ALL CHANGE FOR BROADBAND?

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At the time of writing, the media is full of speculation about the National Broadband Network (NBN), but there is limited hard information available. This article is an attempt to tease out a better understanding of the current developments in telecommunications in Australia. It is a high-level summary of the elements being considered and the policy issues still to be resolved, from the perspective of one interested observer, and as such it is certain to need correction and clarification as more is revealed.

The terminology used in this paper is that given in the Appendix, which provides a short tutorial on the current Telecommunications Environment.

THE NBN – A POLITICAL DECISION

The *Telecommunications Act 1997* set the policy parameters for a decade – full network competition with specific telecommunications regulation. The major concerns of the following years were with the implications of the successive tranches of privatisation of Telstra Corporation Limited.

This changed in the 2007 election. The current Australian Government was elected with the promise of a network offering high-speed broadband to 98% of Australia's population, and promised $4.7 Billion to the successful bidder(s). However, after evaluation by an Expert Group, no bidder was found to meet the bid requirements.

On 7 April 2009 there was a joint Ministerial announcement by the Prime Minister, the Treasurer, the Minister for Finance and the Minister for Broadband.

The main thrust of the announcement was that the Government would not proceed with their announced policy (NBN Mark 1), but instead they would proceed with NBN Mark 2.

The NBN would:

- Connect 90% of all homes, schools and workplaces with speeds up to 100 Mbit/s [urban areas and regional towns with a population above ~1000 using Fibre to the Premises (FTTP)];
- Connect the other 10% with wireless and satellite to deliver 12 Mbit/s;
- Be delivered by a new Government company, with private sector investment
- Require up to $43 billion over 8 years.

The NBN would also:

- Provide optical fibre links connecting rural towns to major centres and cities;
- Be wholesale only and open access;
- Be rolled-out in metropolitan, regional, and rural areas.

Those were the political decisions that are now being implemented.

BEHIND THE NBN – TECHNIQUES FOR BROADBAND ACCESS

Optical Fibre is a thin, very low loss glass fibre, able to pass laser-generated 'light'.

Digital modulation can allow very high-speed data transmission (10 Gbit/s and higher) per 'colour' or wavelength of light, and one fibre can support multiple colours. An optical fibre can operate for over 100 km without need for amplifiers/regenerators.

Almost all techniques for broadband access are based on at least partial use of optical fibre.

Optical Fibre is used almost exclusively in the central parts of a network, and increasingly in access from the user to the network. As a general rule, optical fibre is used as close as possible to the user, with other technologies possible when appropriate in the access network.

DSL (Digital Subscriber Line) The (copper) CAN or Customer Access Network connects each user to their local exchange. The CAN was designed to transmit voice, but as illustrated in Figure 1 the CAN also able to pass higher frequencies, which can be used to carry data.

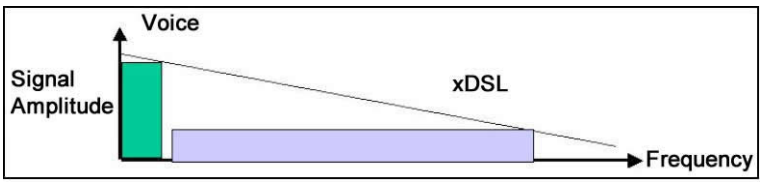

Figure 1 The copper CAN

These higher frequencies are much more subject to attenuation than the voice frequency range, but can still provide high data rates, particularly for users with only a short length of copper.

Most (but not all) standards for DSL are asymmetric, with a greater frequency allocation in the direction to the user than the allocation for the direction to the network, and thus a higher download bit-rate – hence **ADSL** or Asymmetric Digital Subscriber Line.

Data providers provide **DSLAMs** (DSL access multiplexers) at a telephone exchange, to connect to the user's copper pair. The copper provider (generally the incumbent telco) is able to use existing copper pairs it already provides for telephony. Other providers have to use the incumbent's copper, either by taking over an existing copper pair (the **Unconditioned Local Loop** or **ULL Service** specified by the ACCC in Australia) or only the higher frequencies (the **Line Sharing Service** or **LSS** specified by the ACCC).

The pricing and arrangements for these wholesale services have been the subject of continuing disagreement between the incumbent (Telstra), competing service providers and the ACCC. The indicative pricing principles issued by the ACCC suggest geographically varying prices for CBD, urban and rural areas, increasing as the density decreases and the cost of copper provision increases.

A number of ISPs are using ADSL 2+ standards to provide downstream speeds in excess of 10 Mbit/s to users close to the exchange where the ISP's DSLAM is located.

FIBRE TO THE NODE

In order to achieve higher speeds using ADSL, the distance between the user and the DSLAM should be kept to a minimum. In 2005, Telstra estimated that one third of their customers could

achieve a download speed in excess of 10 Mbit/s downstream with a direct ADSL connection to the local exchange, but the remaining two thirds would require a 'node' located closer to the user, served directly by optical fibre.

The initial proposal (NBN Mark 1) by the Australian Government was based on this technology.

FIBRE TO THE PREMISES

Optical fibre can be extended all the way to the user's premises. The standards bodies have defined two approaches. The first[1] uses a dedicated optical fibre per user, in a similar fashion to the current arrangements for individual copper in the telephone network. The second (and cheaper) approach uses a passive optical device in the distribution network[2], splitting the data stream across a number of users.

The current proposal (NBN Mark 2) uses fibre to the premises (FTTP) for about 90% of users. The CEO of the NBN Co. Ltd, Mike Quigley, has indicated the NBN is likely to use the second approach, using Gigabit Passive Optical Network (GPON) equipment[3].

FTTP does not have the distance limits of DSL – a user served by a GPON system could be 30 km or more from the 'exchange'.

RADIO

Optical Fibre to the premises cannot be used when the user does not remain at the one fixed location (mobile) and is often not appropriate for 'nomadic' users.

Final distribution to the end-user, for example within a dwelling or an office, can use a radio **LAN** (Local Area Network) such as WiFi technology.

Geostationary satellites can also provide final digital distribution, though the inherent latency caused by the time to reach and return to the satellite causes problems with some services.

The Third Generation (and the forthcoming Fourth Generation) of cellular mobile networks are optimised for data access, and are especially suited for mobile and nomadic access. These systems share the available radio spectrum between multiple users, and at best offer low to medium speed broadband in areas of high service density. Networks based on UMTS (3G) and WiMax currently offer some competition to ADSL Broadband, but are not able to support the higher speeds of FTTP.

TELEPHONY AND THE NBN

In developed economies, there is almost universal provision of telephony, combined with substantial regulation to ensure that the (fixed) telephone service is generally available[4]. In Australia, Telstra is designated as the USO provider, and must

> 'ensure that standard telephone services are reasonably accessible to all people in Australia on an equitable basis, wherever they reside or carry on business; and…ensure that payphones are reasonably accessible to all people in Australia on an equitable basis, wherever they reside or carry on business; and…ensure that prescribed carriage services are reasonably accessible to all people in Australia on an equitable basis, wherever they reside or carry on business.[5]

The first generation of telephony used analogue technology. The second generation used circuit-switched digital, and the current generation uses packet-switched digital, combining '**next generation network**' or **NGN** standards with IETF Internet standards.

Current telco networks use an Internet Protocol (IP) core able to support full Quality of Service (when needed) with a full range of services and applications, including but not limited to fixed and mobile telephony. These network can still support analogue access, but are designed to be digital end-to-end, using the digital access techniques described above.

INTERNET STRENGTHS AND WEAKNESSES

Some commentators have suggested that the NBN is basically designed to give access to the Internet, and as such should use a simple approach based on using Internet protocols. Whilst this is in part correct, it does not take into account the realities of the existing (public) Internet and the telephone network.

The layered architecture of the Internet enables substantial innovation, with new services and applications able to be introduced without any change to the access arrangements. (The introduction of greater speed in the access enables a whole range of applications such as higher definition video that are not possible over slower access arrangements.)

The public Internet is, however, 'best endeavours' with no guarantee of time to delivery, or even if a packet is delivered at all. This is overcome by utilising a retransmission protocol (**TCP**) to request missing packets. This works well for most applications, but causes problems for services that need real-time interaction such as gaming and telephony (interactive voice). This becomes evident with current **Voice over Internet Protocol** or **VoIP** services that provide good quality most of the time, but are degraded at times of high packet loss. (The solution used in private networks, including telco internal networks, is to use one of the available **Quality of Service** [**QoS**] techniques to ensure that packets are not lost or delayed. This has not been implemented across the public Internet.)

Arrangements need to be in place to make sure the introduction of the NBN does not degrade the existing telephone standards, but rather adds flexibility to the current network.

NBN REQUIREMENTS

With the excitement of 'ultra high speed broadband' promised by the NBN, it seems to this observer that a number of points are being lost in the current media discussion:

- Many future applications and services will require much lower speeds than the headline 100 Mbit/s of the NBN;
- Many users will want to pay for speeds much less than 100 Mbit/s, at prices comparable to those established by DSL in today's market; and
- Users will expect that the current telephone service will continue, and in the short term many would not accept 'cheap and cheerful' VoIP services as a substitute for the regulated standard telephone service;
- The economic viability of an NBN access will depend on a single wholesale charge for access to multiple services, including telephony. (Much of the analysis of the NBN economics seems

to have forgotten the existing 'line rental' charge that is part of the retail charges for telephony.)

IMPLEMENTATION OF THE NBN

At the time of writing, many of the details of the operation of the NBN Co. are not clear. In particular, the relationship between the Incumbent (Telstra Corporation Limited) and the new NBN Co. Limited is uncertain, and the scenarios below try to investigate the possibilities. The statement of 19 December 2009 describing the "terms of engagement" in continuing discussions between Telstra Corporation and the NBN Co. does little to indicate the likely outcome.[6]

Telstra at present is very much an integrated company. It has (or shortly will have) a core QoS enabled IP network, digital mobile access networks, a copper analogue telephony network that also supports ADSL broadband, and a substantial HFC pay-tv network in the major capital cities. It has the nation's largest ISP (Bigpond) and exclusive content deals for both the Internet and (via its 50% stake in Foxtel) Pay TV.

As the Incumbent Telco, it has had to make its facilities in non-competitive areas available to other service providers. It has the obligation to provide universal service (the **USO**, offering telephony or equivalent) across Australia, and must meet a regulated customer service guarantee (**CSG**) in the performance of its (fixed) telephony service.

At the time of writing, the *Telecommunications Legislation Amendment (Competition and Consumer Safeguards) Bill 2009* has passed the Lower House of the Australian parliament and is before the Australian Senate. As described in the associated Explanatory Memorandum,

> the package has three primary parts: addressing Telstra's vertical and horizontal integration; streamlining the access and anti-competitive conduct regimes; and strengthening consumer safeguard measures such as the Universal Service Obligation (USO), the Customer Service Guarantee (CSG) and priority assistance.

In other words, it is an attempt to tighten the regulatory constraints on Telstra. It 'encourages' Telstra to undertake a voluntary separation into a network/wholesale company and one or more retail units, with the threat of exclusion of Telstra from future spectrum areas that would be used for mobile services if this does not happen. If Telstra does not accept this 'invitation', it will be forced into a functional separation, and may have to divest its ownership of its HFC network and effective control of the pay TV business.

It is not clear at the time of writing if this legislation will be accepted, modified or rejected – the Government does not have control of the Senate.

The NBN Co. Limited has been established as a fully Government owned company. Mike Quigley (formerly of Alcatel-Lucent) has been appointed as CEO, and initial staffing has begun. At a Communications Alliance Forum on the NBN, Mr Quigley said that NBN Co. intends to provide a layer 2 bitstream service. He also said that it was likely that the network termination device (ONT or Optical Network Termination) would have one or more ATA (Analogue Telephony Adaptors) as is the case for Verizon in the USA, but this would not be operated by the NBN Co. The ONT would offer Ethernet (Layer 2), and perhaps the ATA and a pay TV radio-frequency output. The NBN Co issued[7] a Consultation Paper "Proposed wholesale fibre bitstream

products" on 24 December 2009 that gave more detail on the NBN Co. proposals, and forms the basis for current industry consultation.

Much of the detail of the operation of NBN Co. will come from a current **National Broadband Network Implementation Study**, with McKinsey-KPMG as Lead Advisor. The study is to provide advice on the NBN, including operating and governance arrangements for NBN Co.; ownership caps; ways to attract private sector investment; network design; and ways to provide procurement opportunities for local businesses. The study report is due early in 2010.

Little has been heard about the progress of this study, but significant work has been continuing on the technical details. The Communications Alliance has commenced a major project, and has produced a broad architecture for the NBN[8], shown in Figure 2. This is not an official output from the NBN Co., but has had input from NBN staff and indeed the initial leader of the group, Gary McLaren, has been selected as the Chief Technology Officer for the NBN Co.

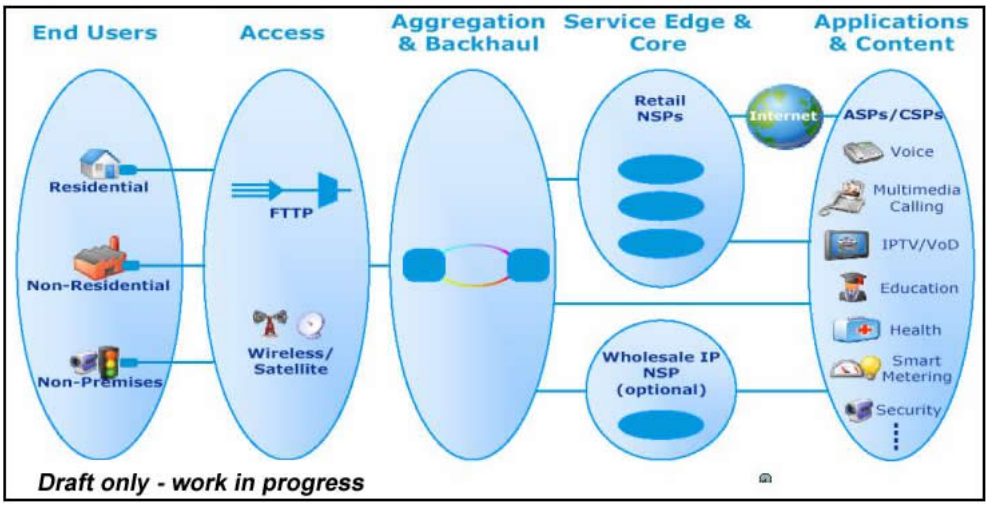

Figure 2 Simple model from communications alliance

If the NBN Co. restricts its product offerings to Layer 2 (as indicated by its CEO), its network would presumably extend from the user to a point of aggregation / point of interconnection, which may be relatively close to the end user (as is the current case for telephony) or at a remote location (for example a capital city, as is the case for current data/Internet).

Services to the end-user, including telephony, would require separate network service provider(s) responsible for Layer 3 and above. The NBN Co. would be a carrier in a strict legal sense, but would not have responsibility for the end user-to-end user carriage of any service, including telephony.

SCENARIOS

OPTION A: TELSTRA ACTIVELY OPPOSES THE NBN CO.

In this scenario, Telstra would attempt to retain control of its copper network, whilst using the potential competition from the NBN Co. to argue for regulatory relief. It would claim that little

or no space is available in existing Telstra CAN ducts for NBN Co. use, whilst giving tacit support to the environmental lobby that is likely (based on HFC experience) to object to aerial cabling.

Telstra may re-activate its Fibre to the Node (FTTN) plans, and would be able to offer medium speed broadband in competition to the NBN Co. It would be in a good position to undercut NBN Co.'s wholesale rates for all but the highest speeds, and would be able to offer competitive retail rates.

Telstra is likely to have to continue to offer the ULL and LS services as defined by the ACCC, and if it proceeds with FTTN, may have to support sub-loop unbundling, in a similar fashion to Chorus in New Zealand.

The NBN Co. would have great difficulty in achieving profitability, particularly if it is under a political direction to offer a uniform wholesale price in all geographic areas, based on the following factors:

- The high cost of initial installation, by comparison with Telstra's marginal costs;
- The inability to access the immediate revenue stream from the telephony line rental; and
- The relatively low wholesale tariffs for the LSS and the ULLS mandated by the ACCC for the CBD and suburbs of major cities when compared with the need to for the NBN Co. to subsidise non-metropolitan areas

OPTION B: TELSTRA REACHES AGREEMENT WITH NBN CO.

If Telstra is required to separate its access network from its services, either by structural or functional separation, it may find its best commercial option is to offer the current copper access network in some form to the NBN Co. (This may be by sale, if a price could be agreed, or by some form of leasing.) This approach is implied in the current "terms of engagement" for Telstra / NBN Co. discussions.

If the NBN Co. has control of the Telstra CAN, it would be able to establish an orderly transition to the new FTTP CAN, and use existing Telstra ducts where possible. This would enable a much cleaner transition, and ensure a source of revenue from the telephony line rental.

However, both before and after the transition to the new CAN, there would be major policy implications. Who would operate the (regulated) telephony service? Who would provide the Standard Telephone Service, and be responsible to the user for meeting the Customer Service Guarantee? As retail services, the NBN Co. would have no direct responsibility to the end user, but the performance of NBN facilities would play a major part in the total service.

The NBN Co. would have the best chance for achieving profitability under this scenario, as it would have a virtual monopoly for the fixed CAN in many geographic areas. However, current retail tariffs for telephony and low to medium speed data would establish a wholesale floor above which the NBN Co. would be unlikely (politically) to substantially climb.

Under this scenario, the NBN Co. would have a monopoly. Who is going to regulate the NBN Co., and how, and to what extent?

SCENARIO C: MUDDLING THROUGH

If Telstra and the NBN Co. are not able to achieve agreement, for example over the value of Telstra's existing CAN, then there will be a raft of policy issues for the Government to address,

some of which may be the reason for aspects of the legislation now before the Senate. Some of these issues include:

- Will Telstra be required to stop providing its copper CAN when the NBN Co. FTTP CAN is available at a location?
    - How would this be enforced? By what existing or new regulatory head of power?
    - Would the Government be liable to pay compensation to Telstra and its shareholders?
- Would Telstra be prevented from providing its own optical fibre in the CAN and/or digital IP telephony? (The same questions as above apply.)
- Who would be responsible before, during and after the transition, for
    - Provision of the Standard Telephony Service under the USO?
    - Maintenance of the Customer Service Guarantee

OTHER POLICY ISSUES

There will be many policy issues that need to be resolved in an NBN environment. Some have been outlined above, but others still have to be publicly considered, including:

- Maintenance of the USO and CSG before the NBN introduction in an area;
- Transition arrangements
    - For access;
    - For telephony;
    - For data services; and
    - For other services;
- Regulatory arrangements for telephony (and telephony bundled with other services) after the transition;
    - Division of Operations and Maintenance responsibility between the NBN Co and retail telephony service providers;
    - Continuing arrangements for the USO and CSG;
    - Maintenance of the telephony numbering plan after the transition;
- Relationship between Internet Protocol address allocation (IP versions 4 & 6), Internet naming (particularly the .au domain names) and the telephony (E.164) national numbering scheme;
- New arrangements for Layer 3 wholesale service providers (transport service providers;
- New arrangements for non-telephony services and applications in an NBN environment;

- Quality of Service arrangements in the NBN between the NBN access and the range of services and applications;
- Geographic arrangements for NBN wholesale tariffs;
    - Universal tariff vs ACCC nidated geographically variable ULLS tariff; and finally
- Which socially important services are part of a future package of 'standard' telecommunication services?

CONCLUSION

A political decision has been made, and applauded by most in the industry (including this writer). The technology exists, but there is a massive challenge ahead to roll out the new network.

This analysis suggests that much depends on the arrangements for a successful transition from the current regulated telephony arrangements to the future environment of an open access NBN and the competitive supply of services and applications. We may all change, but we carry the luggage of the past with us.

The policy issues as well as the technical arrangements need to be discussed openly – Australia cannot afford to get this wrong.

APPENDIX: THE TELECOMMUNICATIONS ENVIRONMENT

'Telco' (or telecommunications company) is the term used in this article to indicate communications service providers in general, often moving from providing telephony to a broad range of communications.

Telephony (interactive, two-way voice) was first provided over twisted copper wires to each user, switched at a telephone exchange. More recently, cellular radio-frequency techniques have been used to provide mobile telephony.

(The **Standard Telephone Service**, provided by Telstra as the incumbent telco, has special policy significance in Australia.)

The **Incumbent Telco** the former monopoly provider of telephony service, provider of a copper CAN (customer access network) that gives access to each user in the area of incumbency (which may be national or regional). In the past, an incumbent telco was often Government owned and/or tightly regulated, with social/political goals such as universal service. In developed countries, the incumbent telco is now fully privatised, with a Board of Directors with prime responsibility to the company's shareholders. Government policy is asserted by detailed regulation of (some) of the Telco's operations.

This pattern was followed in Australia – the PMG (Postmaster General's Department) was a Government Ministry, Telecom Australia was coporatised as a Government-owned company, and Telstra Corporation Limited has been fully privatised in three tranches.

Competing Telcos have been allowed in many countries over the last twenty years. In some geographic areas of each country these telcos cannot economically duplicate the facilities already installed by the incumbent telco (for example, the copper CAN). The incumbent telco would be likely to charge a wholesale rate for services using these facilities that would include some element of monopoly return. As a consequence, the wholesale price at which such 'declared services' are available is set by the regulator at levels that (arguably) remove this monopoly return. For other services were there is more open competition (for example mobile services and long-distance telephony) there is much lighter regulation.

Competing telcos are often owned by an incumbent from another market – for example Optus (owned by Singapore Telecom) and AAP-T (owned by Telecom New Zealand) in Australia.

Pay TV or Cable TV is a reticulation network for video entertainment, often with satellite delivery to a head-end, and then optical fibre to a final coaxial delivery (hence Hybrid Fibre Coaxial or HFC). Originally these networks used analogue radio-frequency delivery, but now use digital techniques, and it is possible to provide Internet access and Internet telephony with an appropriate architecture. In many countries these networks are the main source of competition to the incumbent telco, offering this 'triple play' of video, broadband Internet and telephony. In Australia the HFC networks are owned by the incumbent telco and its main competitor, Optus, and the HFC networks have not grown – extension of the Pay TV services has been via direct satellite distribution rather than by growth of the HFC networks.

The **Internet** is a network of networks, using the Internet Protocol (IP) defined by the Internet Engineering Task Force or IETF. Internet technology is used for a wide variety of private and public networks – the network generally known as 'the Internet' (the public Internet) is formed from interconnected public networks, provided by ISPs.

The Internet uses a layered architecture so that providers of services and applications generally do not need to have regard for the details of the access, which may use a range of media.

Internet Service Providers or **ISPs** enable access to the (public) Internet over a variety of transmission media, including

- The telephone network, using dial-up modems;
- Cellular radio networks;
- Higher frequencies over copper originally provided for telephony use; and
- Optical fibre access.

(ISPs interconnect to other networks, including backbone networks that enable access to other Internet users.)

Content Service Providers utilise the various networks to provide content-based services. The Internet, in particular, has many companies offering services that have no connection with the ISP serving a particular user, utilising the standard interfaces such as the World Wide Web.

End users of networks could be:

- **Fixed,** always accessing the network from one location;
- **Mobile,** accessing the network over a wide area, either while in motion or stationary; or
- **Nomadic,** accessing the network from a fixed location which changes over time (e.g. home, coffee shop and office).

ENDNOTES

1 This point-to-point approach has been standardised by the IEEE as 802.3ah.

2 This "passive optical network" or PON approach has been standardised by the International Telecommunication Union in the G.983 series of Recommendations.

3 Mr Quigley indicated the likely use of GPON (and other initial technical views) at a Communications Alliance Forum on 23 September 2009 – see www.commsalliance.com.au/__data/assets/pdf_file/0020/19055/NBN-Co--Initial-steps-14092009.pdf.

4 There is generally considerably less regulation of the mobile telephone service, which generally has multiple providers (and may be larger in size if not geographic coverage than the fixed telephone service.

5 Quoted text from Section 9 of the Telecommunications (Consumer Protection and Service Standards) Act 1999.

6 Telstra Corporation Company Announcement of 18/12/2009, archived at www.asx.com.au/asxpdf/20091218/pdf/31mtg0mgkndsm8.pdf.

7 The NBN Co Consultation Paper is available at www.nbnco.com.au/content/upload/files/NBN001_concept_paper_final.pdf.

8 A substantial Paper was issued for public comment in November 2009, and was discussed at a number of public seminars. See www.commsalliance.com.au/__data/assets/pdf_file/0005/19517/Draft-National-Broadband-Network-Reference-Architecture-Oct-2009.pdf for the paper.

Cite this article as: Darling, Peter. 2010. 'All change for broadband?' *Telecommunications Journal of Australia*. 60 (1): pp. 3.1 to 3.11. DOI: 10.2104/tja10003.