Requirements for Leveraging NBN Infrastructure for Smart Grid Applications and Specifically Smart Metering

prepared by
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Intelligent Networking Working Group
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2 Executive Summary

- This paper has been produced by a working group of Smart Grid Australia (SGA), a peak industry body representing major utilities, equipment vendors and professional services organisations in Australia.
- This is the second paper produced by SGA for NBN Co and is intended, along with the previous paper, to provide NBN Co with industry insights and requirements that can help it design its network with industry and end-users in mind.
- This paper presents various requirements for the design and rollout of NBN infrastructure to make it suitable for energy utilities for smart metering and smart grid. The paper considers these utility requirements from the joint perspectives of end-user premises and non-premise locations.
- This paper argues that it makes sense for the NBN Co to anticipate and accommodate the needs of utilities in its rollout and services as there will be mutual benefits. Utilities can become anchor tenants of the NBN, such as for metering services at the home, and the NBN can provide for the utilities additional infrastructure necessary for smart grids at a fraction of the cost of building them independently and separately later.
- Three direct benefits from this symbiosis are identified: a boost to residential take-up of the NBN, lower installation and maintenance costs for the NBN ONT, and capital expenditure savings from shared network infrastructure.
- This paper puts particular focus on NBN fibre-to-the-home as a sensible way of providing connectivity for utility smart meters, and it explores some of the opportunities for NBN fibre infrastructure to provide connectivity to a range of highly distributed locations important for utilities, such as pole-top devices and utility facilities, such as zone substations that are vital to the power grid.
- This paper recommends that the NBN ONT be located on the household's exterior, proposes that it be co-located with the utility smart meter, discusses how they should be inter-connected and suggests that grid-side power supply to the ONT should be provided. Five configurations are considered for the ONT's installation and power.
- This paper also considers the characteristics of NBN services that utilities will need in different circumstances. The paper observes that while smart meter connectivity will have relatively modest requirements (e.g. peak load 1Mbps), and multi-casting to smart meters would also be useful, other services suitable to support utility communications needs will need to be assured, point-to-point circuits of the kind being considered by NBN Co to supplement its standard offering suitable for households.
- This paper identifies that there are also significant opportunities for the NBN network footprint to allow the inter-connection with utilities' networks in key locations. This will help make the NBN more readily attractive as a service for utilities, and it could provide a number of advantages for NBN Co.

- This paper recognises that NBN services will present a number of security considerations for utilities. It identifies several features, including service segregation, authentication, encryption and DoS, and it identifies where these are the domain of NBN Co or the utility that will be using an NBN service.
- This paper concludes by examining some applications that are likely to present some particular challenges, such as multi-unit dwellings, or some additional requirements, such as NBN services suitable for smart grids inside and outside the home or to connect utility facilities, such as zone sub-stations.

3 Introduction

This paper has been produced by the Smart Grid Australia (SGA) NBN Study Team, Intelligent Networking Working Group. SGA is a peak industry body representing major utilities, equipment vendors and professional services organisations in Australia.

The National Broadband Network (NBN) is a generational investment in Australia's communications infrastructure setting out to deploy Fibre-To-The-Premise (FTTP) to around 90% of Australian homes and wireless/satellite access for the balance. In parallel with this, industry and government are looking at ways to improve energy management using smart grids. The intersection of these two initiatives will produce significant synergies and opportunities.

This paper builds upon the previous paper produced by SGA titled "Key Considerations for the use of the NBN Infrastructure for Smart Grid Applications". This paper aims to provide a set of definitive requirements to leverage the NBN infrastructure for Smart Grid and predominately Smart Metering applications. The identification of synergies between the NBN and other applications could provide an opportunity to strengthen the business case for the NBN.

The paper aims to facilitate a dialogue between SGA and NBN Co to consider the accommodation of these requirements in NBN Co's plans.

Disclaimer:

This "*Requirements for Leveraging of NBN Infrastructure for Smart Grid Applications and Specifically Smart Metering"* paper represents a range of options from information supplied by the various Parties as outlined above but does not create a binding obligation or agreement between the Parties.

4 Scope

This paper presents a set of requirements for the NBN infrastructure and deployment plans to enable utilities to leverage the NBN for smart metering and some Smart Grid applications. Both NBN connectivity to end-user premises and non-premises are considered in this scope.

The requirements are grouped as follows:

- ONT deployment
- Wholesale Service Characteristics
- Security of Smart Grid traffic transiting shared infrastructure
- Smart Metering in various Multitenant Dwelling Units (MDU) environments
- Intelligent grid and non-premises deployment

The requirements relate to end−user premises and non-premise locations connected to the NBN FTTP access network. However, they may also apply to the wireless/satellite footprint subject to further investigation.

Advanced HAN solutions other than those considered in this paper, such as in−home appliance communications and more traditional broadband services such as Internet access are not considered within the scope of the requirements in this paper. That said, the requirements for the NBN Co wholesale service e.g. SLA are forward looking and cater for all conceivable uses that are appropriate and allow for conservative headroom to provide extensibility.

5 Synergies & Benefits

There are considerable opportunities to combine resources and deliver benefits to both NBN Co and Australian Utilities which should spur both organisations to actively partner.

Significant increase to NBN Take-up

Commercial success for NBN Co is dependant on a very high take-up by subscribers for a range of broadband and associated services. As the cost of "homes-passed" is shared across the "homes-connected", it is of fundamental importance that the vast majority of homes "passed" by the NBN are "connected" to the NBN.

By making it possible to use the NBN for remote meter reading, NBN Co will achieve connections approaching 100%. This represents one commercial use for which the NBN could be utilised, however, the deployment timing may preclude NBN from being the initial and primary solution for remote meter reading as utilities that require a solution prior to the availability of the NBN (eg. Victorians) may be required to install their own communication systems. However, the business case for NBN Co related to uptake of services, other than meter reading, would be facilitated if the majority of homes are connected.

It is important to note that if NBN Co becomes integrated into the control functions of an electricity meter then they become part of Critical Infrastructure which is subject to Attorney General Office Guidelines.

Reduced Costs to Connect

By arranging to share workforces, for example by having the same installer put in place the ONT power and cabinet, as well as the new electricity meter, it will be possible to realise considerable cost-savings for both organisations.

Shared Access for Assets

The availability of utility overhead powerline infrastructure provides an opportunity for the NBN to implement its network and maintain its route as a shared access and maintenance regime at the lowest cost. In return, the NBN offers the opportunity for utilities to gain access to robust smart grid communications services at a cost much lower than for a separate build. It is estimated that the cost saving from achieving this sharing arrangement could be over $2B for utilities (assuming an Australia wide smart meter rollout).

6 Reference Models

6.1 Smart Grid and NBN Reference Model

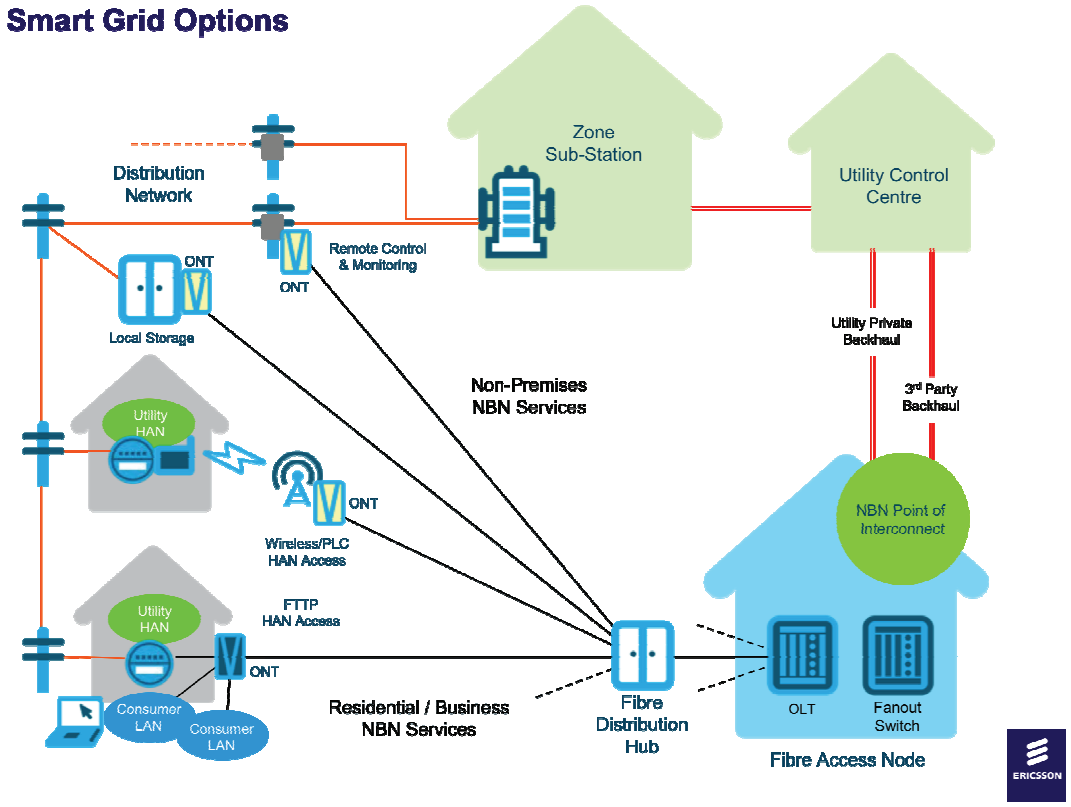

Figure 1: Smart Grid Reference Model

This diagram shows a range of ways in which the NBN could be used by utilities to support the realisation of a Smart Grid (i.e. meter-reading, monitoring and control of infrastructure and distributed generation).

NBN Co has identified its intention to build a fibre access network, based on GPON and P2P standards, to provide layer-2 (i.e. Ethernet) connectivity from a PoI (regional point of interconnect) to user premises or to locations that are not on users' premises (e.g. traffic lights, sensor locations, ..).

For meter reading the diagram shows the provision across the NBN of a layer-2 (Ethernet) path from PoI to the ONT on the users' premises. The option shown is an Ethernet cable connection between the ONT and Smart Meter, which is premised on smart meter vendors providing support for this type network connectivity.

NBN Co will not provide backhaul connectivity from the PoI to the Utilities network. Backhaul could be provided by third party backhaul operators, or where the utility has usable backhaul assets the utility may be able to provide their own backhaul.

The Ethernet connection to each meter is carried through a VLAN (a secure logical "tunnel") which is designed to provide security, and the agreed quality-of-service.

For utility subscribers who do not have an NBN connection, or perhaps as part of a transitional process, it will be possible to use the NBN to provide a path to wireless base stations for wireless connected meters.

NBN Co have committed to the support of such non-premises services.

This concept can then be extended to provide fibre connections to a whole range of utility infrastructure for Smart Grid applications, such as Transformer Temperature Monitoring, Remote Control of Power Switching, Monitoring and Dispatch of Local Storage, etc.

Similarly NBN Non-Premises connections could support connectivity to a wide range of Distributed Generation infrastructure (PV, Wind, Fuel-Cell, etc.).

The NBN infrastructure could also be used in some cases to provide an alternative (or backup) route to utility premises, increasing the overall robustness of the grid through increased diversity of communications. This may involve the use of P2P (point to point or dedicated fibre services) which NBN Co will provide for business services at 1Gbs or faster.

It is important to understand that ALL these uses of the NBN access network are assumed to require no more than conventional residential or business reliability and speeds. They do not replace the need for utilities to build and operate robust fibre transport between utility premises, but rather provide a complementary communications network to locations (e.g. street equipment, residential premises) which do not have utility connectivity today.

The success of an arrangement for a utility to leverage NBN services will depend upon either infrastructure sharing arrangements with the utility or be based on the NBN services having advantages over other telecommunications service providers such as Optus, Telstra etc, or purpose built utility solutions.

7 Requirements

7.1 ONT deployment

By utilising Electricity utility property access rights at residences, NBN may have an assured consistent deployment model with the facility of a secure power supply to the ONT. The NBN will have access privileges and consistent installation arrangements for servicing and maintenance of the ONT equipment in the future without the need to access the inside of the customer's home.

By providing communications services to electricity utilities for the reading and control of metering devices and demand management facilities NBN Co will have a mechanism to enter customer's premises and provide ready access for cost effective future customer connectivity to NBN. The electricity utility could then be the anchor customer for NBN services at the consumer's premises.

The provision of supply side power is important for utilities contemplating smart meter deployments because it enables the remote re-connection of power by communicating with the meter to enable a supply switch inside the meter. This is a regular activity carried out by utilities whenever customers move house, for example. The failure to provide this facility could present a regulatory obstacle for some utilities or result in the need for utilities to continue with manual connection services.

Supply of Electrical Power to ONT

The following highlight all of the possible options for the supply of electrical power to the ONT. Those options that are considered viable for Smart Metering applications are described. Further implications, such as with respect to the installation of the smart meter and the ONT are described in the following sections.

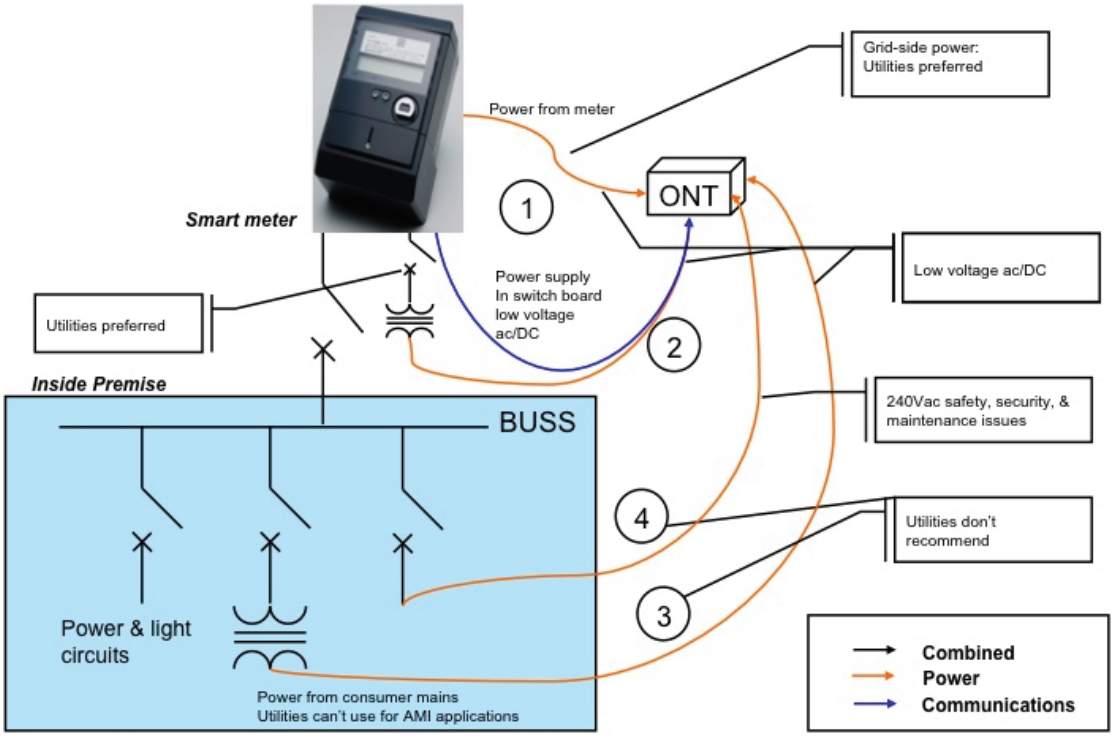

Figure 2: Supply of Electrical Power to ONT Options 1-4

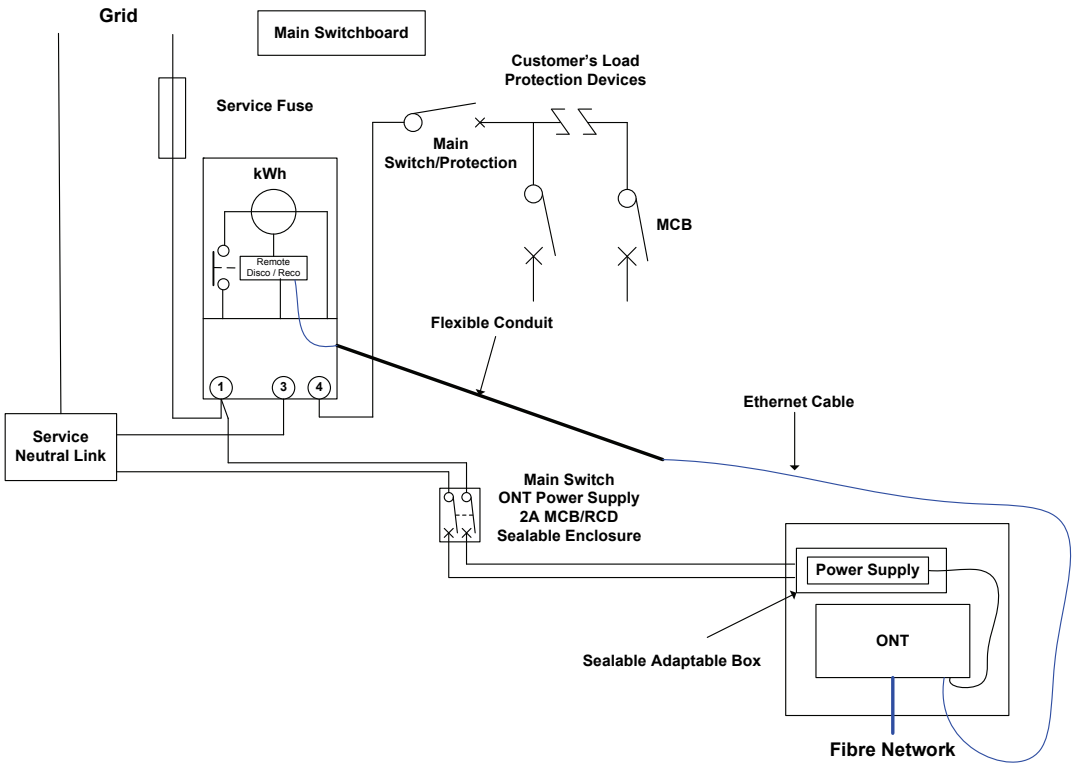

Figure 3: Supply of Electrical Power to ONT Option 5

Viable Options:

Option 1: ONT takes power from the electricity smart meter (Figure 2**)**

- Low voltage supply to ONT from smart meter
- Possibility for combined communications and power (cost and maintenance advantages)
- Custom cable
- Power over Ethernet (future)
- Configuration consistent with an integrated ONT/smart meter (future)

Option 2: ONT takes power directly from grid-side (Figure 2**)**

- Low voltage power to ONT via separate power supply
- Separate communications and power connections
- Suitable for non-smart meter installations
- Requires installation of a transformer to provide low voltage AC/DC power (similar to a doorbell transformer) which enables the NBN to connect the ONT without an electrician (once the transformer is installed).

Options 3 & 4 are discarded at this stage due to the inability to provide power from the grid side and hence enable a remote reconnection service for the utility.

Option 5: 240v AC from Supply Side, (Figure 3)

- The ONT enclosure is to be located next to the Electricity Meter Box. Alternatively a Combined Utilities Enclosure may be installed.

- The Power Supply cable for the ONT must be installed in accordance with NSW SIR & AS/NZS 3000. The maximum length of the 230V wiring for the ONT Power Supply shall be one metre.
- Warning Labels must be provided to indicate Customers Main Switch does not isolate the power supply to the ONT.
- Where more than 2 metres is to be connected to the Service Fuse a service active link shall be installed and sealed on the front of the switchboard for the connection of all the meters.
- Ethernet cable must be installed in accordance with AS/NZS 3000.
- Ethernet cable within the meter box must be enclosed in a flexible white conduit. Conduit must be attached to the meter panel at two extreme points. The Ethernet cable must be as short as practicable for both:
    - within the meter box and;
    - when it exits the enclosed conduit and terminates on the metre communications port.
- This option is suitable for non-smart meter installations.

For this option it is considered the responsibility of utilities to replace an ONT power supply upon failure which would be considered as a service supplied to NBN Co. This is due to the requirements for electrical safety certification of personnel to perform the replacement.

A variant of Option 5 is to recognise that the ONT and its power supply can be separated, such that the power supply is in the meter box and fed by 240V supply before the meter, and connected by a DC cable to a nearby outdoor ONT. This has the advantage that the un-metered 240V supply is kept short, and can be securely fixed to the power supply.

It is understood that for maintenance purposes the ability for the end-user to power the ONT off and on for diagnostic purposes is desirable. This could be provided by an appropriate button on the power supply, which would thus be accessible if the power supply was installed in the meter box. (A switch would not be suitable as it could leave the ONT powered off for long periods and thus stop meter-reading for long periods.)

Power Cable Options:

The following have been identified as options for the cabling required for power and data connectivity to the ONT in the aforementioned power supply scenarios.

(a) Separate and dedicated cables for power and data connectivity as per existing specifications – possible today

(b) Custom cable specification to provide power and data connectivity.
It is the preference of utilities to have involvement in the specification of this cable which provides power and data, to enable simplified installation. Cable specification will need to consider NBN Co requirements with respect to their choice of ONT. Meter design will also need to be considered to accommodate this option.

(c) Power over Ethernet
Smart meter specifications could be updated so that in the future they are able to

deliver Power over Ethernet (802.3af, 802.3at); anticipate this to be of interest to NBN Co and possible with future ONTs. Only 100-BaseTX will be possible in this case.

The cable connectors as related to the above power options are as follows:

- Option (1) Power socket that has yet to be defined
- Option (2) Power cable wired directly into circuit board
- Option (5) Standard GPO power connection

The data cable provided between the smart meter & ONT will conform to Cat 5/6 specifications and will utilise RJ45 connectors.

Acceptable ONT Power Requirements

- AC / DC for options (1) & (2) – preferred option
    - 5-10W range. In the case of Option 1 due to the practical limitation of the meter power supply
    - 12V (potentially 6V)
- Scenario (5) is AC @ 240V

Order of installation

The following provides an explanation of the implications that arise in each of the order of installation permutations.

- ONT & Smart Meter installed at the same time with fibre drop:
  This option is the clear preference of utilities and allows any of the 3 power options to be selected.
- ONT & Smart Meter installed at the same time without fibre drop:
  This option is based on the assumption that the field force deploying smart meters also installs the ONTs. This could facilitate the electrical certification of personnel installing power for the ONT. NBN Co could then install the fibre drop at an appropriate time during the NBN roll out schedule.
- Smart Meter installed first:
  All three powering options can be catered for with this scenario if an ONT enclosure is installed at the time of smart meter installation with power and data pre-wired for the ONT.
  Note: Scenario (2) as described above requires a new circuit breaker to be installed and secured.
- ONT installed first
  In this instance only scenario (2) for power is viable and a suitably qualified electrician is required to perform the installation.
  There will be minimal synergies will be gained from dual installation.
- Further options become possible if the ONT and the ONT Power Supply are installed by different installers and at different times. For example the Smart Meter and ONT Power Supply (with un-metered 240V supply) could be installed separately from the ONT (and fibre drop cable).

Metering / Charging of ONT power

The power supplied to the ONT would be treated as unitised / unmetered power from the utilities perspective. This would be catered for in the overarching commercial agreement.

Physical Location of ONT

Based on the requirement for the electrical powering of the ONT to remain active when the power to an individual property may be inactive, it is the view of utilities that an outdoor ONT must be deployed.

An outdoor ONT may be deployed either inside or outside of the meter box with the following observations and implications:

- Inside meter box
    - In the majority of cases the ONT will not fit in current meter boxes.
    - Where the ONT can fit inside, it is feasible for the ONT to be installed inside.
    - Where battery backup for an ONT is required, it is highly unlikely the ONT and battery will fit inside.
    - Where the ONT is installed inside the meter box, some form of separation between the smart meter and ONT is required. This is currently provided by a simple plastic divider.
- Outside meter box
    - It will be necessary for NBN Co to provide the ONT in an appropriate secure enclosure to avoid tampering
    - A secure conduit is required to connect the ONT to the smart meter and to enclose the power and data connections
- Back of meter board
    - There is an option for the ONT to be deployed on the back of the meter board in a certain percentage of the footprint.
    - A secure conduit is required to connect the ONT to smart meter to enclose the power and data connections.
    - This option enables the ONT to be deployed in close proximity to the smart meter to facilitate secure grid side powering and data connectivity in an efficient manner.
    - Access and maintenance requirements for the ONT would require disconnection of the smart meter during this period.

Connectivity from outside ONT to inside house

Utilities understand that NBN Co will have a requirement to present the UNI ports of an outdoor ONT somewhere inside the end-user premise.

If the ONT is not located close to the meter box, then apart from the loss of access to grid side power, the cabling costs for the utility are likely to make utilisation of the NBN infrastructure cost prohibitive. NBN may want to consider inserting a Zigbee or Powerline carrier solution (eg HomePlug) for communication between the ONT and the

meter, however, the utility powering requirement to enable remote re-connect would need to be resolved.

At the current time, there is no perceived aspects of utilities' smart meter installations which could be leveraged to provide this connectivity to the inside of the premise.

It should be noted that the utilities may provide connectivity to in-home displays (IHD) and other electrical appliances via an utility home area network through the electrical wiring or a wireless communication (eg. Zigbee in Victoria) into the premise dependent upon the metering solution that the utility installs.

Exceptions to the Above Requirements

Utilities consider that a certain minority of end-user premises will not be able to meet the aforementioned requirements. Primarily this will occur where grid side power cannot be provided to the ONT. For example in some multi-dwelling units (MDUs) or where the meter is not located inside a power distribution board or the location of the meter board is not suitable for an ONT installation.

As a result, consumer side powering is acceptable for a small number of premises. The implication for utilities is the inability to reconnect electrical power to end-user premises remotely through the NBN connection. The impact of this on utilities varies, with some subject to regulatory issues and some commercial implications.

7.2 Wholesale Service Characteristics

There are a number of areas of significant interest to utilities related to the NBN Co wholesale service. These are grouped into the following areas:

- NBN Co and utility relationship
- Wholesale service SLA
- NBN Co physical footprint and PoIs

NBN Co and Utility Relationship

It is the clear preference of utilities to be able to enter into a direct relationship with NBN Co to be able to achieve the synergistic benefits described at the beginning of this paper.

In effect, this means that utilities have the ability to inter-connect with NBN Co at the defined PoIs directly. There may be instances where a utility chooses to acquire a backhaul service from a 3rd party, however, this should not be mandated.

The relationship will facilitate the unmetered powering of ONTs and the potential leveraging of a combined field force for the roll-out of AMI and NBN.

Wholesale Service SLA

The SLA is required to ensure performance measures and accountabilities are taken into account for various areas including, but not limited to:

(1) NBN Co

(2) Electricity Utilities

(3) Third Party Services Providers

Where NBN Co or the Utilities have agreements for services and/or performance levels that are contracted or provided by a third party, both sides need to ensure that a back to back arrangement is feasible with a Contractor or Third Party Service Provider.

A general SLA which applies to all areas should cover;

- Fault response service levels and timeframes
- Notice and notification periods – Installations, network upgrades, outages, billing, etc
- Change and maintenance schedule reporting
- Emergency response and notification to an end-user device (national or state disasters {floods, bush fires, etc}, obligation under a disaster recovery event)
- Power supply
- Ownership, insurance and risk management
- Data protection and physical product security
- Consumer reporting, outline of responsibilities, stakeholder management
- Dispute resolution provisions
- Audit and OH&S
- Access, installation and accreditations
- Data/Bandwidth requirements and supply
- Possibility of power disruption due to ONT issues (also to be considered within the commercial arrangements)

Smart Metering / AMI

Specifically considering smart metering to residential and business end-users the following provides an indication of the utility requirements on the NBN Co wholesale service SLA.

Figure 4 depicts the utility Home Area Network (HAN). The diagram also provides an indicative list of devices that may be present on the utility HAN and that have been factored into the following requirements. The diagram shows the clear delineation from the utility HAN and the multiple consumer LANs, for which RSPs are responsible. An Energy Gateway is shown, this may be a component that is developed in the future for a particular use case, however, at the current time it has not been included in these requirements.

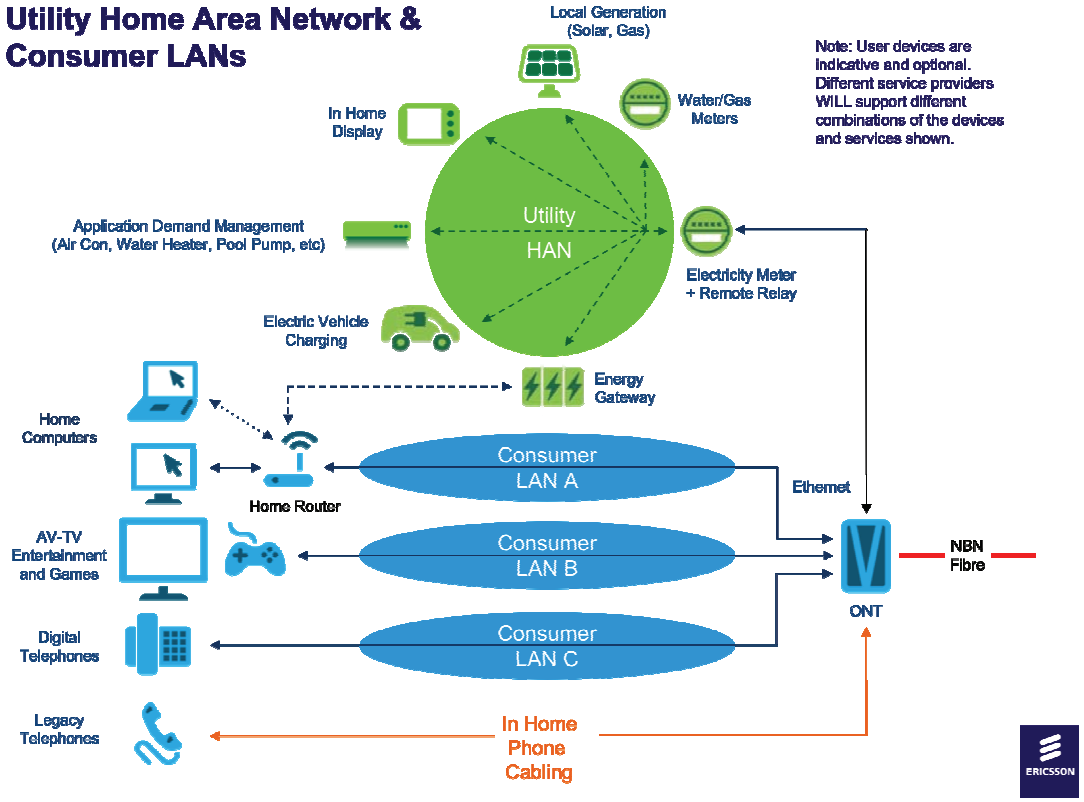

Figure 4: Relationship of Utility HAN and Consumer LANs

The requirements are based on the following applications running over the utility wholesale service:

- Meter reading (data generated at 15-30 min intervals)
- Demand management
    - Direct load control of any energy hungry household appliance
    - Direct load control for A/C compressors (as indicated by the thermostat icon)
    - Direct load control for pool pumps
    - Compressors / water etc
    - Electric Vehicles (EV)
    - Distributed generation (Photovoltaic (PV), Wind, etc)
    - Energy storage solutions
- In home displays
- Feed in Tariff (FIT) Generation
- Smart Meter software/firmware updates (images up to 20MB), multicast use case (further details below)

Based on the applications, utilities envisage that the following SLA characteristics will be sufficient:

- Committed Information Rate (CIR): 10 Kbps

- Peak Information Rate (PIR): 1 Mbps
    - This PIR has been chosen to allow future proofing of unforeseeable applications

With respect to reliability of the NBN Co wholesale service, it is expected that many of these applications will not require availability requirements more stringent than any other RSP that utilises the NBN. That said utilities would like to discuss with NBN Co the projected policies to deal with outages, considering scope/impact of the outage and time to restore

Multicast Wholesale Services

Utilities can foresee benefit in the use of a wholesale multicast service for mass smart meter communication e.g. distribution of smart meter firmware updates.

In this instance, the level of security implemented for the unicast services should also apply to the multicast service. That is, the multicast service should be fully segregated at layer 2 from all other NBN services and RSPs.

Utilities believe that the Communications Alliance Ethernet Multicast Service defined in "Wholesale Service Definition Framework – Ethernet" will be sufficient.

At the current time, utilities can see an additional requirement for the wholesale multicast service which is likely to differ from other RSP requirements. This is the need for the multicast service to be fully established statically through the NBN Co infrastructure. That is, there should be no requirement for a smart meter to issue an IGMP join message to be able to receive multicast traffic from the utility wholesale multicast service. In effect, traffic sent into the utility multicast service is broadcast to all smart meters connected to the service.

Intelligent Grid & Non-Premise

The following table provides an indication of the SLA requirement for general smart grid applications to non-premise locations.

For the non-premise wireless base station use-case, the SLA characteristics for the previous section would apply in an order of magnitude related to the number of smart meters served by the base station.

Smart Grid Components	Average data volume or Data rate per device (both way)	Peak data volume or rate per device (both way)
Substation Automation points	1Mega Bytes (Mbytes) per day over a 24 hr period	20 kbps dedicated with 1 second response
Distribution Automation Points	100 Kbytes per 10 minute period	1 Kbytes with 1 second response for potentially 50 simultaneous sessions
Other requirements e.g. CCTV and Corporate LAN	1Mbps	10 Mega bits per sec (Mbps)

NBN Co Physical Footprint and PoIs

The number and location of NBN Co PoIs is of interest to utilities in relation to the applications that will run over the NBN infrastructure.

Generally, utilities would like to continue to leverage their existing infrastructure to the greatest possible extent. Based on reasonable deployment of fibre to zone substations and the like, this would lead to a reasonable number of PoIs distributed around Australia. Previous indications from NBN Co of approximately 200 PoIs, without knowing the exact location, would appear to provide the right level of distributed access.

Should a fewer number of more centralised PoIs be adopted, utilities do not see an issue with the applications associated with smart metering, however, they are concerned about the duplication of infrastructure being inefficient and potentially being cost prohibitive.

Further, certain smart grid applications that have been considered in relation to the non-premises deployments require a certain degree of distribution of PoIs to support the distributed utility management infrastructure. Some utilities would not be able to take advantage of centralised PoIs for these applications.

7.3 Security of Smart Grid traffic transiting shared infrastructure

While there are Security Standards and frameworks that apply to Smart Grid architectures (such as NIST SP 800-53, NERC-CIP in USA etc.), they mainly relate to architectures owned by a single entity, making it easier to implement security measures and policies. Given that the services that NBN Co is likely to offer to utilities will be Layer 2 based services (L2 E-Line), NBN Co will only provide security for the L2 Ethernet connectivity service. Therefore, utilities will be responsible for more advanced security measures at higher layers and within the application.

The following security aspects should be considered by utilities and NBN Co in order to achieve end to end integrity and security of utility traffic utilising NBN Co's underlying infrastructure:

- **Service Segregation** ensures that complete separation between services offered via the ONT must be maintained at all times.
- **AAA (Authentication, Authorisation and Accounting)** is required for authentication of devices connecting to ONT ports (such as smart meters) as well as ensuring general NBNCo network infrastructure security.
- **GPON encryption keys management** addresses inherent GPON downstream specific security issues.
- **Denial of Service (DoS) Protection** highlights some of the common practices that can be used to efficiently manage DoS attacks.
- **Multicast Traffic Considerations** ensure that multicast traffic is treated appropriately over the NBN Co network if it is not encrypted. If encrypted, the same considerations as for unicast traffic apply.
- **Encryption of utility traffic** across the NBN infrastructure is very important security aspect since encryption from the Smart Meter is being mandated by some regulators (DPI in Victoria). This section provides discussion on common requirements in this area.

- **Firewalls and Intrusion Prevention Systems (IPS)** are the responsibility of utilities and this section discusses their place in the network and policy requirements.
- **ONT – Smart Meter Physical Security** is an important aspect to be addressed by both parties, NBN Co and utilities.

The above requirements are described in more detail in the following sections, highlighting the expectations of utilities and areas that warrant collaboration between the organisations. The diagram below provides a high level overview of an interconnect scenario between Smart Meters, NBN Co network and a Utility's network.

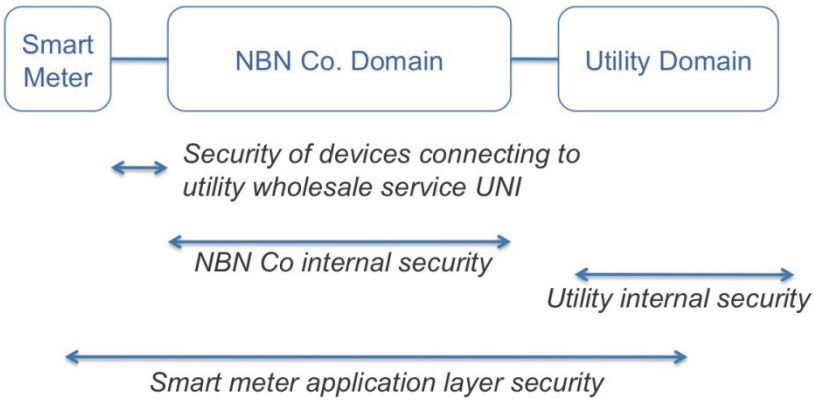

Figure 5: E2E View of Security Domains

Service Segregation:

It is expected that an ONT will provide a dedicated Ethernet port for Smart Meter connectivity. Additional Ethernet ports on the ONT could be used for other RSP services.

It is critical that the local control traffic and any other type of traffic (coming from other ports on the ONT) cannot affect the smart meter and that the local switching between the ports is disabled to ensure complete service segregation. Due to the need to ensure data connectivity to the smart meter cannot be tampered with, it is the view of utilities that the Ethernet port can not be shared with other NBN wholesale services e.g. using VLANs for segregation.

In summary, complete separation between services offered via the ONT must be maintained at all times.

AAA(Authentication, Authorisation and Accounting):

High level AAA requirements can be classified into the following categories:

- authentication of devices connecting to ONT ports associated with utility services;
- security of the NBN Co network and its components such that utility traffic transiting the NBN Co infrastructure is only delivered to the legitimate destinations and that illegitimate traffic cannot enter the utility services;
- appropriate security of NBN Co infrastructure to protect against physical tampering and electronic hacking.

Authentication of devices connecting to ONT ports:

It is expected that utilities will be responsible for Smart Meter authentication with the backend application located in the utility's data centre. This step is critical in ensuring that NBN Co does not potentially cross-connect different services and that only authorised end points such as Smart Meters can communicate with the backend applications. This must be carried out by utility due to the nature of the E-Line service provided by NBN Co.

The most efficient technology choices that exist today for the authentication of end point devices are 802.1X and 802.1AE (MACSec). Given the L2 nature of 802.1AE protocol, this area represents a strong candidate for collaboration between Smart Meter vendors, utilities and NBN Co to implement an end to end security approach that spans from Smart Meter, NBN EAS aggregation trunks at the interconnect point with utility, and the backend application in the Utility data centre.

Security of the NBN Co Network

Like with any other large shared infrastructure, appropriate end to end security measures should be deployed in NBN Co network to ensure full security of the services running across it.

Key examples of the security measures to be carried out by NBN Co at each layer of its network infrastructure (e.g. ONT, OLT, EAS etc) are:

- **Access Control** addresses access policies and procedures, account management and the associated tools and techniques for access enforcement and password control, systems notifications, separation of duties, session lock and termination and remote and wireless access.
- **Audit and Accountability control** enforces appropriate use policy for network and information systems. NBN Co needs to enforce appropriate use of network-based elements and be able to produce an audit trail of that usage.
- **Configuration Management control** addresses policies and procedures, change control, monitoring of configuration changes, configuration settings and access restrictions for configuration changes
- **Identification and Authentication control** addresses policies and procedures, device and host identification and authentication, authenticator management, feedback and cryptographic authentication.

GPON encryption keys management:

Like all PON standards, GPON uses a point-to-multipoint access architecture downstream (to the user) and a point-to-point architecture upstream.

Downstream signals are broadcast to each premise sharing a single PON and it is essential that encryption of the downstream traffic is used to prevent eavesdropping and snooping of PON traffic by malicious end-users.

Mutual and strong authentication between the OLT and ONT as well as secure key management for the generation and exchange of the (AES) encryption keys are essential security measures at this network point.

Denial of Service (DoS) Protection:

DoS attacks can be prevented and managed by relatively simple measures inherent to most networking devices today:

- Quality of Service (QoS) model consistent across end to end NBN Co's infrastructure, backhaul provider and utility's network could also serve as a security measure to prevent potential attacks. For example, by defining Committed Information Rate (CIR) per service per VLAN consistently across the network the impact of potential DoS attack could be minimised.
- Widely published and readily available best practices exist to protect large networks against DoS attacks by deploying DoS filters and security policies in an end to end approach.

Multicast Traffic Considerations:

Multicast is a likely requirement for the utility to distribute firmware updates to the smart meters. Were a utility to leverage a wholesale L2 Ethernet multicast service, such as that defined by the Comms Alliance EMCS service, the utility would require full segregation at L2 as described for unicast services. This would also apply to the SLA characteristics such as the bandwidth profile (CIR/PIR).

Depending upon an individual utility's implementation and vendor support the multicast traffic may or may not be encrypted. If an encryption mechanism is used in an end to end point-to-point fashion, it would be impossible for NBN Co to recognise encapsulated multicast traffic, in which case normal unicast traffic rules will apply.

Encryption of utility traffic across the NBN infrastructure:

According to mandatory DPI requirements in Victoria, refering specifically to meter traffic, traffic must be encrypted (today mainly using IPSec/TLS), which removes the need to mandate NBN Co to provide traffic encryption of its own. It becomes a matter between Smart Meter and the backend application in a Utility Data Centre.

Two possible models become apparent:

- IPSec tunnels from each client (Smart Meter) to back end servers. Servers will have to encrypt and decrypt data for number of tunnels equal to number of smart meters deployed. This model may not scale very well as the number of smart meters deployed increases requiring ever increasing number of IPSec tunnels at the back end servers.
- MACsec (802.1AE) is an approach that could potentially be scaled more effectively and being L2 protocol may be an appropriate choice given the L2 nature of NBN Co's services. MACsec defines a security infrastructure to provide data confidentiality, data integrity and data origin authentication. This capability could potentially be implemented from the ONT port facing the smart meter, all the way on the hop by hop basis through the POI and on to the Utility's Data Centre. MACSec as a technology could become a unified way of providing security measures at Layer 2 that will represent consistent approach regardless of the application (i.e. Smart Meter vs. distribution and automation etc.). The exact MACSec deployment model and its suitability is open for further study.

Other utility traffic, such as distributed generation control and feeder automation schemes, may require other solutions dependent upon their operation.

Firewalls and IPS:

Firewall and Intrusion Prevention System (IPS) polices could be used at the Points of Interconnect (PoIs) between NBN Co and the utility or between NBN Co and the

backhaul Service Provider (SP) connecting NBN's PoI to the utility. This aspect of the overall security framework has to be the responsibility of the utility itself. Also, with the traffic from the smart meter likely to be already encrypted, firewall and IPS capabilities are not essential but should be considered carefully for other applications the utility may be sending across NBN (such as distributed generation control and feeder automation schemes etc).

If not encrypted, smart metering application traffic should be well defined such that it should be easy to deny all traffic except what is explicitly required at the interconnection point. Further, an application firewall should be put in place to protect the smart meter applications themselves for example against malformed packet attacks. IPS provides a secondary layer of defence in case there is a breach or that other security mechanisms are not working properly.

ONT – Smart Meter Physical Security

The physical security of the ONT and connectivity between the ONT and smart meter is discussed in the ONT Deployment section above.

A key concern for ONT physical security is that it cannot be turned off by the customer to avoid remote meter reading. Thus a hard wired power connection to the ONT is desirable and no access to the ONT power switch should be available to customers.

It is understood that for maintenance purposes the ability for the end-user to power the ONT off and on for diagnostic purposes is desirable. This could be provided by an appropriate button on the power supply, which would thus be accessible if the power supply was installed in the meter box. (A switch would not be suitable as it could leave the ONT powered off for long periods and thus stop meter-reading for long periods.)

Summary

This section has addressed various security aspects relevant to both utilities and NBN Co in the context where utilities do not own end to end infrastructure but use NBN Co services. The following matrix summarises the areas of security concerns and indicates whether they should be addressed by the utility, NBN Co or both.

Security Measure	NBN Co	Utility
Service Segregation	✓	
AAA (Infrastructure)	✓	✓
AAA (Smart Meter)		✓
GPON Encryption Keys	✓	
DOS Protection	✓	✓
Encryption	✓*	✓
ONT/SM Security	✓	✓
* if L2 encryption applied		

From a cyber security perspective, three key areas of focus appear to be Service Segregation, Authentication and Encryption. The synergies around providing the physical security aspect of the ONT and smart meter should be explored in the collaborative way between the utility and NBN Co.

Furthermore, two possible encryption scenarios were discussed as potential ways forward. Traditional IPsec scenario where the utility is fully responsible for end to end encryption would work but scalability may become a problem. An alternative newer scenario was proposed based around MACsec protocol which would scale more effectively but would also require cooperative effort between utilities and NBN Co in implementing it.

7.4 Smart Metering in various Multitenant Dwelling Units (MDU) environments

Meters in MDU are typically in one of two locations:

- In the basement
- On each level of the dwelling inside an electrical cabinet

A special case arises with certain Universities. In this case each MDU has only a single meter. In this instance the smart meter would be located in the distribution substation.

In MDU's placing a meter within an end-user's premise/apartment is rare. In this case the meter will need to connect to the ONT deployed in the unit and the ONT would be powered from the end-user electrical supply. As these installations are so rare, the use of grid side power can be dropped.

Thus for the majority of MDU's the use of ONT's dedicated to utility services is the preferred option. Such ONT's can have larger numbers of Ethernet ports than residential ONT's and each ONT could provide connectivity to 8 or 16 meters. For a large MDU with centralised meters several of these ONT's would allow the bank of meters to be connected. Where the meters are collected in groups to service a floor, an ONT would be co-located with the meter groups on each floor.

For extremely large MDU's the number of meters may be such that aggregation of connections through a utilility provided switch/router may be necessary, as shown in Figure 6.

In the basement

In this setup, the smart meters are grouped together inside one electrical cabinet. The ONT would be connected to a utility provided by a layer 2 switch or router. The router connects to all the smart meters.

On each level of the dwelling

Two different options are possible in this scenario:

- The smart meters on all levels are connected centrally to a router/switch. The router connects to the ONT.
- The smart meter on each level is connected to an ONT. The number of ONTs will depend on the number of levels in the dwelling.

The choice between Option 1 and Option 2 is dependent on:

- The physical layout of the dwelling – Some layouts may prohibit connections to a central router found in Option 1.
- Cost of cabling – In large MDU substantial cabling will be needed for Option 1. Depending on which party bears the cost of cables and their associated

installation, Option 2 may be a more efficient solution. However, in this case alternative smart meter communications may be preferable.

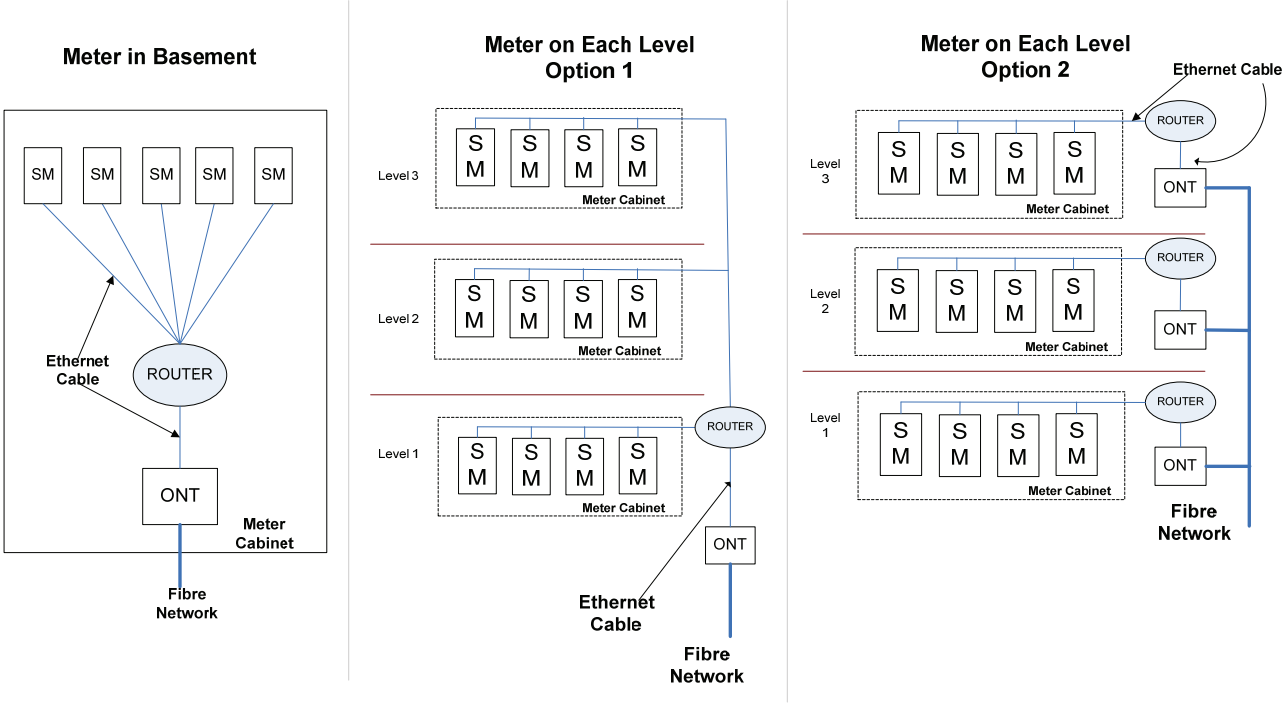

Figure 6: MDU Smart Meter and ONT Locations

7.5 Intelligent grid and non-premises deployment

NBN Co have proposed offering two distinct services, namely

- shared fibre services (Ethernet over GPON), approx 100Mbps capacity to residential and small business users, and
- dedicated fibre services (Point-to-Point Ethernet), approx 1Gbps capacity for large business and infrastructure users.

While the shared fibre services do share the traffic to/from a set of users (~ 32 users) on a common feeder fibre, the resultant capacity (~100Mbps) is more than adequate for many utility purposes (meter reading, device monitoring) using Carrier Ethernet VLANs.

Where high-capacity links (1Gbps) are needed, NBN Co also propose a redundant cabling approach that could be used to make this link capable of withstanding some cable cuts.

Both the shared and dedicated fibre services can be delivered to residential and business premises, or to "non-premises" locations (traffic light controllers, security cameras, etc.).

For non-premises services, for example the monitoring and control of battery banks distributed around the electricity distribution network for "peak shaving", the ONT may be exposed to the weather and to vandals, so a ruggedised enclosure for the ONT may be required. Also special provision may have to be made to allow for powering the ONT and including a battery pack.

ONT's servicing equipment in hard-to-reach locations (e.g. pole-top equipment) may have to be located in a more accessible location (e.g. in an enclosure at the base of the pole) to allow NBN Co to install and service the ONT. There are many issues which

will need to be taken into consideration if this option is pursued such as access to potentially live supplies, availability of land to lease, etc.

Non-Premises Services for Smart Meter backhaul

While this document focuses on the direct use of FTTP services to provide connectivity to residential and business users for meter reading, there are some situations in which other forms of communications to the premise may be used, and in these circumstances the NBN can still provide a valuable role in supplying backhaul (i.e. connection from a central site to a node or concentrator in the field). .

Examples include:

- Backward compatibility with areas in which wireless or DLC has been used to the premises (e.g. Victorian utilities).
- An overlay access network to pick up subscribers who have chosen not to have an NBN connection.
- A means of extending meter reading connections into areas not covered by NBN fibre.

NBN shared or dedicated fibre connections could provide substantial capacity for backhaul to a wireless base station or DLC controller. For shared services in which many more premises are to be connected than with FTTP a different split ratio may be used in the fibre distribution hub to increase the capacity of the shared fibre link. Alternatively dedicated fibre services could be used.

As an example, some utilities are planning that up to 32,000 premises may be served from a single wireless base station.

Figure 7 is a diagram showing the case where a PON is utilised.

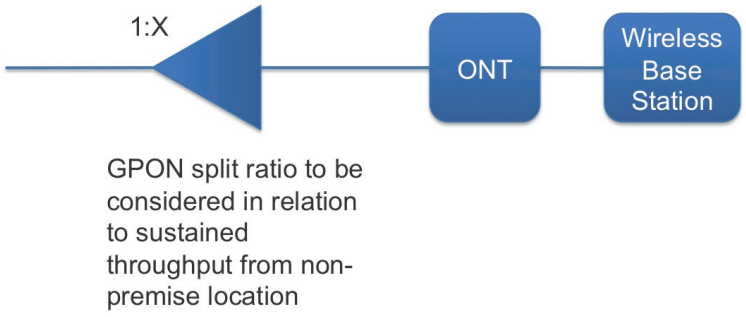

Figure 7: Shared PON to Non-Premises Wireless Basestation

Based on the current approaches planned by utilities, the number of such non-premises services will not be large, and is estimated as up to 20 per Fibre Serving Area in a metropolitan region (in which there are estimated to be approximately 80,000 premises per FSA). Regional FSA's will be less homogeneous (as they will be broken up into large and small towns), and will also have more premises outside of the fibre served area, and thus are expected to require significantly more non-premises services.

Synchronisation with a network-wide timing source is required for some radio / base station technologies, which may require a different ONT to the ONT used at normal residential premises.

Non-premises services for Utility Equipment Monitoring and Control

As well as wireless base-station and DLC concentrators, there are a wide range of other utility owned infrastructure which could benefit from permanent monitoring and control.

Examples are

- Transformers
- Remotely controlled relays
- Distributed Local Storage
- Distributed Generation (PV, Fuel Cell)
- Security Systems (Cameras, Sensors)

Non-Premises Services for Zone Substation Connectivity

In most cases larger utility sites such as zone substations warrant having utility-owned fibre for monitoring and control as the primary form of communications access. However the more important sites may require redundant access for increasing the overall availability of communications.

Diverse utility fibres are one option. Another option is to use dedicated NBN connections to provide an even greater level of diversity (i.e. network diversity), making the utility network even more resilient in the face of disasters.

The availability of utility fibre for its own electrical protection systems, may provide the opportunity for some utilities to connect to the NBN FAN sites and provide its own backhaul.

8 Glossary

Term	Definition
AAA	Authentication, Authorisation and Accounting
AC	Alternating Current
AMI	Advanced Meter Infrastructure
AS/NZS	
100BaseTX	100Mbps Ethernet over copper
CAC	Call Admission Control
CCTV	Closed-Circuit Television
CIR	Committed Information Rate
CPE	Customer Premise Equipment
DC	Direct Current
DoS	Denial of Service
DPI	Department of Primary Industries
E2E	End-to-End
EAS	Ethernet Aggregation Switch
E-LAN	Ethernet Local Area Network - MEF definition for multipoint services
E-Line	Ethernet Line – MEF definition for P2P services
EMCS	Communications Alliance Wholesale Ethernet Multicast Service
EV	Electric Vehicle
FAN	Fibre Access Node – site in NBN Co where fibres from access network (PON and P2P) are terminated
FIT	Feed in Tariff
FSA	Fibre Serving Area
FTTP	Fibre-To-The-Premise
Gbs	Gigabytes per second
GPO	
GPON	Gigabyte Passive Optical Network
HAN	Home Area Network- Utility term for end-user premise network for utility applications
IGMP	Internet Group Management Protocol – for multicast control
IHD	In-Home Display
IPS	Intrusion Prevention System
IPSec	Internet Protocol Security
Kbytes	Kilobytes
L2	Layer 2
MACSec	Media Access Control (MAC) Security
Mbps	Mega bits per second
MDU	Multitenant Dwelling Units
NBN	National Broadband Network
NBN Co	National Broadband Network Company
NERC-CIP	North American Electric Reliability Corporation - Critical Infrastructure Protection
NIST	National Institute of Standards and Technology

NIST SP	
NT	Network Terminal
OH&S	Occupational Health and Safety
OLT	Optical Line Termination
ONT	Optical Network Termination
P2P	Point to Point – WRT a dedicated fibre in the access networks from the FAN site to the premise (end-user or non-premise)
PIR	Peak Information Rate
PoI	Point of Interconnect – Boundary between NBN Co network and 3rd party network
PV	Photovoltaic
QoS	Quality of Service
RSP	Retail Service Provider
SDU	
SGA	Smart Grid Australia
SIR	
SLA	Service Level Agreement
SM	Smart Meter
SP	Service Provider
TLS	Transport Layer Security
UNI	User Network Interface
VLAN	Virtual Local Area Network
ZSS	Zone Sub Station