

1 Executive Summary

SUMMARY OF IMPLEMENTATION STUDY FINDINGS

- Government's objectives for the National Broadband Network can be implemented within the \$43 billion estimate of capital expenditure by deploying fibre to 93 percent, fixed-wireless from the 94th to 97th percentiles and satellite to the final 3 percent of premises.
 - The NBN should be deployed efficiently by setting practical coverage objectives, being willing to make use of existing infrastructure, providing appropriate legislative support and leveraging the capabilities of commercial wireless operators.
 - Retail competition should be improved through mandating NBN Co's wholesale-only, open-access role and by ensuring NBN Co eliminates network bottlenecks and operates at the lowest appropriate layer in the OSI stack.
 - The fibre access network should be expected to become the predominant fixed-line telecommunications infrastructure over time by pricing for affordability and take-up and providing continuity for existing services.
 - Full Government ownership should be maintained until after the roll-out is complete requiring temporary peak funding in the vicinity of \$26 billion by year 6—which can be paid down quickly from then with investment-grade debt prior to privatisation. Government should expect to cover its cost of funds under most plausible business case scenarios.
 - Future competition and innovation potential should be safeguarded by preferring a network design that preserves options for active-layer competition and shifts in technology, and by ensuring a healthy industry structure and appropriate regulatory regime are in place prior to privatisation
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The conclusion of the Implementation Study is that Government's objectives for the NBN can be implemented within the original \$43 billion estimate of capital expenditure, by deploying a mix of fibre, wireless and satellite technologies. Once implemented, the NBN will deliver Australia a world-class broadband infrastructure.

Along the way, there will be many risks to manage and many challenges to overcome. Successful implementation will require sustained, focused and accurate execution over many years by NBN Co, Government, and the ecosystem of vendors, carriers and end users involved.

The new fibre infrastructure covering 90+ percent of premises will be long-lived and will redefine the current industry structure, superseding the copper network that has been in place for over 50 years in many places. The fibre laid over the next decade will be in place for possibly as long again. Today the Australian telecommunications industry is

shaped by a highly profitable vertically-integrated and horizontally-integrated incumbent with a monopoly position in most fixed-line access and many backhaul routes. With the advent of the NBN, a fundamentally different industry structure will emerge around NBN Co, a new wholesale-only infrastructure provider. This change will accelerate the evolution of the industry. At times this may be smooth; at other times it will be uneven. New business models and companies will emerge. Existing participants will need to adapt to succeed.

In this context, three mutually supporting principles have shaped the approach recommended by the Implementation Study: pragmatism; flexibility; and foresight.

First, recognising that the implementation task is enormous, a pragmatic approach is needed. Up to 250,000 kilometres of access network and backhaul fibre must be buried or strung overhead, along most roads across the country. Up to 5,000 customer visits per workday could be required over the 8-year roll-out. Since much of this work is repetitive however, lessons learned in early deployments can be applied quickly, allowing the NBN to evolve over time.

Second, acknowledging the pace of change and the uncertainty of markets and technology, flexibility is required—in commercial arrangements, in technology choices and in the translation of broad policy goals into practice. Any approaches developed early in the process should be grounded in an appropriate level of confidence in the ability to predict accurately how technology and markets will develop over time.

Third, recognising that today's decisions about the design of the NBN will shape the structure, conduct and performance of Australia's telecommunications industry for decades—and address many conflicting interests—foresight is called for in making recommendations that will withstand the test of time and serve the country's interests beyond short-term pressures.

The challenge for Government is to balance these three principles of pragmatism, flexibility and foresight successfully over the next decade as the network is deployed and the industry progressively evolves.

This executive summary provides a stand-alone overview of the most important findings and recommendations of the Implementation Study. The remainder of the report contains detailed recommendations and supporting analysis.

1.1 Set coverage objective as fibre to 93 percent, fixed-wireless and satellite from 94 to 97 percent and satellite-only from 98 percent—achievable within estimated expenditure of \$43 billion

Government's initial policy announcement set an objective of providing fibre to 90 percent of premises and using wireless and satellite technologies to deliver at least 12 Mbps to those 10 percent of premises expected to be beyond the reach of fibre.

Based on detailed geospatial modelling of every address in Australia, the Implementation Study recommends that the NBN coverage objective be adjusted to take fibre to 93 percent of premises by the end of the 8-year roll-out. Another 4 percent of premises should be covered by a commercially-tendered fixed-wireless service delivering at least 12 Mbps—and much greater speeds for many premises in the coverage area. NBN Co should provide a wholesale Ka-band satellite service to ensure at least 12 Mbps is delivered to the remaining 3 percent of premises, and also to provide a coverage option to the 4 percent of premises within the fixed-wireless footprint.

1.1.1 RECOGNISE THE GEOGRAPHIC, ECONOMIC AND TECHNOLOGICAL CONSTRAINTS TO PROVIDING FAST BROADBAND NATIONALLY

The most significant driver of total cost for a fixed-line or wireless access network is the density of premises it serves. For a fibre network, civil works are approximately 70 percent of deployment costs and those costs vary with the distance that fibre needs to be trenched or strung along electricity poles. For a wireless network, density determines how many towers and radio transmitters are needed: in highly-populated areas denser networks of base stations are required for a given amount of spectrum and at low densities there may be few premises per tower, making the economics challenging. Satellite is an exception—geostationary satellites can cover all of Australia, so density determines provisioning of bandwidth, but relative to the fixed costs of launching a satellite, is not a substantial cost driver.

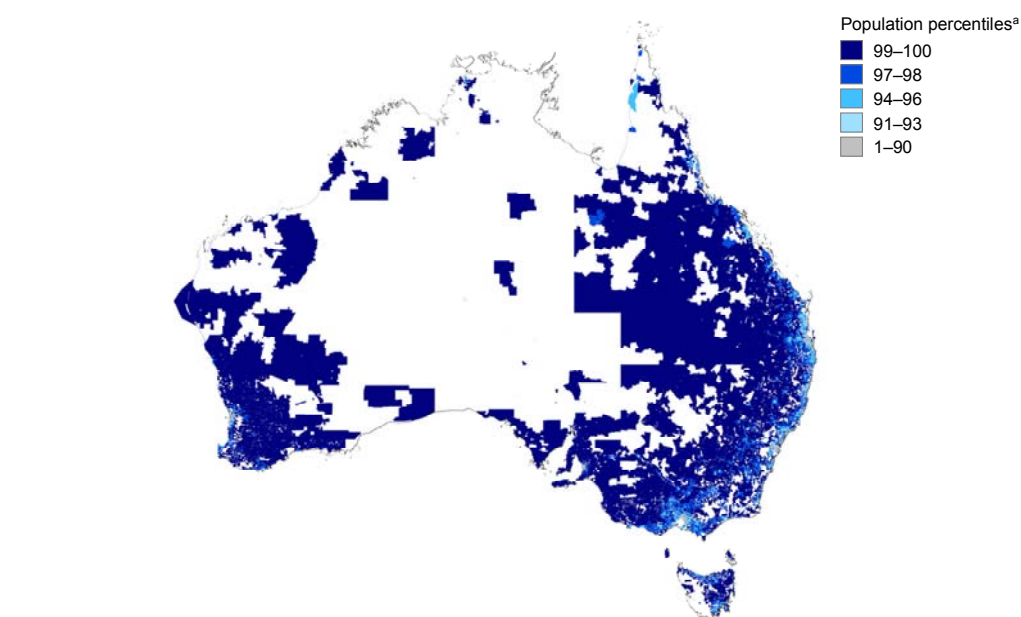
The importance of density means that to set the coverage objective for the NBN accurately, detailed geospatial data is required to calculate distances on a premises-by-premises basis, as is granular data about deployment techniques and costs by geo-type, to translate these distances into network deployment costs. The geospatial modelling undertaken by the Implementation Study maps all addresses and roads in Australia in order to design a plausible network to deliver Government's policy, estimates costs of deployment and determines appropriate coverage objectives. These costs will be refined as deployment proceeds: the evolution of NBN Co's network will be informed by the

experience of on-the-ground implementation (including NBN Co's first release sites), and hence will not match our reference network model precisely. Nevertheless, within the constraints of pre-roll-out analysis the modelling undertaken by the Implementation Study provides as accurate an estimate of deployment costs as is practical to develop, and should be used for setting upfront coverage objectives that can then be revised over time.

Most Australians live in relatively dense areas. Only around 9 percent of Australia is inhabited, and 90 percent of the population occupies just 0.2 percent of the land mass, as shown in Exhibit 1–1. This leaves 10 percent of premises distributed across 98 percent of the populated land mass, with significant variability in density within this final 10 percent.

As well as truly-remote premises, the final 10 percent includes premises in rural towns, at the edges of regional towns and urban fringes. This is illustrated in Exhibit 1–2 which shows the extent of the proposed fibre coverage to 93 percent of premises on the urban fringes of a metropolitan city. As the exhibit demonstrates, many premises near metro areas will fall outside the economically-feasible fibre footprint, and the boundary between the fibre and non-fibre areas will be complex.

Exhibit 1–1. Coverage area for final 10 percent



a. Population percentiles defined by cost of fibre deployment (1 = lowest cost)

SOURCE: Implementation Study

Exhibit 1–2. Example of potential boundary between fibre and non-fibre areas



SOURCE: Implementation Study

Today, an estimated 92 percent of premises have access to broadband via a digital subscriber line (DSL) connection over a dedicated copper pair, including the estimated 20 percent who also have access to high-speed broadband over hybrid fibre coaxial (HFC) networks. Beyond this 92 percent, mobile data services are, in principle, available to 99 percent of the population according to reported coverage statistics. In reality however, service quality and experienced data rates can be poor, particularly if the user is indoors—and often well below advertised peak rates—unless in close proximity to a wireless tower and in an area with relatively few concurrent users.

In very remote areas it is not economical for service providers to install DSL equipment in small exchanges or for wireless operators to upgrade radios or increase tower density for a relatively small number of customers.

With the advent of 4th generation (4G) wireless technologies (both the LTE and WiMAX families), peak data rates and spectral efficiency (bits per Hertz) will improve substantially. However, guaranteeing peak data rates of at least 12 Mbps to comply with Government’s coverage objectives will require the number of premises served by any given tower to be capped at a significantly lower number than in today’s networks, which were designed for mobile voice. In addition, in a scenario where 2.3 GHz spectrum is used, premises would also need to fall within approximately 7 km of the nearest 4G wireless tower—even with the use of a fixed, professionally-installed external antenna.

In the least densely populated parts of Australia, the only economically-feasible way to deliver broadband is via satellite. Fortunately, next-generation Ka-band satellites will

have vastly improved throughput rates compared with today's Ku-band satellites, and will enable substantial increases in broadband speeds at lower prices.

The technology characteristics of wireless and satellite, in combination with the highly fragmented location of the final 10 percent of premises, have important implications for the NBN. They mean that a wireless network covering the 94th to 97th percentile, as recommended by the Implementation Study, would need to cover most populated parts of Australia, and a satellite service would need to be configured to cover effectively the whole of Australia's land mass.

1.1.2 SET COVERAGE OBJECTIVES BASED ON EXPECTED COST PER PREMISES AND A PREFERENCE FOR SUPERIOR TECHNOLOGIES

Government has selected fibre as the preferred access network technology to meet Australia's future telecommunications needs. As a physical medium, fibre can far exceed Government's stated objective of 100 Mbps—already, single fibres can carry 1,000 times this traffic. Fibre is widely accepted as the optimal medium for data transmission, and with a lifespan of 40 years or more, is clearly the preferred technology for future-proofing a network. The Implementation Study recommends that Government set NBN Co an objective to deploy fibre to 93 percent of premises by the end of the 8-year network roll-out, rather than the 90 percent objective of the original policy statement.

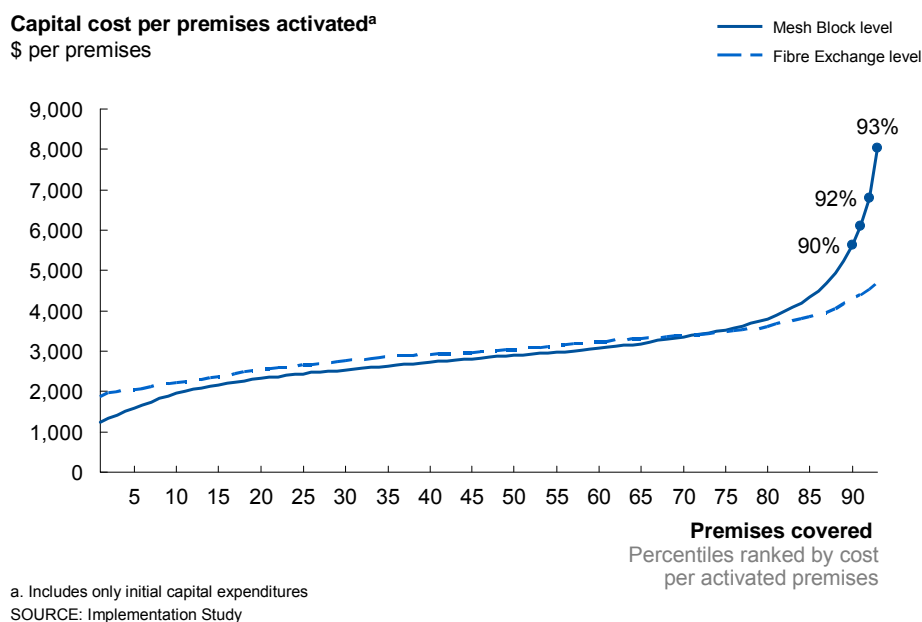
Over time, we expect that Government would aspire to extend fibre even further, however, we recommend that 93 percent be the objective for the initial network build for three reasons.

First, the cost of deploying fibre to 93 percent is not prohibitive. Our geospatial modelling shows—as expected—that the cost to deploy fibre rises as the distance between premises increases. As shown in Exhibit 1–3, the rate of increase begins to accelerate starting at around the 80th percentile, then starts to rise more sharply as it nears the 90th percentile at which point it is 1.9 times more expensive per premises to deploy fibre than at the 50th percentile. By the 93rd percentile, it costs 2.8 times the 50th percentile cost.

This cost curve is obtained by analysing the cost to deploy fibre in incremental units of aggregation—ABS Mesh Blocks—each of which account for an average of 30 premises. In a practical network roll-out however, the decision of whether to expand the fibre footprint incrementally would be made on an exchange-by-exchange basis.

Since exchanges aggregate many more premises than mesh blocks, this means that premises at the 93rd percentile would be aggregated with premises at lower points on the cost curve to form exchange groupings. This means that the sharp increase as the curve

Exhibit 1–3. FTTP cost curve (93 percent coverage)

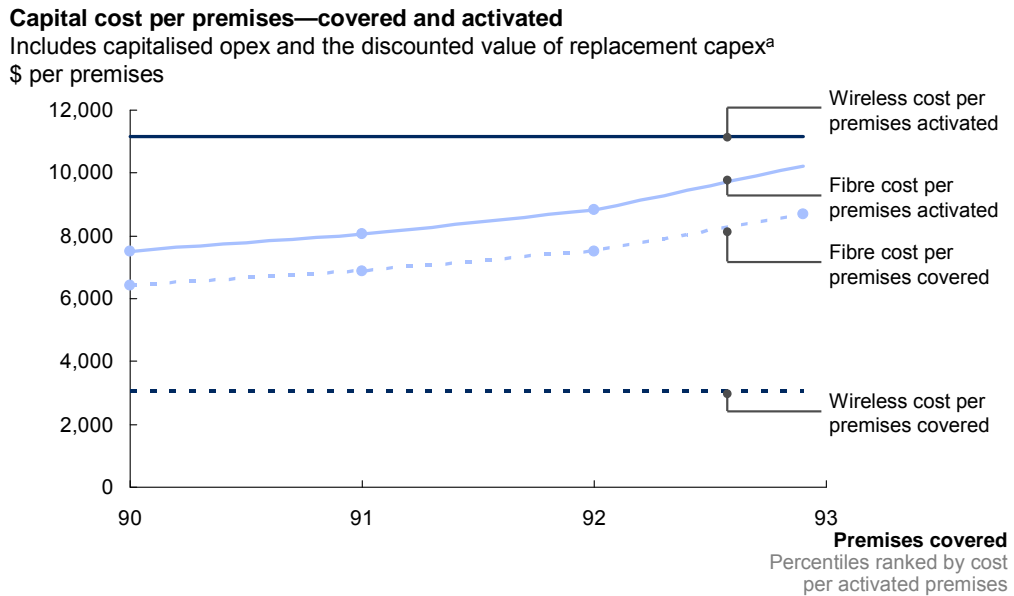


approaches the 93rd percentile is smoothed when represented as the average cost per premises by fibre exchange as shown by the dashed line on Exhibit 1–3. While the total cost (represented by the areas under the curves) remains the same, the additional incremental cost per premises to push fibre beyond 90 percent to 93 percent, is more modest when considered in these terms.

Second, stopping at 90 percent would mean fewer premises would receive fibre than currently can receive DSL broadband connections. Most premises out to 93 percent have access to DSL today, which is likely to provide a superior service to wireless or satellite solutions due to low latency and fast data rates.

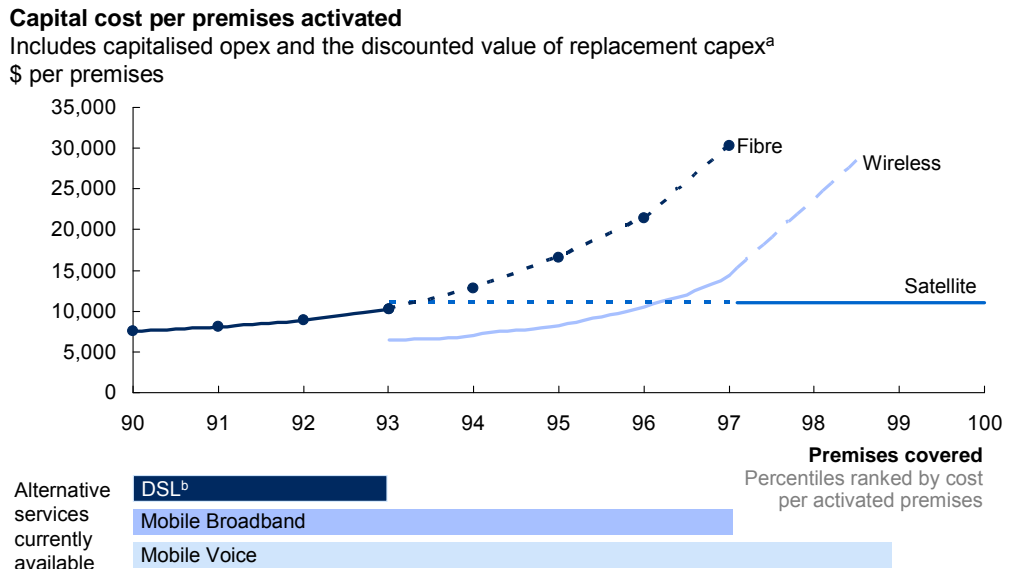
Third, the cost per premises *activated* for an NBN fixed-wireless service is potentially higher than for fibre in the 90th to 93rd percentile range. While the cost of *covering* a premises in this range is much cheaper with wireless, applying a realistic take-up rate to a fixed-wireless service in competition with both established mobile broadband and DSL services raises the average cost per premises *activated* substantially, as shown in Exhibit 1–4. Even if the take-up rates for a fixed-wireless solution were higher and average costs proportionally lower (e.g. if the copper network was deactivated so that DSL was no longer an alternative), the Implementation Study considers that Government should be willing to pay a premium to extend the fibre footprint further given its superior performance.

Exhibit 1–4. Cost comparison of alternative technologies from 90–93 percent



a. Network specific operating expenditure (including maintenance, leases and power) capitalised at 9% discount rate; replacement capital expenditure modelled based on useful life of active and passive infrastructure and discounted at 9%
SOURCE: Implementation Study

Exhibit 1–5. Cost comparison of alternative technologies in the final 10 percent



a. Network specific operating expenditure (including maintenance, leases and power) capitalised at 9% discount rate; replacement capital expenditure modelled based on useful life of active and passive infrastructure and discounted at 9%
b. Fixed-line broadband currently covers 92% of premises. Future greenfields adjacent to the fibre access network mean the percentage of premises with access to fixed-line broadband is expected to rise to ~93% in 2018–19
SOURCE: Implementation Study

Extending the fibre footprint beyond the 93rd percentile becomes too expensive based on Implementation Study cost modelling applying current deployment techniques. By the 95th percentile for example, the cost accelerates to almost 5 times the 50th percentile cost.

Exhibit 1–5 shows a cost comparison of the proposed technology deployments across the final 10 percent of premises. This exhibit shows the cost per premises activated, where the fibre curve matches that shown in Exhibit 1–4. To the right of the fibre curve, the cost curve for the fixed-wireless solution begins at the 94th percentile. The trajectory of this curve is lower than that shown for fixed-wireless in Exhibit 1–4 since beyond the 93rd percentile DSL is not a viable alternative, so take-up of the fixed-wireless solution is expected to be higher.

Under any solution a satellite service is required since guaranteeing 12 Mbps data rates via a fixed-wireless solution becomes extremely expensive in the most remote areas, as each tower is shared by very few premises. As shown in Exhibit 1–5, the fixed-wireless solution becomes prohibitively expensive to deploy beyond approximately the 97th percentile.

Once a commitment is made to satellite, any practical solution will require at least two satellites for redundancy, given the possible (albeit unlikely) scenario of a catastrophic satellite failure followed by a 3-4 year design and launch cycle to restore service. While such a satellite service could be configured as the sole solution to deliver Government's objective of at least 12 Mbps peak data rates to all 7 percent of premises outside the fibre footprint, this would be a sub-optimal solution for those premises that could otherwise receive a fixed-wireless service.

The Implementation Study therefore recommends that NBN Co deploy two Ka-band satellites with the ability to cover the 7 percent of premises outside the fibre footprint and provisioned for up to 350,000 activated premises with sufficient throughput to enable a substantial increase in average data rates from today (e.g. an increase in average data rates by more than a factor of 20). This will result in a satellite service which is vastly superior to that possible on today's technology.

Even though a Ka-band satellite service will be able to deliver impressive data rates to end users, the use of geostationary satellites causes unavoidable latency in the signal, making real-time interactive services such as videoconferencing and video gaming impractical. This fact, combined with the 4-year delay before Ka-band satellite services could be in operation, leads the Implementation Study to recommend that fixed-wireless technologies be deployed beyond the fibre footprint out to 97 percent of premises.

While the satellite service would be the sole NBN solution offered beyond the 97th percentile, it should be offered to all premises outside the fibre footprint. While take-up in areas covered by fixed-wireless is likely to be low, offering satellite service will ensure coverage for premises in wireless blackspots. It will also fulfil Government's commitment to provide a wholesale-only service in all areas, given that the commercial

fixed-wireless provider is expected to offer both wholesale and retail services, as discussed in Chapter 5.

In the near-term, the performance of the existing Ku-satellite solution for remote areas could be improved by upgrading the satellite modems deployed in end-user premises to provide greater throughput. These modems should be capable of supporting both today's Ku-band services and a future Ka-band service. In addition, by requiring NBN Co to aggregate demand for today's Ku-band satellite capacity, savings in the cost of satellite bandwidth should be possible, allowing retailers to provision greater throughput to end users at equivalent prices.

1.1.3 EXPECT TOTAL CAPITAL EXPENDITURE TO BE WITHIN INITIAL ESTIMATE OF \$43 BILLION

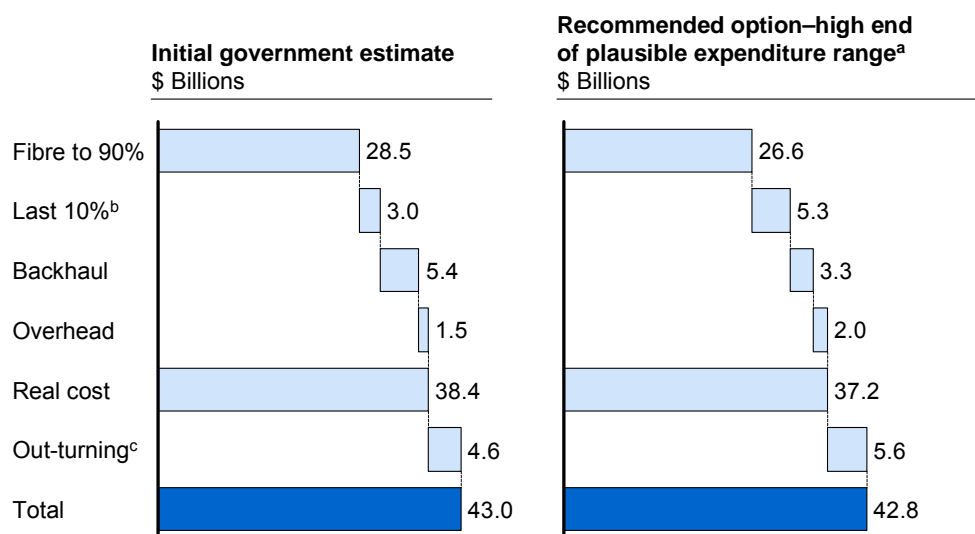
The recommended solution to deploy fibre to 93 percent, a fixed-wireless network to the next 4 percent, and satellites capable of serving all premises beyond the fibre footprint, is affordable within Government's initial cost estimate of \$43 billion. This cost estimate encompasses the capital expenditure to build the network and to activate services.

Exhibit 1–6 shows a comparison between Government's initial cost estimates and the estimates resulting from the detailed cost modelling conducted by the Implementation Study. The figures are shown as the total of actual expenditure incurred in real dollars, 'out-turning' adjustment (commonly applied in Government costings) which calculates the cumulative nominal total that would be reported at the end of the roll-out. The out-turning adjustment in the Implementation Study's analysis is higher than in Government's initial estimate due to differences in the timing of costs being incurred, based on the Implementation Study's granular analysis of expected network roll-out.

The costs shown in Exhibit 1–6 show the high end of the plausible range of costs modelled by the Implementation Study. Informed by the detailed geospatial model, the cost of the fibre access network to the first 90 percent of premises is slightly less than estimated by Government. By contrast, the last 10 percent solution is more expensive, primarily due to the recommendation to extend fibre to 93 percent of premises. A fixed-wireless solution for premises in the 91st to 93rd percentiles would be less expensive to deploy in total, but more expensive per premises activated due to low expected take-up, as illustrated in Exhibit 1–4.

Backhaul costs are projected to be lower than initially estimated, with shorter total distance required and a lower expected unit cost. Overheads are higher, and have been estimated conservatively in the Implementation Study model.

Exhibit 1–6. Estimated cost to build the NBN



a. Cost assumptions are for the 'High-end of the plausible range' scenario.
 Technology assumptions: 50% of the Fibre Access Network uses a Home Run topology; 50% uses a shared feeder with distributed splitter cabinets;
 Wireless network uses 2.3GHz spectrum and LTE technology; Satellite transitions to Ka Band.
 b. Fibre from 90 to 93% is included in last 10%.
 c. Conversion from real to nominal expenditure, using a nominal inflation rate of 2.5%
 SOURCE: Implementation Study

These costs reflect the assumption of a unilateral build—i.e. without assuming an agreement is reached with Telstra to share infrastructure such as ducts, pits, exchanges and unused backhaul fibres, as contemplated in the Terms of Engagement between Telstra and NBN Co announced on 18 December, 2009. Such an agreement could lower the overall cost. This approach also means that any consideration paid to Telstra for an agreement to use Telstra's infrastructure is implicitly included in the cost estimates—an agreement would only make commercial sense if it reduces NBN Co's total cost to build relative to not using Telstra's infrastructure.

If an agreement to migrate traffic onto the NBN is struck with Telstra or any other service provider (a 'migration agreement'), any consideration paid should be treated as an incentive payment netted against the revenue that is brought forward from early migration of the traffic concerned, and hence would not be relevant to an analysis of the \$43 billion capital expenditure estimate.

1.2 Deploy the NBN efficiently: set practical obligations, leverage existing infrastructure and provide legislative support to NBN Co

The nature of the physical NBN roll-out across millions of premises over 8 years will be highly repetitive, notwithstanding tailoring for local conditions. Decisions taken around the design of components or the techniques to lay fibre will be replicated across millions of sites around the country. Therefore, seemingly small decisions have a substantial impact on the business case. For example, a decision that would add or subtract \$100 to the cost of deploying to each premises scales to close to \$1 billion in additional costs or savings nationally. At the same time, in most cases, the NBN will represent long-lasting infrastructure so that potential short cuts or infrastructure-sharing agreements to save money need to be evaluated in this context.

1.2.1 SET CLEAR, TRANSPARENT AND PRAGMATIC COVERAGE REQUIREMENTS FOR THE NBN

By 2018, Australia will have approximately 12 million premises, growing from 10.7 million today. This forecast growth should form the basis of NBN Co's coverage objectives to ensure that open-access, wholesale services are available to all premises. In most cases, within the fibre footprint, this requires NBN Co to provide wholesale services directly. In the few places where fibre exists and retail competition is already vibrant, or where retailers can already obtain NBN-like speeds and prices on a wholesale basis over fibre, NBN Co should not be required to duplicate infrastructure.

For the purposes of practical implementation and to be consistent with industry terminology, Government's objectives around the provision of superfast broadband should be interpreted as coverage—rather than activation—objectives.

There are three steps in activating service to a premises. First, NBN Co lays fibre down the street. Next, the fibre is brought to the side of the building—this final cable run is known as the drop. Finally, the company (or a contractor on its behalf), installs an ONT (Optical Network Terminal), either on the side of, or inside, the building. Service can then be activated by a retailer once the ONT is live, by connecting a residential gateway to the ONT to allow computers, telephones, gaming consoles or other end-user devices to receive retail services.

The Implementation Study recommends that a premises should be considered 'covered' by the superfast broadband network if NBN Co is able to provide a wholesale service to that premises within a reasonable time (i.e. measured in days for metro areas) over a customer access network that enables retailers to deliver superfast broadband services to that premises. Premises should be considered to have been 'activated' once a service is

being delivered via a retailer. The Implementation Study uses the terms ‘covered’ and ‘activated’ with these specific meanings to avoid ambiguity.

Some commentators also use the term ‘connected’, which is ambiguous: for a new network it does not refer to actual service activation, and could be misinterpreted as NBN Co being required to extend the network to the actual premises prior to services being ordered. Installing the ONT upfront in this way implies purchasing and installing ONTs for premises that may not ever take a fibre service during the network build period. Moreover, this could force deployment of a more expensive ONT configuration with more external components due to lack of access to the home.

Modelling by the Implementation Study suggests these changes could add substantially to the initial deployment cost, and therefore should be avoided. There are some scenarios, for example under a potential migration agreement with Telstra, where—with the appropriate powers and immunities—NBN Co may decide to do more than pass the house at the time of first deployment. However, this should be left to management’s commercial judgment.

Similarly, in the satellite and fixed-wireless footprints, premises should be considered covered by the NBN when the wireless or satellite service is available at that location. No installation of wireless antennas or satellite dishes should be required until a service is ordered.

The roughly 1.3 million new premises to be built over the next 8 years will comprise 11 percent of the projected total premises in 2018. The majority of these new premises will be constructed within the eventual fibre footprint; hence NBN Co must plan to cover them in order for the coverage objective to be met by the end of the roll-out.

Government has proposed a requirement for all new developments to allow for fibre from 1 July 2010. The most practical way for this to be implemented is for NBN Co to provide fibre when it has fibre infrastructure sufficiently close to be able to deploy fibre to the new development economically. If NBN Co has not yet deployed close enough, then Government should encourage the most efficient transition path to those developments having fibre by the end of the roll-out. The preference for these areas should be to encourage fibre to be deployed, but in a way that makes integration with NBN Co’s network simple. This requires setting specifications for a fibre provider to comply with so that the network can be integrated as is or so that the underlying fibre can be used with NBN Co electronics. In some cases, it may not be practical for fibre to be deployed—either backhaul is not available or the estate is too small to attract a service provider. In such a case, the objective should be to ensure that costs for NBN Co to deploy fibre subsequently are minimised. This requires insisting that all new premises are built with duct, pit and pipe infrastructure that NBN Co can use to deploy fibre to each of the premises in the new development.

Another category of premises requiring special consideration is multi-dwelling units (MDUs). They represent a significant portion of the market—up to one third of Australian premises form part of an MDU. These include small residential units, mixed use 2- to 3-story premises on suburban main streets, and CBD towers. MDUs can present unique challenges for rolling out fibre infrastructure because installation typically requires access to common areas or areas owned by other parties. In addition, the cost and method of installation can vary substantially based on the age and layout of the building.

While Government's intent is to connect premises receiving a fixed-line connection with fibre, the body corporate at some MDUs may choose not to permit NBN Co sufficient access rights to install a fibre solution to individual premises. In these cases a compromise solution could be pursued in which NBN Co connects fibre to the basement and then re-uses the in-building copper wiring to deliver fast VDSL services to the individual premises.

This technology can deliver speeds of above 50 Mbps and in some cases, could be cost-efficient. However, this approach would forego a one-time opportunity to fibre up as much of the country as possible. Therefore, the Implementation Study recommends that bodies corporate be compelled to facilitate access to deploy fibre. VDSL should be considered as a fallback only if in a few years' time NBN Co finds access to a substantial number of MDUs has been frustrated.

Today, HFC networks owned by Telstra or Optus (primarily in Melbourne and Sydney) pass about one fifth of Australian premises. These networks comprise fibre cables as far as nodes located close to premises, with a 'last mile' connection via coaxial cable from the node to the premises.

With an upgrade to the network software (e.g. to DOCSIS 3.0), HFC networks may be capable of delivering speeds to meet Government's objective of 100 Mbps for downloads, although they would deliver much slower upload speeds. However, HFC has a less certain upgrade path than does a solution taking fibre all the way to the premises. In addition, not all premises within the HFC footprint are capable of being activated on the HFC network.

Having designated fibre as the access technology of choice and being able to meet its coverage goals within its capital expenditure estimate by deploying fibre, Government should set NBN Co an objective to cover at least 93 percent of premises with fibre, notwithstanding existing HFC connections. This will involve NBN Co overbuilding existing HFC networks and migrating traffic either through competition or commercial agreement. As long as NBN Co meets its fibre coverage objective over the specified 8-year window, in the near term, it should have the flexibility to acquire and upgrade the HFC networks and offer a wholesale open-access service over HFC if this is commercially attractive and proves technically feasible.

In addition to the premises where Australians live and work, there are a significant number of non-premises sites that are connected to telecommunications networks. Examples include traffic lights, mobile base stations, and remote telemetry services at dams. NBN Co should negotiate commercial terms to provide connections to service providers who want to deliver services to these sites, with prices set through competition with existing Telstra services or wireless alternatives.

One exception to this principle is mobile base stations, where NBN Co should be required to offer a commercially-priced service to a base station within a fibre exchange area, and should have the option to offer a commercially-priced service outside a fibre exchange area. Even though mobile broadband will compete with NBN Co's service across the fibre footprint, ensuring a thriving mobile industry will be a healthy check on NBN Co's monopoly power in the fibre access network and will be in the long-term interests of end users.

To ensure transparency, NBN Co should maintain a register that details its progress in making high-speed broadband available to all Australians. This should contain an up-to-date record of all premises, and keep track of premises covered by fibre and by satellite. It should detail where coverage has been frustrated by lack of MDU access or where NBN-compliant coverage was already provided by other parties. This register should be available via a publicly-accessible website with maps showing existing and planned coverage at a regional level, subject to privacy restrictions.

1.2.2 COMMIT TO BUILDING UNILATERALLY, BUT MAINTAIN WILLINGNESS TO SHARE INFRASTRUCTURE

The Implementation Study, consistent with Government's stated policy, assumes the intention to build the NBN unilaterally. Nevertheless, there is existing infrastructure that could be used to build the network more quickly and cheaply.

Most obviously, Telstra has an estimated 100,000 to 140,000 km of underground ducts that NBN Co could potentially use to deploy its fibre. Where there is room in those ducts (estimates range from 50 to 80 percent) it is a win-win for NBN Co to pay a reasonable charge to use them. This creates value for NBN Co as long as it is cheaper than the alternative of stringing aerial cable or digging its own trenches to install ducts; and value for Telstra given there are few alternative ways of earning money from these ducts.

Similarly for backhaul, Telstra likely has unused backhaul fibres in many places where NBN Co will need them. It would be costly for NBN Co to construct new backhaul where it is required for the NBN, but for Telstra the cost of providing access to its unused backhaul fibre is minimal. In a potential agreement, NBN Co might, for example, acquire indefeasible rights of use over sufficient fibres and install its own optical and electronic equipment to meet its capacity requirements over time.

For both ducts and backhaul, this provides incentives for both parties to obtain value from use of existing assets. This implies an agreement is likely over time, but given the value at stake and the long time period of the NBN roll-out, it may not be reached quickly. In the absence of an agreement, NBN Co should proceed to build both its access network and its backhaul unilaterally.

1.2.3 PROVIDE SUPPORT TO NBN CO TO BE ABLE TO DEPLOY EFFICIENTLY

Government can reduce the risk of cost over-runs by enhancing existing powers and immunities commensurate with the scale and aspiration of the NBN. Otherwise, costs are likely to increase due to potential delays in gaining planning approvals from the many relevant authorities and NBN Co not being able to choose the most efficient deployment technique by area.

These powers and immunities should ensure that the key components of the NBN deployment are deemed low-impact facilities and that access rights to ducts and power poles are available at reasonable cost. In addition, NBN Co will be able to make much more efficient build-versus-buy tradeoffs if it is able to obtain detailed information about existing network infrastructure. This requires legislative support.

The work to construct the NBN will employ thousands of people over an 8-year period. It has the potential to lead to the development of innovative fibre deployment techniques and innovations in the business models of NBN Co and its sub-contractors. At the same time, two workforce transitions must be managed during the implementation of the NBN. The first depends on the nature and timing of migration from Telstra's copper network to the NBN and the potential re-skilling and employment of the existing copper network workforce for fibre deployment (both employees of carriers and of contractor organisations, many of which will be small and medium enterprises). The second will be the transition of NBN Co from extensive construction-related activities to operating the network, with new deployment confined to new premises or extensions of the network beyond 93 percent.

To address these challenges it is important that NBN Co retains the independence and flexibility to pursue the approach that will lead to the most efficient network build.

1.2.4 LEVERAGE COMMERCIAL OPERATORS TO DEPLOY FIXED-WIRELESS SOLUTION

Wireless technologies have a substantial role to play in delivering broadband services to the final 10 percent of premises, and this role is likely to expand over time.

Unlike fibre, the wireless market has multiple existing infrastructure-based providers offering broad coverage. Currently however, the business case to provide wireless

broadband outside the fibre footprint at the guaranteed minimum speeds Government envisages is not viable for these operators. This is due to the high cost of backhaul, the need to install additional radio transmitters and towers and the lower overall revenue pool available relative to metropolitan areas.

To deliver a wireless solution that meets its coverage objectives, Government should run a public tender process for a provider to build and operate a fixed-wireless network to deliver at least 12 Mbps peak data rate broadband services to all premises within the designated coverage footprint. This network should cover 4 percent of premises beyond the fibre footprint (essentially the 94th to 97th percentiles), with the precise locations covered to be specified by the tenderer with reference to NBN Co's geospatial modelling to define the 93 percent coverage area.

This tender should be preceded by an EoI process to assess interest from the market and inform the detailed tender design, particularly in light of previous experience tendering for the provision of a fixed-wireless network. NBN Co should not participate in this tender process, but Government should ask NBN Co to provide an initial estimate of its costs to provide such a network. This will serve as a valuable reference point when evaluating the tenders received, and in the unlikely event of a lack of commercial interest, Government should reserve the right to instruct NBN Co to build the network.

While the emergence of acceptable commercial bids through such a tender process is not guaranteed, the Implementation Study believes it is likely as there are several participants in the market who have the necessary expertise and who would benefit from either monetising existing assets or protecting against loss of existing revenues. Further, current participants would be able to construct and operate the network at a significant discount to NBN Co by making use of existing assets (e.g. towers, backhaul and spectrum) and expertise (e.g. existing wireless network engineers and technicians).

Experience shows it is difficult to design a successful tender process for provision of fixed-wireless services. To maximise the likelihood of success, the tender should be designed with four features:

First, allow the tenderer(s) to identify the 4 percent of total premises they would cover beyond NBN Co's fibre footprint, using the same geospatial data set as NBN Co. Once the tender is concluded, NBN Co can configure its satellite to serve the remaining 3 percent. This approach permits maximum re-use of existing infrastructure and alignment with retail interests.

Second, define specifications of the 12 Mbps peak speed service offering in detail, including minimum average data rates and busy-hour usage assumptions for inclusion in the network design.

Third, build in flexibility for inevitable adjustments in coverage boundaries. As NBN Co deploys its network, it will not be exactly as modelled. The tender needs to contemplate

fibre being deployed to wireless areas, and also gaps in the fibre network where additional fixed-wireless services may be required.

Fourth, have NBN Co deploy additional transit backhaul to wireless tower locations where required by the successful tenderer. This will reduce the cost of building the wireless network and remove backhaul bottlenecks. This backhaul would be offered to other operators on an equivalent, open-access basis.

The successful tenderer(s) would be required to offer an open-access wholesale service as well as to offer retail services. In the unlikely event that no acceptable tender is received and NBN Co is instructed to build a wholesale-only, fixed-wireless network, retailer incentives may be required to guard against retail market failure—without them, retailers may simply not offer services given the geographic dispersion.

Where fixed external antennas must be provided to premises as part of the service, the type and cost of this customer premises equipment (CPE) should be specified as part of the tender. Spectrum is expected to be commercially available, but Government should be open to further action to free up suitable spectrum if required.

Affordability should be ensured by mandating inclusion of an entry-level offer with minimum performance (e.g. at least 4 Mbps peak speeds) and at a price that Government specifies in the tender. This price would be broadly consistent with entry-level pricing for fibre and satellite offerings. A mechanism for adjusting the price over time would also be required, and could take the form of a cap on the annual price increase permitted or an alternate mechanism regulated by the ACCC. The exact specifications of the entry-level offer would be proposed as part of the competitive bid submitted by each tenderer. In addition, the wholesale offer should be priced at a level that encourages entry by other retail providers.

Over time, Government should facilitate infrastructure-based competition in the wireless broadband market, by encouraging expansion of the footprint served adequately via mobile technologies. In particular, the upcoming availability of 700 MHz digital dividend spectrum affords an opportunity to improve mobile broadband coverage in regional and rural areas. As part of any auction of digital dividend spectrum, Government should require successful purchasers to deploy next-generation technologies in rural areas concurrently with metropolitan area upgrades. As today, wireless pricing is likely to be uniform nationally.

1.3 Improve retail competition by eliminating bottlenecks, operating at the lowest appropriate layer in the stack and through NBN Co's wholesale-only, open-access mandate

Broadband end users in Australia face very different retail offers depending on where they live. This is due to variability in the cost of access to Telstra's copper access network by geography, limited competition in HFC infrastructure, and whether there is competitive backhaul from exchanges.

In densely populated areas, competition is vigorous among Internet service providers (ISPs) who frequently have their own DSL equipment installed in Telstra's exchanges and use Telstra's Unconditioned Local Loop (ULL) or Line Sharing Service (LSS) services. These ISPs offer consumers attractive prices, speeds and download allowances. As a result, service providers other than Telstra now have over 60 percent share in many of these exchanges.

In other areas, ISPs resell Telstra's wholesale broadband or do not participate at all due to high regulated prices or no access to competitive backhaul. Telstra's retail market share in these exchanges remains high.

NBN Co can level the competitive playing field in three ways. First, it will deploy infrastructure where bottlenecks exist in access and backhaul. Second, it will operate on a wholesale-only, open-access basis with equivalent service for all access seekers (construed as the provision of like services on like terms to access seekers in like circumstances), removing the problems of vertical integration. Third, it will offer Layer 2 services over fibre and Layer 3 services elsewhere to strike a balance between lowering barriers to entry and preserving the ability of access seekers to differentiate their retail offers. These measures strike a balance between intervention and permitting markets to function where possible. However, each part of the market will need to be monitored to determine whether further interventions are required.

1.3.1 DEPLOY WHERE BOTTLENECKS EXIST IN ACCESS AND BACKHAUL

The NBN will enhance retail competition by creating alternatives to existing bottlenecks in the access network and in backhaul. The NBN will create new bottlenecks, but will be restricted to providing services on a wholesale-only, open-access, equivalent basis.

An access network is a network that links end-user premises to a point of aggregation such as a local exchange. Today, these links are mostly copper pairs extending from Telstra exchanges and mostly represent a Telstra monopoly. The NBN will transform

broadband data rates and resolve the copper bottleneck by replacing it with a superfast wholesale-only, open-access infrastructure.

Access networks are not the only infrastructure bottlenecks that constrain retail competition today. Beyond the access network, transmission links—backhaul—carry data between exchanges and hubs which tend to be in capital cities. Many of these already have fibre, but with the exception of links between capital cities, few are competitive.

If the access network is analogous to local roads, backhaul represents the arterial roads and highways. For many parts of the country, these backhaul links are only served by Telstra. While Telstra permits access to these links, this access is provided on a managed basis, as opposed to allowing access seekers direct access to the passive or ‘dark’ fibres, on which they can provide their own electronics. Further, access seekers have frequently struggled to make the economics work due to the cumbersome nature of the negotiate/arbitrate model of access regulation (amendments to which are before the Parliament) and the need to negotiate each backhaul link separately.

As a result of the lack of competitive backhaul, there are around 300 Telstra exchanges (serving a total of approximately 2 million premises) that are capable of supporting competitive DSL based on the number of customer premises they each serve, but in which no competitive DSL equipment has been installed.

In addition to building an access network, NBN Co must therefore enable access seekers to connect to this network at points where it is economic to do so—which in many regional areas will not be at the local exchange. This requires NBN Co either to build or acquire transit backhaul links to connect local exchanges to points where there is competitive backhaul, or where there is a reasonable incentive for the market to supply competitive backhaul.

As described in Section 1.2, NBN Co’s operations should be confined to those areas where the market has not delivered a competitive outcome on its own—this principle should also apply to NBN Co’s participation in backhaul. Commercial operators like Optus, Nextgen Networks, Pipe Networks and Telstra have created competitive backhaul markets on high-traffic routes. NBN Co should not overbuild these links for the purpose of creating a contiguous national network. In the absence of market failure, there is no commercial rationale for NBN Co to duplicate this investment, and duplication would be harmful to competition and industry investment incentives.

Restricting new backhaul to only non-competitive routes would require deploying approximately 60–70,000 kms of backhaul, including the approximately 6,000 kms as part of the Regional Backbone Blackspots Program.

For a non-contiguous NBN to serve the needs of access seekers adequately, Layer 3 wholesale access providers will need to emerge (as discussed in Section 1.3.3), and industry will need to adopt consistent protocols and service configurations to enable high QoS traffic (e.g. IPTV) to move readily across network boundaries. While this is

technically achievable, NBN Co will need to define its network interfaces thoughtfully and Government will need to monitor the development of the Layer 3 market.

1.3.2 DEFINE NBN CO'S MANDATE AS WHOLESALE-ONLY, OPEN-ACCESS WITH EQUIVALENCE

NBN Co's wholesale-only, open-access mandate is crucial to achieving Government's competition objectives. Vibrant competition is held back in telecommunications industries in many markets around the world by a monopoly wholesaler offering better wholesale services to its own retail arm than to the retail businesses of competitors.

Regulators frequently try to combat this incentive by imposing an equivalence obligation—that is, vertically-integrated companies are required to provide the same wholesale services, terms and prices to external customers as to their own retail arms. In practice, this has been difficult to enforce and expensive for operators to implement, given their business processes, IT systems and commercial frameworks are simply not designed to operate at arm's length between wholesale and retail.

By contrast, NBN Co will offer the same wholesale services to access on equivalent basis from Day 1 as it rolls out its network and brings across traffic from legacy networks.

Defining wholesale-only is simple in theory but complex in practice. For residential users, it is straightforward to restrict NBN Co from any direct relationship. The situation for sophisticated businesses is more complex. Consider an entity, such as a bank, that uses telecommunications services as an input to delivering banking services to end users. This could be classified as either a wholesale or a retail service depending on the strictness of the definition. The risk is that relaxing the wholesale definition in this or other similar ways could provide an opportunity for NBN Co to expand its scope beyond what was originally intended by Government.

The Implementation Study recommends a narrow starting definition for the wholesale-only restriction, but with practical flexibility. NBN Co should only be permitted to offer services to a carrier or service provider as defined by the Telecommunications Act, unless specific exceptions for classes of customer are made by the Minister. Of course, obtaining a carrier licence is not difficult, so an alternative for a sophisticated enterprise seeking a direct relationship with NBN Co would be to set up a wholly-owned carrier to serve its own needs. In practice, the impact of either a Ministerial exception or a business developing an in-house carrier capability in this way, is limited by the sophistication required from a customer to take a Layer 2 bitstream service. This problem would be more acute were NBN Co to offer Layer 3 services.

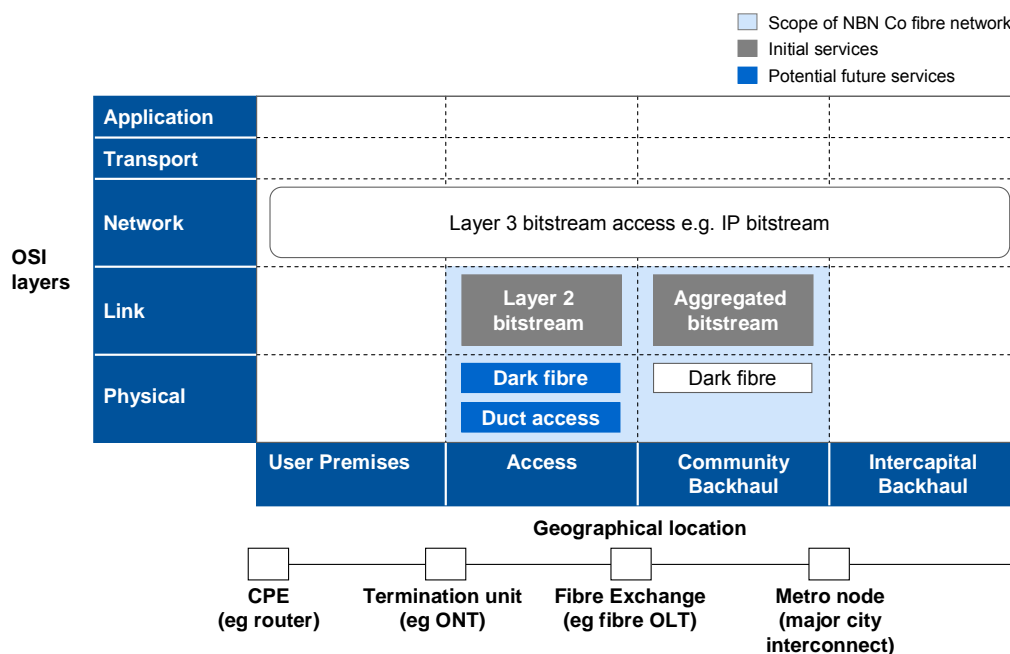
1.3.3 OFFER LAYER 2 SERVICES ON FIBRE, AND LAYER 3 ON WIRELESS AND SATELLITE

Initially, NBN Co should offer only a Layer 2 bitstream service on its fibre network. This means NBN Co will own active equipment in all fibre exchanges and at the customer premises served, to ‘light’ the fibre. However, retailers will also need to install some equipment to move data around the network and translate the Layer 2 bitstream service into meaningful end-user applications such as broadband Internet, voice and video. In terms of the analogy to today’s DSL environment, this level of service from NBN Co lies in between a ULL service and a resale service, lowering barriers to entry across the market, yet still providing scope for product innovation and differentiation. Exhibit 1–7 shows where NBN Co is expected to participate, both initially (the Link or Layer 2 level) and potentially over time with the fibre access network (e.g. providing dark fibre and duct access in the physical layer of the access network as described in Section 1.6.4).

For satellite, wholesale services should be delivered at Layer 3 to enable effective management of the access link. Similarly for wireless, the wholesale service should be at Layer 3 although Layer 2 tunnelling, may be investigated.

With NBN Co providing only a Layer 2 service, ISPs will need to negotiate commercial terms with backhaul owners to ensure national access. However, in doing so, they will have a choice on all routes given NBN Co’s commitment to provide transit services from local exchanges to a point of interconnect at which competitive backhaul is available.

Exhibit 1–7. Options for NBN products/services in stack layers and network locations



SOURCE: Implementation Study

Some service providers—for example, those who want to sell standalone applications such as in-home health monitoring solutions—may find negotiating terms with multiple backhaul providers and ensuring end-to-end quality of service guarantees too onerous. To cater to these types of applications, a Layer 3 wholesale market is likely to emerge, with existing telecom operators and system integrators expected to be interested to enter.

1.3.4 MONITOR HEALTH OF RETAIL COMPETITION TO DETERMINE WHETHER FURTHER INTERVENTIONS REQUIRED

The intervention of NBN Co in removing bottlenecks, being required to operate on an open-access and wholesale-only basis, and in offering Layer 2 services promises to level the retail playing field and hence improve the ability for service providers to compete. Nevertheless, Government needs to be aware of future adverse competition scenarios and monitor the health of retail competition to determine if further intervention is required.

There are five potentially adverse scenarios that the Implementation Study has identified. First, limiting NBN Co to offering backhaul only on monopoly links creates a risk of duopoly conduct on some of the remaining links. Second, smaller ISPs may remain structurally disadvantaged by peering arrangements that favour scale operators. Third, some stakeholders argue that NBN Co should go further than Layer 2 and also offer Layer 3 services—concerned that the Layer 3 wholesale market will not emerge, or if it does, it will take too long. Fourth, if bandwidth becomes commoditised and content becomes the basis for differentiation, concentration in content arrangements could entrench incumbent operators. Fifth, if the levelling of the playing field triggers intense, price-based competition without much differentiation in services, then incentives to invest in new services will be limited.

Each of these scenarios needs to be monitored and Government should be prepared to act to mitigate their impact. For example, the risk of backhaul duopolies stifling retail competition can be mitigated through ACCC action, and/or by NBN Co moving its POIs higher in the network to strand duopoly links.

For Layer 3, potential failure of the market is a legitimate concern, but the solution is not for NBN Co to ‘move up the stack’ and become more vertically integrated. To do so would pose risks to innovation and diminish prospects for competition at Layer 3. Commercial operators will enter the market if there is demand certainty, and Government can use its own needs for delivery of services such as e-health and e-education and its purchasing scale to stimulate entry into the Layer 3 market. In the unlikely event of persistent market failure Government can revisit the decision to preclude NBN Co from Layer 3 participation.

1.4 Expect the fibre network to become the predominant fixed-line telecommunications infrastructure by pricing for affordability and take-up and providing continuity for existing services

Over time, the Implementation Study expects the fibre network to become a mass-market essential service. Wireless networks will continue to be important, but as bandwidth-hungry applications and content become more prevalent, they are expected to become complementary to fibre, rather than a substitute.

If NBN Co prices for affordability and take-up and given the expected deterioration in the quality and economics of copper, NBN Co's fibre network is likely to emerge over time as the predominant fixed-line access network. This will require careful planning for the transition of legacy services and obligations that are technology-dependent.

1.4.1 EXPECT MASS-MARKET ADOPTION OF FIBRE-BASED SERVICES OVER TIME

Government should expect strong take-up of NBN services in the long-term if NBN Co sets prices to enable retailers to offer superior value to end users currently served by the copper network. Driving take-up should be the main priority for NBN Co over the coming decade.

The Australian broadband market has future growth potential above population growth. There are numerous countries with higher fixed-line broadband penetration, and current offers in Australia have dampened growth—services are slower, more expensive and subject to lower download caps than elsewhere. The NBN will unlock a new wave of fixed broadband growth by providing superior services.

Mobile broadband will continue to be popular, but will not replace fibre for most households in the long run. As end-user bandwidth demand continues to grow, fibre will become the fixed-line network of choice, and while some households will permanently abandon fixed-line broadband services, most will not. For these households, wireless will be viewed as complementary to, rather than a substitute for, fibre.

The growth of mobile broadband in Australia in recent years has been rapid. This rapid growth relative to fixed-line broadband can be attributed to several factors, including aggressive pricing, strong marketing, take-up by business users and today's typical web-use patterns. Experience in overseas markets and historical growth rates for bandwidth demand however, suggest that over time wireless broadband will not be able to keep pace with richer broadband applications. As rich content becomes mainstream, the

Implementation Study believes that fixed broadband over fibre is likely to emerge as a mass-market essential service.

The most immediate consumer application for high-speed IP networks in other markets is video, whether delivered as an IPTV service or ‘over the top’ (OTT) on a best efforts Internet connection (e.g. YouTube). Video can also be broadcast via an RF overlay employing a dedicated wavelength on the fibre—but this is not well-suited to an open-access platform given that current RF functionality only permits one provider per exchange area. Nor is it commercially compelling—the presence of satellite as a cheap alternative broadcast platform caps potential revenue to around \$2 per subscriber per month.

In other markets, such as the United States, a step-change in potential speeds on cable and phone networks has led to the development of ‘triple play’ offers where voice, broadband and video are bundled together by retailers. New offers and new business models will emerge for video in the Australian market, but these models may struggle to achieve mass-market adoption in the near term given the content arrangements in place with the free-to-air TV networks and with the PayTV operators. Given the current industry structure, Australians have not yet benefited from strong competition for triple plays. Therefore, Government should not assume that the Australian market will develop on a similar triple-play path as other markets without changes to media and content market structure and regulation. Detailed analysis of the nature of the changes that might be required is beyond the scope of the Implementation Study.

1.4.2 SET PRICES TO DRIVE AFFORDABILITY AND TAKE-UP, ACHIEVING COMMERCIAL VIABILITY OVER TIME

Wholesale prices for NBN services should be set to meet the goals of affordability and take-up. As a wholesale-only provider, NBN Co cannot set the retail prices that end users will ultimately pay. However, the wholesale price that NBN Co charges will be the largest input cost for a retailer. This price will therefore have a substantial influence on retail price levels.

NBN Co’s immediate priority should be take-up of services, which will require wholesale pricing that provides retailers with a better business case on fibre than they currently enjoy on copper, for a significant portion of their customer base. Over time, it is likely end users will see additional value in high data rates as more bandwidth-hungry applications and content become common. New services such as IPTV and innovative applications will also emerge. However, the timing and nature of these future services are uncertain, hence the Implementation Study has taken a conservative approach to innovation-driven take-up in the revenue modelling.

For some time, NBN Co will co-exist with legacy copper and HFC networks, either in competition, or during a transition period in which retailers are migrating their traffic onto the NBN.

NBN Co should set prices to deliver a superior offer to service providers compared with such legacy networks. Based on the Implementation Study's modelling, this implies pricing entry-level wholesale fibre services at between \$30 and \$40 per month—depending on the level of the competing copper ULL price—with uniform prices across the fibre access network.

Given the advantages that fibre has over copper in operating costs, set-up costs and expected churn, this will enable retailers to offer consumers much faster broadband speeds without increasing the prices they charge end users. Over time, end users will attribute greater value to fibre capabilities, particularly as rich services continue to become more prevalent. As this happens, NBN Co should be permitted to increase real prices gradually under ACCC supervision to earn a reasonable return on its assets over its lifetime—but must not be permitted to extract monopoly rents.

NBN Co should have wide discretion to set migration incentives to encourage take-up in the most efficient way. Different incentive levels will be appropriate in different situations based on variations in legacy service availability and plans, local competition, local demographics, the stage of roll-out and available applications and services. Without discretion in migration incentive levels, NBN Co would need to set prices uniformly to meet the cheapest current retail offers in the market—which would substantially harm its commerciality. Further, allowing flexibility in migration incentives should not be interpreted as a relaxation of the principles of equivalence and fair treatment of all service providers. These incentives should be disclosed transparently and subject to ACCC review to ensure consistency with NBN Co's broader equivalence obligations.

Transit services from remote fibre exchanges to points of interconnect with competitive backhaul should be priced to be consistent with Government's affordability objective. This requires capping the cost to a reasonable level relative to retail prices. Depending on the price charged and the cost of these links (which in turn depends on construction costs or the outcome of negotiations with Telstra), this may require a cross-subsidy within NBN Co.

Prices for NBN services should be set uniformly across the fibre footprint to deliver affordability across the country, with a price architecture that encourages take-up of high data rate services and usage. Setting a uniform price provides an implicit cross-subsidy from lower-cost (denser) areas to higher-cost (less dense) areas. If the higher-cost areas have very substantially elevated costs, then the uniform price must be set high so there is sufficient cross-subsidy from the prices charged to lower-cost areas. This can result in a uniform price that is too high to drive take-up.

In actuality, the shape of the fibre deployment cost curve shown in Exhibit 1–3 has a relatively gradual slope, with fibre deployment costs equal to 1.9 times the 50th percentile costs at the 90th percentile, and 2.8 times by the 93rd percentile using the Mesh Block methodology. The more realistic exchange-level aggregation shows a less pronounced difference. As a result, the magnitude of the cross-subsidy required is manageable, and a uniform price can be set at a level that is expected to attract retailers to migrate their traffic from the copper network.

Prices should be differentiated by service features and tailored for end users—for example, by offering wholesale business services with faster fault rectification and superior committed data rates than for consumer services. Higher prices should also be charged for higher data rates, but with an entry-level offer of at least 20 Mbps. A unique feature of the Australian market is that broadband plans typically offer limited, or ‘capped’ usage. While usage caps are increasing—that is, usage is getting cheaper—with retail competition, retailers will continue to charge for usage where they can. For NBN Co, usage patterns have limited impact on cost in the fibre access network (except in driving active equipment cost on transit backhaul links) and the actual usage for a given premises could prove difficult to measure. Thus while some usage-based pricing by NBN Co could improve its commerciality, Government should encourage NBN Co to keep wholesale usage charges to a minimum.

Finally, uniformity of wholesale access pricing should apply only within access technology platforms and not universally across fibre, wireless and satellite. The capabilities of these platforms are too different for any uniformity across platform to be practical. Nevertheless, prices for wireless and satellite services should be set so that entry-level wholesale services are similarly priced to entry-level services on fibre, although they need not be identical.

Within the wireless and satellite footprints, just as NBN Co will pay for the ONT for fibre services, allowance for the cost of expensive CPE has been made to provide incentives for retailers to offer service. The details of providing the CPE should be designed in consultation with NBN Co in the case of satellite and the successful tenderer(s) in the case of fixed-wireless, and should be linked to a requirement to provide services at appropriate peak and average data rates to guarantee service quality.

1.4.3 CONTINUE WITH UNILATERAL BUILD TO FACILITATE MIGRATION

NBN Co should price to offer a compelling proposition to existing retail service providers, Telstra included. Under the Terms of Engagement announced by Telstra and NBN Co on 18 December, 2009, NBN Co and Telstra are negotiating a potential agreement for migrating traffic and/or deactivating the copper network. An agreement between NBN Co and Telstra to migrate traffic would allow an orderly migration of customers and an efficient transition to the new national fibre platform. However, such an

agreement could also accelerate Telstra's revenue loss and so Telstra would likely seek compensation.

A key consideration in determining the level of compensation that is appropriate is to understand the likely outcome if there were to be no agreement. In this 'no-deal' scenario, Telstra's retail operation, if operating at arm's length from the copper network, would be expected to migrate much of its traffic to the NBN over time. Specifically, if NBN Co offers a wholesale fibre access service which is preferable to the wholesale copper service for some portion of customers (e.g. based on cost and operational complexity), all retailers—including Telstra's retail operation—would be expected to migrate those customers onto fibre. Further, the NBN fibre service will enable retailers operating on it to offer end users a variety of innovative offers, helping them win further share over time.

As more traffic migrates from copper to fibre over time, assuming some portion of the cost of supporting the copper access network is fixed, the cost of supporting the remaining customers on copper will increase. Faced with deteriorating copper economics (and deteriorating condition of the copper) over time, in any given exchange area, Telstra would face the task of stripping out costs or migrating the remaining traffic to fibre and shutting down the exchange. A decision to deactivate an exchange would need to be accompanied by sufficient notice to various end users and an agreed migration of network obligations that are attached to the copper network to NBN Co or an alternative network such as wireless.

Reaching a migration agreement with Telstra could be attractive to remove uncertainty for the industry. However, such an agreement would depend on reaching a common view of the likely level of take-up for fibre and the cost structure of the copper network. In practice, these are not simple issues to agree upon, especially given the potentially large amount of value at stake. A further complication is that as of the time of writing, Government's *Telecommunications Legislation Amendment (Competition and Consumer Safeguards) Bill 2009* is still under consideration by Parliament. Given this uncertainty, if Government's goal is to maximise the likelihood of its objectives for the NBN being met, the imperative for Government is to maintain its resolve to continue to proceed unilaterally.

1.4.4 MANAGE TRANSITION OF USO AND SUPPORT FOR LEGACY AND EMERGENCY SERVICES

Although detailed consideration of voice services is outside the scope of the Implementation Study, it will be important to address migration of voice services as part of the industry transition, particularly in non-fibre areas. In addition, if fibre becomes the universal fixed-line infrastructure, Government needs to plan carefully for if and how legacy services and obligations transition to fibre.

As the USO provider, Telstra faces the prospect of continuing to be obliged to provide standard telephone services. Within the fibre footprint, providing an analogue telephone emulation service on the ONT will facilitate this. In non-fibre areas, the issue is more complex, particularly given the relatively high cost of maintaining copper lines beyond densely-populated areas. If it retains the voice USO, Telstra will need to choose whether to continue to supply voice services by means of its copper network or by some other means, such as via wireless. Telstra has over 99 percent mobile voice coverage today, and with the advent of 4G technologies such as LTE, the quality and reach of its coverage is expected to improve further, to reach 70 km or more from a tower location. The large and increasing share of total voice usage captured by mobile telephones demonstrates that for many users wireless is already an acceptable substitute for fixed-line voice services.

Even with an expanded footprint enabled by 4G radios, a small number of premises will remain that cannot be served by a wireless network. Providing voice to these premises remains challenging for the industry. Telstra fulfils its USO obligation for many of these premises today with long copper loops, except for around 20,000 premises where fixed radio solutions are deployed, and an even smaller number where voice is delivered via satellite.

As the industry transitions to the NBN, either Telstra will retain its USO for these premises or Government will need to find an alternative USO bearer. In either case, a mix of technologies such as those described above will continue to need to be deployed for the foreseeable future.

Over time, the NBN is likely to become the only fixed-line infrastructure for the country, replacing the copper as Telstra deactivates it. Government must develop a plan to transition the services offered on, and regulatory obligations associated with, copper to a new industry structure underpinned by a wholesale-only NBN Co and national commercial wireless networks. Some services, most obviously broadband, will transition easily. Others, such as fax lines and conventional phone services, can relatively easily be delivered via emulation of an analogue telephone service over fibre. Some, such as payphones will not easily move onto fibre and sufficient notice will be required for application providers and end users to find alternatives or innovate to make the transition.

The copper network also plays a critical role in supporting emergency services that will need to be supported on the NBN to meet social policy imperatives. For example, non-cordless telephones are powered over the copper lines and hence can operate if the mains electricity to a premises is cut. To offer similar capability over the fibre network, NBN Co should design its ONT to provide end users with the option of a self-supplied, self-maintained battery backup to maintain telephone access in the event of a power failure. There are customers who will need assistance with maintaining the battery backup—principally designated priority assistance customers who qualify for lifeline services and currently receive special assistance from telecommunications providers. Government should pay to provide and maintain battery backup for these priority

assistance customers, and NBN Co should enable such features as required via contractual arrangements.

Finally, NBN Co should coordinate with Commonwealth security and law enforcement agencies to understand their requirements around providing support for emergency services, as well as to ensure the network design provides reliable and secure services with appropriate levels of redundancy and resilience. In particular, the copper network today has a capability to send the caller's number to 000 emergency services. For emergency calls, Telstra maintains an Integrated Public Number Database (IPND) that emergency service operators use, along with the calling number, to locate a fixed-line caller dialling 000. NBN Co should coordinate with law enforcement agencies to determine what capabilities are needed on the new NBN network to support similar functionality.

1.5 Fund NBN Co with Government equity and introduce investment-grade debt over time; expect to cover Government's cost of funds under most plausible business case scenarios

Under a range of plausible business case scenarios modelled by the Implementation Study, Government can expect to cover its cost of funds for the equity investment required in NBN Co to implement the NBN policy objectives.

Government policy is to establish NBN Co as a commercial entity, operating with commercial incentives and funded, to the extent possible, with private capital. This policy is achievable over the life of the NBN. Initially however, Government should fund NBN Co solely with Government equity until NBN Co can raise its own investment-grade debt and pay interest from its own earnings. This will allow Government to preserve policy flexibility and avoid diluting the returns it could earn over time.

NBN Co has been established as a wholly-owned Government Business Enterprise (GBE). Given its intention to operate commercially, it has been classified as a Public Non-financial Corporation (PNFC), and should be able to maintain this status based on current Australian Bureau of Statistics (ABS) guidelines.

1.5.1 ANTICIPATE PROJECT RETURNS TO EXCEED GOVERNMENT COST OF FUNDS UNDER REASONABLE ASSUMPTIONS

The projected internal rate of return (IRR) for NBN Co exceeds the Government bond rate of 6 percent based on reasonable assumptions for cost and revenue (Exhibit 1–8). In other words, project returns are sufficient to cover the cost of interest on the Government debt that would be raised to fund the equity investments in NBN Co. Once the network is built and the business is mature, NBN Co is expected to generate substantial free cash flows and margins, with an EBITDA margin in the vicinity of 75 percent.

Exhibit 1–8. Sensitivity analysis

| Revenue Scenarios ^a | Build cost scenarios | | | |
|---|-------------------------------|---|-----------------------------------|--|
| | Fibre deployment cost blowout | Build cost at higher end of plausible range | Reasonable infrastructure sharing | Build cost at lower end of plausible range |
| Higher demand • \$35 basic service | 5.0% | 6.7% | 7.5% | 8.3% |
| Mid-case demand • \$35 basic service | 4.5% | 6.3% | 7.0% | 7.9% |
| Mid-case demand • \$30 basic service | 4.2% | 6.1% | 6.8% | 7.7% |
| Lower demand • \$30 basic service | 3.6% | 5.6% | 6.3% | 7.2% |

■ Project IRR above Government borrowing rate
■ Project IRR below Government borrowing rate
 Theoretical corner case without changing plans

a. Fixed-line broadband penetration (ie the total of fibre, copper and HFC) ranges from 70% (Lower demand) to 80% (Mid-case demand) to 90% (Higher demand). Prices are entry-level prices at the start of roll-out. Real growth (including a glide path for the \$30 entry price scenario) is applied thereafter
 SOURCE: Implementation Study

These returns are achievable under a conservative set of assumptions, taking costs at the higher end of the plausible range calculated by the Implementation Study. This assumes a unilateral build and no productivity improvements in labour or deployment techniques.

Further upside exists depending on the nature of any agreement reached on sharing infrastructure. For revenue, a steady, but conservative, take-up of fibre services has been modelled based on analysing fibre deployments in international markets and previous technology transitions in Australia. Wholesale prices are assumed to be set based on competing with the economics of existing copper services to a retail service provider, whilst delivering the superior offers possible with fibre. Conservative assumptions have also been made about the price premium NBN Co will be able to extract for selling services at higher data rates than the entry level offer, and about the revenue from new services such as IPTV. While substantial innovation is expected as a result of the NBN, the Implementation Study's approach is to assume that NBN Co will not capture much additional revenue from these innovations.

In the most pessimistic scenario shown in Exhibit 1–8, costs increase and the market demand for fibre is much lower than expected, with pricing at the most conservative end of our range. However, deploying a large-scale fibre network is different to other large capital projects such as new mines, ports or plants. These assets tend to be one-off projects with complex interdependencies and can be challenging to stage. By contrast, the NBN roll-out is a highly incremental and repetitive project, albeit with local tailoring.

The work required to deploy fibre to a given premises, or to build a given wireless tower, is very similar as the roll-out progresses street by street and town by town. This repetition has real benefits for managing project costs, in comparison with one-off projects. There are significant opportunities to trial and improve deployment techniques to improve performance over time. In addition, a large number of civil work contractors and equipment vendors will want to participate in a project of this scale. This helps create competitive tension between suppliers to drive productivity improvements and bring costs down. Furthermore, the repetitive nature of the work is conducive to benchmarking contractor performance to improve price and performance over time and encourage innovative techniques.

Thus NBN Co has the ability to manage the risk of cost over-runs during roll-out. If costs blow out in early deployments, steps can be taken to find more efficient ways to deploy. If technical problems emerge, they can be addressed early in the process for the remainder of the roll-out. Outside the fibre footprint, deploying a satellite solution is quite different, with the financial impact of a failure at launch very difficult to mitigate other than through insurance contracts.

NBN Co and the Government can also take more fundamental steps to improve the returns over time if costs prove higher or take-up lower than expected. While each of these steps relax some element of Government's stated objectives, they are consistent with the overall objective of dramatically improving the speed and affordability of broadband services.

First, the roll-out schedule could be tailored to improve returns. The reference case models a uniform roll-out, where fibre is deployed uniformly to higher and lower density areas, and areas with different competitive environments—for example ranging from where there is competition from HFC, to exchanges housing multiple competitors' Digital Subscriber Line Access Multiplexers (DSLAMs), to those with no DSLAMs (and hence no DSL service). NBN Co could adapt this roll-out instead to focus first on areas where the rate of take-up will be greatest or where the cost of deployment is least.

Second, the roll-out could be slowed. If new broadband applications do not emerge rapidly enough to stimulate demand for superfast fixed-line services, the rapid rate of roll-out over 8 years could be slowed down. In reality, the number of FTTP trials and deployments being announced in other nations suggest that a host of innovative content and applications will emerge and that the demand for high-speed broadband will increase each year.

Third, Government could allow HFC and VDSL to be sufficient to meet the coverage objectives. If deployment were significantly delayed or over budget, then there is scope to alter some of the Government's policy settings to speed up roll-out or improve NBN Co's economics. These include using VDSL in apartment blocks and/or reusing HFC infrastructure as an interim solution beyond the 8-year roll-out timeline.

By contrast, take-up could be stronger and the cost estimates could prove to be more conservative than allowed for, for example, based on productivity improvements or a satisfactory agreement being reached with Telstra. Government could choose to accelerate roll-out, or reinvest the higher returns to take fibre beyond the 93 percent of premises recommended by the Implementation Study.

1.5.2 EXPECT LARGE CAPACITY FOR INVESTMENT-GRADE DEBT, BUT MAINTAIN FULL GOVERNMENT OWNERSHIP UNTIL AT LEAST AFTER ROLL-OUT COMPLETE

Government should fund NBN Co solely with Government equity until NBN Co can raise its own investment-grade debt and pay interest from its own earnings. Private equity should not be introduced at least until the network roll-out is complete. To do so any earlier would be too expensive, in terms of the returns required by investors, and would constrain Government's ability to establish the right policy and regulatory settings. It will also lead to a substantial distraction for management around the equity transactions concerned. This applies to both cash injections and any proposals to vend in assets in return for equity.

Private investors value certainty and demand high risk premiums to compensate for perceived uncertainty in an investment business case. In the case of the NBN, this is expected to translate into private sector investors demanding returns in the early phases of NBN Co's network roll-out in the vicinity of 15 to 25 percent—well above expected project returns. To accommodate such financing, Government would need to accept a lower return on its equity, while implicitly bearing most of the risk given its commitment to the success of the NBN.

Beyond its high cost, private sector equity has other drawbacks during roll-out, including the restrictions it places on Government's flexibility. The certainty demanded by private investors to lower their investment risk premiums would require Government to provide certainty upfront around the regulatory and policy safeguards it intends to implement—a requirement with which it would be difficult, if not impossible for Government to comply.

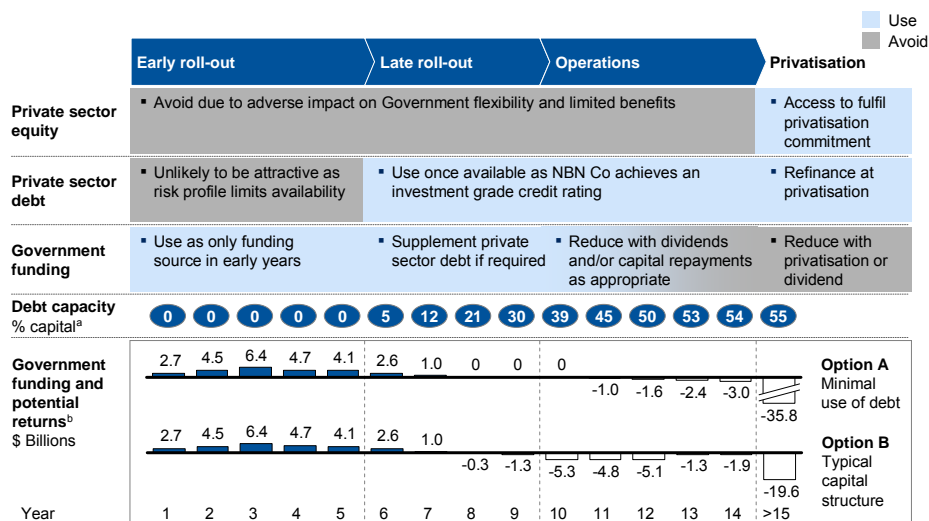
With the implementation of the NBN, the industry will go through a substantial and uncertain transition. Both Government and NBN Co need flexibility to adapt and learn through the various stages of the network roll-out, customer migration and delivery of new wholesale services. Similarly, the regulatory framework must expand from primarily addressing a vertically-integrated paradigm to embrace a wholesale-only paradigm as well. To attempt to design and lock in upfront the safeguards required against the potential downsides of a natural, national monopoly in private ownership would place at risk the success of the NBN by being restrictive and inflexible. More simply, the chances of getting all these settings right at the outset would be slim.

From a purely commercial standpoint, Government is the most natural owner of the risk versus return trade-off before NBN Co reaches steady-state operations. In its start-up phase, NBN Co faces uncertainty on multiple dimensions: competitive, technical, regulatory and political. Its financial profile requires large upfront investment with revenue generated over a 40+ year period. The Implementation Study’s detailed cost modelling and conservative revenue modelling shows that over this long asset life, returns are likely to exceed Government’s cost of funding. However, this requires government funding of the upfront capital costs until investment-grade debt can be raised.

Government must be prepared to adapt the amount and nature of funding for market conditions and project uncertainty. Policy preferences will also be important—for example, the impact on total government net debt and the willingness, or not, of Government to provide a guarantee to investors. Investment-grade commercial debt is likely to be available around 6 years into roll-out, when NBN Co is generating a positive EBITDA. Until that time, Government will need to invest up to \$26 billion as a temporary peak investment. After that, if NBN Co maximises investment-grade debt, it is likely to be able to gear up to 50 percent debt and pay out dividends and/or capital repayments to Government totalling around \$20 billion by Year 15.

The recent economic downturn and the effective closure of debt markets show how volatile capital markets can be. Debt spreads on BBB bonds are still around 300 bps at the time of writing, approximately 3-4 times their through-cycle average. If debt remains expensive, then the amount of commercial debt that NBN Co can sustain will be lower.

Exhibit 1–9. Recommended funding approach



a. Proportion of debt capacity to total capital (debt and equity)
 b. Privatisation occurs at year 15 based on DCF of future cash flows (equivalent to 7.7x EBITDA). Option A—debt maximised to meet funding requirement only. Option B—debt maximised to meet a debt to total capital ratio of 50% by year 15
 Note. Based on funding reference scenario
 SOURCE: Implementation Study

Furthermore, Government will face a sharper trade-off between preserving returns on its own equity and maximising commercial debt.

The timing and nature of a potential agreement with Telstra will influence Government's peak funding requirement. For example, if an agreement is structured with upfront cash payments for infrastructure and revenue rebates for migration, this will likely need to be funded entirely with Government equity. Alternatively, these payments could be spread over time as the infrastructure is used and traffic is migrated, thus reducing the short-term funding requirement. Any agreement that brings forward revenue will also bring forward EBITDA and therefore the ability to support commercial debt. Consequently, such an agreement, if structured with an upfront payment, could increase the peak funding requirement but make debt available earlier.

Although it is plausible that NBN Co could be ready for privatisation within 5 years from completion of roll-out (expected to take 8 years), this timing is aggressive. While it is not possible to anticipate the behaviour of capital markets so far into the future, it is possible there may not be enough regulatory or policy certainty within 5 years of roll-out completion to avoid a valuation discount. As 2008 and 2009 showed, the IPO market can effectively close at times. Therefore the timing of privatisation should be subject to market conditions and Government should preserve flexibility.

NBN Co could be attractive to a wide range of potential investors, but will be a large and complicated business to privatise. With an enterprise value of around \$40 billion expected in Year 15, it would be an ASX top 20 company and hence difficult to sell in one tranche. Specific elements of the business would be very attractive to different investor segments, but an integrated business of this expected size may not be easy to sell. This suggests considering the sale of the business in parts.

The passive elements of the business are likely to appeal to infrastructure investors as a typical regulated utility with stable cash flows, low capital expenditure and a long asset life. These characteristics are attractive to investors, such as superannuation funds, trying to match long-duration liabilities and are also conducive to taking on high levels of debt. However, many infrastructure funds prefer unlisted assets and have no mandate for listed assets. This suggests that Government will want the flexibility to privatise the passive assets separately in an unlisted vehicle. If listed, the passive assets would need to find a place in equity portfolio allocations but may lack the growth profile required to achieve an attractive valuation.

The active part of the business resembles a typical telecommunications business more closely, with greater risk and uncertainty. It could also have a much more compelling growth profile if separated from the regulated monopoly at the passive layer. As such, it would be more appealing to equity investors and potentially easier to privatise, for example via an Initial Public Offering (IPO).

As discussed in Section 1.6.5, backhaul is expected to remain a bottleneck asset that is difficult to regulate, and as such would be problematic in private hands. The Implementation Study recommends that Government have a bias not to privatise NBN Co's backhaul assets.

Government should preserve flexibility in both the timing and nature of privatisation to avoid diluting returns and to stay true to its coverage and competition policy objectives. Full privatisation 5 years after roll-out could dilute Government's returns over the life of the project, with returns sensitive to the size of the exit multiple and the timing of privatisation. Attractive earlier alternatives to privatisation may also emerge such as taking on higher levels of commercial debt to effectively reduce Government's equity investment through special dividends.

1.5.3 TAKE ACTION NOW TO SECURE FUNDING AND CLARIFY COMMITMENT

NBN Co requires certainty of funding to engage confidently with suppliers and customers. With a peak funding requirement substantially higher than currently set aside, clarity on funding availability is even more important. Government can provide this certainty with a formal funding agreement. This type of agreement has been used to fund major projects in the past and would suit the context of the NBN in several ways. It would enable Government to match funding to NBN Co's needs and performance and adapt it over time. In the longer-term it would also be positive for funding transparency.

1.6 Safeguard future competition and innovation through a network design that enables active-layer competition, and by requiring a healthy industry structure and appropriate regulatory regime prior to privatisation

While much of the focus of NBN Co management and Government—rightly—will be on ensuring the network is built and customers and services are transitioned, foresight is important given this is a once-in-a-generation opportunity to restructure the telecommunications industry in Australia.

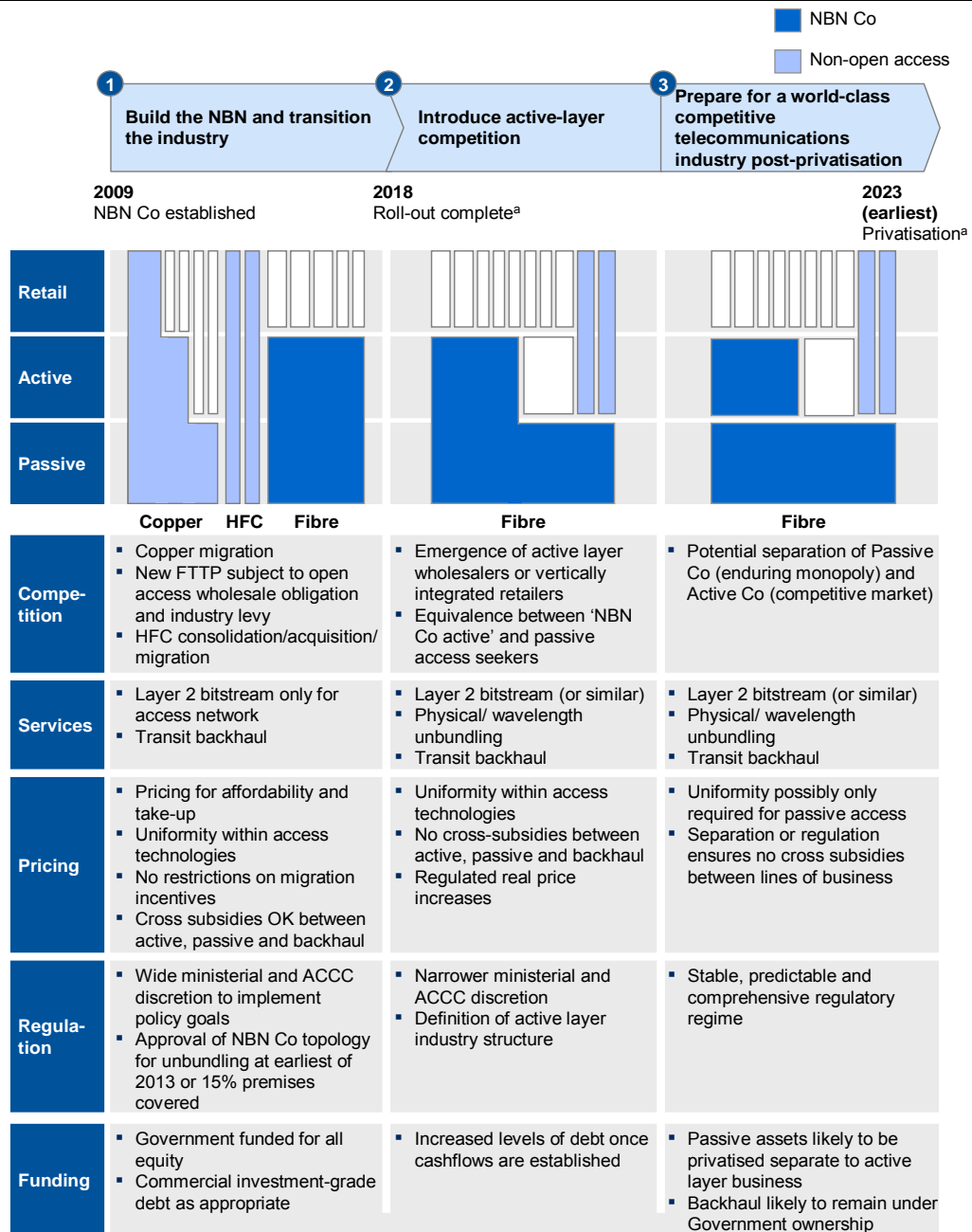
As NBN Co emerges with a new wholesale access infrastructure monopoly, Government must make privatisation conditional on a healthy industry structure outcome and ensure that decisions are not made today that are short-sighted relative to long-term competition goals.

In most developed markets, governments and regulators endeavour to create competition in telecommunications either through competing networks, or through competition on a single network between different owners of active equipment. This has also been the case in Australia historically. Wireless competition is strongest in areas where multiple operators have competing radio equipment—sometimes with shared passive infrastructure such as wireless towers. Similarly, broadband competition is strongest where ISPs (Internet Service Providers) have installed their own active DSLAMs (equipment installed in local exchanges to provide fast Internet over copper) in Telstra exchanges to use the underlying copper assets.

In building the NBN, Government will create a new monopoly passive access network for most of the country; moreover, through NBN Co being the sole provider of Layer 2 services, this will also create a monopoly at the active layer. This departs from the collective experience in most other markets, where competition has been encouraged at the active layer. While the danger of undesirable monopoly behaviour is mitigated to an extent by the requirement that NBN Co operate as a wholesale-only, open-access provider, as discussed in Section 9.4 significant risks will remain.

To ensure healthy competition in Australian telecommunications in the long term, NBN Co's monopoly at the active layer should be for a limited period only (e.g. 8–10 years), with the duration to be determined by the rate of industry transition to the NBN and to subsequent market stability. Exhibit 1–10 illustrates how this industry transition could unfold from a build phase during which NBN Co operates as a monopoly on the passive and active fibre infrastructure; through a phase in which active-layer competition is introduced; to a final phase of preparation for privatisation in which NBN Co might be structurally separated into Passive and Active elements.

Exhibit 1–10. Fixed-line industry structure evolution to fibre



a. Copper and HFC networks still likely to be in service
 Note: Layer 2 and layer 3 have been simplified here into 'Active' and 'Retail' layers
 SOURCE: Implementation Study

1.6.1 BUILD IN FLEXIBILITY FOR FUTURE GROWTH AND UPGRADES

The fibre access network will have at least a 40-year life. Approximately 70 percent of the construction cost of the access network is driven by civil works, with relatively low ongoing costs. Therefore, where NBN Co digs trenches or strings cables aerially, the decisions around how much fibre it deploys, and in what configuration, must be

considered carefully. In particular, they must anticipate the future evolution of the market and make sense not just for today, but for at least a generation.

Exhibit 1–11 provides an overview of the characteristics of the various elements of the fibre network to be deployed. While the active components have a lifecycle of roughly 3–7 years, with a dynamic upgrade path, the passive infrastructure has a very long life and large associated costs, hence decisions regarding passive-layer architectures must be considered particularly carefully.

In particular, when constructing the passive elements of the network, additional fibre should be laid and additional duct space provided to allow for future growth in premises. For example, in 1960, the Community Telephone Plan for Australia allowed for a population in 2010 of 33 million people. Similarly, NBN Co should provision for at least a 40-year fibre asset life and account for increasing population density and changes in end-user needs.

The network design should be consistent with Government’s decision to prefer fibre as the access technology of choice. Fibre offers almost unlimited future upgrade potential, so NBN Co should deploy the network in the most future-proof way possible, not limiting the upgrade paths that could emerge to those seen today.

Exhibit 1–11. Brief overview of network elements and principal characteristics

| Network layer | Description | Lifetime (years) | Principal characteristics |
|---------------------|---|------------------|---|
| Service (Layer 3+) | Retail services provided to end users (NBN does not specify, but must be cognisant of demand) | n/a | <ul style="list-style-type: none"> ■ Retail demand ■ Innovation of applications and services |
| Active (Layer 1/2) | Wholesale services offered to service providers | n/a | <ul style="list-style-type: none"> ■ Wholesale inputs required for service providers to meet end-user needs |
| | Active equipment installed on the network (OLT and FAN switch) | 7–10 | <ul style="list-style-type: none"> ■ Operational efficiency ■ Upgrade path ■ Cost |
| Passive (Layer 0/1) | Fibre topology | 20–50 | <ul style="list-style-type: none"> ■ Desired competitive outcomes ■ Network performance ■ Cost |
| | Physical deployment: Poles, ducts and trenches | 30–60 | <ul style="list-style-type: none"> ■ Open access ■ Security ■ Cost |

Source: Implementation Study

The most effective way to accomplish this is to deploy a single fibre per home, described as a ‘home-run’ topology. As discussed later, where possible a dedicated fibre for each home is also preferable for competition outcomes. This approach may not be affordable across the entire network, and on-the-ground deployment experience by NBN Co should be used to determine the exact cost of a home-run topology and hence the optimal mix of shared and home-run topologies to deploy.

The data rates delivered to end users over the access network will depend on the active components installed to ‘light’ the fibre. For mass-market services, Gigabit Passive Optical Network (GPON) technology is sufficient to meet Government’s 100 Mbps objective. GPON is an efficient technology in its use of exchange space and power consumption, and can be deployed over both shared and home-run fibre topologies.

For schools, hospitals and businesses however, Ethernet point-to-point (EP2P) technology offers a more appropriate range of speeds and symmetrical services. EP2P service can only be delivered over a dedicated fibre from the exchange to the premises—a home-run topology. NBN Co will need to estimate the demand for EP2P services and provision accordingly. For example, NBN Co should consider the likelihood of EP2P-enabled services being adopted by SMEs and some premium consumer end users in addition to enterprise users.

1.6.2 ACCEPT AN ENDURING MONOPOLY ON PASSIVE INFRASTRUCTURE

Government policy in building the NBN is likely to create an industry structure with no significant competition between fixed networks, since the existing copper and HFC networks are likely to be deactivated over time. The trade-off is that NBN Co will offer wholesale-only equivalent access to service providers. The rationale for this is that—given the high cost of laying the fibre, the long asset life, and the limited ability to differentiate—fibre has the characteristics of a natural, stable infrastructure monopoly analogous to an electricity grid or gas pipes.

NBN Co will be subject to various obligations on its network. It must provide coverage to all premises, not only the most profitable ones. It must price uniformly within access technologies, not discriminate by cost-to-build or ability-to-pay. It may not vertically integrate to capture retail margins. However, these obligations could put it at a disadvantage relative to other infrastructure owners if they are not required to compete on a level playing field. For example, a vertically-integrated company could ‘cherry pick’ the most attractive geographic areas and deploy its own network, reducing the overall economic viability of the NBN while delivering minimal competition benefits to the population taken as a whole.

Therefore, it is desirable that alternative high-speed fixed broadband networks are subject to the same open-access requirements as the NBN, with strict equivalence standards if

they are not wholesale-only. If they do not meet the requirements of an NBN-like network, then the premises covered will remain under NBN Co's coverage obligation and NBN Co will need to overbuild them. This would apply to new Greenfield networks, new fibre deployments to existing premises and any future FTTN roll-out.

1.6.3 ALLOW A TEMPORARY MONOPOLY AT THE ACTIVE LAYER

In addition to anticipating that NBN Co will create a Layer 1 fibre monopoly, it makes sense in the near term to allow NBN Co to create a monopoly in providing the electronic equipment to send information across the network (a Layer 2 bitstream service). This active layer monopoly is appropriate, in the near term, for four reasons.

First, allowing Layer 2 competition from the outset would be counter-productive for overall competition objectives. Once fibre is laid, only Telstra, and perhaps Optus, would have the scale to deploy active electronics widely and would be advantaged by their legacy customer bases. Although the roll-out will start at relatively small scale, the investment and risk of deploying electronics in any given area will still be significant, particularly if the operator is not confident of gaining a large market share.

Second, allowing multiple active layer wholesalers from day 1 would be inefficient and commercially difficult for both NBN Co or a private investor. Active electronics are still a significant percentage of the cost, and significant on a per-household basis—particularly if duplicated by multiple operators.

Third, an NBN Co integrated across Layer 1 and Layer 2 will be better able to manage the complexity of the build and migration task. Trying to co-ordinate across a wholesaler and a retailer to migrate traffic is challenging. Trying to co-ordinate a Layer 1 wholesaler, a separate Layer 2 wholesaler and a separate retailer, would simply not be practical in many instances.

Fourth, prices for passive services would need to be higher or non-uniform. The Layer 2 monopoly allows NBN Co to generate revenue from differentiated services and cross-subsidise the cost of Layer 1 during network roll-out. Open access to Layer 1 is likely to lead to active services offered close to marginal cost, with little scope for premiums for higher data rates.

While an active layer monopoly is appropriate in the short-term, Government should not permit Layer 2 services to be an enduring monopoly. This is because active layer economics are different to Layer 1, more innovation is possible, and effective regulation is difficult.

Costs per customer at Layer 2 are around one fifth of Layer 1, and the investments have a 5–7 year life rather than a 40+ year life. More importantly, Australian consumers and businesses will benefit from innovation through competition in active equipment where technology is improving and changing rapidly. While regulation is an appropriate

solution for Layer 1 given most of the investment is upfront and the infrastructure is similar to a classic utility, regulating Layer 2 effectively to achieve innovation will be difficult at best, given the complex technology choices involved.

1.6.4 TAKE STEPS TO PRESERVE OPTIONS FOR ACTIVE-LAYER COMPETITION

Government should require NBN Co to anticipate Layer 2 competition after the network roll-out is complete. There are two feasible ways for this active-layer competition to emerge. The first is through wavelength unbundling, which works by multiplexing several wavelengths down a single fibre with each wavelength allocated to a different competitor. That competitor can then specify the types of services it wants to provide to the end user.

The second approach is through providing access to dedicated unlit (dark) fibres, thus allowing competitors to install their own active equipment in the fibre exchange. This is called physical unbundling and is analogous to the successful DSL competition today over ULL. Physical unbundling allows greater service differentiation, as all active layer equipment is then subject to competition.

The availability of wavelength unbundling as a scalable commercial technology is not guaranteed. The underlying technology of wave-division multiplexing (WDM) is proven and is used on backhaul links. It is reasonable to expect that it will continue to evolve and be deployed in an access network. However, there are two caveats. First, as with any technology, there are uncertainties as to whether an alternative will emerge that is better and cheaper requiring infrastructure to be retrofitted to take advantage of it. Second, there is commercial uncertainty as to whether an ecosystem of customers, vendors, researchers and component suppliers will emerge to support wavelength unbundling specifically. The challenge with wavelength unbundling is that current GPON deployments around the world are typically incumbent-led, where those incumbents are not subject to obligations to unbundle. Incumbents will no doubt resist being unbundled as they did on copper, so the incentive for vendors to develop solutions that their largest customers may not want will be low.

Thus while the technology may work in the lab and on expensive backhaul links, without a broader ecosystem there may not be enough scale and economic viability to deploy it as an access technology. Nevertheless, to keep the option open for wavelength unbundling, NBN Co needs to anticipate physical space requirements for competing equipment at its fibre exchanges and the requirement for future upgrades to ONTs, but does not need to take further action until it deploys its next generation of optical equipment in 5–7 years.

Unlike wavelength unbundling, steps are required today to preserve the option for physical unbundling. For its early roll-out, NBN Co is planning to deploy a distributed point-to-multi-point topology. This means a single feeder fibre runs from the exchange to

a splitter in the field, where the signal is split to run on dedicated distribution fibres to individual premises. The shared nature of the feeder fibre makes physical unbundling on a premises-by-premises basis impractical unless additional fibres are provisioned in the feeder network and other design modifications are made.

The rationale for NBN Co's proposed topology is that it is typically more efficient to deploy than a home-run topology where a single dedicated fibre runs from the exchange to each premises (and which is suitable for physical unbundling). In particular, there may sometimes be enough space in existing ducts to run shared feeder fibres running out of an exchange, but not enough to run separate fibres for each premises. In addition, less space is needed in exchanges with a shared configuration than if every fibre runs to the exchange as with copper today.

However, these efficiency differences become marginal where new trenching is required or where there is plenty of space in ducts. Furthermore, some level of cost premium is justifiable given the value of preserving the option for technological uncertainty and physical unbundling for competition—but not where this premium is excessive.

Under any deployment scenario, NBN Co should expect to implement wavelength unbundling across its network. Ideally, NBN Co would go further and deploy its entire network in such a way as to preserve the option for physical unbundling. This is not likely to be practical however, as in some areas a home-run topology is likely to incur significant additional cost.

Until the network roll-out is underway and pre-roll-out estimates of deployment costs and duct availability and cost are refined by in-field experience, it is difficult for Government to mandate how much of the network should be designed to be physically unbundled. A pragmatic solution is for NBN Co to develop an efficient topology (such as home run) to permit physical unbundling after it has reasonable experience in deploying its fibre network. By the earliest of: the end of 2013; and the time fibre covers 15 percent of premises, NBN Co should develop a plan in consultation with the ACCC as to what the appropriate topology is to enable physical unbundling and the appropriate extent of its deployment, and secure Government's approval for the plan.

By this stage of network development, there will also be more experience to draw on from regulators in other markets such as the UK and Switzerland. Modelling conducted by the Implementation Study indicates Government should expect unbundling to be feasible for less than a 10 percent cost premium to the fibre access network costs where deployed. Further, Government should expect this to apply to a substantial proportion of the network (i.e. in the range of 30–60 percent of the network). Implementation Study modelling of capital expenditure assumes a home-run topology will be implemented across 50 percent of the fibre network, adding an average of 8 percent for those areas or 4 percent to the total fibre access network cost.

One consequence of anticipating unbundling to dark fibre or wavelength services is that NBN Co would be in a position to compete on a wholesale basis with its customers at Layer 2. To safeguard competition, NBN Co would need to offer equivalence of inputs. In other words, the same systems and processes used to serve itself would also be used to serve other access seekers and NBN Co would be required to deal at arm's length with its downstream business.

To avoid expensive rebuilding of IT systems and redesign of business processes, it may make commercial sense for NBN Co to anticipate some of the requirements of equivalence in today's product definitions as well as in its IT and business process architecture. This requires tradeoffs to be made, and should be left to the commercial judgment of NBN Co, subject to Government's endorsement as shareholder.

In any event, through either a Ministerial determination or declaration by the ACCC, NBN Co should expect to be required to offer dark fibre and/or wavelength services some time after network roll-out is complete. NBN Co would need reasonable lead time to be operationally ready from the decision to unbundle to the time it offers services.

1.6.5 ENSURE PRIVATISATION TIMING AND STRUCTURE SAFEGUARD COMPETITION

Government's intention to privatise NBN Co sets a high bar to ensure the market structure and regulatory framework are appropriate prior to privatisation. The unsuccessful series of negotiations between Government, the ACCC and Telstra around new broadband investments from 2004 to 2009 are a recent and vivid reminder of the difficulty of aligning incentives with a privately-owned monopoly infrastructure owner in the complex telecommunications industry. Implementation of the NBN provides a unique opportunity to get the structure of the market right.

Fears raised by some stakeholders around 'creating a new Telstra' by forming a new monopoly and then privatising it are overstated, given that NBN Co will be wholesale-only, but are not without foundation. More generally, given the high increasing returns to scale, capital intensity, technical complexity and pace of change in the telecommunications industry, regulators have struggled to achieve coverage and competition goals when dealing with commercial owners and managers. Commercial owners have a fiduciary duty to maximise shareholder value, including finding and exploiting loopholes in regulation. Around complex technology issues, regulators tend to be at an information and expertise disadvantage.

The underlying fibre asset is easier to regulate as most of the investment is upfront and no decisions are required about new technologies. It can be operated and regulated in much the same way as a traditional utility. Layer 2 is challenging, and barring substantial advances in regulation, should not be a monopoly if not in Government hands. Therefore, privatisation should be deferred until a competitive market exists, or is highly likely to

emerge, at Layer 2. In other words, until NBN Co has successfully implemented either wavelength unbundling or physical unbundling, Government should defer privatisation or only privatise the Layer 1 business.

In the lead-up to privatisation, Government should seek independent advice about the competition safeguards that need to be in place to privatise NBN Co, and what form that privatisation should take from a competition perspective. The independent advice could reasonably be that strict equivalence is insufficient to safeguard competition once NBN Co is in private hands, and that the Layer 1 business (the ducts, poles and physical fibre) should be privatised separately to the Layer 2 business (the active equipment that lights the fibre). However, telecommunications is a dynamic industry and committing to an inquiry by an independent agency such as the Productivity Commission prior to privatisation would avoid locking in a particular solution today.

The situation for backhaul assets is different—uncontested backhaul will remain a bottleneck asset that is very difficult to regulate. Volume will be constantly increasing thus requiring upgrades in active equipment to increase data throughput, without being able to raise prices sufficiently to achieve economic returns. Stand-alone commerciality of backhaul will always be challenging while ensuring affordability, so a commercial owner will rationally under-invest. Government should therefore have a bias not to privatise NBN Co's backhaul assets, although it could allow private operators (including a privatised NBN Co) to tender for their operations. The independent review into competition prior to privatisation should start with a rebuttable presumption to keep backhaul under public ownership.

Other safeguards are also required once NBN Co has private investors seeking to maximise returns. Through a strong regulatory regime, Government needs to safeguard against monopoly incentives to minimise reinvestment and to keep prices higher and volume lower than in a competitive market. A more aggressive NBN Co in private hands could seek to increase the scope of its operations by trying to move into Layer 3 services or serve end users directly by exploiting exceptions in the customer restrictions. Explicit restrictions will be essential, removing the flexibility that is appropriate under Government ownership.

Finally, customers must not be able to exert influence on NBN Co beyond what is commercially reasonable, so consistent with most precedents, customers should be restricted from owning more than 15 percent of NBN Co.

These privatisation safeguards should be set today in the NBN legislation. This will make it more difficult to undermine competition outcomes in the future by seeking to maximise privatisation proceeds—and therefore will be an important component in safeguarding the NBN's competition legacy.