ALCATEL-LUCENT SUBMISSION

NBN Request For Regulatory Submissions

JUNE, 2008

Introduction

During recent decades, telecommunications technologies have been developing at an increasing pace. Commercial pressure to reduce operational cost and to respond to aggressive services competition mean that telecommunications investment cycles which used to span several decades, are now more commonly evaluated in a two to five year timeframe. Reduced technology cycles place pressure on the business case for investment. More than ever before, an efficient telecommunications industry is necessary if local infrastructure is to meet internationally competitive standards.

A defining capability of contemporary telecommunications infrastructure is its ability to support 'Multiservice' and the corresponding market demand for a plethora of network borne services on an end to end basis beyond simple and traditional telephony. Next Generation Networks and Application capabilities carry significant implications for industry structure, proponent responsibilities and the manner in which consumer welfare is to be assured through effective competition. To date in most jurisdictions, it would be fair to generalise that technology and its implications have been evolving at a significantly more dramatic pace than that of telecommunications policy, regulation and legal reform.

The uncertainties introduced by the policy, regulatory and legislative lag is often and justifiably claimed to introduce investment risk and thereby impede investment. Today's challenge for policy makers is to balance regulatory settings to simultaneously:

- encourage efficient investment in Next Generation technologies to underpin a nation's international competitiveness and provide a framework for significantly reducing greenhouse emissions
- encourage and assure healthy competition to stimulate innovation and deliver the best consumer outcomes.

The aim of this submission

All technologically advanced nations are now engaged in local discussions about the best policy, regulatory and legislative environment for supporting potential investors embarking upon next generation telecommunications infrastructure and applications projects.

In its dialogue with regulators and policy makers the world over, Alcatel-Lucent is frequently asked to share its experience as the leading international vendor of wireline broadband access technologies. Our experience shows us that whilst there are many significant similarities in the needs, national approaches differ considerably.

In this submission, Alcatel-Lucent will endeavour to examine those key similarities and differences between recent approaches or proposed approaches to advance competition in the telecommunications industries within various member states of the European Union (EU).

Also reproduced, attached to the end of this submission in its entirety, is a previous submission to the ACCC from July 2007, on the impact of Sub-Loop Unbundling on the benefits for the next generation of VDSL2 enhancement using Dynamic Spectrum Management Level 3. This is included in two contexts. Firstly it is a technical constraint that must be addressed in policy and accommodated through regulation to ensure that the utility of the existing copper network can be further enhanced to provide higher speeds whilst optimising NBN costs. Secondly it is a clear example of the kind of challenge rapid technological advancement poses to traditionally slower paced policy and regulation; showing that consumer benefit may be ultimately constrained by the flexibility and pace of policy and regulatory reform.

In summary, this submission contends that:

- There is no one clearly proven or preferable model of ‘separation’
- The most advanced implementation of separation, that of the UK, provides no evidence that separation has accelerated or facilitated investment in Next Generation Access.
- Design and implementation of a ‘future proof’, ‘carrier grade’, ‘resilient’ and ‘reliable’ National Broadband Network in an environment of rapid technological change will be impeded by the distraction surrounding unresolved separation speculation.
- To the extent that separation might or does impose open ended technical requirements, the implementation of a technically efficient solution will be impeded and complicated. A requirement or implied requirement for a more complex technical solution will impact both the time to deliver and consume additional deployment resources, adding to the NBN’s cost.
- The specific manner of separation can have significant bearing upon the extent to which benefits of a truly multi-service, converged network can be practically realised.

About Alcatel-Lucent

Alcatel-Lucent (Euronext Paris and NYSE: ALU) provides solutions that enable service providers, enterprises and governments worldwide, to deliver voice, data and video communication services to consumers. It:

- has provided equipment and technology underpinning 80+ FTTx deployments in 90% of the top broadband economies including 20+ nationwide operators and 60+ municipalities and utilities,
- is the world’s leading supplier of xDSL technologies, a position it has held since 1997,
- is the world’s leading supplier of GPON FTTH technologies,
- is engaged with 25+ major telecommunications incumbents and competitors in IP end to end network transformations and in many more non end to end transformation projects,
- Everyday, more than 300 TeraBytes of data equivalent to around 3 billion web pages or 60 million songs, is delivered across our DSL technology platforms in Australia and New Zealand,
- Daily, more than 25 million calls are made across our technology platforms in Australia.

Alcatel-Lucent is proud to supply equipment and services to Australia’s leading telecommunications incumbents and competitors. It has supplied the infrastructure for a significant portion of Australia’s residential DSL community, making it a leader in helping Australians access the advantages of a digital lifestyle. Its solutions achieve advances in DSL, fibre optics, wireless and satellite access that help companies and individuals get maximum benefit from fast Internet services.

Alcatel-Lucent’s commitment to Australia is not new. It has been part of the Australian telecommunications fabric since 1895.

Its leadership in the development of Australia’s communications infrastructure has included the country’s first undersea cable network, the introduction of broadband Internet, the country’s first 3G mobile network (m-Net) and the world’s longest optical link, between Adelaide and Darwin.

As a leader in fixed, mobile and converged broadband networking, IP technologies, applications, and services, Alcatel-Lucent offers the end-to-end solutions that enable compelling communications services for people at home, at work and on the move. With operations in more than 130 countries, Alcatel-Lucent is a local partner with global reach. The company has the most experienced global services team in the industry, and one of the largest research, technology and innovation organizations in the telecommunications industry. Alcatel-Lucent achieved revenues of Euro 17.8 billion in 2007 and is incorporated in France, with executive offices located in Paris.

Alcatel-Lucent wishes to continue to play a leading role in improving Australia’s economic outlook and standard of living by ensuring that the community has access to a rich variety of broadband services, wherever they live.

For more information, visit Alcatel-Lucent on the Internet: http://www.alcatel-lucent.com.au

Or contact

Ric Clark, VP Solutions, Strategy and Technology: ric.clark@alcatel-lucent.com.au

Stefan Keller-Tuberg, Principal Engineer, Regulatory and Access: stefan.keller-tuberg@alcatel-lucent.com.au

Angela Armstrong, Corporate Communications Manager: angela.armstrong@alcatel-lucent.com.au

The different degrees of separation

At the highest level, several alternatives have been proposed for supporting Next Generation competition. An important aspect of the policy objectives can be categorised as being directed towards reducing the power of telecommunications incumbents in relation to bottleneck infrastructure so as to facilitate efficient competition in downstream markets. Variously, the approaches have been called 'accounting separation', 'functional separation', 'operational separation' and 'structural separation'.

To some extent, these terms have acquired meaning in the telecoms sector without prior agreement upon formal definitions. Because of the lack of definition, it is sometimes difficult to fairly compare and contrast approaches between two disconnected or loosely connected jurisdictions or markets – because of differences in the way these terms are used. With the aim of avoiding this kind of confusion in our submission, we wish to explicitly define our use of them.

Accounting Separation

Accounting Separation aims to eliminate tariff squeezing by the incumbent by imposing a regime of cost-oriented accounting, reporting and financial management upon it. By adopting this remedy, the incumbent is constrained from cross subsidising less profitable investments and services from the proceeds of more profitable investments and services. The accounting separation approach aims to reduce barriers to entry by establishing clear distinctions between core and access activities to ensure cost-oriented pricing for wholesale services offered by incumbents to new entrants. Accounting separation is aimed at implementing financial mechanisms to guarantee fair terms for competitive markets.

Functional Separation (sometimes referred to as 'Operational Separation')

The Functional Separation approach requires the incumbent to transfer bottleneck assets into a separate wholly owned division of the company. A separate management team and staff are assigned to the new division. Incentives for its staff are tied to the success of the division, rather than to the success of the company as a whole. These steps are taken with the express intention for assuring equivalence of treatment for downstream users of the products offered by the bottleneck asset division. In other words, the primary purpose of Functional Separation is to provide a transparent means of assuring non-price related "behavioural" equivalence between competitors and the incumbent's downstream arms.

Following its voluntary separation of access into a new division called 'Openreach', BT (British Telecom) has been the most outspoken promoter of Functional Separation. TNZ (Telecom New Zealand) is the only other major operator well down the track of a practical implementation of Functional Separation, but even this varies in detail to that of BT.

The European Competitive Telecommunications Association (ECTA), which represents competitive operators, ISPs and suppliers of products and services to the communications industry has adopted the position that Functional Separation could be used to address barriers to competition in the sector[1] but has not indicated preference for either the BT or the TNZ form of the functional split.

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[1] Refer to http://www.ectaportal.com/en/upload/File/Press%20Releases/2008/BB_Sc_Q307_prv2.pdf

In the 2007 Package Review, the European Commission proposed granting national regulators with powers to impose functional separation. Functional separation is intended to be a remedy of last resort and is aimed at opening broadband access markets in countries where the strategy of copper loop unbundling has failed. The proposal is being hotly debated at the European Parliament and still requires agreement by the governments of EU member states. It is unclear at this stage what form the ultimate regulatory changes will take, but it is likely that prior agreement by the Commission will be required before imposing separation on a national incumbent – making this particular remedy extremely complex and long to implement.

Structural Separation

The Structural Separation approach is regularly confused with Functional or Operational Separation. The difference with Structural Separation is that a structurally separated entity's ownership is totally severed from its former parent. Each independent organisation resulting from a structural split therefore has its own capital for listing on the stock exchange. Corporations and Anti-Trust Laws typically play a much greater role in confining the nature of the relationship between the separated entities.

The Irish operator Eircom has been the only example of an incumbent considering a structurally separated split, but in April 2008 amended its proposal in favour of a form of Functional Separation[2].

Is Functional Separation an effective tool for broadband competition?

Five basic "remedies" to breaking non-competitive markets were defined under the initial *European regulatory framework for electronic communications networks and services* in 2002 and under review since June 2007[3]:

- Transparency (regarding any commercial operations, investments, tariffs decided by the incumbent that could negatively impact competition)
- Non-discrimination (between internal incumbent activities and market competitor operations)
- Ex ante tariff control i.e. tariff controls based upon anticipated economic, market and technology developments (both in retail and wholesale markets)
- Access to essential facilities (such as interconnection)
- Accounting separation (between incumbent access, backhaul, core network and service accounts to fight against cross-subsidization)

Functional Separation has been proposed as a regulatory complement to existing Accounting Separation practice. Once adopted, national regulators would only initiate mandatory Functional

[2] Eircom's change in plans was widely reported: http://www.telecompaper.com/news/article.aspx?cid=615768
http://archives.tcm.ie/businesspost/2008/04/20/story32158.asp
http://www.telecomdirectnews.com/do.php/105/30241

[3] European Commission (2006), Communication on the Review of EU Regulatory Framework for electronic communications networks and services, SEC(2006)816-7, European Commission, Bruxelles.

Separation after having exhausted all other remedies regarding broadband market regulation. It is an ex post (i.e. retrospective) tool used for corrective action by reinforcing existing measures.

This remedy was conceived for invocation in regard to issues surrounding broadband access linked to the legacy copper access network, and its usefulness, notably the example of the UK broadband market, has been effective. However, its applicability to other types of access networks (mobile, cable, fibre) or other national markets with different competitive conditions is yet to be fully explored. Similarly, uncertainties surround the Functional Separation approach with respect to different investment models, for example, NGA operator investment plans can integrate a large number of network components or communication layers, for example;

- Fibre distribution architecture choices such as PON (Passive Optical Networks) and Point-to-Point fibre,
- New access node location strategies,
- Convergence services with other access networks (such as wireless / mobile networks),
- OSS/BSS (Operations Support Systems, Business Support Systems) optimisation, choice of server platforms,
- The introduction of video / TV / interactive entertainment capabilities and services,
- And so on

To date, the frontier between NGA applications and the underlying access network (DSL-based, fibre-based, wireless based), or between access and core network elements or interfaces is not clear, to the contrary, convergence continues to blur the borders.

Other than the UK[4], only Sweden[5] and Italy[6] amongst all European nations have officially decided to move forward with some form of Functional Separation. The government and / or National Regulatory Authority (NRA) in a number of major EU markets oppose separation; notably Germany[7], France[8], Spain[9] and The Netherlands[10].

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[4] Ofcom, the British regulator, accepted British Telecom's undertakings to voluntarily separate in September 2005. Refer to http://www.ofcom.org.uk/telecoms/btundertakings . In BT's submission to the Australian FTTN Experts panel in March 2008, it describes its own approach to separation as 'Functional Separation'. Refer to its "*Suggestions for the FTTN – National Broadband Network for Australia*" paper available at http://www.dbcde.gov.au/communications_for_business/funding_programs__and__support/national_broadband_network/submissions/BT.pdf

[5] The Swedish government's legislative proposal for functional separation of TeliaSonera was published on March 18, 2008. Refer to http://www.regeringen.se/content/1/c6/10/10/56/d661f776.pdf

[6] The Italian regulator, AGCOM, commenced a proceeding on December 12 2007 that may eventually lead to functional separation of Telecom Italia. Refer to http://www.agcom.it/provv/d_626_07_CONS.htm

[7] The national regulator as well as the German government have made public statements against separation, see also Angela Niebler (German Member of Parliament) comments to Telecom Review package (EP ITRE – AM / Art 42 2008)

[8] In April 2007, the French regulator ARCEP outlined arguments for and against functional separation, highlighting the negatives and apparently taking the negative position. Refer to http://www.arcep.fr/uploads/tx_gspublication/lettre55-eng.pdf

‘Convergence’ raises the question of integration versus separation

The nature of convergence

To be clear, there is no single dimension of convergence. Convergence is taking place between

- The fixed and mobile networks,
- The telecommunications, broadcasting and other media industries,
- The architecture of formerly disparate telecommunications technologies towards a single all-IP (Internet Protocol) network carrying all and every form of telecommunications traffic,
- The unification of different forms of access into next generation access nodes that support many forms of access on a single platform,
- The unification of different forms of transmission and backhaul into higher capacity and higher order multiplexes,
- The unification of disparate subscriber management systems into an integrated IT platform,
- The unification of disparate billing systems into an integrated IT platform,
- The integration of formerly disparate voice systems and applications into an integrated VoIP (Voice over the Internet Protocol) platform,
- The unification of general network resource servers.

When taken together, these different forms of convergence have already had a profound affect upon the telecommunications industry and will continue to have an even greater impact as technology and applications continue to mature in the future. Regulators and policy makers are encouraged to explore the nature of these different dimensions of convergence and contrast them against the traditional telecommunications industry and its traditional regulatory and policy objectives.

In the past, the success of regulatory interventions has frequently been assessed in terms of the degree to which intervention has promoted the emergence of new market entrants, healthy price competition and the emergence of new innovative market offerings. The characteristics of the independent dimensions of convergence strongly suggest that in the future, additional attributes will need to be considered when evaluating the success of interventionist policy and regulation:

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[9] In January 2008, the Spanish regulator CMT concluded that Functional Separation would require changes to their regulatory framework but would be an ‘extreme and exceptional’ measure. Refer to http://www.cmt.es/es/home/novedades/anexos/ANEXO_NGA.pdf

[10] The Dutch regulator OPTA examined the separation of British Telecom and its relevance to Holland in March 2007 and found that functional separation may produce undesirable effects to infrastructure competition . Refer to http://www.opta.nl/asp/en/newsandpublications/backgroundinformation/document.asp?id=2143

- the extent to which the capabilities of local infrastructure transformation projects are tracking the OECD best practice capabilities (simultaneously delivering higher throughput, greater resilience and reliability and a broader range of applications),
- the extent to which collaborative application developments between the telecommunications, media, health, education and corporate sectors are tracking industry reformation on the OECD best practice countries (the convergence between formerly disparate sectors).

It can be strongly contended that these additional attributes of convergence are just as much in the Long Term Interests of End Users as traditional measures.

Alcatel-Lucent wishes to stress that in many significant aspects, the benefits and drivers of ‘convergence’ concern the integration, not the separation, of network elements. It would be eminently reasonable to look at each of the individual dimensions of convergence in isolation and to measure the appropriateness of any particular regulatory approach on the basis of the degree to which it promotes or discourages the benefits that will be derived from that particular dimension of convergence.

It is likely to be largely because of this realisation that a majority of National Regulatory Authorities are approaching the possibility of imposing separation in such a cautious and measured manner.

> *"In recent years, Alcatel-Lucent has been deeply engaged in transforming the world's telecommunication infrastructure to IP based broadband networks, including all of the world's leading operators. Given the importance of national telecommunications infrastructure and its role, particularly at times of national emergency, we have always placed considerable attention to engineering flexibility, resilience and reliability into our network designs. It is just as important for our customers to understand the vulnerabilities as well as the capabilities of the next generation networks they are deploying.*
>
> *Network resilience and reliability are not always features that excite nor do they always seem to add value. It is easier and less expensive to implement a less resilient and less redundant network design, and there will be little effect on network performance until there is some unforeseen event. Whether this be a natural disaster, consumer driven demand or network failure the outcome is the same, without the proper network design a seemingly less expensive network can end up costing more.*
>
> *In the ongoing regulatory debates in various countries, a lot of attention has been focused on driving the cost to consumers down, and towards imposing one of several alternate forms of separation to drive equivalence as a necessary precondition for effective competition. Unsurprisingly less has been said about assuring the nation a reliable and dependable infrastructure.*
>
> *The frustration many of us experience when our Internet connections are lost or unavailable could not have been imagined as little as five years ago.*
>
> - *It is easy to forget that telecommunications networks are a significant part of the critical infrastructure of all nations, more so with the advent of broadband networks.*
> - *It is easy to fall into a trap of sweeping the burden of robust design under the carpet, to avoid investment in reliable designs in favour of short term economics.*
> - *It is easy to compartmentalise reliability and resilience into access and core functions, missing the point that effective infrastructure is engineered end to end, and robustness is most effectively managed by consideration of the network as a whole, not as its parts.*
>
> *National broadband infrastructures will underpin the worlds leading economies and it is imperative for Australia that policy makers balance the twin requirements of a competitive market with engineering driven reliability and resilience. Both have their place. Few would be satisfied with an outcome that delivers one without the other."*
>
> **Scott Nelson, CTO - Carrier Business Group, Alcatel-Lucent, Paris Headquarters**

Convergence in the EU

The revised regulatory framework confirms that "convergence", in each of its varying dimensions, is beneficial to consumers, industry and competition. However, when discussing the frontiers between functionally separated units, convergence becomes a policy challenge rather than a competitive advantage. It is literally impossible to optimally separate today's integrated network elements and services – separation can only happen through arbitrary decisions based on complex bilateral negotiations between the incumbent and the regulator. Separation adds unavoidable and intrinsic underlying cost because it imposes artificial boundaries that constrain fundamental engineering decisions, leading to duplication of equipment and operational support sometimes foregoing economies of scale or efficiencies at the interfaces between separated units.

Recent studies in countries debating separation (Ireland[11], Portugal[12], Italy[13], Sweden[14], Poland, Austria[15]) show that approaches vary considerably and that there is no pre-defined perimeter for what should be included in the separated "access" unit. Moreover, when compared to markets where vertical integration is dominant (US, Asia), the impact of such separation on inter regional competition is unknown.

Two risks have been recognised by EU's policy makers:

- The potential need to artificially maintain regulated conditions over a separated access unit, even when the broadband access market has matured,
- The creation of a new access monopoly in the functionally separated entity, discouraging future competitive infrastructure investments.

It is clear that Functional Separation is a fundamental remedy having structural effects on communication service and equipment markets that go beyond today's typical market analysis periods of 2 to 3 years. If separation fails or if future market conditions change, Functional Separation cannot easily be rolled back to a "less separated" form of regulation. As a result, the Functional Separation approach cannot be implemented to assure a given set of known competition objectives within a given period of time.

Separation is not a precondition for investment

Recent trends show strong investment either in the traditional copper access network (xDSL) or in the NGN core. The largest access investments have been noted in nationwide migration plans towards NGA fibre + VDSL2 (i.e. FTTN)[16], or in FTTx announcements such as those in Sweden, Denmark and France[17], which are countries in which no form of separation has been necessary to encourage those investments to date.

[11] Eircom, the Irish incumbent, has indicated mandatory requirements for functional separation are not required. During 2007 and 2008, it has issued several discussion papers on the subject of voluntary structural separation.

[12] The Portuguese regulator ANACOM remains ambivalent to separation and will conduct a six month survey of the experiences of European functional separation commencing in the third quarter of 2008. http://www.anacom.pt/streaming/planoestrateg2008_2010.pdf?categoryId=1755&contentId=534635&field=ATTACHED_FILE

[13] The Italian regulator, AGCOM is encouraging Telecom Italia to voluntarily separate along functional lines.

[14] The Swedish regulator is in favour of functional separation and in June 2007, published a report with suggested legislative amendments. Refer to http://www.pts.se/upload/Documents/EN/Improved_broadband_competition_through_functional_separation_2007_18.pdf

[15] The Austrian incumbent Telekom Austria strongly opposes any form of separation as 'against the logic of the market'. In October 2007, the Austrian regulator RTR said it would monitor approaches in other European jurisdictions but would not adopt a proactive position until 2010 at the earliest. Refer to http://www.rtr.at/en/komp/NewsletterTK092007

[16] For example, the Dutch incumbent KPN and competitive cable operators, the German incumbent DT and competitive city sponsored broadband deployments.

[17] Incumbents in these markets have progressively released investor statements indicating their intentions and have spoken of their intentions at public forums such as the "FTTH Council Europe" conference in Paris, February 2008.

Discussions have been complex and slow because individual EU markets have differences

Complexity comes from the collision of three issues, initially unrelated, but all directly impacting access evolution:

- Operationally separating access assets from the core network is being discussed as a remedy against behavioural impediments towards LLU adoption in broadband markets.

  (Alcatel-Lucent notes in the attached ACCC regulatory submission that technological evolution towards greater coordination between loops implies that ongoing support for LLU implies diminished access to the benefits of emerging access technologies.)

- Next Generation Access (NGA), e.g. over fibre, has been included in the revised regulatory framework but it's too early to draw conclusions from the second round of market analyses.

- Deployment of fibre deeper into the access network requires costly renovation of passive infrastructure and streamlining of accessibility to consumer premises. New legal and social debates are inevitable and will stretch well beyond the scope of the regulation of the communications sector.

In the EU, today's limited visibility into access investment is largely due to the parallel development by different Member States of different approaches to the abovementioned access issues. This complexity is perhaps best highlighted by exploring the major access regulatory interventions since 2005:

- 2005 – UK's BT (British Telecom) proposed Functional Separation in exchange for NGN investment rights and regulatory relief

- 2006 – Germany imposed "graduated" regulation over DT's (Deutsche Telekom's) new access investments (FTTN / VDSL2) ranging from trench / duct / cabinet sharing to fibre unbundling of the fibre feeder network

- 2007 – France adopted an approach, which focused upon imposing infrastructure-sharing obligations for the incumbent and regulation of Multi-Dwelling Unit fibre cabling to streamline investor access to buildings. Simultaneously, the regulator substantially facilitated local community access renovation projects.

All three approaches represent valid frameworks for promoting competition in NGA markets. At this point in time, the third approach stands out as the most successful in encouraging competitive parallel investment in end to end fibre access.

Are there lessons to be learned from the Openreach experience?

There has been little contention on the point that the establishment of Openreach successfully stimulated the adoption of LLU (Local Loop Unbundling) and competitive DSLAM (Digital Subscriber Loop Access Multiplexer) investments. However Openreach was established in 2005 and contemporary access technologies have moved on considerably since that time. The dominant technology in the Openreach network is ADSL/ADSL2+ but with the recent standardisation of VDSL2, contemporary access transformations are taking the new technology into account.

Although ADSL2+ technology can be deployed in a node based architecture, it is arguably best suited for an exchange based architecture because for the kinds of broadband connection speeds to which it is suited, it is most economically deployed centrally. Conversely, although the more recent VDSL2 technology will work when deployed in an exchange, the reach of its most capable service tiers is shorter and so VDSL2 is more suited to the node based architecture.

The business case for competitive (parallel) DSLAM deployment is unquestioningly more challenging in a node based context because of the substantially smaller addressable market (perhaps 150 to 300 homes reachable from a node compared with 5,000 to 20,000 reachable from an exchange) and the correspondingly high cost of installation and maintenance of many distributed nodes in purpose built housings. It is reasonable to question whether the Openreach LLU success story would be repeated in a node based context, particularly when many of the potential Australian FTTN proponents have previously indicated the business case for node based collocation is difficult[18].

The success of the take up of LLU in the UK market has, in part, been linked to additional factors that have complemented separation:

- Ofcom (Office Of Communications – The British regulator) has purposely excluded NGA (fibre) from the general rules applicable to Openreach which focus essentially on existing infrastructure[19].
- Openreach's operations and commercial offer are based on a mix of passive and active network elements (including transport/backhaul facilities) and not only LLU related components.

Having embraced Functional Separation, BT stands out amongst its EU incumbent peers by not yet having made a significant commitment towards embarking upon FTTN or FTTP deployment. In light of this, the UK government has established its own national programme to promote Next Generation Access and fibre[20]. It is therefore difficult to be confident that the successful adoption of LLU following BT's voluntary separation could translate into a successful deployment of either FTTN or FTTP.

Additionally, the British LLU success can be said to have been achieved in other EU Member States through the successful implementation of both LLU and bitstream wholesale rules and pricing[21], without the need for separation. (e.g. France, Denmark, Holland.)

Finally, Ofcom has announced the establishment of a system of penalties and fines against Openreach[22] due to breaches of Openreach commitments (including towards BT) – suggesting

[18] The point was made by BT itself in its March 2008 "*Suggestions for the FTTN – National Broadband Network for Australia*" paper, section 4.5.

[19] Refer to the Ofcom website for access to the BT undertakings and consultations on NGA. http://www.ofcom.org.uk/telecoms/btundertakings

[20] Refer to the Broadband Stakeholder Group (UK) website. http://www.broadbanduk.org

[21] Refer to comparison of LLU adoption in France and the UK published by the European Competitive Telecommunications Associateion and available at http://www.ectaportal.com/en/upload/File/Broadband%20Scorecards/Q307/BB_Sc_Q307_prv2.pdf

[22] Refer to http://www.ofcom.org.uk/consult/condocs/slg/statement

that the regulator may still be obliged to continue its market intervention despite the incumbent having embarked upon separation.

Conclusions

To date, European operators, competitors, policy makers and parliaments have been exploring many potential strategies towards competition and separation. The differences between opinions and implementations are significant but the British example of Functional Separation is the only one that has been implemented and put into practice. Given the novelty, the variation in approaches and the relatively short time in which policies have been in place, and the limited experience that has been gained to ascertain the degree to which separation has succeeded or failed, Alcatel-Lucent believes it is premature for any particular approach towards separation to be lauded or criticised more than another.

The spectre of separation, particularly when the nature of separation remains undefined, adds considerable uncertainty and therefore risk to a potential investment. Without confidence about the form separation could take, engineering optimisations will be missed, adding to cost. The inability to design an end to end solution leads to missed technical opportunities and can impair the potential benefits of convergence; such as realising the full benefits of Dynamic Spectrum Management and engineered Quality Of Service.

Now that leading fixed access technology has evolved from an exchange based to a node based architecture, it is questionable whether the successful British exchange-based LLU experience could transfer into a sub-loop unbundling success under a node based next generation architecture. It is important to contrast this with the fact that the wholesaling of ‘bitstream’ access has consistently led to notable expansion in the number of competing application providers and retail products on offer. Given recent evolution and ongoing research and development trends in fixed access technologies, Alcatel-Lucent strongly encourages exploration of the potential of bitstream approaches towards new competitive and market models.

ALCATEL-LUCENT SUBMISSION

ACCC Discussion Paper examining possible variation of the service declaration for the unconditioned local loop service

AUTHORS:
MICHAEL PEETERS,
JOCHEN MAES,
MAMOUN GUENACH
AND
JAN VERLINDEN

JULY, 2007

About Alcatel-Lucent

Alcatel-Lucent Australia Limited ("Alcatel-Lucent") is the global leader in broadband access technologies and has designed and deployed fixed and mobile broadband networks in most of the world's leading economies.

Alcatel-Lucent is proud to supply equipment and services to Australia's leading telecommunications incumbents and competitors. It has supplied the infrastructure for a significant portion of Australia's residential DSL community, making it a leader in helping Australians access the advantages of a digital lifestyle. Its solutions achieve advances in DSL, fibre optics, wireless and satellite access that help companies and individuals get maximum benefit from fast Internet services.

Alcatel-Lucent's commitment to Australia is not new. It has been part of the Australian telecommunications fabric since 1895.

Alcatel-Lucent's leadership in the development of Australia's communications infrastructure has included the country's first undersea cable network, the introduction of broadband Internet, the country's first 3G mobile network (m-Net) and the world's longest optical link, between Adelaide and Darwin.

Alcatel-Lucent wishes to continue to play a leading role in improving Australia's economic outlook and standard of living by ensuring that the community has access to a rich variety of broadband services, wherever they live.

Background to this submission

Telstra is major customer of Alcatel-Lucent and has engaged Alcatel-Lucent as a strategic partner. Alcatel-Lucent and Telstra have been collaborating to evaluate alternate candidate technologies for deployment as part of Telstra's proposed access transformation. The candidate DSL technologies include ADSL2+ and VDSL2.

The international community of DSL experts is currently engaged in the standardisation of a technique known as 'DSM' which promises to dramatically improve DSL performance in future generations of the technology. In July 2007, as part of the strategic partnership, Telstra has engaged Alcatel-Lucent to discuss and provide technical advice on the capabilities, characteristics and limitations of 'DSM' technology and its relevance to the roll out and development of sub-loop. This submission is its result and aims to introduce 'DSM' technology for an interested audience.

Alcatel-Lucent does not accept any liability in respect to the use of or reliance upon the advice. Alcatel-Lucent is pleased to offer this submission to the ACCC as an assistance for highlighting issues Alcatel-Lucent believes will be central in helping appropriately resolve sub-loop unbundling issues.

Local Loop Unbundling and DSM

Michael Peeters, Jochen Maes, Mamoun Guenach and Jan Verlinden,

Alcatel-Lucent DSL eXPert Team, Antwerp, Belgium

Introduction

Next generation services require higher broadband throughput than typically available from exchange based DSL. The deployment of fibre deeper into the access network is necessary to improve DSL broadband services for the majority of the community. This is the basis for the Fibre To The Node ("FTTN") architecture.

If too many DSL lines are incapable of supporting next generation applications, the service provider's addressable market will be limited, perhaps to the extent that investment is unviable. By taking current technological developments into consideration, which could lead to significant throughput improvements, the benefit from today's access transformation projects (FTTN) could be extended in terms of higher data speeds.

This paper focuses upon a specific enhancement which is being called 'Dynamic Spectrum Management' ("DSM"). The DSM approach compensates for DSL performance impairments introduced by cross-talk, the interference of one DSL service upon other DSL services sharing the same cable. Crosstalk has an effect upon most lines and is the limiting factor for FTTN performance.

Practically, management of power levels and spectral usage (DSM up to level 2) aims to improve the performance of the poorest lines while minimising the impact upon other lines. DSM level 3 goes one step further to process the transmitted signals in such a way that the crosstalk is effectively cancelled, boosting throughput for all FTTN lines, benefiting all users. Service improvements available through a DSM level 3 deployment promise to be significant. Compared against the incremental improvements achievable through the more basic DSM levels (0, 1 and 2), it is highly desirable to engineer today's FTTN deployments for compatibility with future DSM level 3 technologies.

Although FTTN can dramatically improve the broadband rates available to end users, longer FTTN lines remain intrinsically less capable of matching the throughput of shorter FTTN lines. In order for an application provider to offer a standardised service portfolio within a given market, the portfolio must fit within the capabilities of all lines. Thus the longest FTTN lines generally establish base-line service characteristics.

Specifically because of DSM improvement for the least capable lines, an access provider's minimum throughput guarantee can be increased and with an assurance of higher minimum throughput, a more capable basic service can be offered. The capability to offer improved services in the future will increase the intrinsic value of the FTTN investment and extend its overall life.

Key recommendation

Achieving the significant benefits offered by DSM necessitates a change in our approach to DSL deployment. In order to work efficiently, all lines that interact with each other need to be coordinated. To effectively deploy and benefit from the more advanced DSM level 3 techniques, an entire cable binder[23] needs to be controlled from the same line-card / DSLAM. Most of DSM's benefits are not accessible unless all lines in a cable are controlled by a single device.

Traditional DSL competition models rely upon loop unbundling where competitive providers deploy their own equipment to compete to offer broadband access services. Having multiple devices feeding the same cable binder is incompatible with DSM level 3 techniques because it eliminates the possibility of managing the medium to the degree required to successfully benefit from DSM3.

The authors are therefore of the opinion that the introduction of sub-loop unbundling in the access network will significantly constrain the future deployment of DSM. Sub-loop unbundling in fact takes away the possibility of coordinating the entire binder, as the individual pairs within the binder will be fragmented over different operators. Because of this, continued sub-loop unbundling would be a major impediment to the future deployment of DSM technology and its promise of greatly increased capacity.

Towards dynamic spectrum management

Telephone cables typically contain many individual 'pairs' grouped together in 'binders'. The arrangement of binders within cables can be pictured as 'smaller cables within a bigger cable'. In Australia, binders generally contain ten pairs and a separate pair is required for each broadband service.

The limiting factor in xDSL communications is crosstalk interference coming from other lines in the same binder which degrades the signal received by a 'victim' receiver[24]. Interference degrades the Signal To Noise Ratio ("SNR") thereby reducing the capacity.

Recent advances in signal processing technologies have created a possibility to significantly reduce the impairment due to crosstalk. By centrally and simultaneously processing the DSL signals of all the lines sharing the same cable binder, crosstalk can be avoided (or reduced) by either adapting the transmit Power Spectral Density ("PSD") or by pre- or post-processing the signals over multiple lines. These techniques are collectively called Dynamic Spectrum Management ("DSM"). They are classified according to the amount of coordination needed between different lines as either level 0, 1, 2 or 3.

It needs to be strongly noted that if the DSL signals dedicated to different lines in the same binder are not jointly processed, i.e. processed using one line card or DSLAM, the achievable SNR improvements will be limited and crosstalk noise will have similar impact to noise degradation from other sources.

DSM level 0

DSM level 0 is also called static spectrum management ("SSM"); the transmit PSDs cannot exceed the spectral masks as defined in the standard. Examples are margin adaptive ("MA") and

[23] 'Binder' is defined below.

[24] The inter-binder crosstalk (i.e. the cross-talk occurring between different binder groups within a cable) is much lower than the intra-binder (i.e. the cross-talk between individual pairs within a binder). It remains to be seen (and will very much depend on the cable type) if inter-binder cross-talk will result in similar problems to that of intra-binder cross-talk.

rate adaptive bit loading. In the MA case, all available power is used to maximise the noise margin. This increases the SNR on this line, but also increases the crosstalk noise on the other lines in the binder.

DSM level 1

DSM level 1 is referred to as autonomous power allocation. It consists of avoiding unnecessary crosstalk to neighbour lines, but without an exchange of information between lines. This is achieved by arbitrarily specifying a target throughput based upon calculated performance expectations and then having each DSL line individually limit its PSD to meet, but not exceed, this performance.

It has been shown that in the case of Central Office ("CO", i.e. 'exchange') fed ADSL scenarios, DSM level one based on iterative water filling ("IWF") does not significantly improve the reach of any of the tiers. Additional information on performance may be found in Alcatel Technology White Paper, "Dynamic Spectrum Management for Digital Subscriber Lines - Edition 2", June 2005, J. Verlinden, T. Bostoen, G.Ysebaert.

DSM level 2

DSM level 2 coordinates the (multiuser) power allocation over multiple lines. In contrast to level 1, level 2 also takes into account the line condition and service requirements of other lines in addition to its own line conditions. DSM level 2 by nature requires more cooperation between lines, and therefore can only practically be implemented in a centralized fashion. An example is optimal spectrum balancing ("OSB"), also known as optimal spectrum management ("OSM").

DSM level 2 yields substantially better performance than DSM level 1 as more coordination and information exchange is allowed between the active lines. In a mixed CO/RT deployment, OSB (DSM level 2) shapes the transmit spectra more intelligently than its counterpart IWF (DSM level 1).

The effectiveness of DSM level 2 in simultaneously protecting CO and RT services sharing the same binder is nevertheless limited compared with the gains of DSM level 3 applied from a single controller and further discussed in Alcatel Technology White Paper, "Dynamic Spectrum Management for Digital Subscriber Lines - Edition 2", June 2005, J. Verlinden, T. Bostoen, G.Ysebaert.

DSM Level 3: vectoring and cancellation

As previously mentioned, improving the SNR could be done by mitigating the self-crosstalk at the transmitter and the receiver for the downstream and the upstream respectively. In both cases, some analogue or digital signal processing is required and this is called vectoring. This vectoring does not optimise the transmit PSDs as with DSM level 1 and 2, but rather compensates the present self-crosstalk while transmitting at full power. In a way, DSM levels 1 and 2 reallocate spectra, reduce the overall power levels and come at marginal cost, while DSM level 3 increases the signal and processing power and will require a significant engineering development.

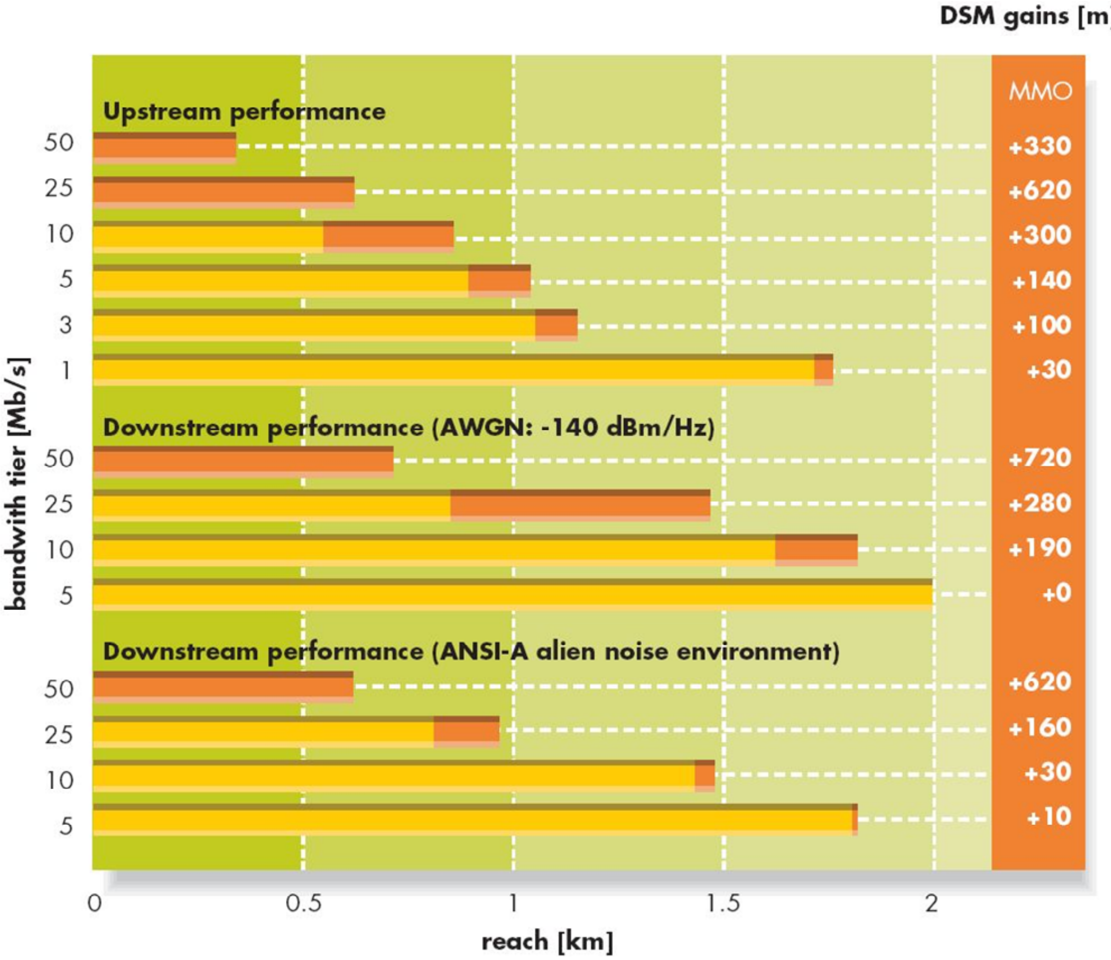

Figure 1 DSM level 3 performance gains (orange) for like-distance VDSL lines, all lines in a binder are part of a DSM3 MIMO noise cancellation system[25]

For residential customers with one twisted pair loop arriving at the premises, the signal processing has to be inside the DSLAM for both upstream and downstream, as this is the only location where joint processing at the symbol level is possible.

Upstream - Cancellation

In the upstream direction, the interference cancellation is performed over a set of strong interferers and no feedback is required from the customer premises equipment ("CPE") : the DSLAM cancels the crosstalk on each line which allows joint decoding of the data arriving on each of the lines. This cancellation requires an estimate of the crosstalk channel.

Downstream - Precoding

In the downstream direction, assuming that the characteristics of the crosstalk channels have been well estimated, one can predict and therefore pre-compensate the crosstalk of each line. However some feedback from the CPE is needed to estimate the crosstalk channel and therefore

[25] Chart referenced from Alcatel Technology White Paper, "Dynamic Spectrum Management for Digital Subscriber Lines - Edition 2", June 2005, J. Verlinden, T. Bostoen, G.Ysebaert.

results in a larger standardisation effort and a dependence on deployment of CPE that implements the required functionality. This CPE feedback can be used as an error signal to track the cross-channel needed for crosstalk precompensation.

Applicability and added value

Vectoring is mainly efficient in increasing the rate/reach of short loop VDSL systems deployed from the RT, such as Fibre To The Node systems. For example, at a loop length of around 800m (a typical 'long' loop in an Australian FTTN deployment scenario), the achievable bit rate can be extended by 40% from around 35 Mbps up to around 50 Mbps by removing 9 out of 10 crosstalkers for both 8d and 17a VDSL2 profiles. At 1 km, more than 25% rate increase is obtained.

It is also interesting to notice that on short (resp. medium) lines, very high bit rates can be obtained by using full vectoring on 17 MHz (resp. 8 MHz). On long loops the vectoring gain is relatively small because the loop attenuation causes most of the far-end crosstalk to drop below the receiver noise floor. As is indicated in Figure 2, we always take into account the presence of at least one crosstalker to allow for new lines coming up. The crosstalk from these lines will not necessarily be cancelled right away, so a provision has to be made for their presence.

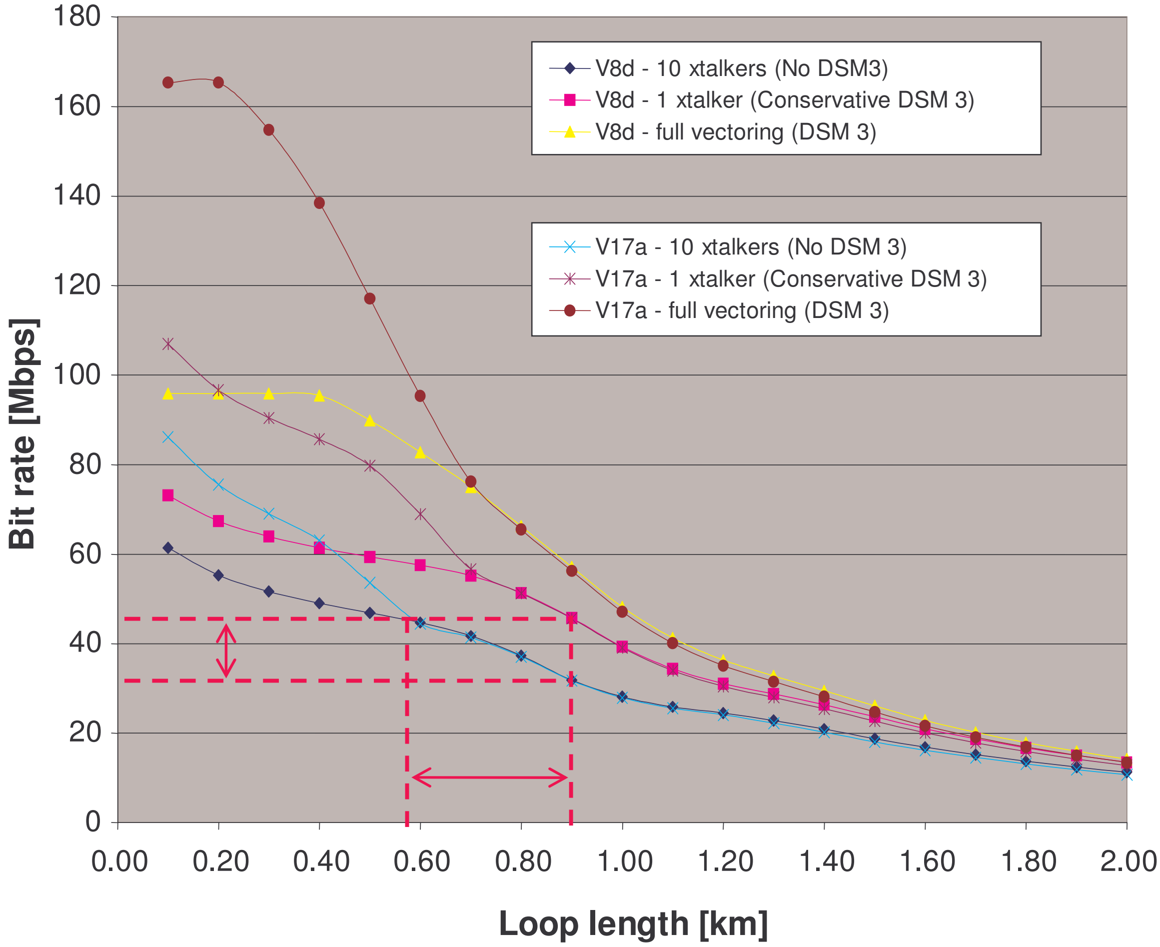

Figure 2 VDSL2 with and without DSM level 3 shows considerable gain

On the other hand, simulations show that vectoring when applied to ADSL2+ systems does not provide any noticeable gain over the alternative, deploying VDSL2, and therefore is not suited for such systems.

It is noteworthy that DSM level 2 and level 3 could be combined to improve the robustness to crosstalk. For example, in RT/CO deployment and assuming that we implement vectoring only on a subset of tones, one may apply DSM level 2 on tones on which no interference cancellation is implemented (e.g. below 2.2 MHz) and boost on the tones subject to vectoring (e.g. above 2.2 MHz).

DSM and Local Loop Unbundling

DSM levels 0 and 1 are, in principle, independent of binder fragmentation across operators. The gains are however very limited. DSM level 2, in the form of PSD-shaping to protect CO-fed lines from RT deployments, is already being put in place now, and many regulators in fact mandate some form of shaping to avoid unwarranted interference and disputes about the quality and noise levels.

The promising DSM level 3 gain comes as a cost in terms of complexity. It requires an in-depth knowledge of the access network topology and the crosstalk couplings to be set and controlled efficiently. Part of the DSM approach will need to be implemented in a distributed fashion (on for example the line-cards), but without a centralised control centre (for example when services originate from more than one DSLAM) the gains will be limited [26].

The implications for loop unbundling are clear: in order to remain viable, DSM level 3 should not be deployed in an environment where more than one DSLAM serves a binder. Depending upon the nature of a market's current broadband competition model, this may have important implications.

Whereas with DSM level 0, 1 and 2 individual loops can be unbundled (either in a shared or full way) at the physical layer, the implementation of DSM level 3 creates a de facto shared medium (i.e. the spectrum within the binder). Within this shared medium, the DSM level 3 operates as a kind of Medium Access Control (“MAC”) layer, which is only effective when all lines obey the same rules. Indeed, when an access provider invests in Fibre To The Node systems relying upon DSM3 gains to meet service performance guarantees, the guarantees will be jeopardised by the presence of lines in the same binder served from an alternate DSLAM.

All lines within a so-called vectoring group need to be synchronized at the symbol level from a central clock on the line-card or in the DSLAM. The additional required digital signal processing results in a non-negligible processing and communication overhead. As an example, assuming only ten crosstalkers are cancelled for all tones and all users, approximately 40%-120% additional floating point operations per line are needed. The requisite bus speed for the communication between the chipsets within a line board can be estimated as 48 lines x 1000 tones x 4000 symbols/sec x 16 bits = 3 Gbps. The crosstalk channel coefficients that are intrinsic to precoding and cancellation technology also need to be stored and shared. These requirements immediately show that it is not realistic to expect cross-DSLAM DSM level 3 to ever be possible in a cost-effective way. Even across line-cards, the requirements are at this time not considered realistic: grooming of the line pairs is expected to be needed to make sure all strongly coupled pairs are fed from the same line-card to allow for precoding to be worthwhile.

[26] See also “AT&T and nSpired Design, Analysis of loop reach increase due to ordered FEXT cancellation”, May 2007.

Table 2 in AT&T’s contribution shows that when there are a number of lines that are not coordinated (in a so-called set S2), for example due to physical layer (sub-loop) unbundling, performance gains are very limited. However with full coordination (implying no sub-loop unbundling), much higher gains can be expected for DSM level 3.

The combination of the central control, the required knowledge of the access topology and the impossibility to jointly process lines not originating on the same line-card indicates that the unbundling for DSM 3 will only be possible logically, not physically (i.e. above the physical layer). This is also the case for example in coax cable access loops, where it is termed bitstream, packet or wholesale unbundling.

Standardisation and timelines

Because of the required feedback from the CPE, standardisation is required to make DSM level 3 and more in particular precoding a reality. Within standardisation, effort and studies have been going on for close to two years and have recently culminated in the decision of the ITU to start a new standard, G.vector. It will build on the existing VDSL2 standard but add the requirements for vectoring to be possible. It is however expected that the process will still take more than one year before a final agreement is reached.

Furthermore, there are still challenges that are not being addressed properly in the different standardisation vectoring proposals such as the transient behaviour and the stability. What happens if a new line is added? How will this affect the stability? What is the exact overhead in terms of capacity loss before the new line is added to the vectoring system? Stability is a key issue that has to be tackled properly if any of the vectoring technologies is deployed. Backwards compatibility with legacy CPE is another open topic.

The system integrators, although some are very active in the G.vector process, very much depend on the chipset vendors to offer appropriate chipsets before the design of new line-cards and access multiplexers can start. As the expectation is that some vendors will have prototype systems by the end of 2007, samples and especially volumes are not expected before the end of 2008, partly due to the standardisation effort still required. As such, we do not expect access multiplexers implementing DSM level 3 before 2010 at the earliest.

About the authors

Jan Verlinden, Ir., is a member of the Alcatel-Lucent DSL eXPerts R&D team which specializes in the DSL PHY layer. He has worked on all aspects of DSL technology with a recent focus on all levels of DSM. He represents Alcatel-Lucent Bell in ANSI standardisation activities.

Michael Peeters, Jochen Maes and Mamoun Guenach form the Research and Innovation core of the Alcatel-Lucent DSL eXPerts team within the CTO organisation. Holding PhDs in Applied Physics, Physics and Telecommunications respectively, their research covers the entire spectrum of bundle optimisation technologies, including DSM level 3, both theoretically and experimentally. As such, they are actively involved in the G.vector standardisation process.

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