemented effectively, due to the inherent risks in any complex Satellite program.
- *This is described in more detail in chapter 4.*

The LTSS needs a more robust product construct

- Higher demand than anticipated was observed with ISS. The Fair Use Policy (FUP) in place at the time, and how NBN Co was able to enforce it, was not sufficiently proactive to guide RSP behaviour. The selling of anytime plans with data usage above the Fair Use Policy by RSPs, caused the degradation of service to all end-users. This did not generate fair and equitable outcomes for end-users, and created significant issues for NBN Co in terms of managing satellite capacity.
- *This is described in more detail in chapter 5.*

In addition, the Review undertook a preliminary evaluation of potential options proposed by industry. Satellite partnership opportunities that have been suggested by industry include NBN Co selling the satellite network while leasing back capacity, or for the government to sell the satellite network along with the government obligation to ensure broadband coverage in satellite areas. *This is described in more detail in chapter 6.*

Further issues identified with fixed wireless are described in Part B of this Review, and a description of how the current plans for satellite and fixed wireless translate into overall coverage issues for the non-fixed line footprint is described in Part C of this Review.

4 **Satellite:** Challenges in delivery

4 Satellite: Challenges in delivery

4.1 Overview

The Review was asked to assess the 'program health' of NBN Co's long term satellite program. Given that the long term satellites are not yet operational, the Review focused on evaluating the technology and program choices that may improve the service and assessing the risks to program as it is currently planned.

The Review found that all key technology choices have been made and the technical system is generally well designed to solve the problem as originally specified.

However, all satellite programs carry many inherent risks due to the highly complex nature of the build, the sheer volume of technical interdependencies and the fact that multiple suppliers are involved. Typical industry delays are ~3–6 months. NBN Co already has a range of mitigation actions in place to manage the many risks inherent in satellite programs.

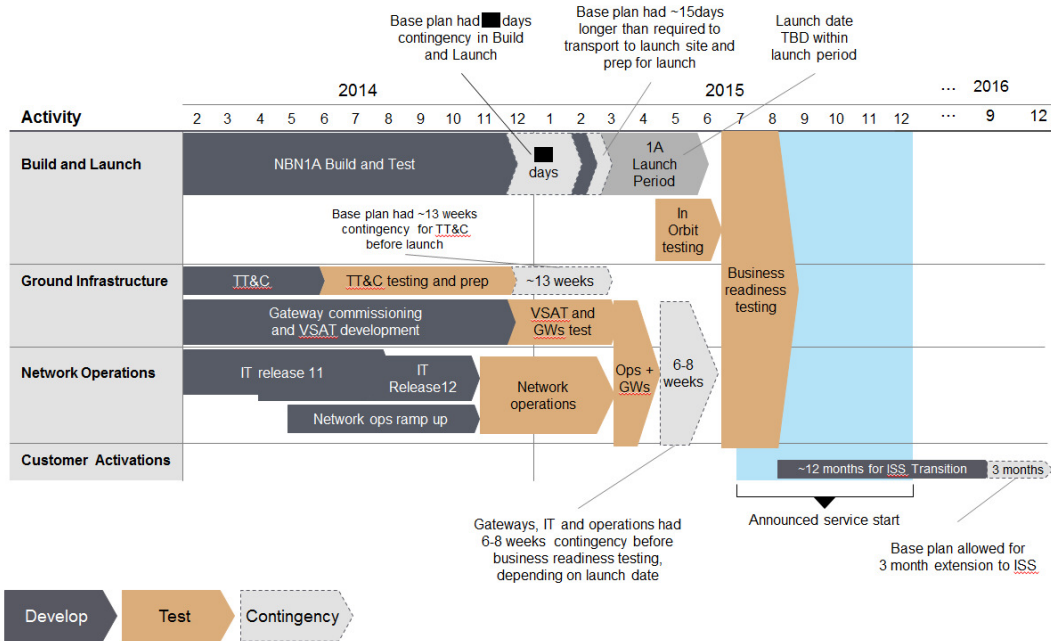
The Review proposes 14 additional, issue-specific actions and 2 timeline changes to help further mitigate risks to program delivery. Considering the portfolio of all risks, and existing and proposed mitigants, the Review considers on the balance of probability that the satellite service is more likely to occur in early CY2016 or sooner rather than Q3 CY2015. Longer delays are unlikely but could materialise.

The existing timeline for the long term satellites has multiple streams focussing on:

- Build and Launch
- Network operations
- Ground Infrastructure
- End-user activations

The timing of these is illustrated in exhibit 4-1. Each workstream has built in some contingency.

Exhibit 4-1: Base plan had contingency built into each workstream



SSL's build and test schedule began on 8 March 2012 and contained █ days of contingency. It is due for completion on 16 February 2015, after which the spacecraft needs to be transported to the launch site and attached to the launch vehicle. This will leave ~15 days further contingency before the beginning of the launch period on 16 March 2015. The launch date of a satellite is not set until ~3 months prior to launch. The plan is to select a date within a launch period between 16 March 2015 and 15 June 2015, agreed between NBN Co, SSL and Arianespace. The final choice of date will be affected by the readiness of the spacecraft, the readiness of the launch co-passenger and the schedule of other launches by Arianespace. Once the spacecraft is launched, it commences in-orbit testing (IOT) which is scheduled to take 2 months, to test components on the satellite and conduct integration tests with Telemetry, Tracking and Command (TT&C) on the ground.

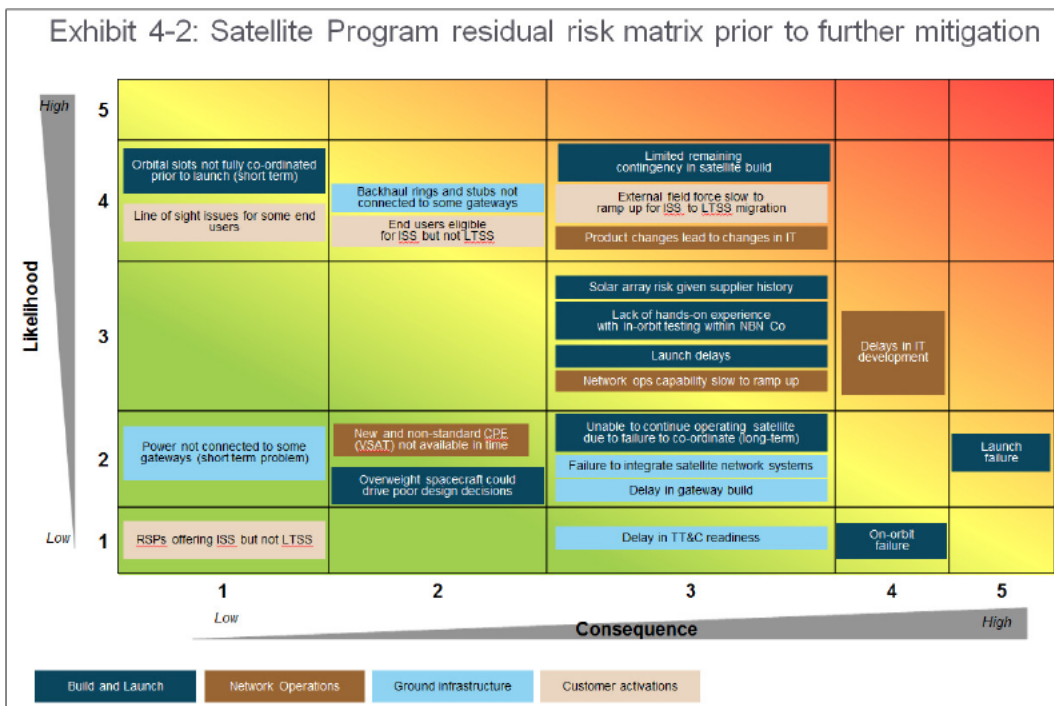
In parallel to the build and launch workstream:

- The ground infrastructure workstream requires TT&C to be tested and in place for in-orbit testing, ~13 weeks contingency is allowed in the base plan. Gateway commissioning and VSAT development and testing needs to be finished in parallel with network operations establishment.
- The network operations workstream involves developing both IT systems and processes development. The base plan allowed for 6–8 weeks contingency across network operations, gateway and VSAT development before IOT is completed.

After IOT, there will be 2 months of business readiness testing (BRT) on the end-to-end functionality of the satellite system. According to the NBN Co plan, all components except the satellite itself should be tested using a satellite simulator prior to BRT to minimise the chance that BRT runs over time. After BRT is complete, the service is ready to commence.

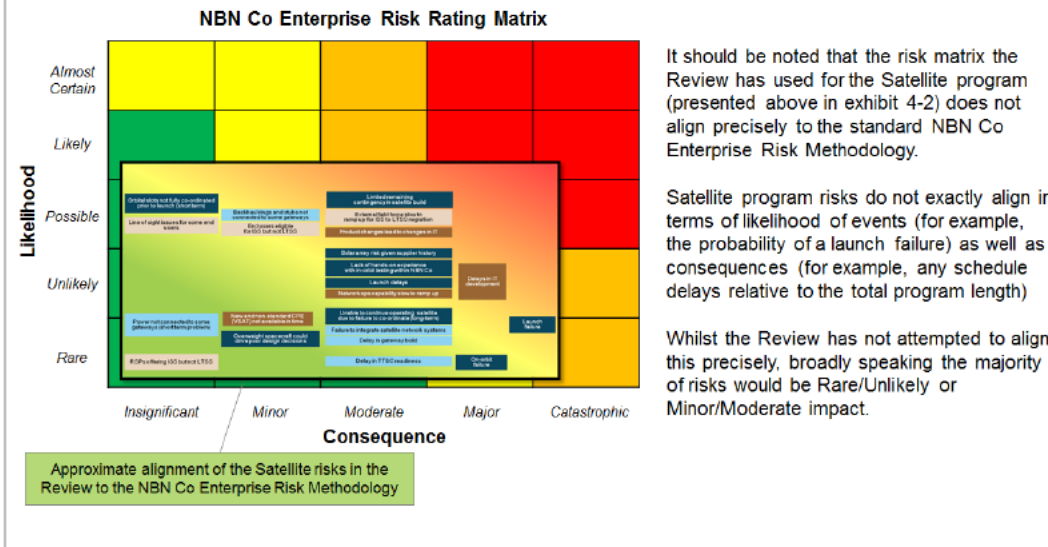
The Review assessed risks to the satellite program delivering on time and within quality parameters.

It focused on risks that experts would consider to be outside of normal ranges of what might be expected for a satellite program of this complexity and those risks which could be better mitigated with additional actions. These risks fall into four main categories: build and launch, network operations, ground infrastructure, and end-user activations. Exhibit 4-2 illustrates how the Review rates the likelihood and impact of these risks, prior to further mitigation by NBN Co.



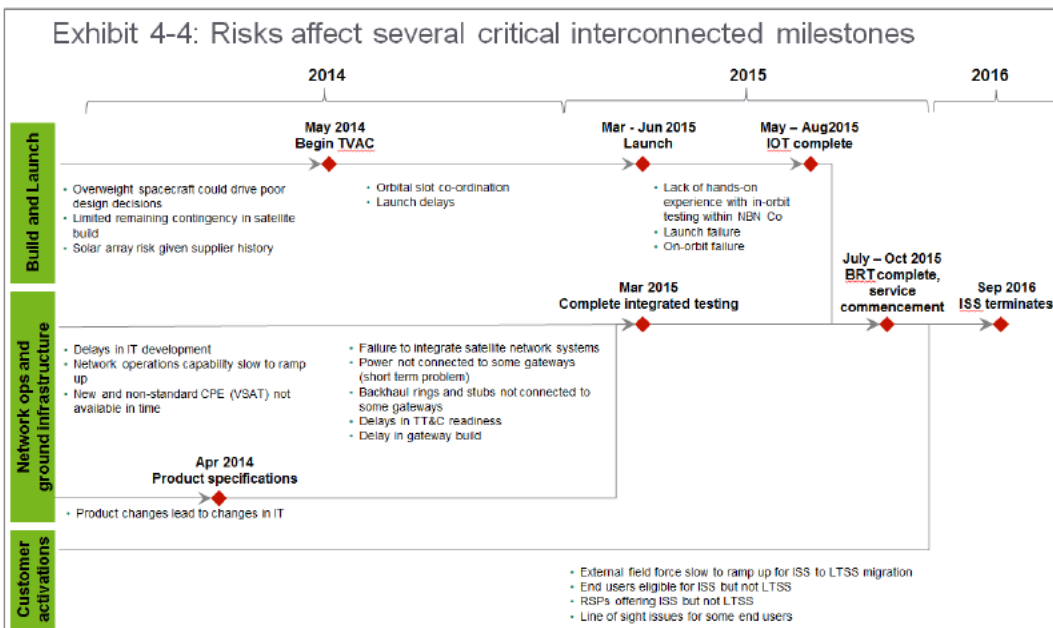
It should be noted that the risk matrix the Review has used for the Satellite Program (presented above in exhibit 4-2) does not align precisely to the standard NBN Co Enterprise Risk Methodology. An approximate alignment of the risks to this matrix is shown below in exhibit 4-3.

Exhibit 4-3: Approximate alignment to the NBN Co Enterprise Risk Methodology



While each individual risk has a differing degree of likelihood and impact, the risk to the program as a whole comes from the interconnected risks and their cumulative effect. The risks affect a range of interconnected milestones as illustrated in exhibit 4-4.

Exhibit 4-4: Risks affect several critical interconnected milestones



The Review proposes that NBN Co should retain its current direction for the satellite program in terms of technology and adopt 14 additional, issue-specific actions and 2 timeline changes to further mitigate risks where possible. Mitigating these risks also calls for significant executive attention.

Even with mitigation in place, the overall satellite program has a fairly high risk profile on its timelines.

- Synthesising all risks, the Review believes it is likely that service commencement will be in early CY2016 or sooner rather than Q3 CY2015
- There is a possibility of further delays, but the likelihood is low.

4.2 Satellite technology choices

For its base level components, NBN Co has made a number of good technology choices. The choice to use a Ka band satellite to provide the high throughput broadband service was appropriate. The reuse of spectrum to achieve maximum capacity is very thorough. Technologies have been selected appropriately to get best performance in spite of the inherent latency in satellite internet, for example through Transparent Performance Enhancing Proxy (TPEP) software. The beam pattern design is well adapted to the footprint as it was assumed at the time of design, however, subsequent changes to the footprint given high take-up (see chapter 14), are likely to cause challenges to the service.

Significant benefits are derived from the use of Ka band frequencies, particularly related to capacity gain versus available spectrum. Ka-band allows for greater density of spot beams and frequency reuse. However, capacity improvement through higher frequencies does come with some trade-offs. Ka-band frequencies, due to physics, are more susceptible to weather related conditions compared to Ku-band frequencies. There are proven mitigations for these issues and operators have typically achieved 99.5 percent availability.

NBN Co has also chosen reliable vendors to deliver the key systems and services. The spacecraft provider, SSL, has a proven industry track record at building complex high performance satellites. The launch vendor Arianespace has a very successful track record with over 59 consecutive successful launches. The ground station gateway technology and VSAT provider ViaSat offer significant industry experience as a vendor and as an operator of broadband satellite services in the USA. Based on their operator experience, ViaSat has developed a number of optimisation techniques to improve bandwidth efficiencies on the satellite, enhancing the customer experience. Telemetry, Tracking and Command (TT&C) functions have been outsourced to Optus Satellite which has extensive flight experience and understands the scope of works.

While some of the parameters of the satellite solution might be questioned, none will seriously inhibit the success of the program. It is an industry view that the satellite systems have been somewhat over-engineered (though there have been initiatives to reduce the level of engineering without compromising quality). Industry also questioned NBN Co's choice to mimic layer 2 functionality over what is normally a layer 3 network. This creates an extra technology risk (see Appendix 2 for further details) for the sake of providing a uniform experience to RSPs.

Industry also questioned the choice of having ViaSat design the VSAT as an end to end system, and suggested introducing competition among CPE vendors. However, the Review concludes that it would be difficult in the short term to introduce another CPE vendor on to the satellite platform. While it could be technically achieved, the economics of introducing a second CPE vendor are challenging, because it is likely to cost more than it saves.

The program is now at the point where any significant changes to scope would delay the launch.

However, the Review proposes that NBN Co exercise the option to change the timing of the launch of the second satellite (NBN 1B) in short succession after the first (NBN 1A).

4.3 Potential upgrade path

The aim of an upgrade path for satellite would be to improve user experience. This means increasing maximum throughput per end-user, which is linked to the monthly capacity caps (or equivalent) in the retail products. If the take-up rate is low, upgrading may be possible without additional infrastructure. If the take-up rate of satellite services is high, it is expected that there will not be capacity to increase the allocated throughput per end-user. In this case, the upgrade paths are: a) to use other technologies to take users off the satellite and increase the throughput for those remaining; or b) to invest in additional satellite capacity either alone or purchasing from a third party, e.g. as an 'anchor tenant'.

If the additional satellite capacity path is chosen, a number of opportunities could be explored ranging from an NBN Co specific satellite to payload sharing with an established operator.

4.4 Proposed actions

The Review proposes that NBN Co:

4.4.1 Build and launch

- **Proposed action 4.1:** Engage specialist negotiators and work with the ACMA to complete the remaining agreements for orbital slot co-ordination.
- **Proposed action 4.2:** Establish a senior executive level relationship with potential launch partners and share information.
- **Proposed action 4.3:** Engage an industry experienced specialist (e.g., Telesat, Optus Satellite or others) to lead and support in-orbit and end-to-end system testing.

4.4.2 Network operations

- **Proposed action 4.4:** Finalise and close out the network operations model. Give NBN Co IT a clear direction and priority to have satellite OSS functioning to meet deadlines.
- **Proposed action 4.5:** Begin recruiting necessary resources now to manage the network operations for satellite testing.
- **Proposed action 4.6:** Ensure that ViaSat's testing of the new CPE is rigorous and make informed choices during 2015 regarding production deployment of the new CPE.
- **Proposed action 4.7:** Revise LTSS IT plan to bring adjustments to full product specification in IR 13.

4.4.3 Integration of ground stations

- **Proposed action 4.8:** Add an experienced senior-level leader to the Network Architecture and Technology- Ground Segment team dedicated to oversight of successful system integration through to operational readiness. Also add experienced specialists to support NBN Co teams in specific areas such as CPE testing and transition to operations.

- **Proposed action 4.9:** Where required, engage a local electrical consultant on a short term basis to liaise with local energy authority representatives until a deal is reached for supply of mains power. Ensure senior NBN Co executive oversight.
- **Proposed action 4.10:** Maintain senior executive oversight of gateway build and existing mitigations

4.4.4 End-user activations

- **Proposed action 4.11:** Lock in contracts with field force management providers early, including volume estimates, to give surety for providers to build up field force. Begin detailed planning of migration 12 months in advance and including processes to batch new installations to achieve level utilisation and increase efficiency. Work with industry to lift end-user connection capacity (fixed wireless and satellite) to 12,000 – 15,000 per month by the start of 2016.
- **Proposed action 4.12:** Consider transition mechanisms prior to the arrival of fixed line or fixed wireless service to prevent any ISS end-users from being disconnected from satellite service without a fast broadband fallback.
- **Proposed action 4.13:** Determine if any RSPs offering ISS will not offer LTSS, and work with industry to resolve any specific issues with individual end-users.
- **Proposed action 4.14:** Develop a process for sub-contractors to recognise and mitigate line-of-sight issues when they occur. Ensure that incentives are right for sub-contractors to try and mitigate the issues properly, e.g. they are paid on successful install, not per site visit.

4.4.5 Timeline changes to mitigate overall risk

- **Proposed action 4.15:** Exercise the option to change the timing of the second satellite launch to make it 12 months rather than 6 months after the first, subject to contractual impacts and agreement with the launch provider. This would allow the team to focus on the IOT/BRT of 1A and service commencement, and allow more time if any issues need to be fixed before launch of 1B. In addition, the efficiency of the satellite replacement program (which will be required in 2028-2030) will be improved by spacing the launches further apart. This timing should also not impact the end-user rollout as the additional satellite capacity should not be needed until this time given the speed with which the industry can connect end-users.
- **Proposed action 4.16:** Take up extension options for the ISS as completing ISS migration by September 2016 may be difficult due to potential late service commencement, combined with residual risk in industry capability for installations. An ISS extension also allows a capacity lever to enable 'new' satellite end-users to access services in the first year of operation.

5

Satellite:

Product construct
and other revenue
opportunities

5 Satellite: Product construct and other revenue opportunities

The Review examined NBN Co's current approach to product and pricing in the non-fixed line footprint, including learning the lessons from poor user experiences with the Interim Satellite Service (ISS).

The Review proposes that NBN Co use different wholesale product 'instruments' for the Long Term Satellite Service (LTSS) (e.g. products with specific capacity allocations, AVC tools which monitor and control usage etc.) to avoid compromising the end-user experience. Establishing these instruments is now on the critical path for the start of the LTSS.

Although this chapter focuses on the satellite product, the Review proposes that NBN Co consider applying this revised approach across technologies to ensure it has the right set of instruments to support RSPs.

In its initial assessments, NBN Co believes that the product construct proposed is consistent with the Uniform National Wholesale Price (UNWP) and SAU. If this turns out not to be the case, other potential product constructs may need to be considered.

The Review also proposes a standard product for the LTSS with potential upgrade options within the fixed capacity of the satellite beams. The proposed product will be a major enhancement in speed and capacity for regional and remote Australia to what is currently offered on ISS. Given the shared capacity nature of satellite, controls are still needed to ensure that user experience is not compromised as capacity fills up. The proposed product construct is based on latest current thinking and on performance estimates provided by the satellite manufacturer.

5.1 History and learning from ISS

The ISS relies on a 'Fair Use Policy (FUP)' and limits on Connectivity Virtual Circuit (CVC) allocation to RSPs in order to manage the finite and shared capacity of the satellite. In reality, the application of the FUP, and how NBN Co was able to enforce it, neither sufficiently guides RSP behaviour, nor generates fair and equitable outcomes for end-users.

The ISS FUP prohibits end-users from using the ISS in a manner that NBN Co regards, acting reasonably, as "inappropriate or excessive use". An example of this includes where 'monthly usage' averages exceed 9.7GB down /3.2GB up on a 4 week rolling window, with no Peak/Off Peak periods. NBN Co's current systems do not allow for geographic based time zones or count Access Virtual Circuit (AVC) usage data.

A single \$24 AVC charge, regardless of usage (same wholesale rate for 1GB as 100GB), means that the AVC charge does not provide any price signal which might manage usage. The CVC charge is intended to play this role but CVC charges, alone, shaped by UNWP considerations, have not been sufficient to constrain usage. Adequate network tools to control RSPs' AVC or CVC are not in place, nor do plans sold by RSPs reflect or impose price signals on usage. Further, a centralised CVC delivers a disproportionate amount of throughput relative to the amount that NBN Co intended within a given beam, noting that some RSPs happen to have concentrated their sales within a beam while drawing on the centralised CVC 'pool'.

Many RSPs acted responsibly and upheld the policies, respecting the finite capacity of a satellite offering, as evidenced by their use of peak/off peak to manage end-user demand. However, individual providers did sell end-user plans permitting data usage above the FUP which caused the degradation of service of all users.

The Review concludes that the FUP as applied to ISS is not sustainable as a demand management tool for the LTSS. In any technology that faces a fixed capacity constraint and is subject to disproportionately high unit costs of capacity augmentation, NBN Co will need to establish both a 'maximum fair use level' and instruments to enforce these.

While NBN Co has been working on possible alternative instruments, none are yet in place. Establishing these new instruments is now on the critical path for the start of the LTSS.

5.2 Proposed wholesale instruments and product options

Satellite technology will always be a capped usage product for end-users due to limited capacity in a shared network environment. However, NBN Co is aiming to use the LTSS to provide a substantially better product and end-user experience than the ISS, and an even better product and experience relative to other currently available services (if any) in the satellite-only footprint.

5.2.1 Overview of proposed actions

The Review proposes that NBN Co make six changes to the satellite product instruments and construct to ensure it can adequately manage capacity usage and the end-user experience, and avoid the issues experienced on ISS.

- Create an initial standard satellite product based on a busy hour throughput (i.e. allocated capacity) of 150kbps per end-user, priced at Uniform National Wholesale Price (UNWP) rates, and ensure that the expectations of end-users are clearly and effectively managed. Upgrade options may then be provided beyond that.
- Create and measure a Service Level Agreement (SLA) describing the aspired consumer experience, without taking on contractual obligations until stable performance is achieved, including requirements for the RSP in terms of managing consumer expectations, usage meters, traffic management etc.
- Adopt a single Point of Interconnect (POI) architecture for LTSS, which recognises that given that all LTSS traffic will necessarily be concentrated at the DPC, it is required to also offer interconnection at that point. As the DPC has geographical redundancy it is also prudent for the POI to have a geographically diverse back-up location.
- Limit end-user ability to bond ports on the Network Termination Device, at the expense of other end-users access to limited capacity. This means that an end-user will not be able to bond two 25/5Mbps ports to achieve a 50/10Mbps speed.
- Put in place AVC instruments and tools which monitor and control usage and provide support for the 'standard product and upgrade options' approach.

Relative to other commercial satellite broadband service providers around the world, the LTSS will be one of the most advanced, offering significantly higher broadband speeds and download capacities than these operators currently have in the residential market. Most operators globally are offering standard speeds of 1-5 Mbps download, with higher speed tiers available up to 5-20 Mbps. It should be noted, however, that as with all satellite services, there are still constraints of latency and capacity that need to be much more carefully managed than with fixed line services, to ensure that a high quality of service for all users is maintained.

5.2.2 Details for standard product with upgrade options construct

The most important change is a standard product with specific network capacity allocation per end-user, with upgrade options possible within the fixed capacity of the satellite beams.

In order to ensure good end-user experience, NBN Co will need to limit the amount of dedicated reserved capacity that RSPs can buy (at uniform national wholesale pricing levels) to the amount required to support the standard product per end-user. Factors to consider in establishing the model include:

- Whether capacity limitations will be applied on a beam-by-beam basis, or across the two satellites at an aggregate level. The preferred direction of the Review is to allocate at the beam level which allows greater control of capacity given some beams are congested, and others are not. As a result, the Review proposes that NBN Co redesign the CVC construct for the satellite product to allow for small increments, or reserve the right contractually to require an RSP to use a separate CVC on a beam when NBN Co has sold a threshold percentage into a beam (~30 percent – to be confirmed by NBN Co with more detailed analysis). NBN Co should work with RSPs through this process to give them information and ensure a seamless sale process of standard product.
- Whether NBN Co creates a Traffic Class 5 (TC5) 'best efforts' traffic class as an additional mechanism to allow RSPs to use excess capacity if, when and to the extent it is available. This traffic class would not be priced higher, but would have traffic that could be dropped during busy times (that is, it would have no committed information rate). While a highly effective instrument, this would be relatively costly and technically complex to institute. The Review proposes that NBN Co only decides on the implementation of the TC5 traffic class after a successful launch of the LTSS product so as not to add any further risk to the program.
- NBN Co will need to carefully model upgrade options and pricing to best use available satellite capacity in a fair and equitable manner, taking into account stated Government requirements. For example, a particular upgrade option might be created over time for 'public interest premises' like schools and health clinics in satellite-only locations, such as a Traffic Class 3 (TC3) – 'designed for the high priority data of small and medium business end-users' – product with time-of-day limitations and eligibility rules (with NBN Co remaining a wholesaler). Other upgrade options and pricing will balance available (and ultimately fixed) capacity with potential demand. Pricing for these upgrade options will need to be substantially more than the highly-subsidised levels of the standard product, but further work will be required to determine potential pricing arrangements and volumes.

Regardless of the actual model employed, NBN Co also needs a commercial rule to manage selling the upgrade options (above the standard product) only to a level that all potential end-users can gain access to the standard product in each of the beams.

A number of relevant regulatory and policy implications of the proposed 'standard product with upgrade options' model are discussed in the next section.

Given timelines for satellite commissioning, these product changes will need to be implemented in NBN Co's IT Release 13, scheduled for scoping by 23 June 2014 and in a manner that allows for subsequent refinements through the Product Development Forum. Urgent consideration will be needed to accelerate the final product instrument design, consultation and decision-making to allow for IT and other changes.

5.2.3 Satellite capacity allocation for the standard product and upgrade options

There is a large variation in the products and retail plans offered by satellite service providers around the world. For example, Exede in the US offer a '12/3Mbps' product with a 10GB cap for \$50 US Dollars per month. This product effectively translates to a cost of ~\$5AUD/GB/month. Hughes in Canada offers a standard '5/1Mbps' product with a 10GB monthly usage cap for \$40 Canadian Dollars, which translates to ~\$4AUD/GB/month. Higher cost plans include Tooway in the UK who sell a 2GB cap product for 20 GBP per month (~\$18AUD/GB/month), VSAT in the US who sell a 16GB cap product for \$359US Dollars per month (~\$24AUD/GB/month) and Ground Control in the US who sell a 3GB cap product for \$400US Dollars per month (~\$143AUD/GB/month).

The Review proposes that NBN Co create an initial standard satellite product based on a busy hour throughput (i.e. allocated capacity) of 150kbps per end-user, priced at Uniform National Wholesale Price (UNWP) rates. Upgrade options may then be provided beyond that. As the LTSS platform cannot be field trialled until the first satellite is deployed, NBN Co may need to revise the marketed performance levels and network capacity allocation per end-user to match the reality of what is delivered. Further, NBN Co has an unbudgeted contingency plan to expand the footprint of the terrestrial technical solutions.

This standard product provides a substantially better end-user service than the ISS, with:

- Download speeds up to four times the ISS levels, and upload speeds up to five times the ISS levels, based on an LTSS PIR 25/5Mbps service compared to the ISS 6/1Mbps service;
- Levels of busy hour throughput (i.e. allocated capacity per end-user) approximately four times higher than the current ISS levels; and
- Levels of monthly usage at least twice as high as the current ISS levels.

If RSPs do not provide differential usage approaches to time of day, the standard product may be sold by RSPs as, for example, a 12/1Mbps service with 20GB monthly usage allowance. It will be up to RSPs to determine retail prices, but if, for example, RSPs were to sell this product for between \$40–80 per month, this would effectively translate into ~2–4AUD/GB/month. In practice many RSPs will likely provide mechanisms for end-users to download or upload in off-peak periods, thereby greatly increasing the total monthly usage allowance of each end-user.

RSPs would have the opportunity to purchase upgrade options beyond the standard network capacity allocation per AVC (150kbps), but would be charged a substantially higher price

In practical terms, 20GB a month is much higher than existing satellite and mobile broadband services offered in Australia and much higher than what is available around the world at fixed line equivalent prices. It is expected to allow an end-user to send/receive emails, browse the web, and use Voice Over IP (VOIP) services such as Skype (albeit with latency issues). They could also download nearly 30 movies per month (of moderate quality and 90 minute length), or listen to 240 hours of music streaming or watch 80 hours of YouTube. However this allowance would not be sufficient to permit more than sporadic streaming HDTV or peer-to-peer file sharing. Videoconferencing and remote education should be possible, with NBN Co providing guidance to RSPs on how to configure their services to allow for it.

If the above standard product is implemented, NBN Co has many options for upgrades. Two are shown below by way of illustration.

<i>Product</i>	ISS	LTSS Standard Product	LTSS Product 2	LTSS Product 3
<i>Headline speed Mbps</i>	6/1	12/1 or 25/5	12/1 or 25/5	12/1 or 25/5
<i>Busy hour throughput kbps</i>	30	150	200	300
<i>Pricing</i>		Universal National Wholesale Pricing	Substantially higher price	Substantially higher price
<i>Potential end-user RSP usage cap in GB if RSP does not provide peak and non-peak usage</i>	~10	~20	~30	~40
<i>Note: Total monthly usage will increase if RSP take time-of-day usage approaches</i>				

The proposed changes to the standard product and upgrade options have a number of regulatory and policy implications:

- NBN Co's assessment is that consistency with UNWP can be maintained, provided certain pricing approaches are taken. For example, that the 12/1Mbps standard satellite product continues to be priced at \$24 per month and the CVC product component continues to be priced at \$20 per month per megabit of capacity, with no additional charge in respect of AVC or CVC for the standard product level. [REDACTED]
- The standard product would likely need to be consulted on via NBN Co's Product Development Forum (PDF), as would any upgrade options.
- [REDACTED]
- [REDACTED]

It should be noted that with the non-contiguous nature of the non-fixed line footprint, premises in the same vicinity may well have different technologies and therefore different usage allowances. This will create challenges for NBN Co to address in terms of how this is communicated to the public.

[REDACTED]

5.3 RSP installation

To date, NBN Co has only used a single field force operator, engaged through managed service providers, for installs of each technology. Ericsson has subcontracted TechLife for fixed wireless, and Optus Satellite (through Gilat) has subcontracted Skybridge for ISS.

It has been suggested that RSPs be given the option to complete their own installs, with NBN Co retaining a contract with a field force operator, given that not all RSPs would want to perform this task, and the geographic spread of the installations.

Under this scenario, end-users would benefit from a more seamless set-up process. They would have one visit for the install of the equipment and the set-up by the RSP's elected field force. RSPs that opt to have their own field force could perform a single 'truck roll' and develop a deeper relationship with their customers. Interviews with RSPs suggested that some of the larger players would be keen to perform this service.

There is an opportunity to add RSP own-installs to the ordering system without major IT functionality change. However, this would require further evaluation including the impact on IT solutions. [REDACTED]

NBN Co would also benefit by minimising the risk of ISS migration, as RSPs would have ownership for their installs.

5.4 Other Satellite revenue opportunities

The Review also examined various incremental revenue opportunities across fixed wireless and satellite. For Satellite the only opportunity identified involves the **selling of B2B products** on the satellite service (as a wholesaler to NBN Co customers, not end-users), where there is excess capacity. The resultant retail products would be sold to end-users at near commercial rates offering transportable, mobile and high data throughput services to new markets like mining and construction sites. This would have relatively high complexity given the need for mobility licences and co-ordination with other satellites, requiring VSAT providers to place hubs in 10 gateways with Forward and Return carriers in those beams. It would also involve potentially similar regulatory implications to those discussed for POI backhaul which is detailed later in the report in chapter 10.

The Review proposes that NBN Co evaluate various approaches to selling excess capacity, including selling an IRU to a major reseller, alongside the alternative of creating NBN Co business-grade products.

5.5 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 5.1:** Create a standard satellite product with a specific network capacity allocation per end-user (150kbps) with upgrade options possible, and ensure that the expectations of end-users are clearly and effectively managed.
- **Proposed action 5.2:** Create and measure a Service Level Agreement (SLA) describing the aspired consumer experience, without taking on contractual obligations until stable performance is achieved, including requirements for the RSP in terms of managing consumer expectations, usage meters, traffic management etc.

- **Proposed action 5.3:** Adopt a single Point of Interconnect (POI) architecture for LTSS, which recognises that given that all LTSS traffic will necessarily be concentrated at the DPC, it is efficient to also offer interconnection at that point. As the DPC has geographical redundancy it is also prudent for the POI to have a geographically diverse back-up location.
- **Proposed action 5.4:** Limit end-user ability to bond ports on the Network Termination Device, at the expense of other end-users access to limited capacity. This means that an end-user will not be able to bond two 25/5Mbps ports to achieve a 50/10Mbps speed.
- **Proposed action 5.5:** Put in place AVC instruments and tools which monitor and control usage and provide support for the 'standard product and upgrade options' approach
- **Proposed action 5.6:** Further evaluate the opportunities for RSPs to complete their own installs
- **Proposed action 5.7:** Further evaluate B2B products on satellite as a potential incremental revenue opportunity.

6

Satellite: Partnership opportunities

6 Satellite: Partnership opportunities

In the course of the rollout, NBN Co has received a range of suggestions from industry about how to undertake broader and deeper co-operation and/or spin-out parts of the business. The Review analysed these options, seeking appropriate input from industry participants. This chapter discusses the specific opportunities relating to the Satellite network:

- **Divest the satellite program, and lease back capacity**
- **Divest the satellite business entirely**

6.1 Divest the satellite program and lease back capacity

NBN Co has been approached by third parties with proposals to purchase, and run the entire NBN Co satellite network. Specifically, an upfront cash amount would be paid to NBN Co in exchange for direct transfer of satellite ownership, and responsibility for all subsequent operations under an agreed service-level-agreement. NBN Co would then agree to a minimum annual capacity lease rate, with the third party being able to externally sell capacity unused by NBN Co.

Subject to specific deal negotiations, this option is likely to be financially neutral for NBN Co. The real benefits would be to substantially reduce funding requirements in the peak year by spreading costs over the life of the satellite. A further benefit is to provide NBN Co a direct path to commercialise spare capacity on the satellites (although it would still be possible to arrange this in simpler ways such as selling an Indefeasible Right of Use (IRU) for any spare capacity directly).

However, several questions remain unanswered, which make any deal highly risky for NBN Co. These include whether the third party's financial position would introduce bankruptcy and business continuity risks to NBN Co's satellite program, and whether it would be able to build and integrate the systems necessary to operate NBN Co's first satellite by the time it launches.

The Review assesses that NBN Co should not pursue this deal as there are limited financial benefits to NBN Co and a high likelihood it could not be concluded given the short time remaining to the launch of the first satellite and commencement of services.

The Review proposes, however, that NBN Co should remain open to further suggestions for partnerships or acquisitions from the industry and evaluate each on merit.

6.2 Divest the satellite business entirely (including government obligation)

Another option would be for the government to demerge and divest the satellite business from NBN Co (with or without an option for that entity to compete with NBN Co). Such a structure raises the following questions:

- How to arrange the required subsidy streams as the cash-flow of the satellite business is negative virtually every year forever?
- How to adequately ensure the full service obligation is passed to that entity?
- How to ensure Government retains the option to specify/approve modified minimum performance levels?

- How to make private ownership of a business that requires subsidisation, financially attractive for another owner?
- How to regulate the competition between NBN Co and the entity such that it is beneficial but does not waste subsidies?
- How to ensure the adverse impact on NBN Co's financials is acceptable?
- How to account for reduced NBN Co operational flexibility on hard to reach premises in the fixed line footprint?
- What degree of retail competition is required on the divested fixed wireless/satellite infrastructure and – by extension – how should RSPs be enabled to work on both national infrastructures effectively and efficiently, and switch end-users seamlessly?

On balance, the Review has assessed that the option does not provide financial benefits to NBN Co and should not be pursued.

6.3 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 6.1:** NBN Co should remain open to further suggestions for partnerships or acquisitions from the industry and evaluate each on merit

Part B

Fixed Wireless

7 **Fixed Wireless:** Overview of issues

7 Fixed wireless: Overview of issues

Chapters 1 and 2 described progress with the rollout of the satellite and fixed wireless programs. This chapter sets out the critical issues which NBN Co needs to address specifically with the Fixed Wireless Program:

NBN Co does not currently hold spectrum rights in urban-fringe areas, which drives ~80,000 of the coverage shortfall of ~200,000 premises

- Although NBN Co holds 2.3GHz and 3.4GHz spectrum rights in regional areas, Optus holds the same spectrum in metro areas and the surrounding metro fringe which extends a significant distance from each city. As alternative spectrum has not been secured, NBN Co has a spectrum gap in the urban-fringe zone around Canberra and the five mainland State capital cities
- The Corporate Plan 2012–15 did include a provision of [REDACTED] for additional base stations and spectrum in these areas, but to date the spectrum has still not been secured
- If these areas had to be served with FTTx due to ongoing lack of spectrum, premises would likely be delayed access to fast broadband until late in the fixed line rollout, with extra deployment costs to NBN Co in the hundreds of millions of dollars.
- *This is described in more detail in chapter 8.*

The fixed wireless program is currently behind the targets set out in the Corporate Plan 2012–15 and there is significant risk of not meeting end of FY14 activation targets

- While improvements are being seen, NBN Co has not been able to activate towers in a predictable workflow.
- The cost of tower construction is higher than expected based on benchmarks.
- *This is described in more detail in chapter 9.*

In addition, the Review undertook a preliminary evaluation of potential options proposed by industry, including:

Implementing fixed wireless in the fixed line footprint

- Both the Strategic Review 2013 and industry have suggested that NBN Co could make better use of its planned fixed wireless base stations to serve premises in the previously specified 'fixed line footprint'.
- *This is described in more detail in chapter 11.*

Fixed wireless partnership opportunities

- Fixed wireless partnership opportunities that have been suggested by industry include increased greater of passive tower infrastructure with third parties (either NBN Co using more third party towers, or vice versa to improve mobile coverage), sharing of active and passive equipment, and establishing of broader open access mobile roaming operations.
- *This is described in more detail in chapter 12.*

A description of how the current plans for satellite and fixed wireless translate into overall coverage issues for the non-fixed line footprint are described in Part C of this Review.

8

Fixed Wireless: Spectrum

8 Fixed wireless: Spectrum

8.1 Overview and history

NBN Co's fixed wireless network relies on having sufficient spectrum to deliver its products. Currently, NBN Co has access to two spectrum bands, 2.3GHz and 3.4GHz in much of regional and remote Australia. NBN Co holds up to 98MHz of spectrum in the 2.3GHz band – which is used for the NBN Co TD-LTE fixed wireless access network – and up to 100MHz in the 3.4GHz band, which is currently unutilised.

NBN Co acquired its original 2.3GHz and 3.4GHz spectrum licences, covering regional and remote areas, from AUSTAR in February 2011 for approximately \$120 million. In July 2011, it acquired further licences for 2.3GHz at auction for \$1.3 million. NBN Co recently accepted an offer from the ACMA to re-issue its 2.3GHz spectrum licences through to July 2030 at a cost of \$22.6 million. Spectrum licences in the 3.4GHz band are due to expire in December 2015.

During 2013, the Statement of Expectations dated 17 December 2010 prevented NBN Co from participating in the 700MHz spectrum auction. At the same time, NBN Co decided not to participate in the 2.5GHz auction, based on the assumption that this band is highly valued by mobile network operators. At the auction, all of the available 2x70MHz channels of the 2.5GHz spectrum band were acquired by Telstra (2x40MHz), Optus (2x20MHz), and TPG (2x10MHz) at close to the reserve price of \$0.03/MHz/population for a total of ~\$95 million.

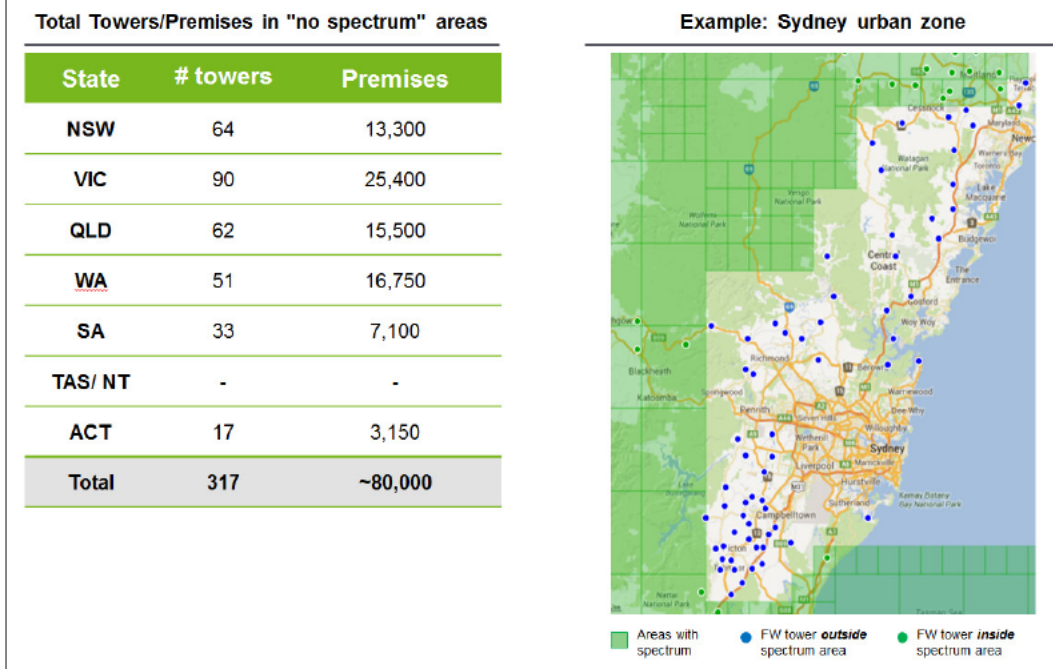
8.2 The spectrum gap problem

Although NBN Co has sufficient bandwidth for its products, currently it does not hold spectrum for approximately 320 of the 2,400 fixed wireless sites initially scoped as required (See chapter 2 for background on the 2,400 sites). The spectrum gap affects around 80,000 premises. The affected sites are located on the fringes of Canberra and the five mainland State capital cities where Optus is the primary holder of 2.3GHz and 3.4GHz spectrum and is already, in some areas, operating a 2.3GHz TD-LTE wireless network. The breakdown of these premises/sites by city and an example of the Sydney urban fringe zone is shown in exhibit 8-1.

While NBN Co could use other delivery technologies like satellite and FTTN in these areas, these cannot entirely meet the shortfall in a cost effective manner and cannot meet the need within the amount provided for in the Corporate Plan. Specifically, extending the fixed line footprint is likely to be costly, and the LTSS does not have sufficient capacity (see chapter 14).

To avoid having to use alternative technologies, NBN Co will need to secure access to additional fixed wireless spectrum in the fringes of the six affected capitals. It needs at least 60MHz of suitable spectrum to address near term demand, and 80MHz to address longer term capacity requirements.

Exhibit 8-1: Number of premises/sites within "no spectrum" areas and example of Sydney urban fringe zone



8.3 Assessment of spectrum options

The Review assessed a number of options for how NBN Co could address the spectrum gap, summarised in the exhibit below. The options take account of several criteria, including bands identified by the ACMA for future wireless broadband use, compatibility with existing NBN Co spectrum holdings, current and future availability.

Exhibit 8-2: Summary of spectrum options for NBN Co considered by the Review

	700MHz	850MHz (expansion)	1.5GHz	2.3GHz	2.5GHz	3.4GHz	3.4GHz (expansion)
Current allocation	Mobile	Cordless telephone systems, point-to-point services, land mobile	Point-to-point, digital radio concentrator systems, aeronautical telemetry	Fixed wireless	Mobile (FDD) and electronic news gathering (ENG)	Mobile/wireless, point-to-point, point-to-multipoint, earth receive	Amateur radio – future band arrangement under review by the ACMA
Current holder in relevant area	-	-	-	Optus	Telstra, Optus, TPG	Mostly Optus, small amount held by Telstra and BigAir	-
Potential Bandwidth Available	2 x 15 MHz (FDD)	2 x 10 MHz (FDD)	2 x 35 MHz (FDD) or 40MHz (UMD)	98MHz (TDD)	2x70 MHz (FDD)	100MHz (TDD)	50MHz spectrum currently unplanned
Access timeframe	Q4 2014	Likely beyond 2015 (uncertain)	Likely beyond 2015 (uncertain)	Currently available for use	Available for use in October 2014	Likely late 2015 or early 2016	Likely late 2015 or early 2016
Estimated market price	[REDACTED]						
Commercial availability of equipment	Widespread deployment globally	Limited deployment in this part of the band	LTE deployment in Japan in FDD (Huawei and NEC)	NBN Co and Optus are both deploying TD-LTE in this band	Equipment available from Ericsson and Alcatel Lucent in FDD	Legacy WIMAX vendors, Huawei and ZTE, Ericsson expecting commercial availability in mid 2015	Legacy WIMAX vendors, Huawei and ZTE, Ericsson expecting commercial availability in mid 2015
Meet capacity requirements	Insufficient for current capacity requirements	Insufficient to address current or future capacity requirements	Sufficient for current capacity requirements; Limited upgrade potential	Sufficient to address current requirements and upgrade potential	Sufficient to address current requirements and upgrade potential	Sufficient to address current requirements and upgrade potential	Sufficient for current capacity requirements; Limited upgrade potential

It should be noted that market price reflects the desirability of the band for parties wishing to purchase spectrum. The desirability for others is driven by factors such as propagation characteristics (e.g. cell coverage, indoor penetration), assigned spectrum usage (e.g. FDD, TDD), and the commercial availability of equipment.

8.4 Proposed pathways to address spectrum gap

The Review proposes a set of pathways for NBN Co to pursue in order to address the spectrum gap issue:

- Work closely with the ACMA on options for NBN Co to secure sufficient spectrum [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]

In the event that none of the above pathways yield the desired outcomes, FTTx should be the ultimate fallback option, but this will likely come at significant incremental cost.

The Review also considered options for using the 700MHz spectrum and the 850MHz expansion band.

NBN Co's ability to use the unsold 700MHz spectrum (2x15MHz) faces two barriers: the limited amount of available spectrum and the high cost of access. Under the current Ministerial Directive, the reserve price will be equal or higher than the Digital Dividend auction reserve price (\$1.36/MHz/Pop). This puts its implied value at close to \$1 billion, which is substantially more than budgeted.

The 850MHz expansion band has a limited amount of spectrum, with only 2x15MHz available. 2x5MHz had already been proposed for public safety mobile broadband making only 2x10MHz available which is insufficient for NBN Co's needs. The cost is also likely to be high, with a 15 year national spectrum licence costing between \$400 million and \$600 million.

For NBN Co, the use of lower band spectrum (e.g. 700MHz and 850MHz expansion), is unlikely to derive greater coverage benefits or significantly reduce the number of towers, due to the requirement for near line-of-sight between the tower and premises.

8.5 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 8.1:** Work closely with the ACMA on options for NBN Co to secure sufficient spectrum [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- **Proposed action 8.5:** Expedite the work of NBN Co's Spectrum Taskforce comprising senior commercial and technology representatives from Commercial Strategy, Regulatory, Finance, Product, Technology, and Planning and Design, led by an Executive Committee member. The taskforce works closely with NBN Co senior executives to maintain internal alignment on spectrum matters and engage external stakeholders (i.e. Communications Minister, the Department of Communications, the ACMA, other mobile network operators) in a strategic and coordinated manner.

9

Fixed Wireless: Challenges in delivery

9 Fixed wireless: Challenges in delivery

9.1 Overview

Over the past two years of the rollout, the NBN Co Fixed Wireless team has dealt with a number of challenges in the process of developing new organisational capabilities. Although many challenges have been resolved, areas of improvement remain.

The Review identified and analysed a range of topics as being critical to designing and managing an effective fixed wireless rollout. The first relates to spectrum, and the need to align decisions about spectrum with the required service level and product set – this was discussed in chapter 8. The remaining topics relate to the technology choices for fixed wireless, the best way to manage planning and workflow, opportunities for cost efficiencies, and the potential upgrade path for fixed wireless. These are discussed, in turn, in the current chapter.

9.2 Fixed wireless technology choices

From a technology perspective, the Review found that NBN Co has been prudent in terms of making choices around technology, network design, and engineering, in order to meet its product requirements. Specifically:

- TD-LTE is a standardised technology with a clear roadmap. Its fundamental characteristics make it suitable for a fixed wireless deployment requiring asymmetric downlink and uplink
- Base station equipment is generally off-the-shelf but reconfigured for specific requirements
- A design parameter of 500/150kbps Committed Information Rate (CIR) for all fixed wireless premises can deliver a satisfactory end-user experience for a product with Peak Information Rate (PIR) of 25/5Mbps
- By using outdoor wireless network termination units (WNTDs) at the premises with near line-of-sight to the fixed wireless tower, NBN Co can deliver the required performance level, and satisfactory cell coverage to address 20 percent of the area within 14km radius
- The WNTDs are fine-tuned to maximise performance (e.g. uplink power level is 1dB above 3GPP standards)
- The placement and selection of sites are generally in close proximity to the majority of serviceable premises (currently 52 percent of connected premises are within 3km of the tower)

However, the Review also identified some 'non-standard' technology choices that have led to higher cost and complexities for NBN Co, than for other third party mobile network operators. The non-standard designs partly reflect NBN Co's unique requirement to guarantee service levels (unlike most mobile network operators that only need to offer 'best effort' service), and offer wholesale services at Layer 2. Specifically:

- The WNTD is customised specifically for NBN Co, which is reflected in higher unit costs (~\$500) than standard indoor CPEs (~\$100–300)
- Professional rooftop installation and service qualification required at fixed wireless premises (~\$500 per premises installation)
- Offering a traditional Layer 3 wireless product at Layer 2 via emulation, creates some inefficiencies (e.g. tunnelling overheads)

The Review believes that if the product requirements were relaxed, NBN Co could theoretically offer a wholesale 'best effort' service at Layer 3 that would significantly reduce the cost of connecting end-users by using self-installed indoor CPEs, and increase the number of serviceable premises by mitigating the needs for service qualification.

In the absence of these changes, NBN Co has limited opportunities to optimise the fixed wireless technology and design. While moving to Layer 3 could still yield some cost benefits, most of the costs are already sunk. For that reason, the Review proposes that NBN Co continue operating in Layer 2 to maintain consistency in product offering for RSPs across technologies, and give them greater flexibility to differentiate.

9.3 Planning and workflow

As a relatively new organisation, NBN Co's Fixed Wireless team faced significant challenges in the first 12–18 months of the rollout, while it got up to speed in planning and constructing the network. During much of this time, it lacked basic tools and processes, and standard engagement models for local councils, and had to negotiate access agreements with MNOs for shared use of infrastructure. This resulted in a significant variability in the workflow of tower builds and higher than expected numbers of 'work-in-progress' sites that are yet to be activated. The NBN Co team has worked with Ericsson to stabilise the program.

To date, NBN Co has acquired ~800 sites. Of these, ~280 are already in service and construction has started on many of the remaining ~520. Average monthly rates across the entire rollout are: acquiring sites at ~28 sites per month, constructing at ~15 sites per month, and putting in service at ~10 sites per month. The last 6 months have shown improvements in volume and stability of acquisition and construction. Over that time, the number of new sites acquired per month has ranged from 30 to 60, the number of new sites constructed per month has ranged from 20 up to 50, and the number placed in service per month has ranged from 10 to 40.

Although headway has been made, several risks remain that could jeopardise the rollout progress:

1. **Forecast accuracy and predictability:** Despite significant improvements to the build run rate, there is still a high degree of month-to-month variance. Forecasts are frequently updated, and can vary widely. For example, in the four-week period of 14 February to 13 March 2014, of the ~200 sites yet to be put in service by end of FY14, ~60 had a change in forecasted service date (~30 delayed by more than 2 weeks)
2. **Pipeline of activities:** Although the recent run rates for activities have improved over the past 6–12 months, they are still inconsistent across activities. Site acquisition has operated at a much higher rate than sites are being constructed and/or connected. This has led to a large backlog of sites that are acquired but not yet constructed, rising from ~80 to ~260+ over the past year, driven in part by changes in planning methodology. Similarly, a large number of sites have been constructed, but cannot be connected due to delays in the availability of backhaul. This applies to ~100 sites, ~60 of which have been constructed for more than 3 months.

NBN Co forecasts suggest it will meet the target of 483 live sites by FY14, set out in the Corporate Plan 2012–15. However, given low predictability of delivered sites, the Review cannot confirm this.

- As of 13 March 2014, only 284 sites are in service, indicating substantial progress is needed to connect the additional 199 sites before 30 June 2014
- Of these, 39 have not yet been acquired, and an additional 53 have not been constructed. Assuming NBN Co maintains its recent run rate of acquiring and constructing ~40 sites per

month, the gap can be closed, but the unpredictability of connection forecasts makes the number of live sites uncertain.

- The biggest risk to the FY14 target is the availability of transit. 93 of the sites yet to be connected do not have backhaul available. NBN Co needs to continue prioritising these sites for attention to backhaul dependencies.

To address these issues, the Review proposes that NBN Co focus much more on integrated planning functions, so that it can plan across all activities rather than progress each one independently. This would avoid situations such as constructing sites that it knows will not be connected. The Fixed Wireless planning team also needs longer term visibility into the progress of transit ring construction and a role in its prioritisation and timing.

9.4 Cost efficiencies

Today, NBN Co pays ██████████ in capex for new site builds, with over █ percent coming from civil construction and exclusions such as access tracks and power lines. These exclusions also account for a wide variation in costs borne by NBN Co, which make it difficult to undertake effective planning and cost forecasting.

MNO build costs for similar specification towers are ██████████ lower than NBN Co). The largest driver of NBN Co's higher costs is its stringent service obligations which mean it must sometimes choose sites with difficult (and costly) construction environments that a typical MNO would not consider. Unless it reduces those service requirements, the Review believes that NBN Co cannot achieve new build costs comparable to MNOs. Nonetheless, there may be an opportunity to reduce costs by █ percent (a net saving of ██████████ capex) on new tower builds by structurally pursuing opportunities, such as:

- Releasing sites in greater volume, and more predictably, to give NBN Co more leverage in negotiations and to realise scale advantages
- Setting up a quarterly review and reducing the cycle for end-to-end processes and costs
- Adopting more flexible tower specifications (e.g. height, different materials, configurations)
- Involve more NBN Co construction resources at the site selection stage to ensure cost effective decision making and design choices

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9.5 Fixed wireless technology potential upgrade path

Expected increases in the take-up and data consumption of fixed wireless premises mean NBN Co will need to assess potential upgrades to the network to meet future demand. Based on the current 25/5 product offer, the TC1 requirements, and expected uplift in take-up, the Review estimates approximately 10 percent of the fixed wireless sectors will need additional capacity in 2019, and approximately 40 percent in 2021.

NBN Co has four main upgrade options:

- **Implement 4x4 MIMO:** Multi-input-multi-output (MIMO) uses multiple transmitters and receivers to improve performance by reducing the impact of obstacles between the tower and the premise. The technology will increase spectral efficiency (hence capacity per sector) by, at most, 20 percent in regional and rural areas. However, it can improve performance where premises have partial obstructions on line-of-sight, and potentially service more premises by reducing failure rates for service qualification (currently ~7 percent). To upgrade to 4x4 MIMO, NBN Co will need to put additional equipment at the base station and replace the radio component of the WNTD. As the upgrade requires configuration of CPE, timing should be based on demand, and coincide with equipment end of life and upgrade cycles.
- **Implement carrier aggregation:** By combining discrete channels of compatible spectrum (adding 20MHz of spectrum to existing sectors), carrier aggregation allows NBN Co to double the capacity per sector and support higher speed products. According to vendor roadmaps, carrier aggregation in the 2.3GHz band will be commercially available in mid 2014, with WNTD chipsets expected to be available in mid-2015. However, upgrading to carrier aggregation is potentially costly, given it involves replacing existing WNTDs, and sizable upgrades of base station components. Future carrier aggregation upgrades should be driven by demand growth on a site-by-site basis and the introduction of higher speed products.
- **Site sector splitting:** Most NBN Co sites already have three sectors in place or planned. By adding more sectors to planned sites, the number of premises served per sector will decrease, which will in turn increase the capacity available per premises. Increasing the number of sectors per site is more cost effective in the short to medium term than carrier aggregation, as the upgrade is limited to the base station (potentially some tower strengthening), without replacing existing WNTDs.
- **Using 3.4GHz in addition to 2.3GHz bands:** NBN Co could use both spectrum bands in the areas where it holds the rights to use both bands. This also effectively doubles capacity availability, and could lead to higher capacity allocation per end-user. This option is unlikely to be available to NBN Co in urban fringe areas.

9.6 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 9.1:** Release sites into the planning process much further in advance, and in greater volume
- **Proposed action 9.2:** Adopt a quarterly review and reduce the cycle to periodically analyse costs and identify savings
- **Proposed action 9.3:** Focus more on the progress of end-to-end site connection, rather than interim milestones
- **Proposed action 9.4:** Provide greater visibility into the transit construction planning and progress, and involve the Fixed Wireless planning and design teams more heavily in transit planning activities
- **Proposed action 9.5:** Drive a further cost reduction of █████ percent on new tower builds by adopting more flexible tower specifications, introducing more competition and involving more construction resources at the site selection and design stage.

10

Fixed Wireless:

Product construct
and other revenue
opportunities

10 Fixed wireless: Product construct and other revenue opportunities

10.1 Proposed wholesale instruments and product options

The Review examined NBN Co's current approach to product and pricing in the non-fixed line footprint, including learning the lessons from poor user experiences with the Interim Satellite Service (ISS). Chapter 5 outlined six changes to the satellite product instruments and construct to ensure it can adequately manage capacity usage and the end-user experience, and avoid the issues experienced on ISS.

Like satellite, fixed wireless is a capacity constrained technology, and as such, NBN Co should consider adopting analogous product changes for fixed wireless. These changes should be subject to different parameters on the same product constructs (e.g. capacity allocated would be between 400–500kbps per end-user).

10.2 RSP installation

To date, NBN Co has only used a single field force operator, engaged through managed service providers, for installs of each technology. Ericsson has subcontracted TechLife for fixed wireless, and Optus Satellite (through Gilat) has subcontracted Skybridge for ISS.

It has been suggested that RSPs be given the option to complete their own installs, with NBN Co retaining a contract with a field force operator, given that not all RSPs would want to perform this task, and the geographic spread of the installations.

Under this scenario, end-users would benefit from a more seamless set-up process. They would have one visit for the install of the equipment and the set-up by the RSP's elected field force. RSPs that opt to have their own field force could perform a single 'truck roll' and develop a deeper relationship with their customers. Interviews with RSPs suggested that some of the larger players would be keen to perform this service.

There is an opportunity to add RSP own-installs to the ordering system without major IT functionality change. However, this would require further evaluation including the impact on IT solutions. [REDACTED]

10.3 Other fixed wireless (or related) revenue opportunities

The Review also examined various incremental revenue opportunities across fixed wireless and satellite. In addition to the selling of B2B products mentioned in chapter 5, other revenue opportunities identified include POI backhaul and NBN Co offering wholesale mobile network access.

POI backhaul involves NBN Co providing backhaul from a number of regional and outer-metropolitan POIs to the capital cities. The most likely purchasers of such a product would be

smaller RSPs. [REDACTED]

[REDACTED] There are (by design) at least 2 fibre transmission providers to each POI, and the ACCC already regulates backhaul on routes not subject to effective competition and has been active in setting the regulated price of backhaul with reference to benchmarks from competitive routes.

The supply of POI backhaul would sit outside the current SAU, but consideration would need to be given to how the associated costs and revenue would be accounted for under the SAU's cost recovery arrangements. In addition, because NBN Co must only supply an eligible service declared under Part XIC of the Competition and Consumer Act, any NBN Co provision of POI backhaul would therefore have to be declared (such as via a Standard Form of Access Agreement) and would be subject to potential ACCC regulation on price and non-price terms and conditions.

Wholesale mobile network access. It has been suggested that NBN Co could offer wholesale mobile network access as a new product. By providing mobility capabilities through established infrastructure, systems and processes, NBN Co could foster competition in the regional and rural areas where transmission and the cost of base stations and network operations are the main barriers to entry for some mobile network operators (MNOs).

NBN Co has already invested in infrastructure that can be leveraged as the basis for operating mobile networks both on NBN Co radio base stations and through core network equipment integrated into MNO or third party infrastructure. However, it should be noted that normal mobile voice functionality is not currently enabled in NBN Co's core network. Revenue to NBN Co would be via a flat monthly fee per subscriber from MNOs for managing the network and infrastructure required to provide mobile network access, including data, voice, roaming and all other standard services provided by an LTE-based mobile network.

[REDACTED] The provision of these services is a major extension of NBN Co's core mandate, and would raise a number of issues. It would also need to be done in such a way that it was equitable to all MNOs.

Given the limited upside and substantial issues that would need to be addressed for this opportunity, the Review does not propose that NBN Co pursue it.

10.4 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 10.1:** Create a standard product for fixed wireless with a network capacity allocation per end-user (500kbps) with upgrade options possible, and ensure that the expectations of end-users are clearly and effectively managed.
- **Proposed action 10.2:** Create and measure a Service Level Agreement (SLA) describing the aspired consumer experience, without taking on contractual obligations until stable performance is achieved, including requirements for the RSP in terms of managing consumer expectations, usage meters, traffic management etc.
- **Proposed action 10.3:** Limit end-user ability to bond ports on the Network Termination Device, at the expense of other end-users access to limited capacity. This means that an end-user will not be able to bond two 25/5Mbps ports to achieve a 50/10Mbps speed.
- **Proposed action 10.4:** Put in place AVC instruments and tools which monitor and control usage and provide support for the 'standard product and upgrade options' approach

- **Proposed action 10.5:** Further evaluate the opportunities for RSPs to complete their own installs
- **Proposed action 10.6:** Further evaluate POI Backhaul as a potential incremental revenue opportunity

11

Fixed Wireless:

Implementing
fixed wireless
in the fixed line
footprint

11 Fixed wireless: Implementing fixed wireless in the fixed line footprint

11.1 Overview

Both the fixed line Strategic Review 2013, and industry, raised the possibility of NBN Co making better use of its planned fixed wireless base stations in its 'fixed line footprint'.

Under the previous Government's Statement of Expectations, NBN Co could not serve more than 10 percent (and ideally not more than 7 percent) of premises with fixed wireless and satellite. As a result, it built or is planning to build, fixed wireless base stations that only serve part of the base station coverage area, typically the outer fringes of a large country town or outer suburb. Due to the constraints of the previous Statement of Expectations, the rest of the coverage area (typically the inner core of a large country town or the denser area of an outer suburb) have no fixed wireless equipment facing them, and occupants of these premises may have to wait years for fixed line technologies to be built, while their neighbours are able to access fast wireless broadband from a nearby tower.

With the relaxation of the previous Statement of Expectations constraints, the Review proposes that NBN Co use its existing and planned fixed wireless base stations to provide fast broadband to more premises in the base station coverage area when the provision of additional equipment is cost and time effective.

- Roughly 1.1 million fixed line premises are covered by the ~1,400 NBN Co base stations in advanced planning stages². Of these, ~500,000 premises are in places where an entire Telstra distribution area can be covered by a base station, allowing NBN Co to delay or forego the build of a fixed line network in such areas. This number will rise when NBN Co determines which Technology Scenario to pursue, as this affects how many additional base station sites it will build above the Corporate Plan levels. For example, Scenario 2 calls for an extra ~1,300 base stations for a total of ~2,700
- Not all base stations have sufficient capacity to serve all premises in a coverage area to the required product standard. However, if all planned NBN Co base stations are upgraded, they can cover ~350,000 'fixed line' premises encompassing ~3,000 entire Telstra distribution areas. Upgrades consist of adding additional sectors (usually, adding 3 sectors to 3 existing ones), and using 3.4GHz spectrum, with equipment becoming available within the next 1–2 years. Where NBN Co already has sufficient spectrum, on a given tower, this gives NBN Co the opportunity to augment capacity at least three-fold without any technological obstacles.

NBN Co can choose between two options to leverage wireless in serving premises slated for fixed line:

- *Option 1* – Use temporary fixed wireless to accelerate deployment. NBN Co can use fixed wireless to accelerate network deployment, serving FTTN premises temporarily with wireless until the eventual FTTN build. This means it can connect ~350,000 premises 2 years earlier and bring forward revenues, at incremental capex of ~\$150–200 million, provided that industry install capacity can be ramped up to ~14,000 premises per month.

² These base stations are in areas where 2.3GHz spectrum is available and coverage has been confirmed.

Quantifying the incremental revenue of this plan is complex due to several variables that are difficult to predict (e.g. roll-out timing, take-up rates, ARPU in these areas etc.). Alternatively, as most incremental capex is driven by end-user connect costs, offering a fixed wireless 'on demand' option, with end-users absorbing CPE costs, could significantly reduce these incremental capex requirements

- *Option 2* – Substitute FTTN by 'permanent' fixed wireless. NBN Co can use fixed wireless to fully substitute fixed line build in areas where satellite capacity is sufficient to serve the small share of premises unable to receive a wireless signal (estimated at ~5 percent, which is lower than the 7 percent assumed in the non-fixed line footprint as there are typically fewer line-of-sight obstructions). The Review estimates that [REDACTED] potential fixed wireless premises can be added without causing capacity shortages on the satellite. Such premises could receive service earlier by fixed wireless than by fixed line. NBN Co could save between [REDACTED] in foregone fixed line build costs, [REDACTED]

For Option 2, NBN Co needs to consider attainable speed and upgrade path. Today, fixed wireless can deliver reliable broadband speeds of 25Mbps. In the future, NBN Co has the option of using carrier aggregation to achieve speeds of 50Mbps. However, in contrast to fixed line premises, fixed wireless end-users would likely be on capped plans.

[REDACTED]

11.2 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 11.1:** Depending on which option it chooses:
 - If NBN Co decides to pursue Option 1 (accelerated deployment) before FY15: The earlier a decision is taken, the earlier NBN Co can reach underserved premises, which will lower incremental upgrade costs, as new sites can be equipped with six sectors from the outset.
 - If it decides to pursue Option 2:
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - When developing business rules for the full multi-technology model, ensure that fixed wireless and satellite technologies are included in the consideration set in any given area, trading off the potential cost reduction and increased speed of rollout against the capabilities of the product.

12

Fixed Wireless:
Partnership
opportunities

12 Fixed wireless: Partnership opportunities

In the course of the rollout, NBN Co has received a range of suggestions from industry about how to undertake broader and deeper co-operation and/or spin-out parts of the business. The Review analysed these options, seeking appropriate input from industry participants. This chapter discusses three specific options:

- **Share fixed wireless passive equipment**
 - Leverage third party towers to host NBN Co active equipment
 - Have third parties construct and own towers for NBN Co
 - Leverage NBN Co towers to extend mobile coverage of MNOs
- **Share active, and passive equipment on fixed wireless towers**
- **Divest the fixed wireless business entirely**

Proposals to leverage NBN Co base stations to extend mobile coverage, and to share equipment with MNOs, also introduce the question of how NBN Co might support broader government policy objectives, including:

- Extending mobile coverage and addressing mobile black spots
- Increasing competition in mobile coverage areas.

The Review identifies below ways in which NBN Co might assist with these policy objectives. In particular, the objectives of the Mobile Coverage Program may be achieved in some localities by the Program effectively subsidising MNOs to co-locate on selected NBN Co base stations. Any decision by Government to change the policy for such subsidisation would need to take account of the potential for MNOs to sell competing products to NBN Co's fixed wireless.

12.1 Share fixed wireless passive equipment

NBN Co could adopt one of three main models for passive equipment sharing. Each is summarised below and described in the following sections.

In the first model, NBN Co would, where possible, leverage third party infrastructure to host active equipment. At present, MNOs, and companies specialising in wireless tower ownership (e.g. Crown Castle and Broadcast Australia) already own a large number of towers in regional Australia for which NBN Co has negotiated pre-determined lease rates.

In the second model, NBN Co would engage specialist tower companies to construct towers on its behalf. In exchange, NBN Co would pay a pre-determined lease, and the tower company would collect rents from any other MNOs wishing to use the towers.

In the third model, NBN Co would construct new towers itself, but lease space on them to third parties.

12.1.1 Leverage third party towers to host NBN Co active equipment

Historically, NBN Co's preferred approach has been to co-locate its equipment on existing third party towers (consistently with the *Telecommunications Code of Practice 1997*), built by companies such as Crown Castle, Broadcast Australia, or MNOs. Currently, ~520 sites or 35 percent of planned towers use this approach. Advantages include a significantly faster lead time in negotiating access.

Where possible, NBN Co should continue to pursue this model. However, the Review believes there is limited scope to increase co-location beyond existing plans as most third party sites do not meet NBN Co's coverage requirements. Where they do, NBN Co already co-locates 80 percent of the time. For the remaining 20 percent, a range of factors prevent co-location including a lack of space on the tower, or high costs for tower strengthening and leasing which make a new build cheaper. The Review proposes NBN Co continues on the current pathway.

12.1.2 Have third parties construct and own towers for NBN Co

Where co-location is not possible, the next preference is for tower companies to construct and manage towers with NBN Co as a long term anchor tenant. [REDACTED]

The Review believes the scope of such a deal will be limited to no more than [REDACTED] additional sites, reducing capex by [REDACTED] million but increasing ongoing opex by [REDACTED] million.

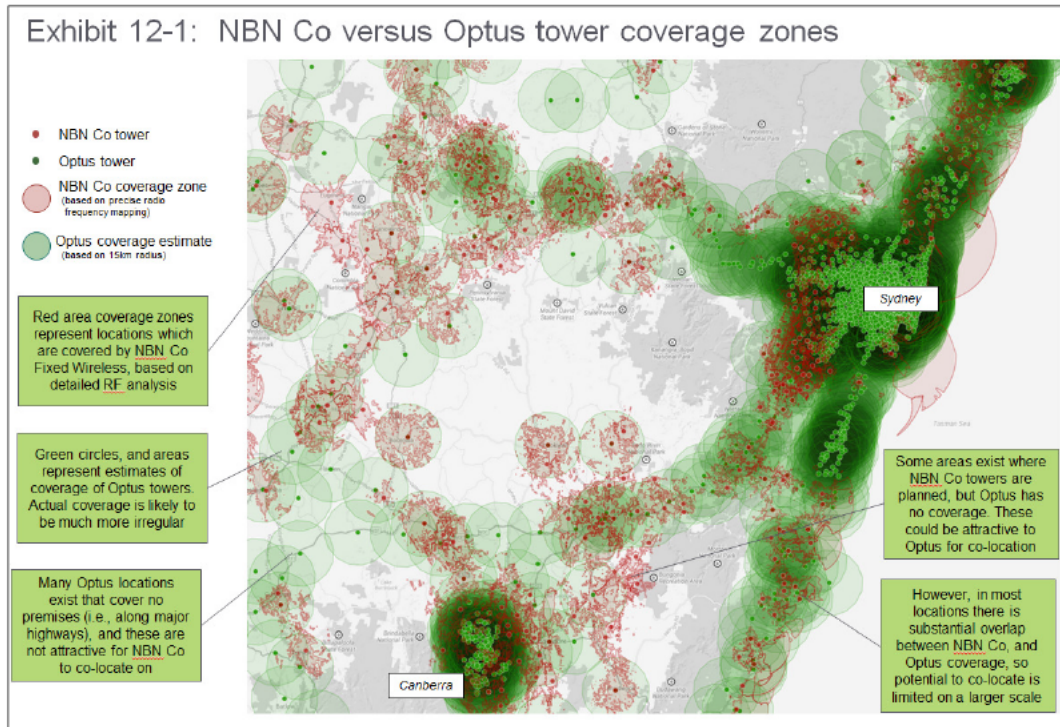
The Review proposes that NBN Co issue tenders for services ranging from site acquisition through to site construction in blocks of [REDACTED] sites under competitive conditions, while actively managing contract risks and incorporating lessons from other MNOs and NBN Co's own interactions with tower owners.

12.1.3 Leverage NBN Co towers to extend mobile coverage of MNOs

NBN Co can also construct new sites and open them up for co-location by MNOs (to place mobile radio frequency (RF) equipment on the NBN Co infrastructure). The Review investigated possible roles for NBN Co to reduce the barriers for MNOs expanding coverage in regional Australia, and to participate in the government's foreseen Mobile Coverage subsidy program.

NBN Co's current process for facilitating access to its towers is done in accordance with the Telecommunications Act, which requires all carriers to share sites containing antenna-supporting structures where technically feasible, when requested by another carrier. Once sites are selected, NBN Co publishes them to a public database and MNOs can request to co-locate their equipment on NBN Co infrastructure. If contacted at this stage, towers can be designed to accommodate additional tenants and lease terms agreed under standard contracts. Despite ~870+ new NBN Co build sites being made public (i.e. Greenfields), only 3 expressions of interest have been received from MNOs, and of these, only 1 site was ultimately deemed suitable for an MNO's needs by the MNO.

GeoAnalytics modelling determined that [REDACTED] sites in the rollout would expand MNO coverage [REDACTED]. Of these, the Review believes [REDACTED] sites, covering [REDACTED] premises, could be economical for the MNO under a best-case scenario [REDACTED]. Exhibit 12-1 shows a snapshot of potential NBN Co planned tower coverage areas (in red), and high level estimates of Optus (as an example) coverage areas (in green). This shows a high degree of overlap between NBN Co coverage areas and areas already covered by Optus (maps of other MNOs show similar results). It should be noted that this is based on desktop modelling of MNO coverage by NBN Co and not on detailed coverage data from any of the MNOs.



NBN Co is currently in discussions with MNOs on this topic [REDACTED]

[REDACTED] The Review identified two ways in which co-location could become economical for MNOs at a larger number of sites:

- Capex subsidy via Mobile Coverage program
- Reduction of NBN Co lease payment to incremental cost level (in pre-defined areas), contrary to direction to NBN Co to see a return on capital.

Initial estimates by the Review propose that [REDACTED] additional sites [REDACTED] premises) could become attractive for co-location depending on the subsidy level.

The Review proposes that NBN Co take additional measures to facilitate greater sharing of its infrastructure for third parties, and identify and capitalise on potential opportunities early:

- Involve MNOs earlier in the site planning and design process, and at both operational and strategic levels. Although NBN Co is adhering to the necessary regulations, the sharing of information and working collaboratively with other third party tower owners has been conducted at an operational level, not a strategic one
- Include Freeview and State Emergency Services as companies to co-locate with
- Government may wish to consider the cost to ask NBN Co to step away from reciprocal pricing arrangements and charge MNOs only incremental costs (rather than seeking a return on capital) in a pre-defined and limited geography

12.2 Share active and passive equipment on fixed wireless towers

The broader opportunity for NBN Co to share both active and passive equipment on its towers is contingent upon being able to provide MNOs with a substantial expansion of coverage and/or mobile services. As previously, only a handful of sites fall under this category, and the complexity it introduces would not result in a net positive NPV for NBN Co. The Review evaluated a number of potential transactions in detail and found that NBN Co could realise incremental value at best.

12.3 Divest the fixed wireless business entirely (including government obligation)

A final option would be for the government to demerge and divest the fixed wireless business from NBN Co (with or without an option for that entity to compete with NBN Co). Such a structure raises the following questions:

- How to arrange the required subsidy streams as the cash-flow of the fixed wireless business is negative virtually every year forever?
- How to adequately ensure the full service obligation is passed to that entity?
- How to balance NBN Co's unique coverage requirements for fixed wireless towers against the need to generate profits by minimising tower build costs?
- How to ensure Government retains the option to specify/approve modified minimum performance levels?
- How to make private ownership of a business that requires (cross-)subsidisation, financially attractive for another owner?
- How to regulate the competition between NBN Co and the entity such that it is beneficial but does not waste subsidies?
- How to ensure the adverse impact on NBN Co's financials is acceptable?
- How to account for reduced NBN Co operational flexibility on hard to reach premises in the fixed line footprint?
- What degree of retail competition is required on the divested fixed wireless/satellite infrastructure and – by extension – how should RSPs be enabled to work on both national infrastructures effectively and efficiently, and switch end-users seamlessly?

On balance, the Review has assessed that the option does not provide financial benefits to NBN Co and should not be pursued.

12.4 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 12.1:** Optimise and continue with NBN Co's current approach of preferring to co-locate its equipment on existing third party towers where technically feasible.

- **Proposed action 12.2:** Issue tenders for services ranging from site acquisition through to site construction in blocks of [REDACTED] sites under competitive conditions, while actively managing contract risks and incorporating lessons from other MNOs and NBN Co's own interactions with tower owners.
- **Proposed action 12.3:** Take additional measures to facilitate greater sharing of its infrastructure for third parties, and identify and capitalise on potential opportunities early.

Part C

Overall coverage
and proposed
future direction

13

**Overall
coverage:**
Overview of
issues

13 Overall coverage: Overview of issues

Chapters 1 and 2, as well as Part A and Part B, have described progress with the rollout of the satellite and fixed wireless programs. This chapter sets out the critical issues which NBN Co needs to address when considering the overall coverage of the non-fixed line footprint:

Based on the Corporate Plan 2012–15 infrastructure and revised take-up estimates, ~200,000 premises will not be able to be served in the non-fixed line footprint

- The Corporate Plan 2012–15 provided a budget of \$3.5 billion capex to 2021 to build 1,400 fixed wireless towers, launch 2 satellites and install end-user premises equipment. The plan anticipated a 22–25 percent take-up rate and predicted connections to ~230,000 premises (with some additional capacity available)
- The Review believes that take-up will likely be 2–3 times higher and that between 440,000–620,000 connections will be required across the footprint. The capacity constraints of the satellites, and the coverage restrictions of fixed wireless towers mean that at the proposed specifications, the Corporate Plan 2012–15 would not be able to provide all the necessary infrastructure to meet the Government's objectives. While fixed wireless towers can accommodate some of the higher demand, at the higher take-up expected, ~200,000 premises would not be able to be served by NBN Co.
- *This is described in more detail in chapter 14.*

NBN Co's functional siloed organisation has inhibited visibility and effective decision-making across fixed wireless and satellite

- Given the complexity of the technology choices in the non-fixed line footprint, decision-making needs to be cross functional. In addition, consideration needs to be given to how to ensure all premises in a given geography have access to at least one NBN Co technology
- Decisions on multiple critical issues have been made in functional silos and, at times, at too low levels in the organisation. Decisions have often been delayed, placing unnecessary pressure on implementation timelines and critical paths
- NBN Co could also be more proactive in approaching industry partners.
- *This is described in more detail in chapter 16.*

14

Overall

coverage:

Increased demand
and capacity,
coverage, cost
gaps

14 Overall coverage: Increased demand and capacity, coverage, cost gaps

14.1 GNAF issues, amended take-up and resulting demand

14.1.1 GNAF issues

The Review used the GNAF count from PSMA Australia taken and washed by NBN Co in September 2013. The number was further adjusted for variances based on satellite imagery.

This gave a total number of premises for the non-fixed line footprint in 2012 of ~905,000. An error margin of 10 percent was included in sensitivities to mitigate the effect of any GNAF inaccuracies

Based on ABS and census data, the Review assumes a growth rate of 1.3 percent p.a. in the non-fixed line footprint between 2012 and 2021. This will lead to a count of ~1,020,000 premises in 2021, which is 4 percent more than the ~975,000 premises forecast in the Corporate Plan 2012–15.

GNAF data is the aggregation of multiple sources with limited access to robust and contemporaneous data. However, it does not represent a precise count of 'premises' as defined by NBN Co. NBN Co attempts to validate the data and adjusts premises counts during the design and construction phases based on a combination of satellite imagery and field surveys. While NBN Co's 'wash' of the data will pick up a large number of errors, such as the existence of premises in the middle of highways, field experience has demonstrated there is a sufficient level of variance between GNAFs and actual premises to warrant caution in the planning process.

The Review proposes that NBN Co proactively seek to minimise the risk of underlying data problems through a concerted effort with Government departments such as the Department of Communications, other Government Business Enterprises (such as Australia Post), and RSPs, including potentially 'crowdsourcing' to supplement existing data sources.

In addition, throughout the Review it was evident that there are diverging views on the number of assumed premises across various NBN Co functions. The Review proposes that NBN Co adopt a consistent definition and count of 'premises' across the company.

14.1.2 Fixed Line Boundary Variations

The number of premises in the non-fixed line footprint is also driven by potential variations in the boundary of the fixed line footprint.

Since the commencement of the rollout of the fixed line network, more detailed planning has been completed on an area-by-area basis and more information about the local conditions is gradually discovered. As a result the geographic boundaries that define which specific premises receive a fixed line service as opposed to a non-fixed service (fixed wireless or satellite), may change due to technical, practical or economic reasons.

NBN Co has historically varied these boundaries substantially, and the net effect of this thus far has been to add a substantial number of premises into the non-fixed line footprint. As the detailed planning and construction of the fixed line proceeds, it is likely that more premises may be moved into non-fixed line areas. In areas where additional premises will need to be served by the satellite, this could put further pressure on already heavily subscribed beams.

The Review proposes that as part of the detailed planning process, NBN Co should carefully manage the risk of a significant number of additional premises being added to the non-fixed line areas for satellite service, unless this is made as part of a comprehensive integrated planning decision weighing all the consequences.

14.1.3 Amended take-up and resulting demand

The Review re-evaluated likely take-up for fixed wireless and satellite.

The Corporate Plan 2012–15 used service provider data to estimate how many services would be needed in the non-fixed line footprint. Using this approach, it estimated a take-up rate of 22 percent for fixed wireless and 25 percent for satellite.

Observations from the ISS were that demand for the satellite broadband product exceeded planned supply. This, coupled with a directive to encourage demand, resulted in the product reaching capacity (44,000 end-users) in ~14 months and being closed for sale due to excess demand.

Current take-up on fixed wireless is already at expectations, partly driven by [REDACTED]. Current fixed wireless take-up is ~18 percent after only six months of being 'on air'. Moreover, the general adoption of broadband has accelerated relative to the expectations of the Corporate Plan 2012–15.

By comparison, around the world DSL roll-outs took more than 4 years to reach take-up rates above 20 percent, and continued to show saturation penetration well above 50 percent.

The Review assessed demand using a top-down approach, based on the total number of premises at FY21 (100 percent) vacant premises (18–19 percent), those without broadband (7 percent) and those using alternative offerings (12–24 percent on satellite and 24–36 percent on fixed wireless).

Alternative broadband includes premises that have:

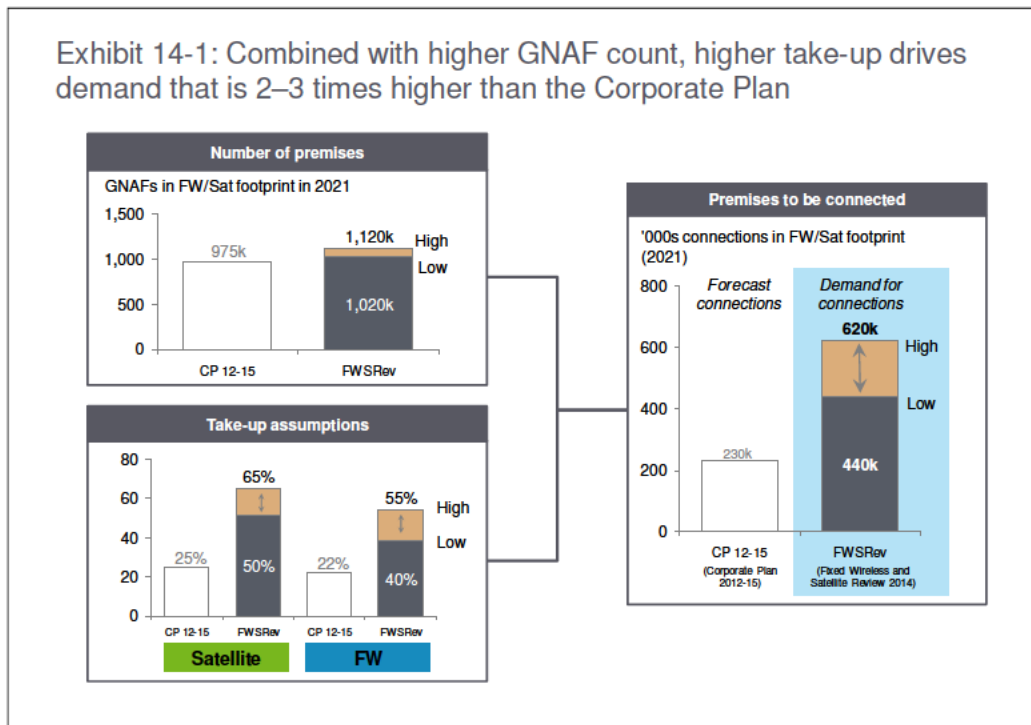
- Mobile broadband only (10–20 percent on satellite, 16–19 percent on fixed wireless)
- DSL (2–4 percent on satellite, 8–17 percent on fixed wireless)
- Competitor satellite offerings, only until IPSTAR end of life in 2021.

The Review estimates take-up of satellite in the non-fixed line footprint at approximately 50–65 percent and take-up of fixed wireless at approximately 40–55 percent by FY2021, based on current take-up and expectations regarding broadband usage³. These ranges result from competitive dynamics of the wider Australian telecommunications market, including uncertainty in the extent to which [REDACTED] will proactively market NBN Co services versus their current DSL, how rapidly the MNOs will expand their 4G mobile coverage, and the extent to which this will compete with, or complement, NBN Co services.

Based on these take-up rates and the premises numbers outlined in chapter 2, the Review believes that take-up will likely be 2–3 times higher than was originally forecast in the Corporate Plan 2012–15 and that between 440,000–620,000 connections will be required across the footprint. This is shown below in exhibit 14-1.

³ Because of differences in alternative offerings by geography, the difference in take-up rates between technologies is driven by the location of the premises rather than the technology. The Review refers to take-up by technology as a shorthand to refer to the differing demand in more remote (satellite) vs more regional (fixed wireless) areas.

Exhibit 14-1: Combined with higher GNAF count, higher take-up drives demand that is 2–3 times higher than the Corporate Plan



14.2 Limits to capacity and implications for coverage gaps

Three key issues drive NBN Co's inability to meet demand using the technology mix outlined in the Corporate Plan 2012–15:

- A lack of spectrum in metropolitan areas means at least ~80,000 premises across Australia are unable to be served by fixed wireless technology
- Revised forecasts of demand are 2–3 times greater than those set out in the Corporate Plan 2012–15
- The extent of NBN Co planned fixed line coverage has reduced since the initial satellite design⁴.

As a result of these issues, NBN Co faces a capacity and coverage gap of 200,000 premises within the Corporate Plan 2012–15 assumptions of 2 satellites and ~1,400 base stations (assuming the satellite throughput per end-user set at 200kbps for the standard product, with headroom for upgrade options).

With the benefit of a deeper understanding of where specific capacity gaps exist, and accurate coverage data for potential fixed wireless base station sites, the Review modelled a scenario known

⁴ FSAM-level planning and design done to date for FTTP has tended to reduce the fixed line footprint at the margins by excluding outlying premises or groups of premises which prove to be costly to reach with fibre

as 'Scenario 1'. Scenario 1 models the number of fixed wireless base stations actually needed to serve the non-fixed line footprint if the two satellites are retained. That number is ~2,900 base stations, or ~1,500 more than estimated in the Corporate Plan 2012–15.

Further constraints on implementation arise from the rate at which the industry can install CPEs. For example, if the current installation subcontractors for fixed wireless (TechLife) and interim satellite (Skybridge) were to ramp up capacity to a combined 8,000–9,000 installations per month, the time needed to connect the non-fixed line premises is relatively consistent across all modelled scenarios at CY20 (see below for further details on scenarios). The Review believes NBN Co should be able to work with industry to grow the overall industry capacity and bring the timelines forward. Achieving a rate of 12,000–15,000 installations per month would remove industry capacity as a rollout constraint.

14.3 Model inputs and calculations

14.3.1 Model inputs

Geodata input: Technology allocation has been modelled on geospatial data. This means that the model does not just consider premises numbers, but considers their location and which technology they can be covered by. Inputs modelled include:

- Include premises covered by the 101 spot beams from the two satellites
- Include premises covered by the ~2,400 planned and a number of hypothetical future base stations
- Overlay spectrum availability in 2.3GHz and 3.4GHz
- Premises which cannot reliably receive the signal (service qualification failure – these locations need to be served via satellite)
- Premises in Telstra copper distribution areas, which are potential FTTN areas. For each premises, the model takes into account loop lengths to determine maximally attainable speeds under FTTN, based on the speed-distance curves developed in the Strategic Review 2013.

The underlying number of premises in the footprint is determined according to the approach described in section 14.1, i.e. it assumes there are ~1.02 million premises in 2021 in the non-fixed line footprint. As the availability of satellite capacity is the single largest constraint in the model, a 10 percent buffer has been included to account for technical issues as well as imprecision in local GNAF counts. A fixed wireless service qualification failure rate of 7 percent is in place, such that 7 percent of all premises in any given fixed wireless coverage area must instead be served by satellite.

Capacity input: The modelling takes into account the fact that both satellite and fixed wireless technologies have inherent constraints in terms of the number of end-users that can be served. Input data consists of satellite capacity (i.e. how many premises can be served maximally by each of the beams) and fixed wireless capacity for each base station (i.e. how many premises can be served maximally by any given base station). The number of satellites in service is an input factor also (two or three satellites). A potential third satellite is assumed to have the same capacity per beam as NBN 1A and NBN 1B, but with the highest capacity beams re-pointed to areas that need the most capacity.

Cost input: For all fixed wireless base stations, build capex including backhaul and opex is considered. For sites in advanced planning stages, the model uses site-specific costs from the purchase order, for all future sites, a cost average including backhaul is applied. Upgrade capex is

added to base stations if and where a capacity upgrade makes economic sense to increase coverage, over and above ongoing upgrade capex.

FTTN capex and opex are fully considered, based on the assumptions in the Strategic Review 2013, adjusted for the particulars of remote and rural geographic distribution areas. FTTN costs include backhaul to the transit network which is assumed to be organised via microwave for small, remote deployments comparable to fixed wireless. Full PSAA payments are considered, reflecting the potential need to pay either an access fee for use of the copper network or a disconnection fee. Duct rental payments are included, as are customer connect costs for fixed wireless and satellite. The model factors in that spectrum is obtained for the urban-fringe areas at a cost of [REDACTED].

Take-up and product input: The model also considers take-up rates in fixed wireless and satellite to determine capacity gaps and technology costing.

14.3.2 Capacity gap calculations

If the number of base stations is held steady, the model can be used to determine the extent of the 'capacity gap' on any given beam. This method has been used to determine the shortfall of satellite capacity if only the ~1,400 base stations in the corporate plan are considered.

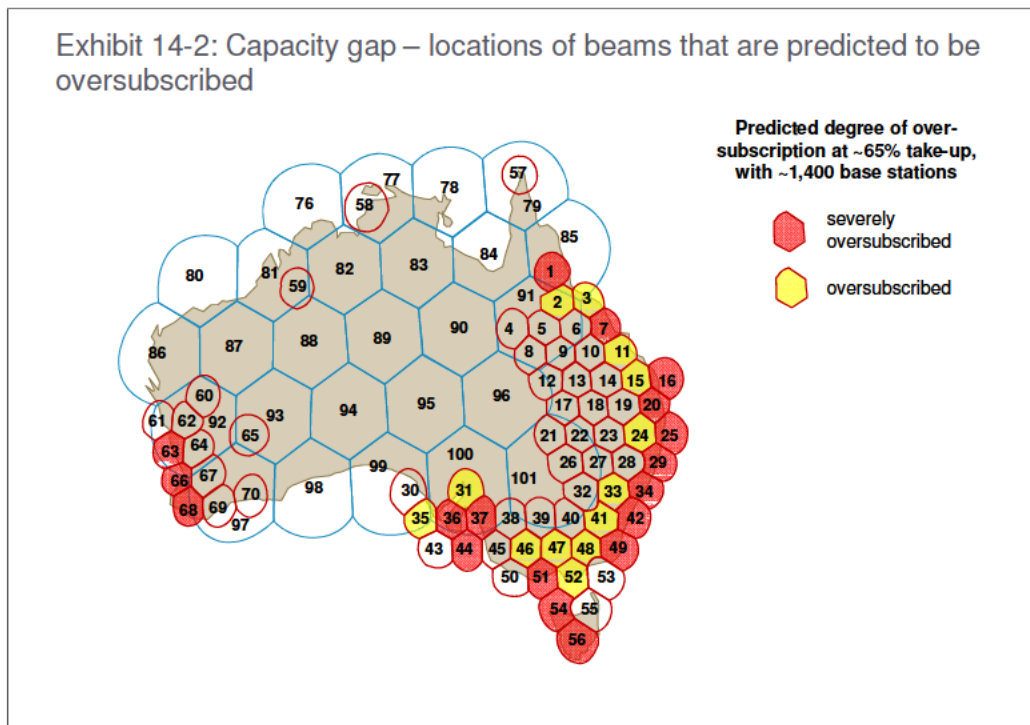
At a given take-up rate per technology (e.g. ~ 65 percent for satellite, ~ 55 percent for fixed wireless), and assuming a consistent product dimensioning on the satellite (e.g. 200kbps network capacity allocation per end-user), and a given number of base stations, the model assesses how many premises are not served by any technology, and in which beams these premises are located.

- If only the 1,400 base stations assumed in the Corporate Plan 2012–15 are built, ~200,000 premises will be left unserved across 31 beams (assuming no FTTN build). Of these beams, 18 are more than 50 percent oversubscribed – meaning that more than 50 percent as many premises need to be served by satellite than is possible given capacity.
- If all 2,400 base stations which are assumed for a full fixed wireless deployment are built, ~30,000 premises will be left unserved across 14 beams (assuming no FTTN build and spectrum has been secured in the current 'no spectrum' areas). Of these beams, 7 are more than 50 percent oversubscribed.

Capacity shortfalls tend to be concentrated in beams covering large population centres – Sydney (Beam 42), Brisbane (Beam 25), Sunshine Coast (Beam 20), Perth (Beam 66) and Melbourne (Beam 51) are among the most oversubscribed beams. This is shown in exhibit 14-2. Although the satellite beams covering these areas generally have a higher capacity than other beams, and the large majority of premises in these dense areas is served via fixed line and fixed wireless, a high number of 'residual' premises remain to be served via satellite.

A number of premises are too remote from any planned terrestrial deployment, or need to be served via satellite due to service qualification failure (i.e. fixed wireless premises unable to receive a signal despite being in a coverage area).

Exhibit 14-2: Capacity gap – locations of beams that are predicted to be oversubscribed



An optimisation was modelled to determine trade-offs between the economics of the different technologies, subject to constraints of satellite capacity per beam, fixed wireless coverage areas by base station (planned sites and potential new sites) and FTTN where 25/5Mbps service levels are available.

The scenarios shown in the following section provide an illustration of the outcome of this optimisation.

14.4 Overview of scenarios

In order to address the capacity and coverage issues highlighted, and to ensure that all premises in the non-fixed line footprint can receive a service, the Review also considered a number of scenarios for how NBN Co should deploy infrastructure. These scenarios model the impact of specific changes in addition to the 'base' of proposed actions across both fixed wireless and satellite programs.

- **Scenario 1: All premises served** – This scenario assumes two satellites as per the Corporate Plan 2012–15, and determines the number of fixed wireless base stations required to serve all premises in the non-fixed line footprint
- **Scenario 2: Build FTTN** – This scenario assumes FTTN is available in the non-fixed line footprint. The use of FTTN is subject to meeting minimum requirements of copper loop lengths and delivering a 25/5Mbps service, as well as economic considerations relative to alternative technologies. In select distribution areas, deployment costs can be held stable while giving users a product that is superior to satellite and superior to, or on par with, fixed wireless. In addition, the availability of FTTN increases the flexibility of, and decreases the risks associated with, a rollout where the availability of spectrum is not currently guaranteed everywhere
- **Scenario 3: Third satellite** – This scenario assumes that NBN Co constructs and launches a third satellite at the end of CY20. This mitigates the need to build some fixed wireless base stations and FTTN distribution areas. The capacity of this satellite will only be partially required [REDACTED] to meet NBN Co's needs
- **Scenario 4: Third satellite in partnership** – This scenario mirrors Scenario 3, but assumes that NBN Co enters into a partnership with an external party to access only the required capacity on a third satellite [REDACTED] rather than building and owning it outright.

All scenarios assume that NBN Co implements a standard product construct with a network capacity allocation per end-user of 150kbps on satellite, given the limited capacity on the satellite. Upgrade options would be available within satellite capacity limits for an average capacity allocation across the satellite beam of 200kbps per end-user. RSPs could be expected to sell ~20GB/month plans using this wholesale product in an anytime plan and higher in 'peak/off-peak plans'. For fixed wireless, the Review proposes a network capacity allocation of between 400–500kbps per end-user.

The exhibit that follows sets out the relative financial outcomes of the modelled scenarios. As with the Strategic Review 2013, undertaking financial modelling over a 30 year time frame presents numerous challenges in deriving absolute numbers. The analysis below should only be used to guide high-level strategic decision-making rather than granular operational decisions.

Exhibit 14-3: Financial outcomes

Highlight of main change to previous scenario

	Corp. Plan	Fixed Wireless and Satellite Review 2014			
	Corporate Plan 2012–15	Scenario 1 All premises served	Scenario 2: + build FTTN	Scenario 3: + third satellite	Scenario 4: or + third Satellite in partnership
Number of Satellites	2	2	2	3	2 + 1 by JV
FTTN availability	-	-	25/5 service	25/5 service	25/5 service
Number of Fixed Wireless base stations	~1,400	~2,900	~2,700	~2,000	~2,000
Technology mix in non-fixed line footprint in FY21					
Fixed Wireless	39%	60%	57%	52%	52%
Satellite	57%	40%	40%	47%	47%
FTTN	0%	0%	3%	1%	1%
Premises not covered of 1.02m premises	~200,000	-	-	-	-
Non-fixed line footprint cumulative FY11–21					
o Revenue	\$0.4bn	\$0.9–1.0bn	\$0.9–1.0bn	\$0.8–1.0bn	\$0.8–1.0bn
o Operating Expenditure	\$1.0bn	\$1.5bn	\$1.5bn	\$1.4bn	\$1.4bn
o Capital Expenditure	\$3.5bn	\$4.6–4.7bn	\$4.5–4.7bn	\$4.8–4.9bn	\$4.4–4.5bn
o Operating cash flows	-\$4.0bn	-\$5.3bn	-\$5.2bn	-\$5.3–5.4bn	-\$4.9–5.0bn
Non-fixed line footprint steady state (FY28)					
o Revenue	\$130m	\$240–300m	\$240–310m	\$240–300m	\$240–300m
o Operating Expenditure	\$140m	\$270m	\$260m	\$220m	\$220m
o Capital Expenditure	\$200m	\$280–290m	\$280–290m	\$260–270m	\$260–270m

It should be noted that the above scenarios have been modelled assuming:

- The technology mix is designed to allow for take-up rates which exist at the high end of the range (~65% for satellite, ~55% for fixed wireless by 2021). However, all financials are shown assuming both a low and high take-up and ARPU. This allows for a situation where the network is designed for a high take-up, but the resulting demand is lower than expected
- Satellite network throughput per end-user is set at 200kbps to allow for the proposed standard product (specified at 150kbps) with headroom for upgrade options including for public interest premises in satellite only areas
- Spectrum is obtained for the urban-fringe areas at a cost of [REDACTED]
- The overall number of premises does not include a 10% error margin (i.e. there are 1.02 million premises in 2021), however, on the capacity constrained infrastructure (satellite) a 10% buffer is modelled
- A fixed wireless service qualification failure rate of 7% is in place, such that 7% of all premises in any given fixed wireless coverage area must instead be served by satellite
- For small, remote FTTN deployments comparable to fixed wireless, the Review assumed that microwave backhaul can be used to connect FTTN distribution areas to the transit network
- The cumulative capex figures (including the Corporate Plan 2012–15 numbers stated) are all exclusive of contingency. Contingency will be added in overall NBN Co financials, equal to the 20% of capex suggested in the Strategic Review 2013
- FTTN costs include a PSAA payment and duct rental payments
- Capex and opex for FTTN deployments was estimated based on the assumptions as the Strategic Review 2013, adjusted for the particulars of remote and rural geographic distribution areas. Premises with copper loop lengths of over 1,000m which cannot reliably receive speeds of 25/5Mbps have been excluded from consideration and are assumed to be served via satellite or fixed wireless.

The exhibit shows that:

- Scenario 1 introduces incremental cumulative capital expenditure (FY11–21) of ~\$1–1.3 billion relative to the Corporate Plan 2012–15, to serve all premises in the non-fixed line footprint. This cost is largely driven by a doubling of the number of fixed wireless base stations required. The need for additional base stations and the associated capital requirements was identified in the Strategic Review 2013, and is now detailed to be ~2,900 base stations
- Scenario 2, which introduces FTTN in the non-fixed line footprint, reduces the number of fixed wireless base stations by ~200 relative to Scenario 1. Cumulative capex reduces by ~\$100 million relative to Scenario 1.
- Scenario 3, by adding a third satellite while using some FTTN, adds an incremental \$200 million in cumulative capex relative to Scenario 2, while also increasing the number of premises dependent on a satellite product that is more capacity constrained than fixed

wireless or FTTN. The Review estimates that only ██████████ of the capacity of a third satellite would be utilised. The remaining capacity could then be commercialised, either by NBN Co or a third party. However, there are limited opportunities for NBN Co to monetise the spare capacity in its third satellite, as the majority of bandwidth supply is unlikely to be met with significant market demand from potential corporate end-users. This scenario also reduces the need for base stations and therefore reduces long term operating expenditure.

- Scenario 4's use of a partnership to access capacity on a third satellite results in a cumulative operating cashflow \$200–300 million lower than Scenario 2, while still maintaining the relatively stronger long-term financials realised in Scenario 3. As with Scenario 3 though, Scenario 4 leads to ~70,000 more end-users on a satellite service in FY21 than Scenario 2. In this Scenario, a JV partner would have a greater opportunity to monetise spare capacity outside of Australia. The JV partner's involvement in the build of the satellite and the ground segment allows for a spacecraft design that directs the capacity where it can be best monetised.

Lower take-up and average revenue per user (ARPU) growth, represented by the low range figures, has little impact on the short-term economics of any given scenario, but does drive a marked difference in long term economics. Note that 'lower take-up' is the low end of a possible take-up range that is still at least twice as high as that assumed in the Corporate Plan 2012–15. The Review believes that take-up will be at the high end of the range.

Irrespective of revenue trajectories, all scenarios have challenging long term economics with marginal EBITDA (some slightly positive, some slightly negative) and negative cashflows beyond FY21.

Scenario 2 estimates cumulative capex of \$4.5–4.7 billion which is ~\$1 billion higher than the Corporate Plan 2012–15, and is broadly in line with the high level assumptions made about the non-fixed line footprint in the Strategic Review 2013 'Scenario 6'. It should be noted that the 2,700 base stations described in scenario 2 do not entirely overlap with the originally planned 2,400 base stations. Around ~500 of the 2,400 base stations would no longer be constructed, and instead ~800 new base station locations would be required.

Assuming NBN Co is able to engage the installer industry to lift installation capacity, Scenario 2 would connect the last end-user that requests a service at the time of the rollout, two years ahead of Scenario 4.

In contrast to cumulative revenues (FY11–21) for the non-fixed line footprint of \$0.4 billion in the Corporate Plan 2012–15, the scenarios above estimate revenues of \$0.8–1.0 billion over this period, mainly driven by the increase in take-up.

Given the complexities and uncertainties, NBN Co should continue to include a 20 percent contingency which would be in addition to the capex values referred to here. This is in line with the assumptions that were included in the Strategic Review 2013 'Scenario 6'.

All of the above scenarios will require NBN Co to implement a deployment in the non-fixed line footprint that is based on a considered mix of different technologies. It is critical that NBN Co incorporate both the fixed wireless and satellite technologies, as well as the non-fixed line geographic footprint into the Multi-Technology Mix (MTM) planning for all addressable premises in Australia. This means creating a set of business rules that balance fast deployment of broadband with better economics.

14.5 Sensitivities

14.5.1 No spectrum

The Review tested the impact of NBN Co failing to secure spectrum in the non-spectrum areas. If the spectrum in the six fringe metropolitan areas continues to be unavailable, and the number of premises served by the planned two satellites (due to remoteness) is held constant in order to preserve speed and download specifications, the coverage gap in these areas is ~80,000 premises.

NBN Co can serve these premises through a combination of extensive FTTN build and in-fills of distribution points where long copper loop lengths prohibit a 25/5Mbps speed experience. Taking into account PSAA payments for these premises, this solution has an aggregate cost of [REDACTED]. The alternative is to launch a third satellite with the sole purpose of serving the non-spectrum areas, and an average throughput of 200kbps per end-user, at a cost of [REDACTED]. These costs are partly offset by capex savings of [REDACTED], from reducing the number of base stations and WNTD installations. As such, the net capex impact of not securing any spectrum is estimated at [REDACTED].

14.5.3 Low take-up

If take-up to FY21 is below the estimated levels of ~50 percent in denser regions and ~65 percent in more remote areas, the two satellites will be able to cover a greater number of premises – to a maximum of 660,000. NBN Co can reduce its short-term fixed wireless deployment costs by using this capacity to defer building the [REDACTED] least-economic base stations. As a net effect, capex deferral of [REDACTED] can be realised due to fewer base stations and end-user connect costs across fixed wireless and satellite.

14.5.4 High GNAF count

If an error margin of 10 percent is applied to the number of premises (see chapter 2), the capacity shortfall is exacerbated and more fixed wireless base stations are required. More FTTN build is needed as well as an extra [REDACTED] base stations, at an additional capex of [REDACTED].

14.6 Upgrade pathways and other considerations

14.6.1 Upgrade pathways

The Corporate Plan 2012–15 did not provide for upgrade pathways on fixed wireless and satellite. However, as internet usage grows, NBN Co could, at some point after the overall rollout, decide to upgrade its products in the non-fixed line footprint where a business case allows.

The Review has considered two types of upgrades:

- An upgrade of the download and upload speeds; and/or
- An increase of the network capacity allocation per end-user, which would translate into higher usage allowance per month by the RSP.

The Review assessed the degree to which fixed wireless and satellite would support either of these upgrade pathways. The upgrade path of FTTN has already been described in detail in the Strategic Review 2013.

NBN Co has four main options to increase download and upload speed, as well as capacity allocation on fixed wireless technology:

- **Implement 4x4 MIMO:** As discussed in chapter 9, NBN Co will need to put additional equipment at the base station and replace the radio component of the WNTD. As the upgrade requires configuration of CPE, timing should be based on demand, and coincide with equipment end of life and upgrade cycles.
- **Carrier aggregation to increase download/upload speed:** LTE will support carrier aggregation in the course of 2015. From a technical perspective, carrier aggregation would allow for 50/10Mbps products in the future. NBN Co would preferably need 80MHz spectrum in an area to allow for this option. With smaller spectrum bands, carrier aggregation could lead to interference issues
- **Site sector splitting:** A typical fixed wireless tower has three sectors. NBN Co could double the number of sectors to six, which effectively doubles capacity and leads to a higher capacity allocation per end-user
- **Using 3.4GHz in addition to 2.3GHz bands:** NBN Co could use both spectrum bands in the areas where it holds the rights to use both bands. This also effectively doubles capacity availability, and could lead to higher capacity allocation per end-user. This option is unlikely to be available to NBN Co in urban fringe areas.

These four options require upgrades of the active equipment on a tower, with costs ranging up to ██████ per tower. In addition, carrier aggregation will require additional CPE costs. With the exception of carrier aggregation, these options therefore provide a fairly cheap upgrade path, with costs not exceeding \$200 per premises.

The capacity of the NBN Co satellites is fixed for the life of the mission. In addition to investing in more capacity, NBN Co can upgrade user experience in two ways:

- **Use unused capacity to increase the capacity allocation per end-user:** NBN Co could allocate more capacity per end-user once it has a better understanding of consumer take-up after the satellite product has been sold for at least 6 months. Depending on take-up, this could require building more fixed wireless towers, as well as actively moving consumers from satellite to fixed wireless products and/or adding satellite capacity
- **Use innovative CPE technology:** On the CPE side, VSAT technology is available which uses statistical methods to cache data locally – particularly video content. This has the potential to improve user experience without actually providing increased capacity. However, this technology has not yet been proven in an open-access wholesale environment such as the one in which NBN Co operates. NBN Co could decide to use such technology once it is better understood in an open access environment.

This leads to two distinct upgrade pathways for NBN Co beyond 2020 described below across the full non-fixed line footprint:

- Increase the network capacity allocation of the base satellite product from 150kbps to 250kbps per end-user by launching a third satellite at a capex of ██████
- Increase the network capacity allocation of the base satellite product from 150kbps to 250kbps per end-user and consider increasing the maximum fixed wireless broadband PIR speed to 50/10Mbps. This option would require building ~█████ additional base stations as well as upgrading base stations. The capex would be ██████.

The Review notes these upgrades will likely not be needed before 2019. At current known parameters the Review would find the second upgrade pathway more preferable, subject to further consideration.

14.6.2 MDUs and complex premises

Complex premises and MDUs have been assumed to be covered by the same technology as the surrounding footprint. Costs for providing access to complex premises (i.e. difficult installations) has been factored in to the weighted average of installation costs. As MDUs are relatively rare in the non-fixed line footprint, deploying a different technology than the surrounding premises is, in most cases, uneconomical. The assumed installation method at this point is to install an individual FW antenna or VSAT for each premises in the MDU.

14.6.3 New developments

NBN Co direction and policy has always been that new developments in the non-fixed line footprint receive the same technology as the rest of the surrounding footprint. Costs to cover and connect these premises have been taken into account in all scenario estimates. The underlying premises growth rate in regional and rural areas has been estimated based on ABS and census data (see chapter 2).

14.6.4 Public Interest Premises

As discussed in section 2.3, there are ~20,000 Public Interest Premises (PIPs) in Australia, of which ~16,500 (~83 percent) are within the fixed line footprint and the remaining ~3,500 (~17 percent) within the non-fixed line footprint. Given that PIPs are likely to have higher usage requirements than a single dwelling unit in the non-fixed line footprint, their needs must be carefully considered alongside the cost of serving them.

With the infrastructure detailed in the Corporate Plan 12-15 at revised take-up, ~1,600 PIPs would fall within the estimated satellite footprint, with ~700 PIPs (~40 percent) in oversubscribed beams. Of these, ~100 already have access to fibre, leaving ~600 PIPs in oversubscribed satellite beams. It should be noted that in the Scenarios described above, more fixed wireless towers will be constructed than was envisaged in the Corporate Plan 12-15, and hence the actual number of PIPs in oversubscribed satellite beams will likely be lower than ~600. Unless carefully managed, serving PIPs can increase strain on the capacity of already-overburdened satellite beams, and result in prohibitive cost to these premises.

One possible solution is to create a specific product construct for schools, which represent ~80 percent of all PIPs, and have a usage profile that peaks before the evening busy hours.

The Review proposes that an appropriate provision of product is made for PIPs.

14.6.5 Premises with limited access to high quality broadband

As discussed in chapter 2, the non-fixed line footprint has a disproportionate share of premises with limited access to high quality broadband. Unlike the fixed line footprint, the challenge lies less in prioritising premises with limited access to high quality broadband, than in ensuring an optimised overall rollout, potentially with a bias towards prioritising the non-fixed line footprint over the fixed line footprint wherever a constraint exists. The Review proposes that NBN Co continues to work with the Government on how best to serve underserved premises.

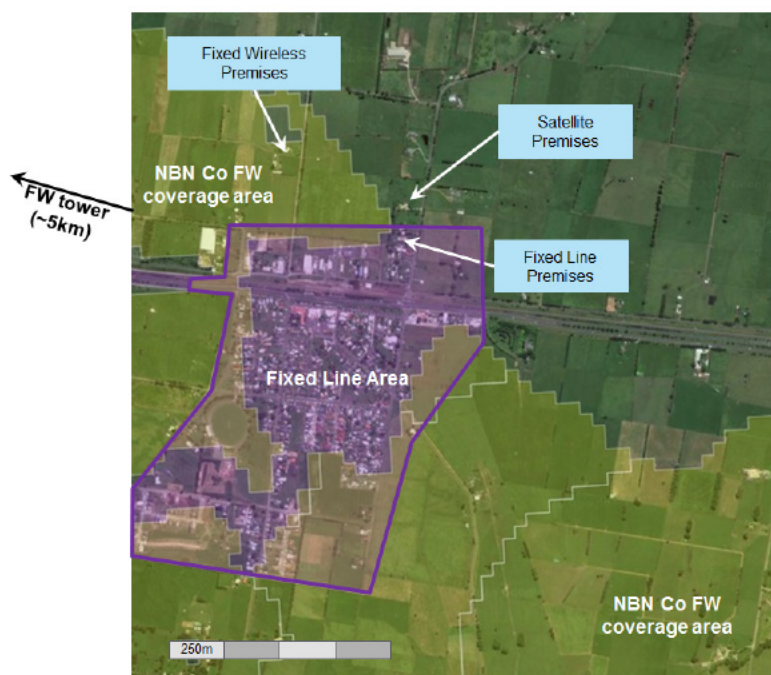
14.6.6 Special situations

Numerous local special situations can be expected to arise as the non-fixed line technologies are rolled out. Examples of special situations include:

- Premises which are just outside the fixed line footprint and are willing to pay the incremental cost of constructing a fixed line connection
- Local communities which lie partly or fully outside the fixed line footprint and are willing to fund a community solution such as an additional fixed wireless tower or an FTTP or FTTN 'island' to serve their community
- Complex premises such as industrial facilities on the outskirts of towns that wish to incrementally fund alternative infrastructure

An example of this is shown in the following exhibit, where, under the current planning assumptions, neighbouring premises within a few hundred metres of each other will be served with a different access technology.

Exhibit 14-4: Example: Fixed line, fixed wireless, and satellite premises within ~500m of each other



The Review notes that NBN Co released a Network Extension Policy in July 2012 to provide ways in which communities and individuals can fund various types of extension to NBN Co's planned network coverage. The Network Extension Policy could provide a route to address many types of special situations. There may also be other ways to address these sorts of special situations.

14.7 Proposed actions

The Review proposes that NBN Co:

- **Proposed action 14.1:** Incorporate both fixed wireless and satellite technologies, as well as the non-fixed line geographic footprint into the Multi-Technology Mix (MTM) planning for 100 percent of Australia. This means creating a set of business rules that balance fast deployment of broadband with better economics
- **Proposed action 14.2:** Proactively seek to minimise the risk of underlying data problems through a concerted effort with Government departments such as the Department of Communications, other Government Business Enterprises (such as Australia Post), and RSPs, including potentially 'crowdsourcing' to supplement existing data sources
- **Proposed action 14.3:** Adopt a consistent definition and count of 'premises' across the company
- **Proposed action 14.4:** As part of the detailed planning process, NBN Co should carefully manage the risk of a significant number of additional premises being added to the non-fixed line areas for satellite service, unless this is made as part of a comprehensive integrated planning decision weighing all the consequences.
- **Proposed action 14.5:** Make an appropriate provision of product for Public Interest Premises
- **Proposed action 14.6:** Continue to work with the Government to confirm the geographic definition of areas with underserved premises.

15

Summary of
proposed future
direction

15 Summary of proposed future direction

The Review proposes that NBN Co implement a deployment in the non-fixed line footprint that is based on a considered use of FTTN, and optimises the mix of fixed wireless and satellite technologies to relieve congestion in oversubscribed beams, minimise cost and maximise the average product available to all end-users without any missing out.

Both Scenarios 2 and 4 will achieve this objective, although they require a trade-off of ~\$200-300 million in cumulative operating cashflow to move ~70,000 premises from satellite to less capacity-constrained technologies.

If NBN Co pursues Scenario 2 to minimise the number of premises using satellite, the Review's initial assessment suggests the mix of technologies in the non-fixed line footprint in 2021 may be:

- Fixed wireless to 57 percent of premises
- Satellite to 40 percent of premises
- FTTN to 3 percent of premises.

If NBN Co pursues Scenario 4 to minimise capital expenditure, the Review's initial assessment suggests the mix of technologies in the non-fixed line footprint in 2021 may be:

- Fixed wireless to 52 percent of premises
- Satellite to 47 percent of premises
- FTTN to 1 percent of premises.

The Review proposes that NBN Co decide in the next 3–6 months whether to pursue an accelerated fixed wireless roll-out (Scenario 2), or a satellite partnership (Scenario 4). Given the trade-offs highlighted, the Review has a preference for Scenario 2.

NBN Co and the government have an option to decide on a different capacity allocation for the standard satellite product. This implies trading off financial outcomes for capacity allocation. This would have implications for the number of base stations required and overall peak funding. For each increase or decrease of 50kbps in satellite throughput, this would drive ~500-700 more/less base stations and ~\$500–700 million in peak funding respectively, as shown in exhibit 15-1 below.

Exhibit 15-1: Outcomes based on different satellite capacity allocations

<i>Initial allocation per satellite user for standard product</i>	100kbps	150kbps	200kbps	250kbps
<i>Capacity allocation across all users</i>	150kbps	200kbps	250kbps	300kbps
<i>Delta in cumulative capex (\$m) to cover all premises</i>	-\$300m	-	+\$300m	+\$600m
<i>Delta in peak funding (\$m) to cover all premises</i>	-\$700m	-	+\$600m	+\$1bn
<i>Total satellites</i>	2	2	2	2
<i>Total base stations</i>	~2,000	~2,700	~3,400	~4,000
<i>Premises in fixed wireless 'area'</i>	48%	57%	63%	67%
<i>Premises in FTTN 'area'</i>	2%	3%	4%	5%
<i>Premises in satellite 'area'</i>	50%	40%	33%	28%
<i>Premises not covered (of 1.02m premises) with Corporate Plan 12-15 infrastructure</i>	~110,000	~200,000	~260,000	~320,000

In order to successfully execute any of these scenarios, it is critical that NBN Co incorporate both the fixed wireless and satellite technologies, as well as the non-fixed line geographic footprint into the Multi-Technology Mix (MTM) planning for all addressable premises in Australia. This means creating a set of business rules that balance fast deployment of broadband with better economics.

NBN Co should put in place protocols to ensure that the use of scarce satellite capacity is actively planned and 'owned' by a specific function within the company. In addition, the various functions within NBN Co must not rely on satellite technology as a 'back-stop' for other access technologies without the explicit agreement of the function which oversees its capacity. These rules should expressly address the impact of potential changes in the fixed line footprint boundaries in relation to scarce satellite capacity per beam.

Once the basic set of rules is in place, consideration should be given to how to deal with exceptions (e.g., Public Interest Premises, complex premises etc.). In addition, NBN Co should consider potential alternatives for managing special situations, and where private and community organisation funding may be appropriate.

To successfully execute this plan, a specific set of further actions will be required. These are laid out in detail in Appendix 1. In summary, these include:

- Expediting the work of NBN Co's Spectrum Taskforce which coordinates senior commercial and technology representatives to work with the ACMA and commercial licence holders on spectrum matters
- Executing 14 specific actions that will help to further de-risk the satellite program including, for example, engaging experienced specialists in specific areas, and engaging with the installer industry more than 12 months in advance of the LTSS commencement to provide surety and enable them to ramp up their field forces

- Implementing two additional actions will help to mitigate overall risk with timeline changes, including exercising the option to change the timing of the second satellite launch to 12 months after the first instead of 6 months (understanding that this may need to be negotiated with the relevant counter-parties), as well as considering extending the current ISS contracts
- Implementing six changes to the satellite product instruments including the creation of a standard product with a specific capacity allocation per end-user (150kbps) with upgrade options possible
- Further investigating the possibility for RSPs to complete their own installs as well as looking at other incremental revenue opportunities
- Implementing five actions to stabilise the Fixed Wireless Program and reduce cost including, for example, NBN Co committing to release sites into the planning process further in advance and in greater volume
- Further considering the option to use existing fixed wireless infrastructure in the current fixed line footprint
- Working closely with mobile operators and other third party tower owners to identify opportunities for further collaboration and reciprocal tower sharing.

In executing Scenario 2, the total cumulative operating cash outflow FY11–21 will be ~\$5.2 billion. This is ~\$1.2 billion greater than the Corporate Plan 2012–15 in order to provide adequate coverage and services to all end-users, including those that would not have been covered under the Corporate Plan assumptions. This level of cash outflow is in line with the Strategic Review 2013 'Scenario 6'. Scenario 2 of this Review does not have a significant impact on overall peak funding, which remains at \$41 billion in 2021, nor on IRR, which is estimated to only change from 3.1–5.3 percent to 3.2–5.5 percent.

16

Next steps:

Organisational
implications,
implementation
pathway

16 Next steps: Organisational implications, implementation pathway

The Review highlighted substantial issues in NBN Co's implementation of the current approach to deliver broadband to the non-fixed line footprint. It suggests a number of major changes, including more pro-active co-operation with industry partners, different product constructs and a significant expansion of the fixed wireless build program. Last, but not least, the Review highlights inherent uncertainties that NBN Co will need to adapt to as time passes. A static plan will not be sufficient.

It should be noted that NBN Co has already commenced a large scale Transformation Program with initiatives that may address some of the issues highlighted.

The Review proposes that NBN Co address these issues in three ways:

- Make organisational and capability-building interventions
- Execute operational changes immediately
- Prepare for medium-term decisions that will be required (2015–17).

16.1 Make organisational and capability-building interventions

These organisational interventions are designed to give NBN Co a holistic, integrated perspective on the most effective and efficient way to serve all premises in regional and remote Australia. The Review proposes that NBN Co:

- Ensure clear accountabilities, transparency and scrutiny at the Executive Level and below to address the issues laid out in the Review to ensure:
 - That every premises for any given geography can access at least one NBN Co technology
 - That all elements in the technology value chain for each given technology will be in place to serve regional and remote end-users
 - Appropriate provision of product is made for Public Interest Premises
 - That scarce satellite capacity is actively planned and 'owned' by a specific function or individual
- Develop financial and management information to provide visibility of the build and forecast user activations relative to target, both by technology and geography
- Create a dedicated team within the COO function to manage the operational scale-up of both the fixed wireless and satellite network operations.

16.2 Execute operational changes immediately

For fixed wireless, three immediate next steps are proposed:

- **Pursue multiple pathways to secure spectrum:** NBN Co should increase its focus on securing spectrum in the metro fringe areas by pursuing multiple parallel pathways:

- Prioritise the IT build as an area of focus for management (including product specification)
- Engage with installation partners, early enough to allow them to ramp up capability in the required areas
- **Clearly define the details of the product construct:** Accelerate the process for determining product specifications to deliver them by 23 June 2014 (for IR13):
 - Construct a 'base' satellite product with targeted mean busy hour throughput of 150kbps per end-user and a peak 25/5Mbps wholesale speed to create an end-user experience in line with or better than targets
 - Implement a differentiated pricing scheme to manage capacity
 - Introduce SLA measurement without contracted penalties

Finally, NBN Co should pursue two further actions:

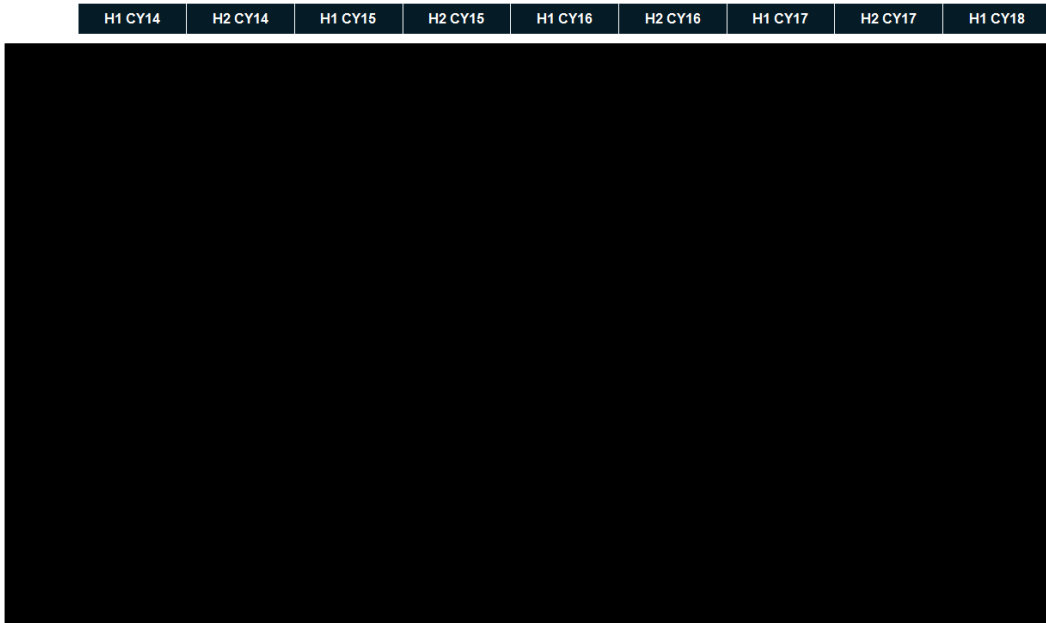
- Work with industry to expand installation capacity: Work with industry towards a target of 12,000–15,000 installations per month by the start of 2016
- Work with the government to secure a better base of geographic premises data: Work with departments such as the Department of Communications, other Government Business Enterprises (such as Australia Post), and RSPs in order to improve the base of geographic premises data. Priority should be given to (non-fixed line footprint) areas of limited satellite beam capacity.

16.3 Prepare for medium term decisions that will be required (2015–17)

At certain points over the next three to four years, NBN Co will face a series of specific decisions. It needs to balance the desire to make those decisions swiftly, and gain certainty of execution, against the benefits of delaying decisions in order to retain optionality. However, it should be noted that while retaining optionality can often lead to a theoretically better outcome, it can also incur additional cost and drive greater complexity. The decisions also involve interdependencies as shown in exhibit 16-1 and described below with reference to Scenario 2.

Exhibit 16-1: **Scenario 2:** Timeline and decision making

Key Input
 ▲ = Outcome known
 Decision Required



Beyond the initial short-term actions, within the next 3–6 months, NBN Co will need to decide whether to proceed with building more than 1,600 base stations (excluding the ~400 base stations in 'no spectrum' areas). Approximately 700 base stations will be released over the following 12–24 months in a measured way that aligns to the network planning and capital release cycles.

By early 2015, NBN Co should have greater certainty regarding the satellite launch timing and the impact of ground testing on any delays. At this point, a decision should be made regarding the extension of the ISS contracts which should cost [REDACTED] to extend [REDACTED]. The Review proposes this extension should be agreed, but a decision does not need to be made until early 2015.

- [REDACTED]
- [REDACTED]

The next major decision will be around mid-2016 when the satellite take-up rate indicates whether the high or low scenario is likely to eventuate. This decision also depends on the launch and IT being completed on schedule. If the low take-up scenario looks likely, NBN Co can then decide whether to increase the throughput of the satellite to more than 200kbps average per end-user to improve performance and end-user experience.

Appendix 1

Summary of proposed
actions

Appendix 1 – Summary of proposed actions

The Review proposes that NBN Co (subject to a legal and regulatory review prior to the time at which a decision is to be made as to their adoption and implementation):

Chapter 4: Satellite: Challenges in delivery

- **Proposed action 4.1:** Engage specialist negotiators and work with the ACMA to close the remaining agreements for orbital slot co-ordination.
- **Proposed action 4.2:** Establish a senior executive level relationship with potential launch partners and share information.
- **Proposed action 4.3:** Engage an industry experienced specialist (e.g., Telesat, Optus Satellite or others) to lead and support in-orbit and end-to-end system testing.
- **Proposed action 4.4:** Finalise and close out the network operations model. Give NBN Co IT a clear direction and priority to have satellite OSS functioning to meet deadlines.
- **Proposed action 4.5:** Begin recruiting necessary resources now to manage the network operations for satellite testing.
- **Proposed action 4.6:** Ensure that ViaSat's testing of the new CPE is rigorous and make informed choices during 2015 regarding production deployment of the new CPE.
- **Proposed action 4.7:** Revise LTSS IT plan to bring adjustments to full product specification in IR 13.
- **Proposed action 4.8:** Add an experienced senior-level leader to the Network Architecture and Technology- Ground Segment team dedicated to oversight of successful system integration through to operational readiness. Also add experienced specialists to support NBN Co teams in specific areas such as CPE testing and transition to operations.
- **Proposed action 4.9:** Where required, engage a local electrical consultant on a short term basis to liaise with local energy authority representatives until a deal is reached for supply of mains power. Ensure senior NBN Co executive oversight.
- **Proposed action 4.10:** Maintain senior executive oversight of gateway build and existing mitigations
- **Proposed action 4.11:** Lock in contracts with field force management providers early, including volume estimates, to give surety for providers to build up field force. Begin detailed planning of migration 12 months in advance and including processes to batch new installations to achieve level utilisation and increase efficiency. Work with industry to lift end-user connection capacity (fixed wireless and satellite) to 12,000 – 15,000 per month by the start of 2016.
- **Proposed action 4.12:** Consider transition mechanisms prior to the arrival of fixed line or fixed wireless service to prevent any ISS end-users from being disconnected from satellite service without a fast broadband fallback.
- **Proposed action 4.13:** Determine if any RSPs offering ISS will not offer LTSS, and work with industry to resolve any specific issues with individual end-users.
- **Proposed action 4.14:** Develop a process for sub-contractors to recognise and mitigate line-of-sight issues when they occur. Ensure that incentives are right for sub-contractors to

try and mitigate the issues properly, e.g. they are paid on successful install, not per site visit.

- **Proposed action 4.15:** Exercise the option to change the timing of the second satellite launch to make it 12 months rather than 6 months after the first, subject to contractual impacts and agreement with the launch provider. This would allow the team to focus on the IOT/BRT of 1A and service commencement, and allow more time if any issues need to be fixed before launch of 1B. In addition, the efficiency of the satellite replacement program (which will be required in 2028-2030) will be improved by spacing the launches further apart. This timing should also not impact the end-user rollout as the additional satellite capacity should not be needed until this time given the speed with which the industry can connect end-users
- **Proposed action 4.16:** Take up extension options for the ISS as completing ISS migration by September 2016 may be difficult due to potential late service commencement, combined with residual risk in industry capability for installations. An ISS extension also allows a capacity lever to enable 'new' satellite end-users to access services in the first year of operation.

Chapter 5: Satellite: Product construct and other revenue opportunities

- **Proposed action 5.1:** Create a standard satellite product with a specific capacity allocation per end-user (150kbps) with upgrade options possible, and ensure that the expectations of end-users are clearly and effectively managed.
- **Proposed action 5.2:** Create and measure a Service Level Agreement (SLA) describing the aspired consumer experience, without taking on contractual obligations until stable performance is achieved, including requirements for the RSP in terms of managing consumer expectations, usage meters, traffic management etc.
- **Proposed action 5.3:** Adopt a single Point of Interconnect (POI) architecture for LTSS, which recognises that given that all LTSS traffic will necessarily be concentrated at the DPC, it is efficient to also offer interconnection at that point. As the DPC has geographical redundancy it is also prudent for the POI to have a geographically diverse back-up location.
- **Proposed action 5.4:** Limit end-user ability to bond ports on the Network Termination Device, at the expense of other end-users access to limited capacity. This means that an end-user will not be able to bond two 25/5Mbps ports to achieve a 50/10Mbps speed.
- **Proposed action 5.5:** Put in place AVC instruments and tools which monitor and control usage and provide support for the 'standard product and upgrade options' approach
- **Proposed action 5.6:** Further evaluate the opportunities for RSPs to complete their own installs
- **Proposed action 5.7:** Further evaluate B2B products on satellite as a potential incremental revenue opportunity.

Chapter 6: Satellite: Partnership opportunities

- **Proposed action 6.1:** NBN Co should remain open to further suggestions for partnerships or acquisitions from the industry and evaluate each on merit

Chapter 8: Fixed wireless: Spectrum

- **Proposed action 8.1:** Work closely with the ACMA on options for NBN Co to secure sufficient spectrum [REDACTED]
[REDACTED]
[REDACTED]
- [REDACTED]
[REDACTED]
[REDACTED]
- [REDACTED]
[REDACTED]
- [REDACTED]
[REDACTED]
[REDACTED]
- **Proposed action 8.5:** Expedite the work of NBN Co's Spectrum Taskforce comprising senior commercial and technology representatives from Commercial Strategy, Regulatory, Finance, Product, Technology, and Planning and Design, led by an Executive Committee member. The taskforce works closely with NBN Co senior executives to maintain internal alignment on spectrum matters and engage external stakeholders (i.e. Communications Minister, the Department of Communications, the ACMA, other mobile network operators) in a strategic and coordinated manner.

Chapter 9: Fixed wireless: Challenges in delivery

- **Proposed action 9.1:** Release sites into the planning process much further in advance, and in greater volume
- **Proposed action 9.2:** Adopt a quarterly review and reduce the cycle to periodically analyse costs and identify savings
- **Proposed action 9.3:** Focus more on the progress of end-to-end site connection, rather than interim milestones
- **Proposed action 9.4:** Provide greater visibility into the transit construction planning and progress, and involve the Fixed Wireless planning and design teams more heavily in transit planning activities
- **Proposed action 9.5:** Drive a further cost reduction of [REDACTED] percent on new tower builds by adopting more flexible tower specifications, introducing more competition and involving more construction resources at the site selection and design stage.

Chapter 10: Fixed wireless: Product construct and other revenue opportunities

- **Proposed action 10.1:** Create a standard product for fixed wireless with a specific capacity allocation per end-user (500kbps) with upgrade options possible, and ensure that the expectations of end-users are clearly and effectively managed.
- **Proposed action 10.2:** Create and measure a Service Level Agreement (SLA) describing the aspired consumer experience, without taking on contractual obligations until stable

performance is achieved, including requirements for the RSP in terms of managing consumer expectations, usage meters, traffic management etc.

- **Proposed action 10.3:** Limit end-user ability to bond ports on the Network Termination Device, at the expense of other end-users access to limited capacity. This means that an end-user will not be able to bond two 25/5Mbps ports to achieve a 50/10Mbps speed.
- **Proposed action 10.4:** Put in place AVC instruments and tools which monitor and control usage and provide support for the 'standard product and upgrade options' approach
- **Proposed action 10.5:** Further evaluate the opportunities for RSPs to complete their own installs
- **Proposed action 10.6:** Further evaluate POI Backhaul as a potential incremental revenue opportunity

Chapter 11: Fixed wireless: Implementing fixed wireless in the fixed line footprint

- **Proposed action 11.1:** Depending on which option it chooses:
 - If NBN Co decides to pursue Option 1 (accelerated deployment) before FY15: The earlier a decision is taken, the earlier NBN Co can reach underserved premises, which will lower incremental upgrade costs, as new sites can be equipped with six sectors from the outset.
 - If it decides to pursue Option 2:
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - When developing business rules for the full multi-technology model, ensure that fixed wireless and satellite technologies are included in the consideration set in any given area, trading off the potential cost reduction and increased speed of rollout against the capabilities of the product.

Chapter 12: Fixed wireless: Partnership opportunities

- **Proposed action 12.1:** Optimise and continue with NBN Co's current approach of preferring to co-locate its equipment on existing third party towers where technically feasible.
- **Proposed action 12.2:** Issue tenders for services ranging from site acquisition through to site construction in blocks of [REDACTED] sites under competitive conditions, while actively managing contract risks and incorporating lessons from other MNOs and NBN Co's own interactions with tower owners.
- **Proposed action 12.3:** Take additional measures to facilitate greater sharing of its infrastructure for third parties, and identify and capitalise on potential opportunities early.

Chapter 14: Overall coverage: Increased demand and capacity, coverage, cost gaps

- **Proposed action 14.1:** Incorporate both fixed wireless and satellite technologies, as well as the non-fixed line geographic footprint into the Multi-Technology Mix (MTM) planning for 100 percent of addressable premises in Australia. This means creating a set of business rules that balance fast deployment of broadband with better economics
- **Proposed action 14.2:** Proactively seek to minimise the risk of underlying data problems through a concerted effort with Government departments such as the Department of Communications, other Government Business Enterprises (such as Australia Post), and RSPs, including potentially 'crowdsourcing' to supplement existing data sources
- **Proposed action 14.3:** Adopt a consistent definition and count of 'premises' across the company
- **Proposed action 14.4:** As part of the detailed planning process, NBN Co should carefully manage the risk of a significant number of additional premises being added to the non-fixed line areas for satellite service, unless this is made as part of a comprehensive integrated planning decision weighing all the consequences.
- **Proposed action 14.5:** Make an appropriate provision of product for Public Interest Premises
- **Proposed action 14.6:** Continue to work with the Government to confirm the geographic definition of areas with underserved premises.

Appendix 2

Further details on
challenges in satellite
delivery

the possibility exists at the extreme that problems found during testing may require disassembly of the spacecraft. Should this be required, it would add 3–4 months additional delay to delivery of NBN 1A.

NBN Co is doing everything possible to mitigate these risks. It is closely monitoring the progress with SSL and pushing for additional shifts and weekend work where possible. No additional proposed action.

Solar array risk given supplier history

[REDACTED]

NBN Co is taking the right steps to mitigate this risk by working closely with SSL to monitor the testing and flagging it as a watch issue. It is important that if an issue is found, it is not rushed to launch. No additional proposed action.

Orbital slot coordination

NBN Co's two satellites will be parked in geo-stationary orbital slots (positions) 36,000 kilometres above the equator. NBN Co intends to position their satellites in slots at 140° east and 145° east.⁵ These orbital slots sit above the high density population areas of Australia and provide ideal angles for residential satellite antennas.

Today, many communication satellites in geostationary slots provide services to different countries. If two satellites are in nearby slots, using the same spectrum and pointing to nearby parts of the world, their signals may interfere, reducing the capacity or quality of service. To minimise interference, each individual satellite must be coordinated through a regulatory framework governed by the International Telecommunications Union (ITU). It is common practice for satellites to share orbital slots and negotiate spectrum and technical arrangements to prevent interference.

The Australian Communications and Media Authority (the ACMA) manages the coordination process for orbital slots over Australia using the ITU's framework and works with satellite operators and international administrations to agree technical parameters for on-orbit operation. The basic rule is that operators who file to use slots first have priority to use those slots. Other operators using the same slot must co-ordinate with all operators having earlier priority in time.

Although NBN Co has been engaged in the slot coordination process since 2010, it is a lengthy process and is not yet complete. So far, NBN Co has concluded several significant coordination agreements, including with Korea and Japan. Most agreements are not critical as there is low likelihood of interference due to the distance between slots or different spectrum usage. Approximately half of all satellites are launched with some non-critical co-ordination yet to be completed.

However, for NBN Co one significant co-ordination negotiation has not yet been completed. NBN 1A will share the same orbital slot at 140° east with the Russian Ka band satellite AM5, which has a

⁵ Slots are referred to in terms of degrees east of zero meridian.

priority filing. The ACMA has strongly advised that NBN Co complete a key co-ordination agreement with this particular operator (Russian Satellite Communications Company, the main state operator of communications satellites) prior to launching NBN 1A.

NBN Co and the Russian Satellite Communications Company should be able to have both satellites operating in the orbital slot at 140° east, with an NBN Co satellite serving the southern hemisphere and the Russian satellites serving the northern hemisphere, but there is some outstanding risk.

In the short term, the current coordination status will not delay the launch of NBN 1A and NBN 1B. While not assuming any risk, the ACMA has advised it will support the launch and ongoing coordination process.

Longer term, if co-ordination is not completed, there is a low probability risk that the Russian Satellite Communications Company could place a future Ka band satellite in the 140°E slot and cause interference with NBN 1A.

The Review has confirmed, based on discussions with [REDACTED], the ACMA and publicly available information, that the current Russian satellite is not technically capable of providing a Ka band service into Australia. Publicly available information also suggests that it has no future intention of servicing Australia in the Ka band. The Russian operator has also previously co-ordinated at the 140°E slot with other operators in Australia, indicating there is no technical reason why NBN Co and the Russian operator would not reach a co-ordination agreement.

One option to mitigate this risk would be to purchase nearby slots with priority filings. NBN Co has explored this option. However, the slots that have been offered for sale expire in October 2015 and require some re-engineering of the satellite solution, or ground-tracking stations. NBN Co has decided that this option is not appropriate to address this risk.

Nonetheless, the NBN Co should endeavour to complete co-ordination with the Russian Satellite Communications Company as soon as possible to eliminate the remaining uncertainty. Appropriate next steps are to engage specialist negotiators and work closely with the ACMA to complete this co-ordination.

Proposed action 4.1: *Engage specialist negotiators and work closely with the ACMA to complete the remaining agreements for orbital slot co-ordination.*

Launch delays

If a spacecraft is delivered on time to the launch site, launch delays can still occur due to delays in Arianespace's schedule of launches (e.g. manifest slippage, bad weather) or issues with the second satellite due to travel as a co-passenger on the launch vehicle. These risks are common to all launches. Industry data suggests that delays of up to 6 months are common – caused either by spacecraft readiness or Arianespace delays.

Arianespace has indicated that, at this stage, it is confident about being able to manage the launch manifest. There is little that can be done to mitigate the risk of manifest slippage as it is a reality of the space industry.

Arianespace has identified two potential co-passengers for NBN 1A. It is important that NBN Co establish a relationship at senior executive level with the co launch partner to share information, provide feedback and guidance to the vendors to ensure that all opportunities to mitigate launch delay are taken.

Proposed action 4.2: *Establish a senior executive level relationship with potential launch partners and share information.*

Lack of hands-on experience with in-orbit testing within NBN Co

From August 2014 through to service commencement (around September 2015), NBN Co will manage the critical integration and testing phase of the project with all vendor components coming together as one system in order to conduct acceptance and operational readiness testing. This will be a peak workload period for technology and operations teams within NBN Co to test and accept systems and operational processes. Launch of the second satellite will extend the period of peak workload into 2016.

NBN Co's current satellite technical and operational teams are relatively small in terms of size and experience compared to the volume of tasks that can be expected during this period. In projects of this size, it is not unusual for teams to have to simultaneously manage a number of difficult issues to keep the program running to time. Unless action is taken to increase the size and experience level of NBN Co's key teams, delays to the program are likely.

To mitigate the risk of delays, it is proposed that NBN Co engage a number of experienced industry specialists to support the existing teams during this critical phase. As well as playing a troubleshooting role, having access to specialists who have launched platforms previously will provide mentorship, knowledge transfer and a level of pragmatic input to facilitate timely decision making.

To support the Network Architecture and Technology – Space Segment team with in-orbit and end-to-end system testing for NBN 1A, the Review proposes NBN Co engage a specialist in the in-orbit testing of complex satellites, including TT&C and RF system checks. It would be wise to retain the services of the specialist for in-orbit testing of NBN 1B although knowledge and skills transfer to the team may reduce the period for this specialist role for testing of NBN 1B.

Proposed action 4.3: Engage an industry experienced specialist (e.g., Telesat, Optus Satellite or others) to lead and support in-orbit and end-to-end system testing.

Launch failure

Launch failure is one of the most common contributors to satellite mission failure, with an industry average rate of 9 percent. Arianespace, NBN Co's launch partner, has the best record of any launch provider with 59 consecutive successful launches since 2003.

NBN Co has done all it can to mitigate this risk: using a reliable launch provider, purchasing full launch insurance and having a second satellite to launch soon after. No additional proposed action.

On-orbit failure

A range of uncontrollable factors can cause failures when launching and deploying on-orbit satellites including: damage during launch, premature component failure, damage from space debris, and damage from solar events or damage from meteor showers. Industry average failure rates are ~6 percent in the first year and 1.5 percent to 2 percent in subsequent years for complete or partial failure.

NBN Co has insurance covering the first year and options for ongoing insurance for the life of the satellite which is standard industry practice and prudent mitigation. No additional proposed action.

Network operations (including IT build and product specifications)

Delays in IT development

NBN Co needs an OSS system in place to provision and assure users and the network. The OSS functionality is required by [REDACTED] for integrated operations testing. However, the first phase of the system needs to be developed and integrated 2 months earlier to enable end to end testing of ViaSat deliverables. This is a very short timeline to develop an OSS system and has a moderate risk of delays. These tests have [REDACTED] contingency before they begin to delay the start of service.

Currently both Satellite (ISS) and fixed wireless operations are outsourced to Optus Satellite and Ericsson, respectively. [REDACTED]

While NBN Co is on track to deliver an integrated release (IR 11) in August with the critical functionality required to commence testing of ViaSat deliverables, another release (IR 12) is slated to contain the remaining critical OSS functionality required in December 2014. However, this release is also the target for other high priority functionality, such as [REDACTED]. These competing priorities pose a significant risk that the satellite OSS will not be delivered and may be delayed until later releases.

NBN Co IT has taken steps to mitigate risks to delivery. They have split the work over two releases as described and decoupled the development from other system changes, such as [REDACTED]

A moderate risk remains of delay from IT, either due to build delays or due to being displaced by competing priorities.

Proposed action 4.4: Finalise and close out the network operations model. Give NBN Co IT a clear direction and priority to have satellite OSS functioning to meet deadlines.

Network operations capability slow to ramp up

In addition to the IT development to support network operations, a key challenge will be ramping up the team to manage operations testing from November 2014. As with delays in IT development, addressing this challenge also requires finalising the network operations model.

In addition, NBN Co needs to begin recruiting immediately to set up an experienced network operations team with the right skills for a satellite network. The Review believes NBN Co should make an exception to the current recruiting freeze to allow this to happen. There is a significant risk that this team will not have ramped up capability to facilitate testing or be prepared to launch the service.

Proposed action 4.5: *Begin recruiting necessary resources now to manage the network operations for satellite testing.*

New and non-standard CPE (VSAT) not available in time

NBN Co has elected to launch with a new version of the ViaSat CPE. Changes include new hardware with certain software components specific to NBN Co layer 2 operation. This hardware will be used by ViaSat as the world's next generation product.

From an industry perspective, any new version of CPE always adds more risk to the project as it increases the chance of design and build issues in both the hardware and the software. Combined with the integration of the CPE onto the platform, delays are likely.

Testing of the new CPE version is critical. In the event that the CPE development runs late, not allowing adequate time or not implementing stringent compliance and quality testing may result in CPE rolled into the field with either software and hardware defects or both, reducing services capability or causing service failure. This would have significant impacts on cost and quality of user experience.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Proposed action 4.6: *Ensure that ViaSat's testing of the new CPE is rigorous and make informed choices during 2015 regarding production deployment of the new CPE.*

Product changes lead to changes in IT

Product/service definitions need to be specified in advance of OSS/BSS development so that these systems have the right functionality. Late changes to products that require modifications to system architecture (e.g. CVC structure) could cause significant delays. Changes that affect the system configuration (e.g. pricing) could cause smaller delays. Several aspects of the satellite products have not yet been specified:

- Dedicated CVC and single POI architecture has been agreed at an Exco level, but may be reviewed by the ACCC
- The implementation of a standard product with a specific capacity allocation per end-user with possible upgrade options has not yet been finalised
- The instruments and tools which monitor and control usage and provide support for the 'standard product and upgrade options' are being developed.

These aspects need to be specified by the end of April to be incorporated into the design of systems developed in IR12. The Review considers it very unlikely that this will be achieved and proposes [REDACTED]

[REDACTED] This increases the risk to IT delivery by increasing complexity and changing the timeframe.

Proposed action 4.7: *Revise LTSS IT plan to bring adjustments to full product specification in IR 13.*

Ground infrastructure

Failure to integrate satellite network systems

As discussed above, from August 2014 through to service commencement (planned for around September 2015), NBN Co will manage the critical integration and testing phase of the project with all vendor and internal NBN Co elements coming together as one system in order to conduct acceptance and operational readiness testing.

To mitigate the risk of delays, it is proposed that NBN Co engage a number of experienced industry specialists to support the existing teams during this critical phase. As well as playing a troubleshooting role, having access to specialists who have launched platforms previously will provide mentorship, knowledge transfer and a level of pragmatic input to facilitate timely decision making.

In particular, the Review proposes NBN Co engage a senior industry professional in a leadership role. This individual must have specific experience in launching a platform of this type (i.e. a broadband satellite ground system platform) to lead the NBN Co teams through the integration, testing and operational commissioning phases of the platform, with support from experienced point specialists having specific skill sets, including the in-orbit testing specialist referred to above.

NBN Co's Network Architecture and Technology – Ground Segment team has the role of overall system integrator for the satellite platform with responsibility for the end to end system architecture and satellite platform delivery, followed by handover to the Operations team. Since the end-to-end satellite system is complex, and relies on a large number of vendors and internal service components provided by the internal NBN Co teams, there is a significant risk of errors that may cause delays in testing or reduce the performance of the overall system. Errors could be made in many areas including architecture design, component interface compatibility, recognition of interdependencies, or resolution of issues uncovered during testing. NBN Co is currently short on experienced resources to conduct the testing, issue resolution, and technical and operational acceptance.

To mitigate this risk, NBN Co requires an experienced senior-level leader to take overall responsibility for the system architecture and to lead the team and provide trouble shooting experience during the peak integration workload that ramps from August 2014. In addition, NBN Co's technical and operations teams are likely to require the support and guidance of experienced specialists who have subject matter expertise from an actual product launch of a broadband satellite program in areas such as CPE and transitioning into operational mode. Given the specialised nature of broadband satellite CPE (VSATs) and long history in the industry of difficulties commissioning satellite CPE, the Review proposes NBN Co gain access to an experienced CPE integration testing and acceptance resource, and having access to similar specialist skills for other domains, specifically transition to operations.

Proposed action 4.8: *Add an experienced senior-level leader to the Network Architecture and Technology- Ground Segment team dedicated to oversight of successful system integration through to operational readiness. Also add experienced specialists to support NBN Co teams in specific areas such as CPE testing and transition to operations.*

Power not connected to some gateways (short term problem)

Some of the RF gateways have been experiencing delays getting high voltage connections into the power grid. Negotiations with local energy authorities for remote area supplies can be a long and difficult process and it is not clear that all gateways will have power connections in place in time for their acceptance testing.

This is not unusual in these types of construction programs and in most cases each connection must be negotiated on a site by site basis.

An appropriate mitigation is to engage a local electrical consultant on a short term basis to liaise with local energy authority representatives until a deal is reached. NBN Co have set themselves up to use generators on a short term basis, which will also ensure that testing can still proceed in accordance with the overall plan.

Proposed action 4.9: *Where required, engage a local electrical consultant on a short term basis to liaise with local energy authority representatives until a deal is reached for supply of mains power. Ensure senior NBN Co executive oversight.*

Backhaul rings and stubs not connected to some gateways

NBN Co needs to have backhaul links in place between the TT&C installations, gateways and the data processing centres (DPC) so that SSL and ViaSat can test their systems, and NBN Co can do integrated testing. It is likely that some of these connections will not be in place in the time required for testing.

Most testing can be conducted over a backhaul link which includes managed service backhaul leased from another provider while NBN Co's network is still being commissioned. This kind of connection is scheduled to be in place to TT&C and all gateways in time for testing.

However, load testing of the system to simulate real end-user traffic requires at least one NBN Co owned complete fibre backhaul link from the DPC to each gateway. This testing is scheduled to begin on 2 March 2015, but two of ten gateways are not scheduled to have a complete backhaul connection to a DPC until 25 March 2015. Though the program is trying to move these dates forward, it is quite likely that at least these two connections will not be ready.

If these connections are not ready then NBN Co will still do volume testing over the other gateways, which greatly reduces the overall risk by proving the system. Testing of the remaining gateways will not be allowed to delay the critical path and volume testing, and will be completed in business readiness testing (post IOT).

NBN Co should continue to seek ways to speed up delivery of these connections. However, existing mitigation of shifting volume testing of gateways to business readiness testing should prevent this risk from having a large impact.

No additional proposed action.

Delays in TT&C readiness

TT&C infrastructure consists of two ground stations connected to Optus Satellite's satellite control facilities in Sydney, and provides the functionality required to manage the payload and orbital position of the spacecraft. SSL are responsible for construction of the ground stations and have reported them to be ahead of schedule. The satellite flight operations function has been outsourced to Optus Satellite with the program on track for delivery and the scope of works well understood.

The program has 13 weeks of contingency and is expected to be delivered in readiness for in-orbit testing. The Review considers this contingency sufficient to mitigate any probable delays.

No additional proposed action.

Delay in gateway build

NBN Co is building a series of gateways in remote locations around Australia using various subcontractors. Commissioning a gateway involves building the physical facility, installation of ViaSat equipment into the stations and connecting power and backhaul.

Driven by the need to be physically isolated from each other, the 10 gateways are located in some of the most difficult locations in Australia. Physical build and/or ViaSat installation may experience delays due to:

- Constraints on [REDACTED] resources – peak demand driven by site delays
- Shipping of components from the US
- Workforces in remote locations
- Weather related delays
- Union action.

If some gateways are not complete the capacity associated with the specific gateway cannot be used until the gateway is complete.

Proposed action 4.10: *Maintain senior executive oversight of gateway build and existing mitigations*

End-user activations

External field force slow to ramp up for ISS to LTSS migration

ISS bandwidth and services contracts are currently intended to terminate in September 2016 requiring the existing 44,000 end-user base to be migrated to LTSS by September 2016 (i.e. in 9–12 months if LTS service were to commence in Q4 2015). To complete migration on plan, a transition rate of 4,000–5,000 end-users (or better) per month will be required. At current apparent industry peak installation volumes in the order of 8,000 to 9,000 per month (a workforce in the order of [REDACTED] technicians) no 'new' end-users could access the long term satellite in the first year of installations and fixed wireless connections would be limited.

This rate of installation is high relative to the historic industry capacity. Early engagement with field force contractors will be crucial to prevent losing months ramping up to the required rate. ISS installation peaked at 3200 installations per month utilising [REDACTED] technicians. Skybridge, the field force manager for the ISS rollout, has access to approximately [REDACTED] technicians. As ISS installations have ramped down, a minimum 6 months should be allowed for a selected contractor to build and train an installation workforce.

The Review notes learnings from the fixed wireless program that some form of on-boarding payments should be considered in order to attract and retain subcontract installers during their training and initial start-up period before they begin receiving payments for completed installations.

Planning the migration will be complicated and should be commenced at least 12 months in advance. Factors such as geography, rate of migrations, rate of new installs (based on demand), the government's 'poorly served' policy, and industry ramp up speed will all need to be considered to create a combined plan for new activations and migrations that is cost effective, fast enough and creates a good user experience. For example, there is an opportunity to batch and co-ordinate new installs to fit in with the planned migration of ISS end-users to increase efficiency. Early engagement with a selected contractor will greatly assist in tackling this planning problem.

Some RSPs have highlighted they would be willing to take on the field install component for their end-user base. This is discussed in more detail in chapter 5.

Even with this mitigation, it will be difficult for industry to ramp up at short notice to migrate all ISS end-users in 9–12 months in addition to fixed wireless end-user connections. It will also be exacerbated by any delays in service start. In order to mitigate the impact, it is prudent to renegotiate the ISS to allow extension of the contract as outlined above. It will also be critical to start immediately to work with industry to lift end-user connection capacity (fixed wireless and satellite) to 12,000–15,000 per month by the start of 2016.

Proposed action 4.11: *Lock in contracts with field force management providers early, including volume estimates, to give surety for providers to build up field force. Begin detailed planning of migration 12 months in advance and including processes to batch new installations to achieve level utilisation and increase efficiency. Work with industry to lift end-user connection capacity (fixed wireless and satellite) to 12,000 – 15,000 per month by the start of 2016.*

End-users eligible for ISS but not LTSS

Due to different eligibility criteria of ISS and LTSS, some end-users of ISS may not be eligible for LTSS. Eligibility for ISS is based on lack of commercial availability of other fast broadband, whereas eligibility for LTSS is based on the technology footprint boundaries. Under the current technology footprint, NBN Co estimates ~6,000 ISS end-users will not be eligible for long term satellite. Approximately 2,000 are in the planned fixed line footprint and approximately 4,000 are in the fixed wireless footprint. When ISS terminates under the current Corporate Plan, these users will be disconnected, but not eligible to migrate to the LTSS. If fixed line or fixed wireless is available in the area during that time, they will be connected to it, but if the fixed line or wireless service is not yet ready, they may be disconnected and forced to wait until it is rolled out.

The Review proposes that NBN Co review the extent of this issue after revising the technology boundaries and consider transition mechanisms prior to the arrival of fixed line or fixed wireless services, such as temporary migration to LTSS where capacity allows, or temporary mobile broadband. Incremental cost of this mitigation would be in the order of ██████████ that is not provided for in the Corporate Plan.

Proposed action 4.12: *Consider transition mechanisms prior to the arrival of fixed line or fixed wireless service to prevent any ISS users from being disconnected from satellite service without a fast broadband fallback.*

RSPs offering ISS but not LTSS

End-users currently on ISS with an RSP will be migrated to LTSS with the same RSP.

In a scenario that an RSP decides not to offer LTSS, end-users will need to be connected to an alternative RSP when migrated.

A process is required to ensure these end-users are given a choice to move to LTSS with a different RSP or terminate connection. Termination of an existing service would present a poor end-user experience, therefore the Review proposes that NBN Co confirm with ISS RSPs in advance to ensure all will offer LTSS. For any ISS RSPs that chose not to continue to offer a service, NBN Co can implement a process to contact end-users and give them a choice of other RSPs.

Proposed action 4.13: *Determine if any RSPs offering ISS will not offer LTSS, and work with industry to resolve any specific issues with individual end-users.*

Line-of-sight issues for some end-users

For any satellite platform, a small number of premises will have difficulty accessing the required northerly look angle due to close proximity objects such as tall multi-storey buildings and trees.

The experience using the IPSTAR satellite at 119.5° east was that [REDACTED] of end-users experienced some issues. Experience with large end-user deployments with Optus Satellite at 156° east found that [REDACTED] experienced issues. The long term satellite system is likely to experience even fewer cases as the two NBN Co satellites have ideal orbital locations of 140° east and 145° east with higher look angles for the vast majority of end-users.

For affected end-users, alternate installation methods may be possible, for example remotely placing the dish on a post next to the premises. Industry experience is that half of problems can be solved easily in this manner. The remaining half may require VSATs to be located further from the premises and therefore could be quite costly. Industry experience shows that almost all cases can be solved in some way, and therefore incentives for sub-contractors to develop local solutions are important.

Proposed action 4.14: *Develop a process for sub-contractors to recognise and mitigate line-of-sight issues when they occur. Ensure that incentives are right for sub-contractors to try and mitigate the issues properly, e.g. they are paid on successful install, not per site visit.*

Timeline changes to mitigate overall risk

Exercise the option to change the timing of NBN Co's second launch to be 12 months after the first

Given the finite life of a satellite (15 years on average) it is usual and prudent industry practice to launch satellites as late as demand allows, in order to ensure maximum return on the spacecraft investment.

The current NBN Co plan calls for two satellites to be launched within a period of six months. The initial reason for successive launches was based on risk mitigation in case of a launch failure or early on orbit life failure of NBN 1A.

However, it poses the risk that in the event of failure of NBN 1A, NBN 1B may need to be launched before the cause of the NBN 1A failure can be determined, heightening the risk of a second failure.

Based on the Review's analysis, it is possible to postpone the second satellite launch by six months to occur twelve months after the first without materially compromising quality of service. Postponing the second launch will provide risk mitigation and benefit to the overall program.

- [REDACTED]
- [REDACTED]

- [REDACTED]
- [REDACTED]

Proposed action 4.15: Exercise the option to change the timing of the second satellite launch to make it 12 months rather than 6 months after the first, subject to contractual impacts and agreement with the launch provider. This would allow the team to focus on the IOT/BRT of 1A and service commencement, and allow more time if any issues need to be fixed before launch of 1B. In addition, the efficiency of the satellite replacement program (which will be required in 2028-2030) will be improved by spacing the launches further apart. This timing should also not impact the end-user rollout as the additional satellite capacity should not be needed until this time given the speed with which the industry can connect end-users.

Extension of the ISS contracts

Fully outsourced ISS services are provided to NBN Co via three contracts, Optus Satellite provide both provisioning services and bandwidth, and IPSTAR bandwidth only. Both Optus Satellite ISS contracts originally expired on 30 June 2016, but have now been extended to terminate on 30 September 2016 at the same time as the IPSTAR contract. The contracts allow for further extension from 30 September 2016 to 30 June 2017 for a cost of [REDACTED] (based on current NBN Co analysis), though this is not allowed for in the Corporate Plan. Extension to September 2017 and beyond is possible at additional cost.

The Corporate Plan 2012–15 would require the migration of all ISS end-users to LTSS between the satellite launch in 2015 and ISS termination in September 2016.

Extending the ISS beyond September 2016 provides two potential benefits:

- Mitigates risk that the migration is not finished by September 2016, which would lead to the remaining ISS end-users being disconnected. There is risk in the current migration plan that industry is not able to ramp up to the required installation rate to meet the migration deadline. Any delays to satellite service commencement would also increase the required installation rate and further exacerbate this risk. Securing options to extend the ISS would effectively mitigate this risk, as well as providing a transition option for up to 6,000 ISS end-users not eligible for LTSS.
- Allows possibility of further prioritising 'underserved' end-users in the rollout of the LTSS. With a lower rate of migration installations required, it would be possible to do a greater number of new installations, which could be targeted to 'underserved' end-users.

This decision is not required until early 2015. Current NBN Co analysis suggests this will cost [REDACTED]. In order to extend the ISS contracts, NBN Co needs only to issue notice for the extensions up to until the end of September 2017. After this the contracts will continue on a month-by-month basis (understanding that either party can terminate this 'holding over' arrangement on notice).

Proposed action 4.16: *Take up extension options for the ISS as completing ISS migration by September 2016 may be difficult due to potential late service commencement, combined with residual risk in industry capability for installations. An ISS extension also allows a capacity lever to enable 'new' satellite end-users to access services in the first year of operation.*

Appendix 3

Glossary of abbreviations
and key terms

Appendix 3 – Glossary of abbreviations and key terms

Exhibit A.3-1: Abbreviations used in this report

Abbreviation	Definition
ABG	Australian Broadband Guarantee
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ACMA	Australian Communications and Media Authority
ADSL	Asymmetric Digital Subscriber Line
ARPU	Average Revenue Per User
AVC	Access Virtual Circuit
AWB	Augmented wireless build
BRT	Business readiness testing (for satellite)
BSS	Business Support Systems
CAGR	Compound annual growth rate
CIR	Committed information rate
CMTS	Cable Model Termination Systems
COO	Chief Operating Officer
Corporate Plan	NBN Co Corporate Plan 2012-2015, dated 6 August 2012
CPE	Consumer premises equipment
CVC	Connectivity Virtual Circuit
dB	Decibel
DOCSIS	Data Over Cable Service Interface Specification
DPC	Data processing centre
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexers

EAC	Estimate at Completion
EBITDA	Earnings before interest taxation depreciation and amortisation
ERP	Enterprise Resource Planning
FAN	Fibre Access Node
FDD	Frequency Division Duplexing
FD-LTE	Frequency-Division Long-Term Evolution
FSAM	Fibre Servicing Area Module
FTTB	Fibre-to-the-building
FTTdp	Fibre-to-the-distribution-point
FTTN	Fibre-to-the-node
FTTP	Fibre-to-the-premises
FTTx	Fibre based access technology
FUP	Fair use policy
GB	Gigabyte
GBE	Government Business Enterprise
Gbps	Gigabits per second
GHz	Gigahertz
GNAF	Geocoded National Address File
GPON	Gigabit Passive Optical Network
HFC	Hybrid Fibre Coaxial
IOT	In-orbit testing
IPTV	Internet Protocol Television
IR	Integrated release, referring to NBN Co's integrated IT releases
IRR	Internal rate of return
IRU	Indefeasible Rights of Use
ISS	Interim Satellite Service
ITU	International Telecommunications Union
IWB	Initial wireless build
JV	Joint venture

kbps	Kilobits per second
Layer 2	Data link layer in OSI model
Layer 3	Network layer in OSI model
LIC	Lead in conduits
LIFD	Low Impact Facilities Determination
LNDN	Local Network Distribution Network
LOS	Line-of-sight
LTD	Life-to-date
LTE	Long Term Evolution
LTSS	Long Term Satellite Service
Mbps	Megabits per second
MDU	Multiple Dwelling Unit
MHz	Megahertz
4x4 MIMO	4x4 Multiple Input-Multiple Output
MNO	Mobile network operator
MTM	Multi Technology Mix
NAP	Network access point
NBN	National Broadband Network
NBN 1A	NBN Co's first satellite
NBN 1B	NBN Co's second satellite
NBN Co	NBN Co Limited
NFAS	Network Fibre Access Service
NNI	Network to network interface
NPV	Net present value
NSMAs	Network Services Master Agreements
NTD	Network Termination Device
Ofcom	UK communications regulator
Optus	SingTel Optus Pty Ltd and associated Optus entities
OSS	Operational Support Systems

P2P	Point to point
PCD	Premises connection device
PDF	Product Development Forum
PIPs	Public Interest Premises
PIR	Peak information rate
POI	Point of interconnect
PSAA	Per Subscriber Address Amount
PSMA	PSMA Australia Limited
RFI	Request for information
RFP	Request for proposal
RSCC	Russian Satellite Communications Company, the main Russian state operator of communications satellites
RSP	Retail service provider
SAU	Special Access Undertaking
SDU	Single dwelling unit
SLA	Service Level Agreement
SOE	Statement of Expectations
SOR	Schedule of Rates
SSL	Space Systems / Loral
TC	Traffic class
TDD	Time Division Duplexing
TD-LTE	Time Division Duplex variant of LTE
Telstra DA or DA	Telstra Definitive Agreements or Definitive Agreements
TMO	Transformation Management Office
TPEP	Transparent Performance Enhancing Proxy
TT&C	Telemetry, Tracking and Command
TUSMA	Telecommunication Universal Service Management Agency
ULLS	Unconditional local loop service
UMD	Unpaired Mobile Downlink

UNI	User network interface
UNWP	Uniform National Wholesale Price
USO	Universal Services Obligation
VDSL	Very-high-bit-rate DSL
VHA	Vodafone Hutchison Australia
VoIP	Voice over IP
VSAT	Very small aperture terminal (part of CPE for satellite network)
WBA	Wholesale broadband agreement
WiMax	Worldwide Interoperability for Microwave Access
WNTD	Wireless Network Termination Device

Exhibit A.3-2: Key terms used in this report

Term	Definition
Addressable premises	See Premises definition below.
Access seeker	A customer acquiring NBN Co wholesale services with the intention to supply broadband services to Retail Service Providers (RSPs) or End-Users.
Active equipment	Electronic equipment that performs the data transmission tasks necessary for operating a fixed wireless network (e.g. radio and microwave transmitters).
Anchor tenant model	A model for deploying new fixed wireless sites, where NBN Co delegates construction and management of new towers to a third party in exchange for a guarantee to lease space for a set period
Asymmetric Digital Subscriber Line (ADSL)	A technology for delivering high-speed data transmission over a copper pair. As the name suggests, it provides different downstream (network to End- User) and upstream (End-User to network) bandwidth.
Average revenue per user (ARPU)	The total revenue divided by the average number of subscribers over a defined period.
Backhaul	The portion of the network between the core network and smaller sub-networks. For the NBN this is equivalent to the Transit Network.
Base station	Physical site that hosts NBN Co active equipment for the fixed wireless network, usually towers
Brownfields	Pre-existing premises that will be covered by either fibre, fixed wireless or satellite services.
Business Support System (BSS)	The set of IT systems that will provide NBN Co with the capabilities to support access seekers, take orders, process bills and collect payments.

Busy hour throughput	Average traffic in the busiest hour of the day.
Capacity	Maximum amount of data that can be transferred over a network path.
Capital Expenditure (Capex)	The cost of purchasing tangible and intangible assets.
Carrier aggregation	Wireless technology which enables multiple spectrum channels (up to 5 channels) to be used together to increase wireless access network capacity.
Cell Coverage Area	Area in which a single user can achieve a Layer 2 information rate of at least 25Mbps downlink and 5Mbps uplink with 93-95 percent probability.
Compound annual growth rate (CAGR)	“Year on Year” growth rate, over a specified period of time
Connections	Premises with an active NBN Co connection.
Copper loop lengths	The length of the copper from the node to a premises (in ADSL and FTTN).
Dark fibre	Optical fibre with no active electronics attached.
Data over cable service interface specification (DOCSIS)	A telecommunications standard that permits the addition of high-speed data transfer and internet access through HFC infrastructure.
Digital Dividend auction	The auction of the spectrum (700MHz band) that has been freed up by the switch from analogue to digital television that was completed in May 2013.
Digital Subscriber Line (DSL)	A family of technologies that deliver high-speed data transmission over a copper pair.
Digital subscriber line access multiplexers (DSLAMs)	Network devices connecting End-User copper lines for the provision of DSL broadband service.
Distribution area (Telstra)	An area in the Telstra copper network where a number of premises are served by a single copper pillar.
End-user	Final downstream customers to NBN Co's Access Seekers.
Fair Use Policy (FUP)	In the context of internet usage, a fair use policy is the management of end-user downloads and uploads to ensure that all users to achieve an acceptable user experience on the Satellite Service.
Fibre to the basement (FTTB)	Network design in which the Fibre network is deployed to the basement of a building.
Fibre to the distribution point (FTTdp)	Network design in which the Fibre network is deployed to a distribution point near the premises.
Fibre to the node (FTTN)	Network design in which the Fibre network is deployed to the node (i.e. a VDSL cabinet), while copper lines are used for the connection between the node and the premises.
Fibre to the premises	Network design in which the Fibre network is deployed to each premises.

(FTTP)

Fibre to the x (FTTx)	FTTx is a generic term for any broadband network architecture using optical fibre to replace all or part of the usual metal local loop used for last mile telecommunications. The generic term was initially a generalisation for several configurations of fibre deployment (FTTN, FTTdp, FTTB, FTTP...), all starting with 'FTT' but differentiated by the last letter, which is substituted by an x in the generalisation.
Fixed Line footprint	The areas of Australia to be served by a fixed line technology.
Fixed Wireless	Network design in which network connections are provided through radio signals.
Gateway or RF Gateway	The network node which transmits traffic (data) via the respective medium (cable, wireless or satellite). In this Report this will typically refer to the network node on the ground that interfaces with the satellites in space.
Geocoded National Address File (GNAF)	GNAF lists all valid physical addresses in Australia. GNAF information is provided by PSMA Australia Limited.
Gigabit-capable Passive Optical Network (GPON)	A fibre-optical access system based on Internet Protocol (IP).
Greenfields	A new development that can be either Broadacre or Infill Premises. Greenfields developments represent premises growth.
Ground station	The physical infrastructure that houses the RF gateway in the satellite network.
Hub sites	A fixed wireless site that connects directly to the fibre backhaul network. Other fixed wireless sites connect to Hub sites via microwave links to access backhaul.
Hybrid Fibre Coaxial (HFC) Network	A network utilising both optical fibre and coaxial cable for the delivery of Pay TV, broadband and voice services.
Installation capacity	The maximum rate of installation of CPE's that can be achieved, e.g. per month.
Internal Rate of Return (IRR)	The average annual total return from an investment over a specified time period, used to measure and compare the profitability of the investment.
ISS to LTSS migration	Process of disconnecting end-users from ISS and connecting them to LTSS.
Ka band	Satellite radio frequency spectrum from 27 – 40GHz.
Kilobits per second (kbps)	A unit of measurement of transmission speed. One Kilobit Per Second is equal to 1,024 bits per second.
Lead in Conduit (LIC)	The pipe or conduit carrying the lead-in cable between the customer's premises and the nearest pit.
Long Term Evolution (LTE)	Standardisation work by the 3rd Generation Partnership Project to define a new high-speed performance air interface for mobile communication systems. The term is used interchangeably with "4G" (fourth generation).
Low Impact Facilities Determination (LIFD)	Telecommunications Facilities that comply with the provisions of the Telecommunications (Low-Impact Facilities) Determination 1997 (amended 1999). The Guidelines provide assistance with the siting and design of new facilities with the aim of minimising visual impact and achieving appropriate and acceptable outcomes.

Manifest	The schedule of rocket launches planned by a launch provider such as Arianespace.
Megabits Per Second (Mbps)	A unit of measurement of data transfer speeds. One Megabit Per Second is equal to 1,024 kbps.
Multi dwelling unit (MDU)	Premises that contains more than one dwelling unit, which can range from duplexes to 200+ unit apartment blocks. Each dwelling unit is assumed as equivalent to one GNAF (e.g. a 50 unit apartment block will have 50 GNAFs).
Network access points (NAP)	The point at which Drop Fibre is connected to Local Fibre.
Network operations	The activity to manage a telecommunications network including end-user fulfilment, assurance and capacity and performance management.
Network termination device (NTD)	NBN Co's termination point on each premise, for residential fibre services currently featuring four Ethernet and two telephone ports.
Non-fixed line footprint	The concept of a 'non-fixed line footprint' originates in the Statement Expectations of the former Government which requires NBN Co to provide fixed line technology to 93 percent of premises by the end of the rollout period (minimum 90 percent), and fixed wireless and satellite for the remainder of premises (effectively the 'non-fixed line footprint').
Operating Expenditure (Opex)	The ongoing cost of running a business, system or product.
Operational Support Systems (OSS)	The set of systems that will provide NBN Co with the capabilities to provision, configure, manage, and operate the NBN.
Orbital slot	Positions for geo-stationary satellites 36,000km above the equator. Slots are referred to in terms of degrees east of the zero meridian.
Passive equipment	Non-network equipment at NBN Co fixed wireless sites (e.g. physical tower, fencing, etc).
Point of Interconnect	The connection point that allows RSPs and WSPs to connect to the NBN Co access capability.
Point to Point (P2P)	A network design in which a dedicated access fibre connects individual premises directly to the fibre exchange.
Premises	Addressable locations which NBN Co is required to connect. Attachment A to the Statement of Expectations dated 17 December 2010 refers to this definition as the basis for measuring NBN Co's achievement of the Government's coverage objectives.
Premises activated	Synonymous to premises connected - premises are activated after receiving and provisioning a service order from a Retail Service Provider to install a new service at the premises.
Premises covered	Premises where all design, construction, commissioning and quality assurance activities have been completed.
Product components	Four parts: UNI, AVC, CVC, NNI.
Product construct	The definition of the product / end-user experience that will be delivered by a particular technology, including kbps, monthly usage limits and pricing.

Repeater towers	Towers in the fixed wireless network that interlink the microwave backhaul. They do not provide fixed wireless services directly to premises. Also referred to as relay towers.
Retail Service Provider (RSP)	A third party provider of retail broadband services to End-Users.
Satellite operator	A company that manages the TT&C and payload of one or more satellites.
Sector splitting	Upgrade technique employed to increase the number of sectors per base station to reduce the number of customers served by that base station.
Special Access Undertaking (SAU)	Undertakings which specify terms and conditions upon which access providers propose to supply a listed carriage service or a service which facilitates the supply of a listed carriage service. Division 5 of Part XIC of the Competition and Consumer Act 2010 (CCA), enables access providers, including NBN corporations (such as NBN Co), to voluntarily lodge written Special Access Undertakings with the ACCC.
Special Services	Telstra retail and wholesale services as defined in the Telstra DA, these include services for which there is no equivalent service on the NBN.
Spectrum	The portion of the range of electromagnetic radiation that is used for communications technologies, such as radio, radar or television.
Spectrum auction	A spectrum allocation processes where interested parties are invite to bid for spectrum assets above a pre-defined reserve price.
Spectrum band	Radio frequency spectrum is divided into a number of spectrum bands with each having been specified a general purpose for which they can be used.
Spectrum licences	A licence which authorises the use of spectrum space at a particular spectrum band within a particular geographic area for a period of up to 15 years.
Spot beam	A satellite signal that is concentrated to cover a defined geographic area.
Statement of expectations (SOE)	Statement to NBN Co from its Shareholder Ministers setting out the expectations that the NBN should work to fulfil. There are several of these SOEs; where an SOE is referred to in this document, it is specifically identified by its date.
Take-up	The rate at which premises elect to purchase an NBN service through an RSP.
Telecommunication Universal Service Management Agency (TUSMA)	The agency responsible for administering the universal service obligation and other public interest services.
Telstra Definitive Agreements (DA)	The suite of agreements entered into between NBN Co and Telstra on 23 June 2011 and which are described in the release issued by Telstra to the ASX on that day.
Tower	A tall concrete or steel structure to which network equipment (such as microwave transmitters) are attached.
Tower operator	An organisation that specialises in owning, and maintaining wireless towers in exchange for a lease rate from network operators, who use space on the tower to host networking equipment.

Traffic classes	A classification of data packets or traffic streams with different performance characteristics and order of priorities on the NBN Co network to enable Service Providers to develop targeted retail offerings for key segments and support application requirements.
Transit Fibre	Connection between Points of Interconnect (POI) where the Retail Service Providers connect to the NBN, and the regional based FANs. Transit Fibre can also provide connectivity from the Metropolitan FANs to POIs if required.
Transit Network	The fibre rings which connect the regional FAN sites and the nearest POI, served by Transit Fibre.
Universal Service Obligation	Policy which obliges the primary universal service provider - currently Telstra – to ensure that all people in Australia are provided with equitable access to standard telephone services and payphones. This obligation applies to all areas in Australia including areas to be covered by the NBN. It continues during and after the NBN rollout.
Urban-fringe	Suburbs and areas surrounding Australia's state capital cities and Canberra.
Wholesale Broadband Agreement (WBA)	A document which sets out the terms and conditions of access to NBN Co's services and products and constitutes one of NBN Co's standard forms of access agreements.
Wholesale Service Provider (WSP)	A provider of wholesale services to RSPs.