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Conference Paper

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23rd European Regional Conference of the International Telecommunications Society (ITS), Vienna, Austria, 1st-4th July, 2012

Provided in Cooperation with:
International Telecommunications Society (ITS)

Suggested Citation: Maton, Alain (2012) : Which are the consequences of vectoring technology, broadcast services and business services on NGA recommendation implementation, 23rd European Regional Conference of the International Telecommunications Society (ITS), Vienna, Austria, 1st-4th July, 2012, International Telecommunications Society (ITS), Calgary

This Version is available at:
https://hdl.handle.net/10419/60345

Which are the consequences of vectoring technology, Broadcast services and Business services on NGA recommendation implementation.

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Keywords	electronic communications, access regulation, market analysis, unbundling, vectoring, bitstream, broadcast, leased lines

Abstract	Competition by FTTH infrastructure is not an universal solution to solve competition on broadband markets. In addition the border between broadband products and leased lines products becomes less clear Competition of legacy copper networks Eurodocsys 3 obliges to increase VDSL performance. Unfortunately, the present state of the proposed technology – the vectoring –is incompatible with subloop unbundling. Without subloop unbundling, there is no possibility for alternative operator to provide broadcast TV services and triple play with the risk to be out of market. Multicast is a huge investment for SMP operator and a huge operational cost for small and medium alternative operator, so the sharing of the IPTV platform can be a win-win alternative but not in the scope of the related bitstream market. Challenging leased lines in NGN environment where bitstream should be the main tool needs also an adapted assessment of these markets.

Introduction

The applied methodology is those of European framework for the expected results to in force competition with more competitor on ultra-fast services, triple play and Ethernet business services.

NGA recommendation and Digital Agenda promote competition by infrastructure with a preference for FTTH.

However all countries are not in the same conditions to start such investments, in particular in terms of existing infrastructures and related competition.

Belgium facing various problems that cannot be addressed by the NGA recommendation as such:

1) In absence of existing ducts, FTTH is a long term objective and the capacities of Eurodocsys 3 oblige to increase VDSL performance. Unfortunately, the present proposed technology – the

vectoring – needs to have a single DSLAM for the best performances, that is incompatible with subloop unbundling. Without subloop unbundling, there is no possibility for alternative.

2) In absence of large deployed unbundling, and taking into account that customers require more and more triple play, alternative operators must provide TV services and triple play to avoid the risk to be out of market. Inclusion of multicasting in bitstream product present some challenges:
    a. The SMP operator on bitstream market is not necessary SMP on television market, in particular in countries with strength cable or satellite deployment.
    b. It represent a huge investment to extend backbone capacity of the SMP operator to handle several times the same signals (one time per operator).
    c. The cost of the required bandwidth is a barrier for the alternative operator because he must paid the full capacity to provide all the channels everywhere with only a small amount of customers.
3) The low throughput business services have yet migrated to xDSL but the migration of high throughput services is starting with a advantage for the incumbent with data nodes closer of the end-user. FTTH services are not the solution because it does not provide the extra features requested such resilience and dual access route.

The Belgian regulator was first NRA to address these problems in market analysis 4, 5 (in force) and 6 (in notification process).

<u>Vectoring</u>

The vectoring is not a technology to increase the theoretical working distance and/or maximum speed, of VDSL but a technology to address the gap between these theoretical performance and the real world.

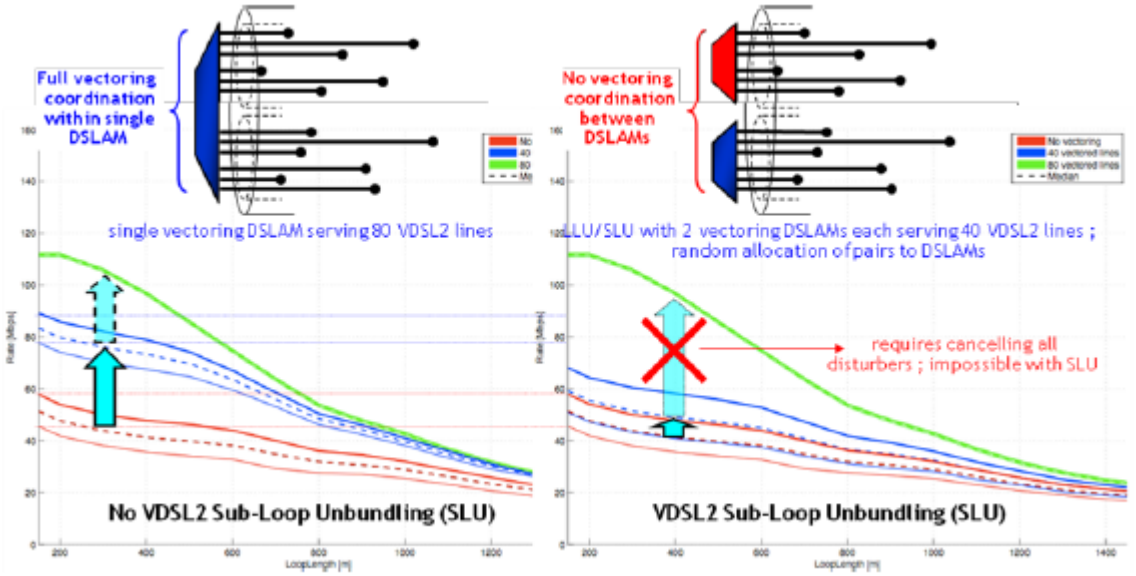
The copper pairs are closely together in the distribution cable with capacities typically between 50 and 200 pairs. Such for the old technologies, the transmission signals generate crosstalk in neighboring pairs, more high the frequencies are and more pairs are used for VDSL, more perturbations occur. In fact crosstalk become the most important source of noise in case of short distance and high frequencies, thus in case of VDSL. The crosstalk generated by ADSL is not so important and do not impact VDSL2 performances.

The vectoring is based on the same concept that Echo cancellation on headphone: the noise is measured and an anti-phase signal generated and send on the line. Obviously the technique is more complex due to the number of noise's sources.

Vectoring is based on a very huge amount of calculation: the spectrum is subdivided up to 4096 narrow band and for each band, the frequency dependent crosstalk coupling between each pair of VDSL2 lines is automatically and dynamically measured and updated, calculation is repeated for each VDSL symbol (4000 times per second). It is made by a Vectoring Control Engine (VCE) that synchronizes all the ports of the vectored lines and calculates a "vector" consisting of the precise frequency and power levels of each port that will generate the least crosstalk. Due to this synchronization, vectoring capable VDSL2 modems are required to benefit of the performance enhancements. It exists 2 levels of "vectoring friendliness": ITU G.993.2 Annex X defining requirements for downstream friendliness such that the crosstalk from the legacy line into the

neighboring vectored lines can be estimated and cancelled in downstream direction only and ITU G.993.2 Annex Y making the same in up- and downstream directions.

Performance enhancements depend of the percentage of lines controlled (thus depending of percentage of "vectoring friendly" modems. Such calculations are intern to the DSLAMs equipment, there are no possibilities to deploy the technology across independent DSLAMs. In the next figures, comparisons are made between no vectoring (red), vectoring on 50% of the VDSL lines (blue) and on 100% of lines (green) in case of a single DSLAM and two no coordinated DSLAMs.



Source: Alcatel-Lucent

It is clear that improvements in the second case are very small and cannot justify the related investment.

Regulator are thus facing a dilemma: encourage infrastructure investments but with the result to reduce the performance of services to end-users. However, such vectoring investments are no more interesting with Sub-Loop Unbundling, it can be also seen as an incentive to invest for FTTH despite the time to market to increase performances.

In fact this dilemma must be evaluated depending of national circumstances:

- Do it exist strong competition with other platform(s) offering higher performance? For example if cable is largely deployed with Eurodocsys 3 and offers at 100Mbps and above, the delay to deploy FTTH will be too long and the cable can acquire a natural monopoly on very high speed
- Do it exist usable ducts to be shared to deploy FTTH? If not, even in absence of alternative platform, the delay to offer very high speed should be incompatible with European digital agenda and vectoring can become a best solution

The elements of analysis to comply with promoting ladder of investment as acted by NGA recommendation:

- Ladder of investments implies subloop unbundling

- FTTH investments are more future proof that Vectoring
- Incumbents as well alternative operators must be able to compete against operators with more powerful infrastructure
- Increase of performance for end-users would not be delayed too much

Subloop unbundling cannot be cancelled without additional remedies on bitstream to enhanced it or without imposing Virtual Unbundling Line Access (VULA) not so different from a enhanced disaggregated bitstream. It must provided the capacities for the alternative operator:

- To be able to define the dimensioning of his services, e.g. by ATM VP switching or Ethernet VLANs
- To be able to define his own CoS by choosing the QoS of the VPs or VLANs
- To be able to provide business services by using ATM VC switching or Dedicated Ethernet VLANs
- To be able to fully manage CPEs
- To be able to request Improved SLA for business end-users

Regulators (NRAs) have the following choices:

1. To continue to impose SLLU, SMP operator taking or not the risk of investment in vectoring or accelerating FTTH deployment (fully compliant with NGA recommendation).
2. To cancel SLLU unbundling with a enhanced bitstream under the rationale that it should be beneficial to all DSL operators (in opposition of NGA recommendation).
3. To continue to impose SLLU with obligation for alternative operator to use the same DSLAM and obligation to SMP operator to provide synchronization between these equipments, difficult to operate due to the absence of standard procedure (compliant with NGA recommendation but with intrusion in the investment of non SMP operator not aligned with framework)
4. To continue to impose SLLU but imposing to the first mover to offer enhanced bitstream to his competitor, it is a mix of SMP regulation (on the copper) and symmetrical one (on the active equipments) not so easy to justify on a legal point of view; additionally it can be a problem to define an harmonized retail products across differentiated wholesale bitstream offers

Belgium does not provide a good base to start FTTH:

1. Copper network is grounded without ducts.
2. Existing Eurodocsys 3 offers nationwide request quick improvements for DSL operators.
3. Low penetration of unbundling due to small size of MDF and enhanced bitstream that do not give technical advantages to unbundling, only scale savings if high market share.
4. No business case identified by alternative operators and consultant for SLLU.

As consequence the Belgian regulator (BIPT), in cooperation with media regulators, have decide to choose the second alternative and to cancel SLLU imposition. However, technology can be enhanced during the analysis delay and BIPT have estimated that this decision can be reverted if the analyzed environment change. It lists a full set of causes that can be a trigger to start new analysis before and of the regulatory period:

- Belgacom does not implement vectoring in a reasonable timeframe after commercial availability of vectoring on their existing DSLAM type
- Technological evolution of vectoring allows to use these functionalities also with several DSLAMs on the same subloop
- Technological evolution of vectoring giving similar performances without the need to monitor all VDSL lines in the subloop
- Technological evolution replacing vectoring which may provide a similar performance
- Demand to use SLU using a technology that does not conflict with vectoring

This decision was the first to deal with vectoring and, before to accept, Commission have closely analyzed it and request to an equipment provider to present its labs tests. BEREC have also take this case into account in its NGA implementation report BoR (11) 43:

"*Therefore the regulator might be faced with a dilemma in that he may want to support investment increasing the performance of the VDSL network on the one hand while at the same time allowing competitors to climb the ladder of investment. Such a decision re-quires a careful evaluation of the trade-offs taking account of the specific circumstances (e.g. are more future proof alternatives available that do not hamper passive wholesale products, the degree of platform competition, demand for unbundling)"*

Multicast

As said for cancellation of subloop unbundling – but not limited to this case because unbundling nationwide is never financially possible – the alternative product must provide the lost capacities: engineering freedom in particular possibility to provide broadcast television at competitive costs.

The first idea is that it is possible to handle such service with unicast bitstream and multicast equipment located outside the SMP network. A quick calculation show that the competition would be unfair:

- Infrastructure operator using multicast module of the DSLAM must configure 1 Gbps in all its network to pass all households with a offer of more than 200 channels with a mix HD and SD, this bandwidth is independent number of customers.
- Alternative operator with its own multicast equipment must use an average of 4 Mbps for each active consumer.
- If we take a network of 100 loops (depending the size of the country), 50% of active consumer at prime time, and a total of 1Gbps on each loop such the infrastructure operator, this operator can only serve 100 loops * 1000Mbps / 4Mbps per channel, this total time 2 due to the inactive customers; thus only 50.000 consumers versus unlimited ones.
- It demonstrates that the costs for the alternative operator is quite higher and competition becomes very difficult, it demonstrates also the difficulties to have large OTT television generalist services.

A second solution is to mix a fix line broadband service with a satellite broadcast service. Sky is successful in UK with such approach but Mobistar in Belgium have difficulties to acquire customers. It

depends of the level of acceptation of satellite dish by end-user, in Belgium it is low due to the initial very high penetration of cable television (95% of households) having yet a large choice of foreign channels. At a general point of view; this solution presents the inconvenient for the alternative operator to pay two different access networks: copper/fiber network of SMP operator for voice and data and satellite for television.

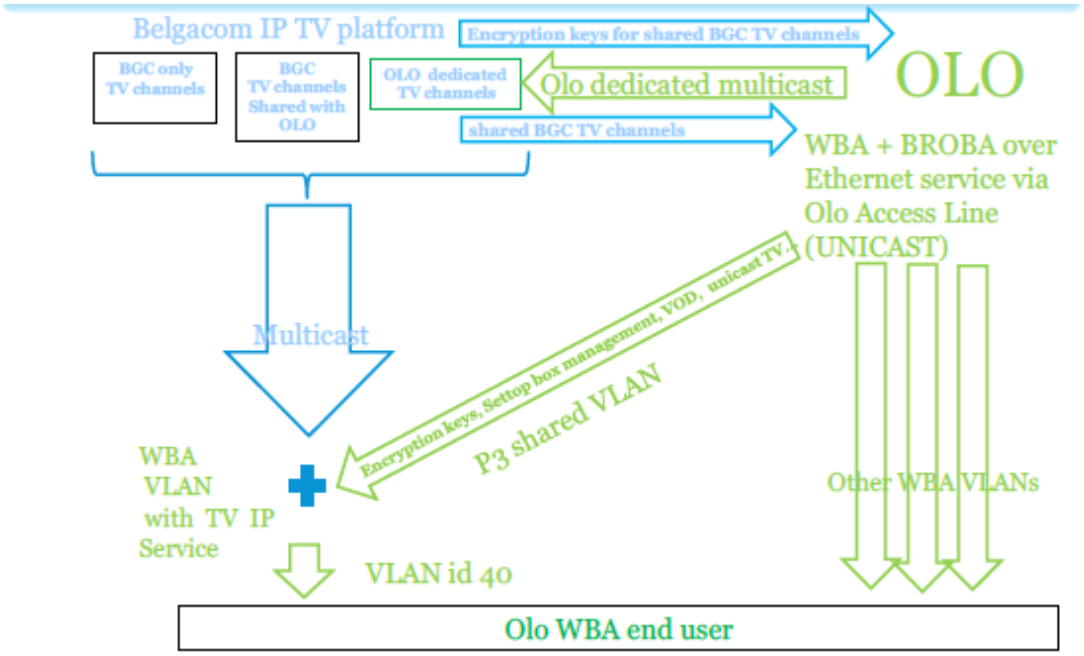
A third solution is to share the IPTV platform to avoid to transport on the network several times the same signal. The best way to proceed should be to use Simulcrypt such for satellite, unfortunately it is not always possible because standardization has been available too late for some implementation that use proprietary systems. Advantages and disadvantages are:

- Bandwidth saving
- Possibility to add channels only for competitor
- Possibility to handle all access control for end-users
- Possibility to differentiate service at level of settop box and to enrich the service via unicast bitstream
- No possibility to differentiate service by signal compression ratio
- In case of proprietary system, the competitor do not have choice for the CAS system, but the main providers sell their products via integrators and there is competition between them

Some regulators – Italia, Slovenia, Belgium – have imposed multicast as remedy within Market 5 Bitstream, it is endorsed by BEREC in his common position. It is based on the fact that multicast is a function of the bitstream that then SMP operator offer to himself and, secondary, that is usable by other services than broadcast (e.g. games on line, …). However the Belgian SMP operator estimates that it is a television service and must thus be the consequence of the analyze of problems on the retail broadcast market and on the assessment of a SMP position on this market, and in Belgium cable company have higher market share on this market. The case is pending at the Court of Appeal.

In addition – BIPT, the Belgian regulator, have included the possibility for the SMP operator (Belgacom) to offer voluntary a regulated offer IPTV platform sharing in place of multicast. Due to the less investment required, Belgacom have opted for this alternative and the related reference offer is presently under public consultation. This service use the proprietary CAS of Verimatrix, the Simulcrypt option of Verimatrix is not usable because a large number of existing settop box Belgacom are not compatible with this release of Verimatrix.

The principles of theses offers are the following ones:



Source: Belgacom

- The end user will have access to:
  - Shared TV Channels, shared between Belgacom and his alternative operator (OLO) at choice of this last one that must negociated itself the author rights.
  - Multicast additional TV channels ingested by alternative operator in the Belgacom network together with other multicast (e.g. STB update) data , a dedicated Multicast Group IP address range allocate to each alternative operator for this purpose.
- Both flows are transported together in the Core network and the aggregation networks, up to the VLAN 40 of the WBA VDSL2 User for whom the alternative operator has ordered the service.
- The TV related unicast to this end user (eg VOD, Encryption keys, unicast Settop Box management, Unicast TV,…) shall be transported via the shared VLAN with QoS “p3” and will also be delivered via VLAN id 40 on the WBA VDSL2 end user line
- The alternative operator obtain encryption keys for the Shared TV channels, agreed with Belgacom and shall distribute them to his end users

This description shows that alternative operator can differentiate his retail offer on a way not so far from unbundling. It is important for the market because subloop unbundling is very difficult to operate on financial point of view and present uncertainty with vectoring.

Leased lines

The leased lines are implemented on WDM and SDH infrastructure, the evolution of the networks will be the withdrawal of SDH equipment’s (in Belgium, Belgacom have planned All IP network, and thus shut down of TDM infrastructure, in 2018).

As consequence, the infrastructure Ethernet MPLS Transport must be able to provide services compliant with the requirements of lease lines. The challenges are:

- Supporting fractional, channelized and unstructured traffic
- Transparency to TDM signaling
- Bandwidth availability
- Resiliency to PDV, packet loss, packet misorder
- Multiple clock domain/recovery
- Point to Point, Star and Mesh topology
- Clock recovery jitter/wander requirements

These needs have been met by the Metro Ethernet Forum with standard MEF-3 and MEF-8 aligned with and complementary to IETF, ITU-T and MPLS Forum.

A second way to provide such service is the "Customer Operated Circuit Emulation over Ethernet" by mean of a specialized CPE operated by operator or end user.

If technically the problem is solved, the regulatory impact is still open on markets 4, 5 and 6:

- On market 4, copper is used to provide "Ethernet on Last Mile" using pair bonding from MDF or symmetrical profile VDSL2 to provide symmetrical 10 Mbps and Fiber To The Office that can be quite different from FTTH
- On market 5, Circuit Emulation is in fact a specific configuration of the bitstream transport in a same way that in ATM world, AAL1 provides Circuit Emulation as configuration parameter only
- On market 6, the ability for the alternative operator to provide the service independently from SMP operator of the infrastructure complicates the market definition
- The border between Terminating Segment of Leased Lines (market 6, ex13) and Trunk Segment of Leased Lines (ex market 14) is also less clear; most of NRA have defined the border in function of Point of Presence of the alternative operators on base of presence of several competitive infrastructures to these points; with NGN infrastructure it should more based on the location of Ethernet interconnection possibilities.

OPTA was the first regulator to deal with the problematic of market 6 in NGN environment. It have defined two different bitstream, a residential bitstream and a business one, and merges the market 6 terminating segment of leased lines with the business bitstream. The Commission had serious doubt but not on this definition, it was about non regulation of line using fiber to connect the end user. However this approach present some problems:

- The differentiation between residential and business is mainly defined by contention ratio, less than 20 is business; this limit is totally arbitrary and does not correspond at any evident differentiation of quality of service
- The enhanced bitstream allowing circuit emulation should be "disaggraded" , the different engineering parameter should be under control of alternative operator with the consequence that the bitstream provider cannot know if the service is residential or

business, thus he cannot know if the product must be provided under which regulated market

- It is also mentioned that fiber access is FTTO because FTTO does not have the same regulation that FTTH, but also it was said that FTTH is used where FTTO is not available, that is a second source of confusion on which regulation rules the product must be compliant.
- Nothing is defined to insure that it will be possible to use the product for Circuit Emulation, e.g. no contention, maximum delay and/or jitter, …

The Belgian regulator have also analyze the problem taking into account the following constraints:

- It exists a demand for a service on NGN infrastructure providing a service with performances as closed as possible to those of leased lines
- The transport service is in fact a particular configuration of bitstream
- The existing bitstream is yet "disaggraded" and provides the requested flexibility
- It exists a demand to keep the existing reliability features at local access on fiber such the redundant routes
- These requirements can be fulfill with a combination of bitstream transport and local Ethernet leased lines; it was presented to Commission that does not agree with such solution to mix services from different markets because bitstream is defined as an "end to end" product and not a set of building blocks (despite de fact that the Belgian bitstream reference offer defines effectively such building blocks on technical and prices levels), but Commission does not disagree with the purpose of this construction

To solve this "formal" problem, BIPT have decided to defined a new product named NGLL (Next Generation Leased Lines) and defined as the replacement of the SDH infrastructure between local MDF/ODF and the border of the trunk segments by Ethernet MPLS service configured to provide Circuit Emulation. Despite the substitutability between classical LL et NGLL, it is also imposed that the alternative operator must choice itself between the 2 products for technical reason (e.g. some application does not accept the minimum delay introduce by packet network) or financial one (NGN infrastructure provide more scale effects and less costly services).

Conclusion

The Framework would regulate infrastructure on base of services. With NGN, it becomes very difficult to define borders between services and to differentiate them in the costs models.

As seen supra, it should be more appropriate to merge markets 4, 5 and 6 in a single "access" market independently of the provided services. Unbundling and bitstream will be not more "markets" but remedies staying related to ladder of investments. It is possible to seen that they are remedies more and more intrusive – up to service platform sharing if requested for competition – with obligation for regulator to limit obligation to the less intrusive ones in function of markets' characteristics, e.g. words the present obligation to do not regulate bitstream if unbundling provide sufficient competition on retail market would stay in place.

Additionally, the replacement of PSTN/ISDN by VoIP, IP Centrex and IP PABX cancel barriers to entry on market 1 and the wholesale "access" market can be sufficient to address competition on all services requiring a physical link to the end user.

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