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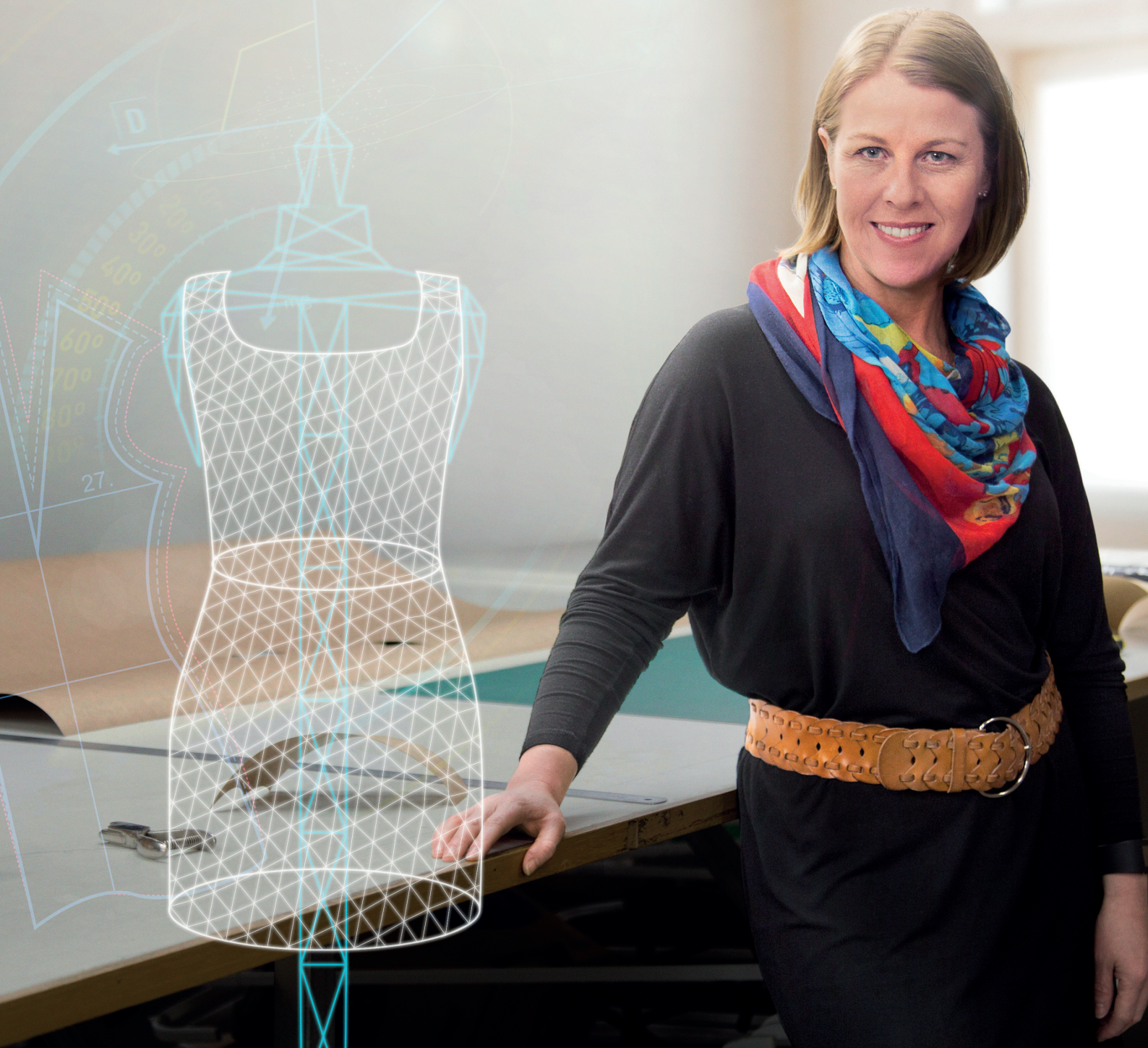
Temporary Special Services White Paper

Frame Relay on the nbn™ Ethernet Bitstream Service



Contents

nbn provides product capability to enable the industry to develop solutions for the migration of copper-based Frame Relay business services to Australia's broadband network.

nbn provides key product capabilities suitable to support the migration pathway for exchange-fed copper services including Telstra's retail and wholesale Frame Relay service offerings to **nbn**'s™ Ethernet Bitstream Service (NEBS).

NEBS can help the industry standardise the provisioning and management of their access infrastructure around solutions comprised of the fibre-based access technologies of Fibre to the Premises (FTTP), Fibre to the Node (FTTN) and Fibre to the Building (FTTB). It also offers a range of enhanced service levels facilitating assurance support to businesses and other end-users.

The purpose of this white paper is to outline how **nbn**'s product capabilities for the fibre-based access technologies of FTTP, FTTN and FTTB can enable the industry to develop business packages and bundles that are the same as, or better than their legacy copper-based equivalents in the Temporary Special Services (TSS) product classes of Frame Relay services, within the meaning of the Subscriber Agreement between **nbn** and Telstra.

Temporary Special Services are a set of telecommunication products delivered on copper, primarily targeted at the business market. The complete list of more than 20 Telstra Retail & Wholesale Special Services is available on **nbn**'s website . This white paper is aimed at the TSS product class of Frame Relay.

This forms part of a series of white papers to illustrate the capability of the **nbn**™ network as a suitable migration pathway for TSS. For the full schedule of white papers, please refer to the Integrated Product Roadmap on **nbn**'s website . This is a white paper published by **nbn** in accordance with the Subscriber Agreement between **nbn** and Telstra.

[1] http://www.nbnco.com.au/connect-home-or-business/information-for-home-or-business/will-it-work-over-the-nbn/what-services-will-be-switched-off.html

[2] Specifically, the SS Classes described as "Frame Relay – P", "Frame Relay – N" and "Frame Relay – B" in Tables 1 and 2 in clause 1 of Schedule 4 of the Telstra Migration Plan.

[3] http://www.nbnco.com.au/content/dam/nbnco/documents/Integrated-Product-Roadmap.pdf

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What is Traffic Class 2 (TC-2) and how does it work?

nbn's Traffic Class 2 capability provides service providers and their end-users with performance objectives covering bandwidth, delay, jitter and packet loss[4]:

Traffic Class	nbn™ network	Frame Delay (one way)	Frame Delay Variation	Frame Loss
TC-2	NEBS-FTTP	≤ 6 ms	≤ 10 ms	≤ 0.01%
	NEBS-FTTN/B	≤ 25 ms	≤ 16 ms	≤ 0.04%

TC-2 is engineered to address the needs of business services that require tighter performance commitments than a 'best-efforts' solution, such as those carrying high-bandwidth, real-time, interactive multimedia applications. Every fibre-based NEBS[5] service may be configured to use TC-2 by selecting a bandwidth rate from a flexible menu of standardised profiles[6].

The TC-2 traffic performance undertakings for bandwidth are enforced by a set of values prescribing burst rates. For TC-2 class traffic, a bi-directional, fixed burst period of 10 ms applies.

The NEBS product is built of four product components, including two key logical components that are dimensioned by the service provider to deliver the value proposition required to secure their target market.

[4] Note: Note: Some minimum speeds, features and capabilities may not be available for fibre-based FTTN and fibre-based FTTB where the Line Rate of the service cannot accommodate this. All performance metrics described in this paper are subject to the service provider selecting appropriate features of NEBS, dimensioning services appropriately and complying with nbn's Fair Use Policy. All performance metrics are subject to exclusions such as End-user equipment configuration and management of application usage. See nbn's Wholesale Broadband Agreement on the nbn™ website for a full list of these qualifications.
[5] Fibre-based NEBS refers to Fibre to the Premise (FTTP), Fibre to the Node (FTTN) and/or Fibre to the Building (FTTB).
[6] Some bandwidth rates are only available for NEBS supplied using FTTP.

What is an AVC?

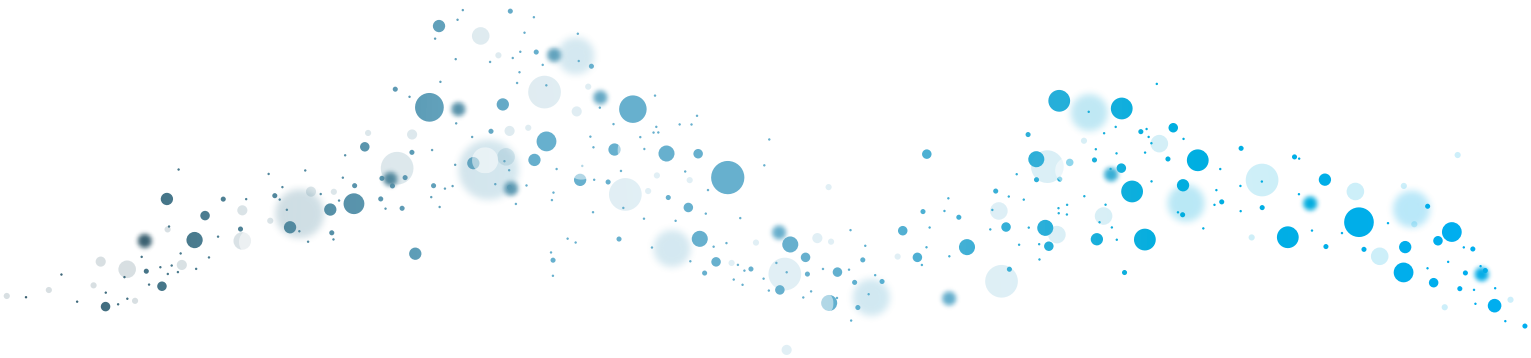
The NEBS Access Virtual Circuit (AVC) provides a direct, one-to-one connection at Layer 2 between the service provider and its end-user's premises. Traffic crossing the AVC is structured to identify the end-user and moves securely through the NEBS infrastructure between the service provider's connection to the Point Of Interconnect (POI)/NNI on one side and the UNI which serves the premises on the other. For FTTP, the location of the UNI port is found on the **nbn**™ supplied Network Termination Device (NTD), for FTTB (and FTTN delivered to a multi-dwelling unit) on the customer side of the MDF or for FTTN (to a single dwelling unit) through the telecommunications outlet. This gives the service provider a high degree of control and management over many aspects of service configuration and performance. When **nbn** terminates NEBS on an NTD it does so on an Ethernet interface. For fibre-based FTTP, the maximum size of an Ethernet frame at the UNI-D is 1,992 bytes for default-mapped or DSCP or 1,996 bytes for Priority-Tagged and Tagged modes. For fibre-based FTTN/B, the maximum size of an Ethernet frame at the UNI-DSL is 1,592 bytes (for Default-Mapped and DSCP) and 1,596 bytes (for Priority Tagged and Tagged). This is from the destination MAC Address to Frame Check Sequence (FCS) inclusive, which matches standard Ethernet behaviour.

AVC bandwidth options

NEBS gives service providers the bandwidth capacity and flexibility to control their end-user's traffic profiles. Each AVC automatically supports a TC-4 subscription, which is a 'best-efforts' bandwidth allocation. At order time, service providers may choose an AVC profile that allows it to carry an amount of TC-2 traffic to support the provision of high-bandwidth, business- critical interactive multimedia applications. The TC-2 bandwidth capability of up to 20 Mbps on fibre- based FTTN/B, or up to 100 Mbps on fibre-based FTTP, can be used to construct retail services that match or exceed the upper end of speeds which many DSL-based retail Ethernet services available in the Australian market today could achieve. **nbn** also provides differing modes of addressing the Traffic Class 2 AVCs at the UNI, including Default-Mapped, DSCP, Priority-Tagged and Tagged options.

What is a CVC?

The NEBS connectivity virtual circuit (CVC) collects AVCs from a connectivity serving area (CSA) and presents them in an aggregated bundle to the service provider at the POI/NNI, again using a selectable mix of highly scalable, cost-effective and widely supported physical Ethernet interfaces. A single CVC may contain AVCs that are presented to end-users and delivered across all fibre-based NEBS access technologies. The maximum Ethernet frame size at the POI/NNI depends on whether a particular AVC is presented to a UNI-D or UNI-DSL. For an AVC to a UNI-D, the maximum Ethernet frame size is 2,000 bytes, which comfortably exceeds the maximum size of a standard Ethernet frame. For an AVC to a UNI-DSL, the maximum Ethernet frame size is 1,600 bytes from destination MAC to FCS (inclusive), which matches standard Ethernet behaviour for double-tagged (802.1ad) frames.



CVC bandwidth options

CVC bandwidth profiles are flexible and can be 'mixed-and-matched' between traffic classes to achieve a granular assortment of traffic class capacities. The CVC profile is a customised set of single traffic class-specific values. The service provider may choose a particular bandwidth for one traffic class independently of the bandwidth chosen for another traffic class on the same CVC. In some cases, the CVC might only specify and carry one or two of the available traffic classes if it has no need to support the others

The speed tiers for each traffic class on a CVC are always symmetric, even for those (like TC-4) that are asymmetric when considered for an individual AVC.

Symmetric speed tiers available		
TC-1 traffic class speed tiers	5, 10, 20, 25, 30, 40, 50, 60, 80, 100 120, 150, 200, 250, 300, 400 and 500 Mbps	✔
TC-2 traffic class speed tiers	5, 10, 20, 25, 30, 40, 50, 60, 80, 100, 120, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900 and 1000 Mbps	✔
TC-4 traffic class speed tiers	100, 150, 200, 250, 300 to 10,000 Mbps (in 100 Mbps increments).	✔

Contention management

The NEBS interconnection architecture allows each service provider to use the aggregating CVC into a serving area to directly influence its end-users' traffic experience. **nbn** does not prescribe the AVC bandwidth ratios applied to a CVC for fibre-based NEBS, so the service provider is free to scale the CVC to either:

- Protect the performance metrics for that class for traffic crossing each AVC; or
- Experience some degree of contention among AVCs, to strike an economic balance between performance and cost.

Provided the service provider doesn't oversubscribe the CVC, and maintains an average utilisation level that does not exceed the recommendations for NEBS (70%), the general performance levels of TC-2 are expected to provide an appropriate migration path for existing exchange-fed copper services available in Australia today. Service providers are responsible for testing the operation of their services, including contention and dimensioning, to ensure they obtain desired performance and other service characteristics.

Traffic class signalling

NEBS is designed to allow the service provider and/or end-user's equipment to set the IEEE 802.1Q PCP field in the Ethernet header of a tagged Ethernet frame presented at the UNI or POI/NNI (available for the UNI if Tagged or Priority Tagged mode is selected). By using this field in supported modes, the frame can declare the traffic class membership (TC-1, TC-2 or TC-4) for the journey over the AVC while leaving the IP Precedence/DSCP field to signal end-to-end Class of Service (CoS).

For the purposes of CPE compatibility and/or management simplicity, the service provider or end-user may prefer to use the IP Precedence/DSCP field in an IP packet, or employ a default class membership for every frame at the UNI. NEBS can also support this requirement and **nbn** has published the required values for IP Precedence/DSCP mapping of each traffic class.

Compatible NTD and CPE

Telstra provides an NTU for connection to Frame Relay services. This equipment requires the end-users to supply 220-240V mains power supply. The type of NTU deployed is dependent on the access method used to deliver the service, and the customer service interface required.

The NTDs used to deliver Frame Relay and Ethernet based services perform an identical function – that is to support the delivery of packet based data services. They, deliver Layer Two connectivity, generally in support of multi-site meshed networks. Often these networks are deployed themselves in support of Layer 3 IP services.

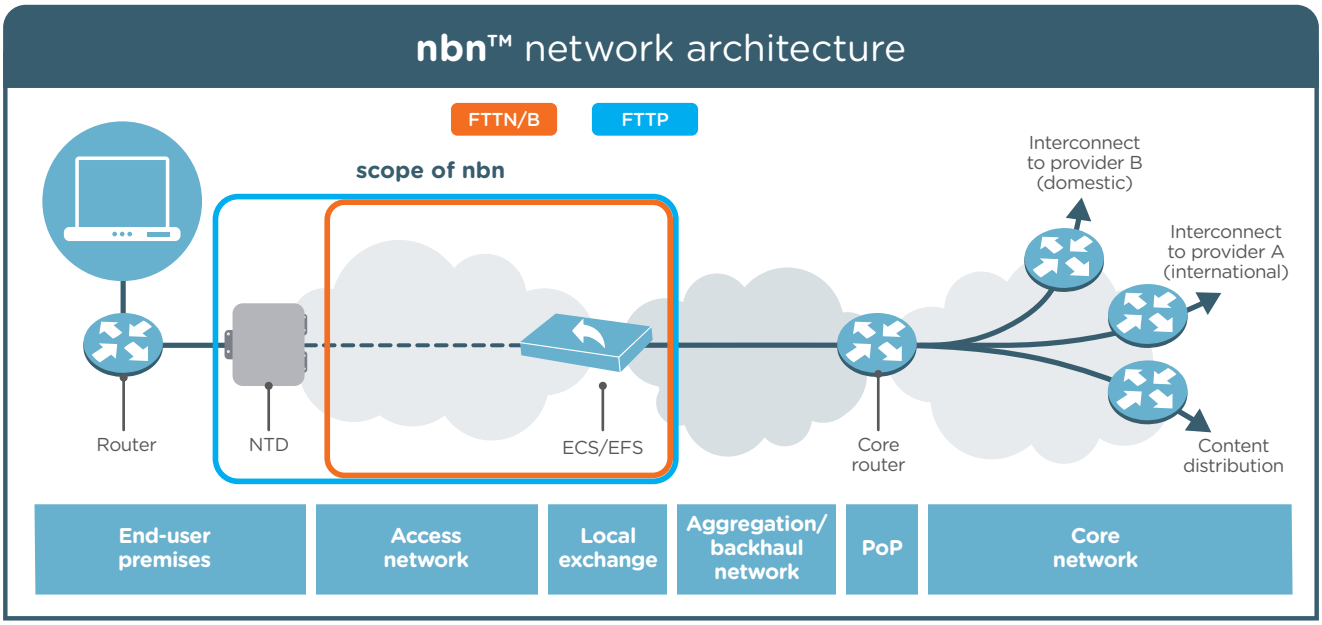
In cases where end-users services are migrated to NEBS-FTTN/B, service providers will need to provide the VDSL modem. In addition, service providers or the end-users would need to replace the Frame Relay WAN interface in any CPE with an Ethernet Interface – which are typically available and relatively low cost.

For services being migrated to NEBS-FTTP, service providers or the end-users would only need to replace the Frame Relay WAN interface in any CPE with an Ethernet Interface and **nbn** provides the NTD.

Standardised broadband network architecture

Each variant of **nbn**'s™ fibre-based NEBS solution involved will either modify or replace the existing access provided as part of a current Frame Relay service. The solution aggregates end-users within a service area and backhauls their Ethernet traffic to and from an NNI/POI for interconnection to the service provider. This is consistent with broadband architectures used in Australia and other parts of the world, and helps to standardise changes at the end-user's premises.

The diagram below shows an illustrative comparison of the scope of the **nbn** access replacement within standardised broadband network architecture.



For the service provider, the use of **nbn**'s™ fibre-based NEBS service will see the modification, replacement or elimination of certain copper access components, depending on the access technology:

- The provision of an **nbn**™ supplied NTD for FTTP or a service provider-/ end-user-supplied VDSL2 modem for FTTN/B
- The existing copper access will be replaced with fibre for FTTP or modified by **nbn** for FTTN/B
- DSLAM infrastructure is not required for FTTP and is provided by **nbn** for FTTN/B

Given the ubiquity of IP for today's data applications and networks, the service provider and end-user may take this opportunity to adopt industry trends and move entirely to a contemporary IP/Ethernet architecture, forgoing Frame Relay-based carriage in the process.

The TC-2 traffic class can be ordered in bandwidth profiles which include enough capacity to replace a 2Mbps Frame Relay service (in fact, several of them in some cases) over a single NEBS link, provided the service provider and end-user configure the NEBS link and services running over it appropriately, for example by scaling the class subscription with sufficient bandwidth, and correctly managing the consumption and Quality of Service (QoS) treatment of other applications.

The result is a simplified access network for the service provider, with a standardised Ethernet access virtual circuit terminating on the UNI used to serve the end-user's premises.

Commercial advantage

For a service provider, **nbn**'s™ TC-2 AVC and CVC product components and Enhanced Service Levels for assurance would be considered cost inputs into an end-to-end solution offered to an end-user e.g. **nbn**'s™ TC-2 product components will be one of the many costs and input parameters in the overall solution. **nbn**'s product capabilities provide attractive commercial pricing for service providers to deliver an end-user solution.

Industry standards

Given the migration to NEBS based services will result in the replacement of Telstra's Frame Relay service, compliance to the Frame Relay standard is no longer required.

nbn's™ NEBS-FTTP and NEBS-FTTN/B services provide end-users with a suitable migration path that delivers a Layer Two alternative to Frame Relay.

Network demarcation

A migration of Frame Relay services to NEBS would introduce two new points of network demarcation at each end of the access service deployed into each end-user site as a result of the copper access being replaced with an **nbn**™ NEBS service. However this is no different to what happens today when service providers migrate end-users to **nbn**™ network services – one at the end-user premises, the other at **nbn**'s™ NNI (POI).

For the end-user, there need not be any change in network demarcation.

Sophisticated customer reporting, monitoring and diagnostics tools

Telstra provides Frame Relay end-users with access to the Next Generation Data Reporting (NGDR) web based system, which provides a range of reporting capabilities including:

- A view of identified important services and their performance at a glance.
- Detailed information on the performance of compatible services within their network.
- Indicative view of certain performance metrics across Telstra's core and edge network.
- Inventory – a list of services and associated attributes within their network

nbn's existing capability provides service providers with similar ability to monitor access services and NTDs (where provided by **nbn** as part of the NEBS FTTP offering). Any other end-user CPE management required would need to be provided by the service provider. **nbn**'s functionality for service providers to monitor access services is comparable with what existing Frame Relay services have in place today.

nbn's Customer Operational Reporting platform also provides the service provider with visibility of the underlying performance of **nbn**™ services that can be used as an input to support existing customer reporting services.

Customer reporting

A key element of the migration of services to the **nbn**™ network is the ability for the service provider to continue to deliver a level of reporting services to its business end-users.

nbn provides service providers with a series of service management and self-management tools to support core operational functions including ordering, activation, management and assurance across all **nbn**™ product and access technologies, including fibre.

Service management information will be accessible via four methods:

1. Database access via the B2B interface
2. An online, browser-based graphical management dashboard
3. Standardised reports with regular delivery timeframes, including regulatory and technology-specific reports that roll up to the dashboard
4. Customised ad-hoc and incident-based reports including the ability for the Service Provider to build their own specific reports

Self-service tools will be accessible by two methods:

1. B2B interface into testing tools and database
2. An online, browser-based graphical dashboard

Customer reporting tools available and in plan as part of nbn's™ NEBS service		
Connection reporting	By status, geography and priority, connection appointment performance	✓
Order and ticket management	Including AVC and CVC MACS performance, fault rectification performance	✓
Network availability	Network availability, sortable by geography, product, volume of service providers impacted (updated hourly)	✓
Operational support tools	• Dashboard reporting on incidents • Monthly trouble ticket reporting • Total active services by product type • Reports on response KPI performance • Port error statistics	✓

Internal reporting, monitoring and diagnostics

The offering based on **nbn**'s™ NEBS fibre services provides the service provider a range of diagnostics capabilities:

Diagnostics capabilities		
UNI-D NTD status (NEBS-Fibre)	Retrieves information about the UNI-D port from the Access Network. **Key attributes:** • NTD status information • UNI-D status information **Diagnostic uses:** • General information about the NTD/UNI port and its operational status	✓
Loopback connectivity test[7] (NEBS-Fibre)	Ethernet OAM based end-to-end connectivity test (for fibre based FTTP based services only) **Key attributes:** • Loopback test result (i.e. pass/fail) • Number of packets sent vs. number of packets received • Number of out-of-order packets **Diagnostic uses:** • Troubleshooting connectivity issues • Aid in fault localisation (be it in a service provider's or **nbn**'s™ network) in the form of Y.1731 loopback (LBM/LBR)	✓
Performance tests[8] (NEBS-Fibre)	Testing of services over a fixed period of time to provide performance metrics (Frame Delay, Frame Delay Variation, Frame Loss Ratio) **Key attributes:** • Frame Delay • Frame Delay Variation • Frame Loss Ratio **Diagnostic uses:** • Troubleshooting throughput related issues • Ensuring end to end performance of service (Ethernet layer) within **nbn**'s™ network according to product specifications as specified in the product specification document using Y.1731 (DMM/DMR)	✓

[7] The Internal loopback test for fibre based FTTN/B is run between the NNI and DSLAM port

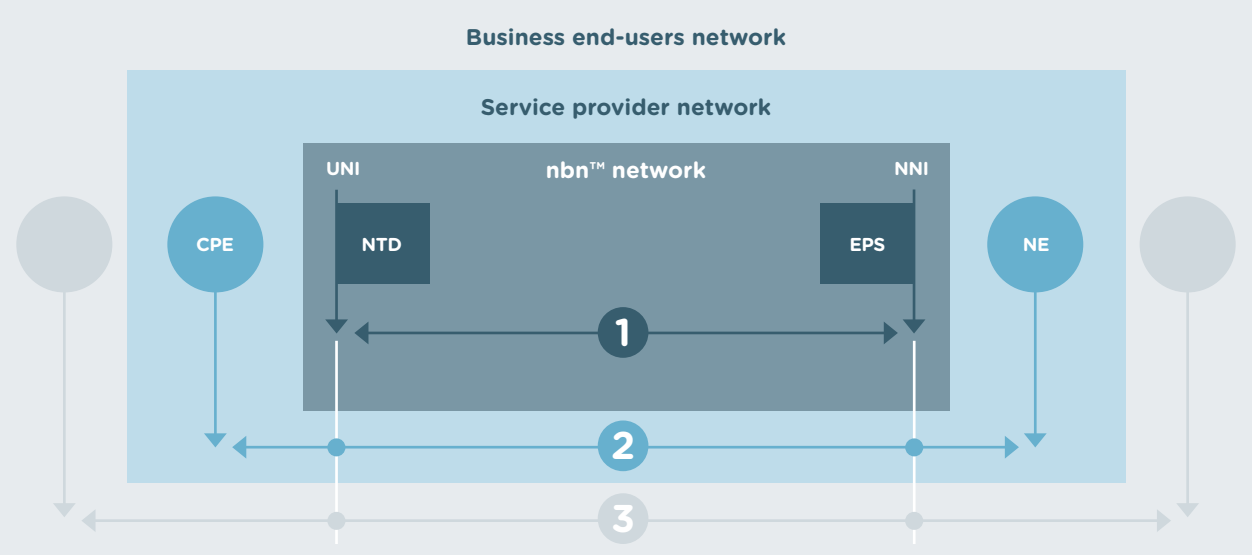
[8] The Performance testing capability for fibre-based FTTN/B is planned to be made available to Service Providers by 2H 2017, as per Integrated Product Roadmap. http://www.nbnco.com.au/content/dam/nbnco/documents/Integrated-Product-Roadmap.pdf

With the introduction of a proposed network demarcation point between the service provider and **nbn**'s infrastructure, a service provider's operational groups will be able to monitor and manage the **nbn**™ infrastructure as another element in their network. **nbn** has implemented an OAM framework in alignment with industry standards, which it plans to further enhance through offering visibility of **nbn**™ service boundaries at the service provider and business end-user level. The diagram below illustrates the monitoring architecture that is available to service providers.

Using the **nbn**™ network to deliver fibre access, the service provider will have monitoring visibility (as per diagram below) of services at a range of points throughout the **nbn**™ network including:

- Point of ingress to the **nbn**™ network via the regional broadband network
- The Access Node
- The **nbn**™ NTD (in the case of fibre-based FTTP)

nbn™ diagnostic capabilities



▼ Diagnostic end point

● Diagnostic intermediate visibility point

1. **nbn** has the ability to perform full diagnoses and monitoring within its network boundaries
2. Service providers have the ability to perform end-to-end diagnostics and monitoring, with visibility of **nbn**'s™ service boundaries
3. Business end-users have the option of performing end-to-end testing across **nbn**™ services, with the option of visibility of **nbn**™ service boundaries

The advanced reporting capabilities available on **nbn**'s™ NEBS fibre services will provide the service provider with Internal reporting capability comparable to current capability. The ability to partition monitoring between **nbn**-provided and service provider-delivered services will enable more accurate root cause analysis of faults, improving the efficiency of fault management and enabling the delivery of a more consistent user experience for business end users.

Service levels

Network availability

The **nbn**™ network availability target is a performance objective of 99.90%[9] across all current access technologies.

Telstra Frame Relay has a target network availability (the core Frame Relay/MSE network) of 99.9%. Telstra's measure of target network availability excludes the access network, while the **nbn**™ network availability target is only focused on the access network, and part of the backhaul network to the **nbn**™ Points of Presence. In a migration, the **nbn** component target network availability is one input into a service providers' end-to-end network availability calculation for Frame Relay comparable services provided to end-users. As such, it is our view that **nbn**™ NEBS solutions do not impede service providers from offering network availability target service levels to end-users that are the same as or similar to Telstra's current target network availability service level offerings for Telstra Frame Relay.

Service installations

nbn's service installation targets specified in its arrangements with service providers for fibre-based NEBS are between 1 and 19 business days, depending on service location and available infrastructure.

The following are **nbn**'s end-user connection service levels (install target in business days). All of these service levels are subject to conditions and exceptions set out in **nbn**'s Wholesale Broadband Agreement with service providers.

Service offering	Geographical Area	Urban Area (days)	Rural Area (days)	Remote Area (days)
NEBS-FTTP	Service Class 1	14	19	19
	Service Class 2	9	14	19
	Service Class 3	1	1	1
NEBS-FTTN/B	Service Class 10	N/A	N/A	N/A
	Service Class 11[10]	14	19	19
	Service Class 12	9	14	19
	Service Class 13	1	1	1

Telstra currently offers service installation targets of 9 days for Frame Relay connections in metro areas where no external work is required. For connections requiring external transmission plant work or third parties' consent, Telstra's targets are 19 or 24 days for metro areas. For non-metro areas targets are 19 days, 39 days or not specified.

nbn's service targets of 9 business days for urban areas (for FTTP Service Class 2 location) to 19 business days in some rural/remote locations are the same as or better than Telstra's service installation targets.

[9] For full details on the Network Availability target and is calculation methodology please refer to the Service Level Schedule section of the WBA, http://www.nbnco.com.au/sell-nbn-services/supply-agreements/wba2.html.

[10] Service Class 11 is not applicable to fibre-based FTTB.

End-user service fault rectification[11]

nbn has introduced a suite of standard and enhanced service levels for assurance which are expected to be of particular use with respect to small and medium business end users.

The following are the standard assurance service level options for fibre-based NEBS:

Eg. Urban zone; with rural and remote zone variations (+1, & +2 days) consistent across Telstra & nbn™ offerings	Telstra Frame Relay	nbn™ fibre-based NEBS	Comparison between Telstra Frame Relay and nbn™ fibre-based NEBS
Default restore time **Hours of operation**	• 12 hours • 24/7	• Enhanced- 12 (24/7) offering • 12 hours • 24/7	• Same
Default response time	• 60 mins	• 60 mins	• Same
Express 8 (Telstra) **Enhanced-8 (nbn)**	• 8 hours restore • 60 mins response	• 8 hours restore • 60 mins response	• Same
Express 6 (Telstra) **Enhanced-6 (nbn)**	• 6 hours restore; • 30 mins response	• 6 hours restore; • 30 mins response	• Same
Express 4 (Telstra) **Enhanced-4 (nbn)**	• 4 hours restore • 30 mins response	• 4 hours restore • 30 mins response	• Same

[11] For full end-user Service Fault Rectification details please refer to the Service Level Schedule section of the WBA, including **nbn**'s 4 and 6 hour response options made available as of 1 September 2016 - http://www.nbnco.com.au/sell-nbn-services/supply-agreements/wba2.html

Conclusion

nbn's Traffic Class 2 technical features and suite of enhanced service levels for assurance provide a solid migration path for the Frame Relay end-users from exchange-fed copper-based access services to the **nbn**™ fibre-based Ethernet Bitstream Service (NEBS).

These features and capabilities provide service providers with the ability to provide simple, converged solutions that satisfy a migration from legacy products to **nbn**'s solution, and also provide a variety of enhanced service level targets for assurance and network feature capabilities that can be used by service providers to meet the needs and requirements of end-users.

Notes: terms used but not defined in this white paper have the meaning given in **nbn**'s Wholesale Broadband Agreement, which is publically available on **nbn**'s website, or the Subscriber Agreement between **nbn** and Telstra which is confidential.

Appendix: Frame Relay comparison table

Considered area of product equivalence	Feature or function	Telstra Frame Relay	nbn's Product capability
Network architecture and product capability	VC-based, connection-orientated packet switching network	✓	✓
	Virtual Circuit hand-off models	✓	✓
	Available transmissions rates	✓	✓
	Multi-service upper-layer protocols, including IP	✓	✓
	Head end handoffs	✓	✓
	Maximum frame size	✓	✓
	UNI operating modes	✓	✓
	Contention management	✓	✓
	Security against opportunistic eavesdropping	✓	✓
Performance metrics	Performance targets	✓	✓
Reporting capability	Reporting on end-user service performance	✓	✓
Network availability	99.9% availability target	✓	✓
Service levels for assurance	Business plus options	✓	✓
Service levels for activation	Service installation targets	✓	✓
Commercials and pricing	'Per-service' based price points	✓	✓

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