

# New paradigms for NGA regulation: *Next-Generation Bitstream, Virtual Unbundling, Sub-Loop Unbundling...*

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## *Executive summary*

This policy paper inquires into new paradigms for NGA regulation. After introducing NGA regulatory aspects for the different stakeholders, virtual unbundling and next-generation bitstream wholesale products are described and compared in details. Other considerations such as technology evolution, investment models and risk sharing may also have an impact on the choice of unbundling and wholesale products. The conclusion draws some recommendations and questions on unbundling over copper and fibre networks. In the Annex, three countries are outlined where active wholesale products have been mandated by the National Regulatory Authorities (NRAs). A few other countries in Europe have undertaken similar market 4 and 5 remedies which are reported.

## **Introduction**

This is prime time for Next-Generation Access (NGA) networks. On the supply side, Media and electronics industries are driving a shift towards internet connected devices (tablets, smartphones, gaming consoles, connected TVs, etc.). On the demand side, consumer surveys point to increasing consumption over the Internet and video usage. These ever-growing bandwidth and traffic requirements will call for the acceleration towards Next-Generation Access networks.

Moreover NGA networks have a fundamental role in terms of investment, job creation and overall economic recovery for Europe. As such, NGA networks have been set as one of the flagship initiatives of EU 2020. The European commission is aiming at promoting efficient investment and innovation taking due account of the risks incurred by all investing undertakings on one side and the need to maintain effective competition on the other side.

In this context at Member State level, National Regulatory Authorities (NRAs) are developing responses raised by the transition from copper to fiber-based networks, built on the analysis of relevant ex-ante markets, as shown in the table below: the wholesale network infrastructure access (Market 4) and the wholesale broadband access (Market 5).

Market	Definition	Remedies
<b>Market 4</b>	Wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location	Grant access to the physical path of the network (copper, fibre) of the Significant Market Player (SMP)
<b>Market 5</b>	Wholesale broadband access (bitstream wholesale)	A range of possible remedies including different levels of bitstream access, different pricing mechanisms, etc. applied to the SMP

*Table 1: Market 4 and 5 definitions and remedies*

The economics and regulation of NGA networks are likely to vary across different technologies and different geographies but any remedy will be reflecting a proportionate application of the ladder of investment principle.

Before digging into each functional feature, let's highlight the way access seekers are going to assess remedies in terms of dependency: technical dependency, operational dependency, economical dependency and strategic dependency.

- Technically wise, the access seeker is looking for access products on which it can develop its own differentiated retail products. So the important criteria are technical restrictions and limitations, architectural choices and network equipment restrictions (maximum packet length, number of simultaneous communications,...).
- Operationally, the access seeker is looking for self-controlled provisioning, commissioning and maintenance of each user access line. Products come with SLAs (Service Level Agreements), including for example information on mean time to repair (MTTR).
- Economically, the access seeker is looking for service catalogue and pricing. The structure should allow the access seeker to differentiate at the retail level with profit margins.
- Lastly, strategically, the access seeker is looking at how financial and cash flows are going to be structured with the network provider and what sustainable business models are possible to be developed over time.

## Specific functional elements to consider in NGA networks

Beyond the above generic dependency components, some functional elements are key enablers in the end-to-end broadband services delivery in NGA networks: video delivery technology, IP aggregation and transport to core networks.

1. Multicast achieves bandwidth savings for video delivery. As video is increasingly being consumed through the Internet, a more cost effective delivery of video services is multicast which enables content to be transmitted simultaneously to multiple parties but carried as a single stream as far into the network as possible. This achieves significant bandwidth savings for the delivery of one-to-many services and allowing more efficient use of backhaul.
2. IP service routers enable seamless service delivery across all network segments. Aggregating a large number of access connections onto a relatively small number of physical interfaces, and transporting these connections from local distributed locations to centralised ones at metropolitan, regional and national levels, require service routers for efficient IP transport across the broad range of residential, business and mobile services are required. These IP service routers provide also connectivity between end devices, application/content services and the public Internet.

So these elements should be part of the equation in the overall regulation framework: the implementation of multicast in wholesale access products, the level of transparency required, flexible interconnection points and aggregation, traffic visibility and service level agreements.

## Wholesale access products at Ethernet level

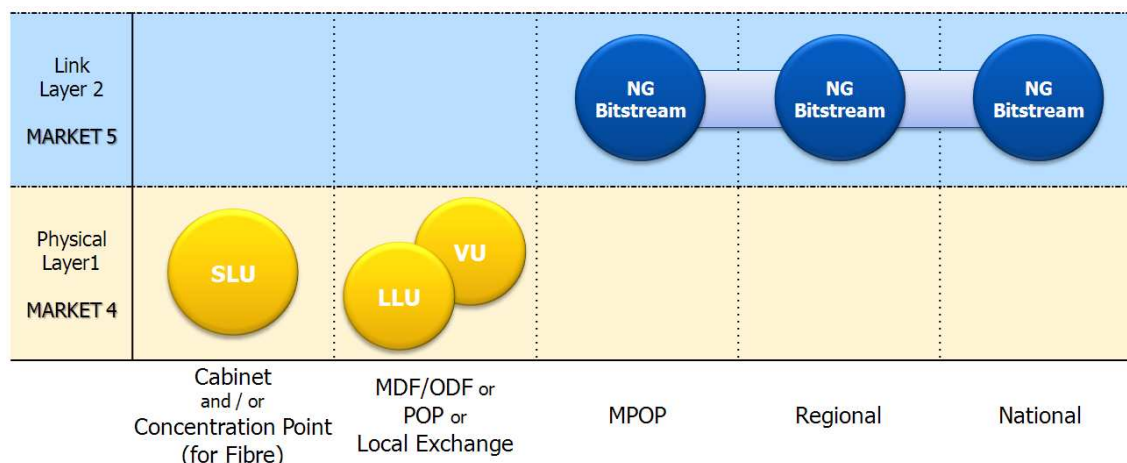
Virtual Unbundling and Next-Generation Bitstream both provide to access seekers wholesale access at Ethernet level protocol (layer 2), with a greater degree of flexibility than legacy bitstream offered on copper based broadband networks.

Legacy bitstream has already been applied for quite a while but is only a basic and limited form of wholesaling. Next-Generation Bitstream on the other hand represents a much more complete and flexible solution: multicast, triple-play services with their associated QoS requirements (by differentiating traffic into classes) and subscription to multiple access seekers for multiple services at the same time, to obtain optimal service mix.

**Virtual Unbundling** partly virtualizes the line by terminating the subscriber line on the equipment (DSLAM or OLT) of the access provider. The access seeker can connect directly to this equipment at the cabinet or local exchange level, thus avoiding the access provider's aggregation network. Although the physical lines themselves are not under control of the access seeker, Virtual Unbundling offers a high level of control over the connections in terms of transparency (for IP configuration and Ethernet transport), QoS, and multicasting capabilities. While in principle (limited) control of physical layer parameters is possible, this would result in significant operational complexity.

**Next-Generation Bitstream** access virtualizes the line further by pushing the Points of Interconnect (Pols) to the edges of an aggregation network operated by the access provider. Connectivity to subscriber lines is aggregated into bigger pipes and offered to the access seekers at different aggregation levels (at metro, regional, national POPs). Next-Generation Bitstream offers a lot of flexibility from a comprehensive level of control for the access seeker (with exception of first-mile settings), to having the access provider taking up some responsibilities on behalf of the access seeker in terms of service management or subscriber management (e.g. IP configuration of the end-user devices).

The figure below shows the handover points of Virtual Unbundling (named here "VU") and Next-Generation Bitstream (named here "NG Bitstream"), independently of the access technology (copper or fibre). SLU and LLU refer respectively to sub-loop unbundling and local loop unbundling.

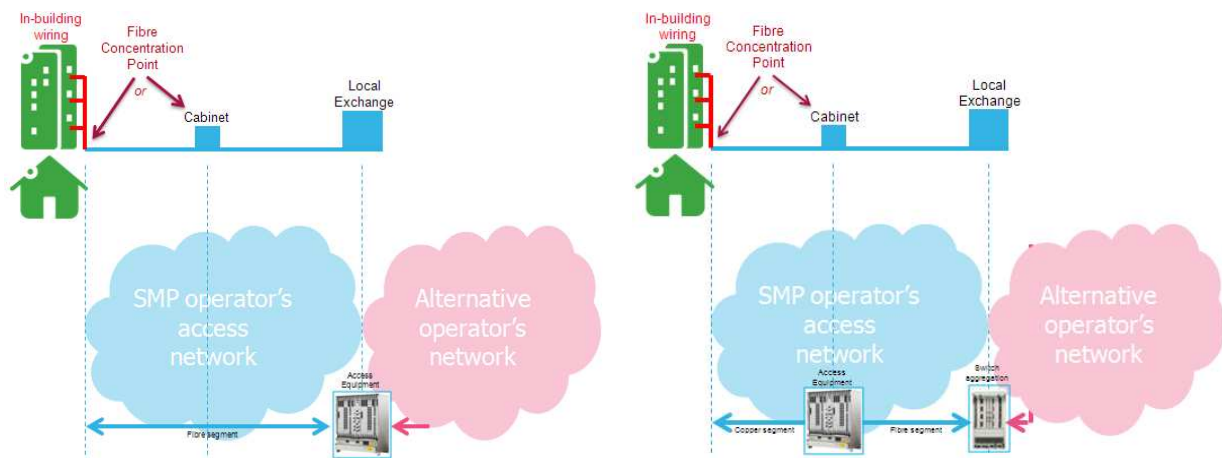


*Figure 1: Positioning of virtual unbundling and next-generation bitstream*

Let's now go into details of each wholesale product.

## Virtual Unbundling

The outcome of Market 4 analysis in some countries led to substitute physical unbundling as a remedy by Virtual Unbundling. **It consists of an active access link to the customer premises (over copper or fibre).** Consequently, handover takes place at local exchange level, similar as LLU. The access seekers have either their backhaul networks reaching the local exchanges or are dependant of backhaul services from other providers.



*Figure 2: Virtual Unbundling in two cases: FTTH PON (UK case described later in the Annex) and VDSL2 vectoring from street cabinet*

Virtual Unbundling is compatible with any physical technology in the first-mile, and shields its specificities from the access seeker. An optional non-blocking switching stage helps in reducing the amount of Points of Interconnect (POIs).

Its main features render it similar to products included in market 4 as shown below:

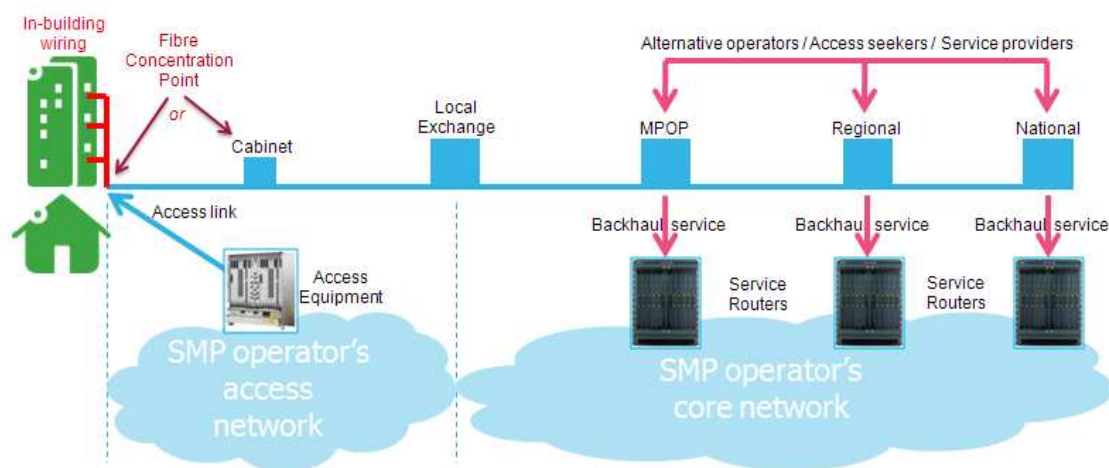
- Point of interconnection or handover point: local exchange (similar to LLU)
- Service agnostic: able to support a multitude of services (scope for product differentiation and innovation by access seekers similar to LLU). If there are multicast packets, they are to be transported transparently.
- Uncontended: the access connection, or capacity, between the end-users' premises and the local exchange where interconnection takes place should be dedicated to the end-user.
- Control of CPE: choice of interoperable CPEs or sufficient control by access seekers if it is owned by the infrastructure provider.

Virtual unbundling involves multiple access seekers using the same access node. As a result, special attention needs to be paid to a number of topics during definition between all stakeholders:

- The connectivity capabilities (e.g. capacity, QoS) need to be well defined in SLAs with the Access Provider. The easiest approach is to use a set of pre-defined quality profiles. The Provider needs to guarantee the SLAs, by managing the priority markings and possible but not necessary oversubscription for example.
- Combining multiple multicast IPTV services on a same node could lead to multicast address overlap. The Provider's network must be able to cope with such overlap to avoid any interference.
- The CPE positioned by the seeker must be interoperable with the access node of the provider. This can be done based on a "whitelist" of CPEs, or by case-by-case validation.
- For the sake of operational simplicity, interaction at OAM level (provisioning, monitoring, trouble-shooting) should be kept at the highest possible level, in the OSS.

## Next-Generation Bitstream

Next-Generation Bitstream is another wholesale product which is imposed or proposed part of the remedies in market 5. **It consists of an access link to the customer premises (over copper or fibre) bundled with a backhaul service to a defined set of handover points (also called points of interconnection).**



*Figure 3: Next-Generation Bitstream with VDSL2 Vectoring from the street cabinet*

Next-Generation Bitstream virtualizes connectivity further by pushing the PoIs to the edges of an aggregation network operated by the access provider. Multiple SLA parameters at individual connection or aggregate level can be negotiated between the access provider and the different access seekers.

There are several benefits which come with Next-Generation Bitstream products:

- Scalability: depending on the size of the network, reducing the amount of PoIs (interfaces) can become a necessity. Several levels become possible (metro, regional, national).

- Flexibility for the end-user: a single user can subscribe to “virtual” connections from multiple access seekers (only one with legacy bitstream).
- Flexibility for the access seeker: aggregating a large amount of users per PoI allows to maximize the statistical multiplexing gain when overbooking the network capacity.
- Flexibility for the access providers: the provider can take responsibility for L3 configuration, CPE management, hosting of end-user self-provisioning portal, etc. and offer this as a paid service to the access seekers (not available in legacy bitstream).

Next-Generation Bitstream features are:

- Point(s) of interconnection or handover point(s): Metropolitan Point Of Presence (MPOP), regional or national level
- Physical layer (access technology): VDSL2, VDSL2 Vectoring, FTTCab, FTTB, FTTH, LTE...
- Ethernet level protocol interface delivery to users
- Customer premises equipment (optical network unit and/or residential gateway): managed by infrastructure provider or access seeker
- Access seeker’s control over QoS: several classes of services defined from frame loss, frame delay, frame delay variation, priority bits...
- Access seeker’s control over bandwidth – also called service contention by managing the mapping of the access link (allocated to a single user) to the backhaul link (shared among multiple users)
- The network provider offers multicast to all access seekers
- Access seeker’s choice on offering its own IPTV service or from other IPTV providers with the flexibility to connect to different content providers (advanced multicast forwarding)
- Access seeker’s choice on specifying the roles of access and core equipments in managing subscribers and services (forwarding models)
- Price control: compatible with cost orientation, equivalence-of-inputs, accounting separation, price/margin squeeze tests...
- Service level Agreement (SLA) between infrastructure provider and access seekers
- Additional options: redundancy, Operations, Administration and Maintenance (OAM), 24/7 SLA...

Next-Generation Bitstream as an additional criterion, an essential one which is the overall contention offered to the end-user which was already available with legacy bitstream.

## Highlight of main differences between both products

From a regulatory eye, Virtual Unbundling and Next-Generation Bitstream are applicable to any access technology, and allow for a fair and non-discriminatory access by Access Seekers to subscriber lines of a given Access Provider. In both cases the Seekers are free to select the service offering in order to differentiate themselves between each other and with the Access Provider offering.

Nevertheless the relevance and application of both products are likely to be influenced by several factors linked to the local economics, and current ISP market:



- The availability of backhaul links for the access seeker to the cabinets or local exchange. High-speed backhaul is key to delivering next-generation broadband services to customer premises. Locations outside of cities and especially in remote areas tend to suffer from lack of access to backhaul provision.
- The scale of the considered network and the aggregation required. Next-Generation Bitstream is scalable up to nation-wide networks and takes benefit from service routers at aggregation and transport levels.
- The role that the access seeker is willing to play; keeping as much control as possible with a minimal role for the provider (Virtual Unbundling), or concentrating on the service aspects by relying on the provider to take care of access and aggregation details (Next-Generation Bitstream).

## Conclusion

Unbundling of physical infrastructures has been the primary tool used by EU regulation to foster sustainable competition with copper technology. But as the note has showed it, there are some NGA roll-out cases where some freedom should be taken with the ladder of investment principle and the relevance of the infrastructure based competition dogma could be questioned. Although offering the highest level of control to the access seeker, physical unbundling quickly reaches its economics limits in its application, especially when envisaging to shorten the last copper part of the network.

Virtual unbundling and Next Generation Bitstream respectively virtualize, partly or completely, the connection addressing the challenges faced by physical unbundling. Most important, even if both products show an “active” dependence of access seekers to the infrastructure provider (access equipment ownership and features, coverage...), this dependence can be minimized and tailored to be non-discriminant and transparent. Time has gone when we would choose second best solutions, these remedies are not.

There are other drivers than regulatory ones leading to multiple service providers to use the same physical network, whether it is for economic reasons (sharing risk & investment) or technical reasons (e.g. optimal vectoring gains).

Next-Generation Bitstream enables the deployment of alternative technologies such as FTTCab or FTTN (G.vdsl2, G.vector, G.fast) by promoting investment and competition over copper networks as long as sub-loop unbundling obligations are removed.

Because NGA networks require costly investments beyond areas where commercial operators may see a commercial return, infrastructure-based competition is rarely happening outside of densely populated areas. In order to maintain the same level of competition reached in broadband networks, access seekers and infrastructure providers will benefit from Next-Generation Bitstream product with a single infrastructure where they are not able to roll-out their own networks.

Next-Generation Bitstream favours co-investment (co-ownership) and risk sharing arrangements which can take different forms:

- Cooperation models respectively build and share models (narrow definition – joint ownership) reducing risk
- Furthermore, the investing operator may also require a commitment from 3<sup>rd</sup> parties before undertaking the investment (broader definition) and granting an indefeasible right of use.

Offering Next-Generation Bitstream allows having one single convergent communication network with one or more technologies and facilitates competition of services and access seekers. Next-Generation Bitstream gives a higher take-up rate with a single convergent shared network and therefore a quicker return on investment.



## ANNEX

### Application's examples of Next-Generation Bitstream and Virtual Unbundling

Different approaches are taken by NRAs. The investment ladder undergoes variations when market analyses are applied.

#### Case 1: Removal of physical sub-loop unbundling on market 4 + enhanced bitstream product on market 5 (Belgium)

In Belgium, they were very limited viability of sub-loop unbundling (SLU) (neither current nor prospective demand from alternative operators). Imposing SLU could hamper NGA investment strategy from operators. More, new FTTCab or FTTN (G.vector called Vectoring and G.fast called Omega) technologies which achieve higher speeds are incompatible with SLU. In other words, SLU would render ineffective these new technologies. Last, FTTH is not expected to be deployed in the current market review period by the regulator.

The regulator decided to withdraw the SLU obligation (market 4) and impose wholesale enhanced bitstream access over FTTCab/VDSL2 (market 5). This Next-Generation Bitstream product has the ability to differentiate QoS levels, service speeds and symmetry and support multicast. This fully fledged product will allow alternative operators to affectively differentiate their products at retail level. All operators will benefit from increased speeds.

#### Case 2: Replacement of physical unbundling by virtual unbundling on market 4 (UK and Austria)

In UK, Ofcom's reasoning is that BT's GPON-based fibre is at an early stage of deployment and that widespread GPON unbundling (at concentration point which is the last optical splitter level) is likely to be impractical from an economic perspective, at least in the short term. Therefore other types of virtual local access, with features similar to physical unbundling should be included in the market for wholesale local access. Ofcom mandated the provision of BT Openreach of Virtual Unbundled Local Access (VULA).

The characteristics of virtual unbundling (listed previously) lead the European Commission to accept that VULA is different from bitstream access and it could be included in market 4 – a market so far reserved to passive access products.

The Commission does not challenge Ofcom's finding that today fibre unbundling would not be a justified and proportionate remedy. However, the Commission argues that Ofcom should "as a matter of principle" require unbundled access to fibre loops (NGA Recommendation) of the network

independently of the architecture implemented by the operator. Ofcom should assess whether GPON unbundling could be cost effective, particularly if BT undertakes selective deployment in densely populated areas where sufficient aggregation could be achieved. The Commission invites Ofcom to re-assess the proposed remedies as soon as the technology enabling fibre wavelength unbundling is available.

In Austria, the virtual unbundling remedy (called “vULL”) is based on Ofcom’s VULA. The Commission accepted it but repeated its comment on the VULA product and added that the product should not be offered at higher levels than the local exchange otherwise it could not be imposed as a remedy in market 4 and that in order to ensure comparability with physical unbundling, a virtual unbundling product should be accompanied by stringent non-discrimination safeguards to ensure equivalence of access.

The next table summarises the current states of Next-Generation Bitstream and Virtual Unbundling in five countries in Europe.

	Austria	Germany	Italy (proposed)	Spain	UK
Product/ Remedy	Virtual unbundling (vULL)	Layer 2 bitstream / Ethernet bitstream	<u>Virtual unbundled access (VULA)</u> “Provision of virtual access to the local exchange of the fibre access network, by means of an active device, with ethernet handover interface”  <u>Ethernet bitstream at feeder nodes</u> (parent and distant levels).	NEBA (Nuevo servicio Ethernet de Banda Ancha) or New Ethernet Broadband Service (in English)	Virtual unbundled local access (VULA)
Status of regulation	Imposed as remedy in market 4/2007 (Sep. 2010)	Imposed in abstract form as a remedy in market 5/2007 (Sep. 2010)	Proposed as a remedy in market 5/2007	Imposed as a remedy in market 5/2007 (Jan. 2009)	Imposed as remedy in market 4/2007 (Oct. 2010)
Coverage	Only imposed in areas where A1 Telekom Austria (A1TA) deploys FTTC/B		Notwithstanding the NGA architecture (FTTH/B/N). Proposals still subject to changes pending the final decision.	Imposed in all areas (from exchange and from remote cabinets), for all technologies (ADSL2+, VDSL2, FTTH) Limited to 30 Mbps	Only applicable in areas where BT deploys an NGA network
Status of implementation	Not yet used in practice. Negotiations on amendments to the reference offer are pending.	Reference offer proceedings will start as soon as general demand is expressed. Individual dispute settlement proceedings could be initiated by access seekers at any time. NGA forum, an industry group chaired by BNetzA develops a specification on a voluntary basis (principles announced in May 2011).	Timing not known yet Deadline for the public consultation: end of June 2011. Telecom Italia (TI) is required to publish for AGCOM’s approval a reference offer within 2 months from the adoption of the final AGCOM decision.	Product specification approved Nov. 2010 (following the architecture defined in a forum with operators) Will be operational by Jan. 1, 2012	BT/Openreach offers a generic ethernet access product (GEA) since June 30, 2010 Industry negotiations under way to implement VULA requirements as set out in Ofcom’s Oct. 2010 decision

*Table 2: Next-Generation Bitstream and Virtual Unbundling in Europe (source: Cullen International, 2011)*