NBN Draft Architecture Paper

[Cisco Comments]

6 November 2009

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Cisco Comments

Cisco welcomes the opportunity to comment on the draft NBN Reference Architecture document issued by Communications Alliance.

Cisco notes that the draft Reference Architecture has been issued ahead of the ongoing work of Communications Alliance in recommending the wholesale services to be offered by NBN Co. As a threshold point of principle, we would disagree with the sequence of these two documents. It is clear that any NBN architecture should be based on the proposed services that the wholesale operator will provide, not the other way around. It is surely the services mix that will determine how the network is to be architected at both the physical and logical levels. Consequently, we have difficulty with the approach that Communications Alliance has taken and would recommend that architecture work be adjourned until there is consensus on the range of wholesale services that NBN Co will offer to the market.

Cisco believes that the proposed reference architecture confuses the role of and delineation of the NBN as a modern wholesale-only service provider, choosing to employ current architectures optimised for more common dual wholesale/retail broadband Service Providers. This assumed replication of traditional approaches to business models and network architectures as presented in the Communications Alliance Architecture document does not, in the view of Cisco, properly accommodate the optimal approach to service instantiation that arises from the critical attribute of the NBN being a platform for wholesale-only operations.

Notwithstanding these views, Cisco has provided commentary on the proposed architecture document but we would like to stress that our comments may be revised depending on the service mix that NBN Co offers.

At a summary level, we would also observe that the proposed architecture is a replication of the existing market approach where vertically integrated Service Providers supply DSL-centric services - i.e. where Service Providers are in both retail and wholesale operations. In other words the Communications Alliance model would encumber NBN Co by proposing services that are retail in their nature and thus have NBN Co crossing the boundary between wholesale and retail.

By its very existence, NBN will commoditise transport so there seems to be no legitimate reason to restrict NBN Co's services to layer 2, whereas offering choice of layers 1-3 (for business and government) will encourage innovation at all levels and result in new service and business models emerging. The stated objectives of NBN are summarised below:

-   [NBN will] "transform the economy and our productive capacity. Once it is implemented, it will completely alter the business environment with opportunities for innovation, the creation of new applications and new business models in the Australian economy" – Lindsay Tanner, 25th June 2009, Hansard

- "broadband will be the key enabler for businesses, for governments, for organisations of all types and sizes" – Lindsay Tanner, Australia-China Business Week Luncheon – 23rd October

- "revolutionising the way in which the business of government is done as well: delivering education services; delivering health services; delivering other services from government" – Kevin Rudd, Tasmanian NBN Launch 25th July 2009

Consequently Cisco believes that market demand exists for a broad mix of telecommunications services supplied at the wholesale level. Given the anticipated scale and scope of the NBN, it follows that the NBN needs to deliver a comprehensive range of services and therefore the architecture needs to reflect this breadth of service approach.

Finally we would also observe that the proposed architecture does not explicitly accommodate video and IPTV services. Cisco sees video-based communications as being a fundamental dimension of many applications for consumers, business and government, now and into the foreseeable future. Given this critical importance of video coupled with the fact that video transmission does place special technical demands on networks, Cisco would expect that the NBN architecture specifically addresses this critical requirement, once the relevant service layer alternatives have been determined.

Communications Alliance Document Review

2 BROADBAND NETWORK ARCHITECTURE VISION
(Page 3 of Communications Alliance Document)

> "Figure 1 shows the end-to-end architecture vision which identifies the different functional and service domains applicable to the provision of Next Generation Broadband Services."

Cisco believes that the functional domains indicated in Figure 1 are not fully consistent with the declared objectives of the NBN and omits some important functions. These can be summarised as follows:

- [NBN will] "transform the economy and our productive capacity. Once it is implemented, it will completely alter the business environment with opportunities for innovation, the creation of new applications and new business models in the Australian economy" – Lindsay Tanner, 25th June 2009, Hansard

- "broadband will be the key enabler for businesses, for governments, for organisations of all types and sizes" – Lindsay Tanner, Australia-China Business Week Luncheon – 23rd October

- "revolutionising the way in which the business of government is done as well: delivering education services; delivering health services; delivering other services from government" – Kevin Rudd, Tasmanian NBN Launch 25th July 2009

Consequently we have a broader view of the NBN service mix and constituents it will service than the Communications Alliance draft architecture implies.

Specific suggested alterations:

1. The removal of the Wholesale Network Service Provider (NSP) component, since this function appears to duplicate the function of Retail NSPs (from the perspective of the NBN Co. as a wholesale only service provider);

2. The "Transport" function should be separated out from "Aggregation";

3. A Packet Core will be required for efficient forwarding of packet-level traffic across the nation;

4. An Optical Transport layer will be required for both the needs of NBN itself as well as for the provision of wholesale Layer 1 services and Layer 1 back-haul service options.

3 BROADBAND NETWORK REFERENCE ARCHITECTURE – FTTP ACCESS

(Page 4 of Communications Alliance Document)

General Observation

Figure 2 should be altered to reflect the wholesale-only role of the NBN.   Existing accepted views on broadband Service Provider architectures arise from industry models that have been deployed for many years dating back to the development of Internet access via dial-up PSTN facilities and later adapted for use with xDSL. These models have been applied here in Australia along with most other countries in a business setting where the Operators offer either a mix of retail and wholesale services or operate only in the retail space. Wholesale-only business constructs have not to date, figured prominently in the application of accepted broadband access models. These existing models leverage a process of pre-authentication of end users' access credentials to select the appropriate Retail Service Provider to which to steer the access request, which in the case of PPP traffic, is carried over tunnels (e.g. L2TP). This process mandates that hardware and software capabilities exist within a Wholesale Service Provider such that this pre-authentication process is supported and that user traffic is correctly carried toward the relevant Retail Service Provider.   The Network Elements of LAC (BRAS), AAA, LNS and BNG are implicated in the various technical processes involved in support of the separation of wholesale and retail services as typically implemented today.

However, in the case of a wholesale-only Service Provider, there are alternate simplified approaches that exist that avoid the necessity for any involvement in the traffic flow of any retail entity, including the need for pre-authentication processing, destination selection and tunnelling. In the case of Internet Service Providers (ISPs) for instance, the use of Ethernet-based peering interfaces with logical traceability of their service instance, end-to-end through the wholesale Operator's infrastructure, permits services to be provisioned on per subscriber, per Service Provider basis. This then results in the wholesale Operator providing complete transparency to retail Service Providers traffic, allowing them to support any service architecture (e.g. PPP or IP/DHCP) they wish and de-couples any mutual interdependency between wholesale and retail facilities that would otherwise exist.

The assumed replication of traditional approaches to business models and network architectures as presented in the Communications Alliance Architecture document does not in the view of Cisco, properly accommodate the optimal approach to service instantiation that arises from the critical attribute of the NBN being a platform for wholesale-only operations. This represents one of Cisco's key difficulties with the architecture as presented.

Specific Concerns

Specific concerns are as follows:

1. Layer 1 Transport services are not explicitly shown;

2. IPTV and video services are not accommodated;

3. Wholesale Layer 3 services are omitted;

4. The concept of wholesale NSPs as shown, directly overlaps with the role of retail NSPs and should be excluded from the diagram[1];

5. The diagram combines the roles of service edge and core. Cisco contends that, as a wholesale only operator, the network function of "service edge" relates to the services instantiated on the NBN for its wholesale customers. In this case, packet based services will be L2 or L3 services rather than individual subscriber services. The service edge for subscriber services, such as Internet access for instance, will lie within the Retail Service Provider's domain and hence is out of the scope of the NBN;

6. The combination of Service Edge with Core as shown in Figures 1 and 2 also gives rise to anther misconception in Cisco's view. A "Core" is a foundational component of Next Generation Networks as deployed in Service Providers around the world today. These networks typically leverage IP and MPLS protocols suites and are engineered to provide high levels of capacity, relative simplicity and are optimized for availability and non-stop operations. Core networks do not instantiate services; rather they provide the raw packet processing capability upon which other architectural elements are overlaid to create services. Therefore, the Core should be represented as a distinct functional element of the NBN's end-to-end architecture.

3.1 Key Network Domains and Functions
(Pages 4 into 5 of Communications Alliance Document)

End User: The text should emphasise "equivalence of access" and the implications of this requirement on NBN end user equipment. ONTs for GPON application should incorporate multiple physical Ethernet ports to permit independent parallel delivery of retail services. NTUs for Active Ethernet direct fibre applications should also provide for the same multi-service delivery capability such that access equivalence is provided. ONTs and Ethernet NTUs should be declared as NBN infrastructure and hence to be controlled as part of this networks functional scope.

Cisco also observes that in all likelihood the NBN will need to instantiate a residential VoIP capability within the scope of its' service delivery framework. Therefore the inclusion of an integrated POTs to SIP gateway within residential GPON ONT devices will need to be depicted. This logical function, whilst supported within the NBN controlled equipment, will need to interwork with the relevant retail voice service provider and operate over NBN standard (albeit logical) wholesale transport constructs.

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[1] All Service Providers will have a wholesale business relationship with the NBN Co. and their downstream business relationships are not relevant to the NBN.

Routing Gateways: This class of equipment should be declared as being outside the responsibility of the NBN, because this device operates exclusively within the retail service provider or end user domain. The comments associated with Wholesale Routing Gateways should be dropped due to reasons already mentioned.

Access Domain: Comments should include reference to the direct fibre (point-to-point) use case. In addition, the Access Domain boundary is suggested to exclude the EAS (depicted as part of the Access Domain). These network elements are best defined to be the first element within the Ethernet Aggregation domain.

> Cisco makes the further observation that the NBN is most likely to used by both current and future media operators to deliver video based services which will include both "on-demand" services which make use of unicast packet flows, and linear broadcast service models, generally characterised as IPTV which make use of "IP multicast" as a foundational technique for efficient forwarding packet level traffic to IP video receivers.

> Multiple independently operating retail video services are likely to be required to be supported on the NBN, extending the concept of equivalence of access in to the video, IPTV and retail media service provider sector. This will imply special consideration of IP multicast technology, protocols and processes that will be required to accomplish the required functional outcomes. These considerations will impact on the Access Domain and extend into the Ethernet Aggregation Domain.

Aggregation and Transport Domain: The Aggregation and Transport Domain should be separated. Transport (optical) only services will need to be provided by the NBN and as such, this aspect of the infrastructure should be separately described. It is suggested that the Ethernet Aggregation domain is best shown as a regional or state based entity such that a relationship with a long haul Packet Core Network function can be established.

3.1.4 Service Edge and Core Domain
(Page 6 of Communications Alliance Document)

Given that the NBN is proposed to be a wholesale-only platform, the service edge should instantiate those packet level services that will be sold at wholesale. Therefore, since there is a direct overlap with retail Service Provider services, especially retail ISP services, the service edge for these services should not be declared or implied as part of the NBN. Rather, the service edge for the wholesale services that the NBN will actually deliver such as Layer 2 E-Line, E-Tree or E-LAN services or Layer 3 IP VPN services is at the boundary of the Ethernet Aggregation Domain where interconnection to the Access domain occurs. Furthermore, this domain should separate out the Packet Core Network as a key component of the NBN's traffic control and routing infrastructure, a functional domain in and of itself facilitating national reach of all supported services.

All services declared under the depicted Service Edge and Core Domain are in the view of Cisco, inconsistent with the objectives of the NBN.   Packet level services that the NBN will need to deliver are all wholesale and not retail. As stated above, Layer 2 E-Line, E-Tree or E-LAN services or Layer 3 IP VPN services may be delivered over a wholesale platform. Retail Service Providers will add value to one or more of these services to create a connection to the Internet or other application or content functions. Network elements typically associated with residential broadband service delivery, such as LAC/LNS in the case of PPP delivered services and BNG in the case of IP Application Service Provider services, fall outside the anticipated scope of the NBN and within the scope of retail Service Providers. Peering between the NBN and retail Service Providers would then be at Layer 1 for Layer 1 services, Layer 2 for Layer 2 services and Layer 3 for Layer 3 IP VPN services. The diagram (Figure 2) and the associated text seek to replicate the conventional models applicable to xDSL delivered Internet Service Provider services, as described earlier in this document, which employ protocols such as PPP and L2TP to establish retail and wholesale network function separation. This approach need not apply in the case of the wholesale-only NBN.

3.1.5 Application and Content Domain
(Page 7 of Communications Alliance Document)

Connection to all Application and Content services will need to be via a retail entity since no end user will gain access to the NBN directly. The range of retail Service Providers would include ISPs (NSP), ASPs and other entities that may bundle NBN delivered connectivity with another ICT and/or content offerings. Such retail operators will address all market segments where demand is identified. The business relationship between the NBN Co and its customers will be pure wholesale. Downstream business relationships between the NBN's customers and other entities are not relevant to the NBN. Therefore, as outlined earlier, architecture descriptions for the NBN should not include specific references to arrangements and interconnections to entities other than the NBN and its direct customers.

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3.2 Wholesale Point of Interconnect and Service Boundary Point Scenarios
(Page 8 of Communications Alliance Document)

Cisco believes that further discussion within the Communications Alliance document of issues such as Points of Interconnection and Service Boundary Points are presented based on a sub-optimal and incomplete reference architecture. The architecture presented does not represent an optimal framework for the delivery of the various classes of wholesale services that can reasonably be expected to be provided by a platform such as the NBN.

Cisco's Recommended Approach

Cisco suggests that the preferred methodology for architecture development would be to initially identify the range of NBN services, their characteristics and respective functional architectures. The NBN reference architecture can then be derived from the service profiles by designing network architecture suited to the needs of the services to be delivered. The Communications Alliance process appears to have commenced with a view of architecture first and then sought to devise potential service models and Points of Interconnects matched to that architecture.

Candidate NBN Services

Cisco believes that market demand exists for a broad mix of telecommunications services supplied at the wholesale level. Given the anticipated scale and scope of the NBN it follows that the NBN needs to deliver a comprehensive range of services. Cisco further believes that the service mix demanded by the market can be broadly classified as follows:

Access Services:

- Layer 1 fibre
- Layer 2[2] GPON class up to 100 Mbps and Layer 2 Ethernet class to 10 Gbps[3]
- Layer 3 not applicable[4] for NBN

Back haul Service

- Layer 1 Fibre or ITU-grid λ (various lambda models possible)
- Layer 2 Ethernet IEEE 802.1q model at Access boundary, (with The Metro Ethernet Forum E-Line, E-Tree and E-LAN service models as options), plus IEEE 802.1p-based QoS
- Layer 3 on Ethernet IP VPN for IPv4 and IPv6 (IETF RFC 4364 and IETF RFC 4798 respectively) with IETF RFC 3270 short-pipe mode QoS (based on IEEE 802.1p QoS markings)

Peering Service

- Layer 1 fibre or ITU-grid λ limited to matching back-haul as provisioned

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[2] Both GPON and Ethernet Class NBN access services are to present IEEE 802.3 interface(s) to the premise/user.

[3] Layer 2 Access service options with specific functional optimisations for video and IP multicast will be required.

[4] The Layer 3 Access function is to be provided by retail Service Providers and is typically instantiated on a Residential Gateway or other CPE.

- Layer 2 Ethernet (only option at Layer 2) IEEE 802.1ad (Provider Backbone Bridging) or IEEE 802.1ah (MAC-in-MAC) at the service provider peering point for aggregated services. IEEE 802.3 or IEEE 802.1q peering for some classes of service
- Layer 3 on Ethernet IP VPN for IPv4 and IPv6 (IETF RFC 4364 and IETF RFC 4798 respectively) with IETF RFC 3270 short-pipe mode QoS (based on IEEE 802.1p QoS markings)

Cisco recommends that the governing principle apply, that all NBN services will be delivered to end user and service provider points of interconnect at the same transport layer, cross-layer translation functions are not the responsibility of the NBN, e.g. Service Providers will secure a Layer 2 end-to-end NBN service, not a Layer 2 to Layer 3 interworking service.

The NBN reference architecture should permit the delivery of each of these identified service classes and should be structured in such a manner to expose suitable Points of Interconnection such that service options can be overlayed logically on the architecture. Further, the reference architecture should identify those functional elements and domains that will be required to accomplish a practical deployment of the infrastructure on a national scale. Accordingly, the following hierarchy should be identified:

- End user site/location
- User Equipment
- User LAN
- Retail Service Provider operated CPE
- NBN ONT/NTU
- NBN FTTP outside plant (PON and direct modes)
- NBN FTTP access termination (Exchange)
- NBN Access Network Elements (GPON OLT and Ethernet Access switching/PE-Agg)
- Access-Aggregation interconnection
- Ethernet Aggregation Nodes (Service Edge for wholesale packet back-haul services N-PE)
- Regional MSTP Nodes (Optical Transport for Layer 1 services and for supporting NBN Ethernet Aggregation/Service Edge function)
- Service Provider Peering Nodes
- Retail Service Provider interconnect and may include reference to Retail Network Elements (e.g. LAC/LNS, BNG or BR)
- Long Haul Packet Core Network
- Long Haul Transmission Fabric

Whilst some of these architectural domains are identified in the Communications Alliance architecture, some important aspects are currently omitted, incorrectly included or are in Cisco's view, not aligned to the strategic vision of the NBN as a fully functioned wholesale network platform capable of meeting the needs of a broad range of potential applications both now and into the future.

Cisco has produced revisions of the Communications Alliance architecture Figure 1 and Figure 2 diagrams based on the preliminary high level view of the service profiles we believe will need to be delivered by the NBN.
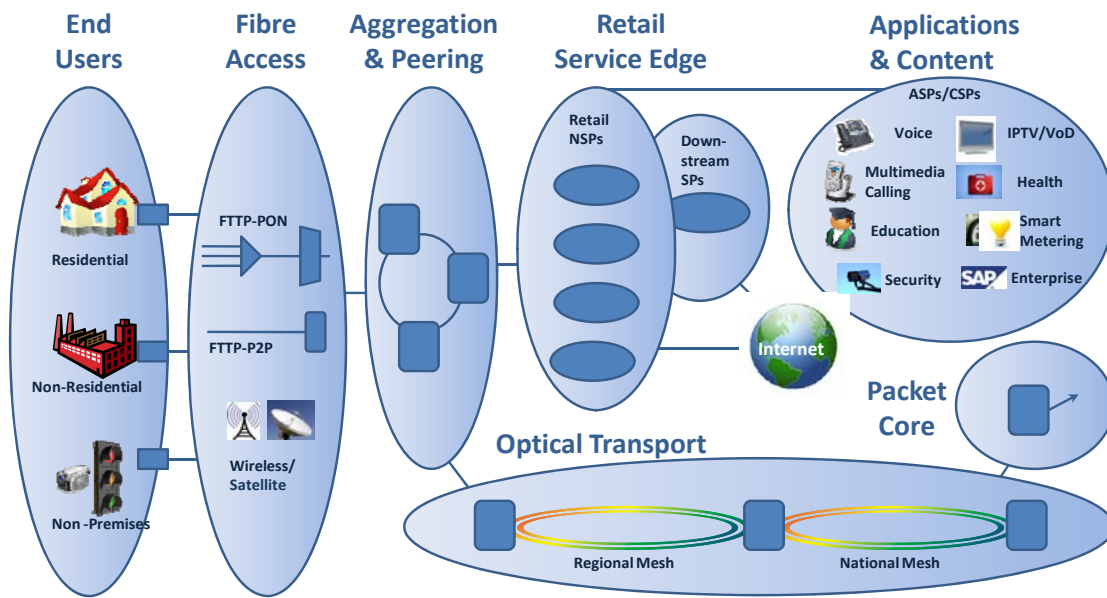
Architecture Diagrams

Figure 1 - High Level Functional Network Architecture Vision

End Users Domain

FTTP Access Domain

Ethernet Aggregation Domain & SP Peering

Retail Service Edge

Applications & Content

NBN Packet Core

Layer 2 or 3 Service Delivery

Device

Device — RG

TV — STB

ONT

GPON Residentail/SMB

PON Fibre

O D F

Splitter

O D F

O L T

NBN L2/L3 Service Edge

NBN /SP Peering

Retail Only NSPs — Control — U-PE — PTA

Retail/W'sale NSPs (L2TP) — Control — Control — U-PE — LAC — LNS

EAS N-PE

Internet

Layer 2 or 3 Service Delivery

LAN — CE

LAN — CE

TV — STB

NTU U-PE

Alt. PE-Agg Bypass

O D F

Pe-Agg

P2P Fibre

Ethernet Bus/Enterprise

EAS N-PE

EAS N-PE

Retail ASPs — Control — U-PE — BNG

Retail IP VPN Providers — U-PE — CE

Layer 1 Service Delivery

Optical CPE

P2P Fibres

O D F

Regional Transport

MSTP

MSTP

EAS N-PE

National Transport

MSTP

Packet Core

Multiple Locations:
• Residential
• Non-Residential
• Non-Premises

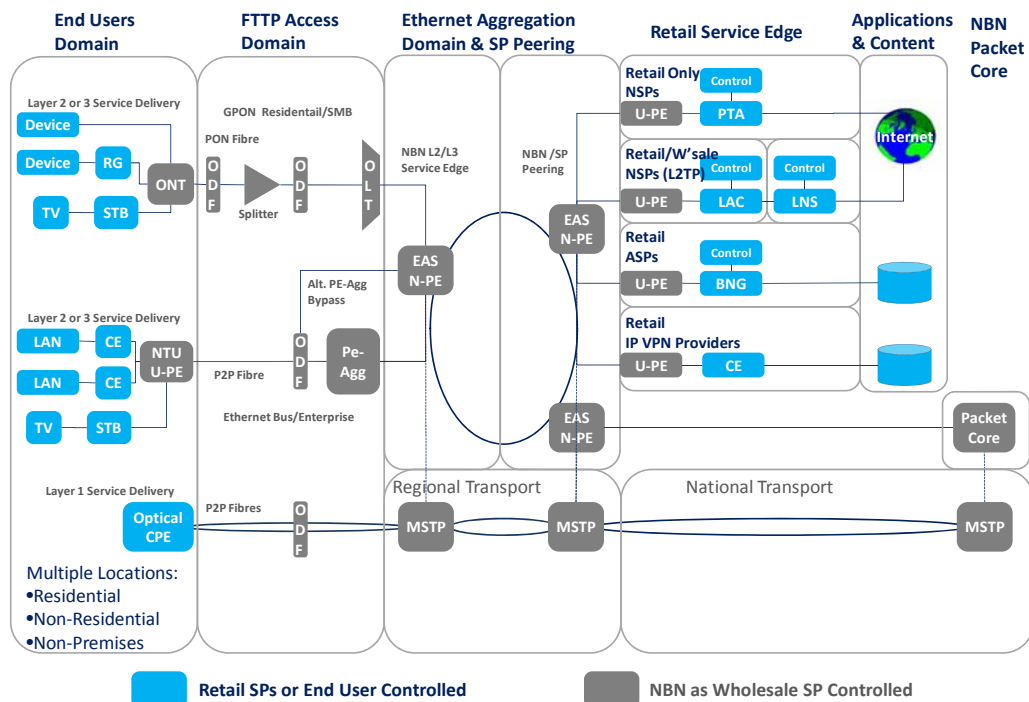**Retail SPs or End User Controlled**   **NBN as Wholesale SP Controlled**

Figure 2 - Broadband Network Reference Architecture – FTTP Access