Report on potential pricing methodologies for Bitstream Managed Backhaul pricing

ComReg

Ref: 2014-34-DB-ComReg

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S.A.S. au capital de 200 000 €
RCS Paris B 394 948 731

November 2014

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1 Executive summary

In the context of broadband usages (in terms of kbps at peak hour) growing very fast and heterogeneously among operators, this report aims at identifying one or several recommended approaches for bitstream pricing to ensure that Eircom's bitstream prices enable ComReg to meet its objectives.

This draft report shows that:

- Eircom's NGN Ethernet core network costs are mainly composed of trench, ducts and fibre costs which do not vary when traffic grows. The main driver of costs is in fact the geography of Ireland. Other NGN Ethernet core network assets are sensitive only to very large increases in traffic (1 Gbps or 10 Gbps);
- Eircom's NGN Ethernet core network (network used to provide CGA-BMB and NGA Bitstream Plus) costs vary very slightly when traffic grows. Sensitivity analyses indicate a variable cost per Mbps of only €✂/Mbps/month, far below the "per Mbps" charge proposed by Eircom (€10 and €15) and calculated by ComReg's WBA floor cost model (around €✂);
- NGA Bitstream Plus costs and CGA-BMB costs differ because NGA Bitstream Plus is concentrated in more urban areas. While in relative terms, the cost per Mbps can be ✂ lower, in absolute term it is only €✂/Mbps/month lower for NGA Bitstream Plus;
- A uniform "per port" charge would not seem appropriate given the presence of different customer profiles in Ireland (different willingness to pay, different usages, etc.);
- Price differentiation[1] is widespread in the electronic communications market. It is already in place for WSEA leased lines, BMB prices, etc.
- If price differentiation is likely to expand demand, it is likely to be beneficial. In the present case, it is likely that, in the context where the level of bitstream prices is constrained (by competition from LLU operators and UPC and by ComReg's decisions), price differentiation would expand demand by allowing lower prices for some customers (those with low willingness to pay – which can be low-usage customers which therefore derive low utility from broadband or high-usage customers who want higher usage but are less willing to pay for that

[1]Price differentiation here means a form of demand led pricing strategy where similar services are transacted at different prices by the same provider in order to maximize customer benefits with a view to increasing consumer demand. In this specific case, this is therefore different from the general concept of discrimination described in Regulation 10 of the Access Regulations[1] which transposes Article 10 of the Access Directive[1] and which provides that ComReg may impose on an SMP operator obligations of non-discrimination in relation to access or interconnection to ensure that, in particular, that operator: *"(a) applies equivalent conditions in equivalent circumstances to other undertakings providing equivalent services, and (b) provides services and information to others under the same conditions and of the same quality as the operator provides for its own services or those of its subsidiaries or partners.".*

usage). Indeed, if price differentiation enables operators to reach lower level of prices for customers with low willingness to pay, it will be beneficial;

- Currently in Ireland, it is observed that operators (even those not constrained by existing bitstream prices) propose a €4 to €8 "discount" (VAT excl.) for users with low usage. This tends to show that price differentiation indeed enables operators to expand demand and that such price difference should be kept as long as OAO's customer usage profiles remain diverse;
- With respect to Eircom's bitstream price structure, ComReg's statutory objectives translate into the following 5 objectives:
    - The pricing structure should reflect to a certain extent cost drivers (i.e. there must be a "per Mbps" charge at a level above the variable cost per Mbps);
    - The pricing structure should provide some flexibility to OAOs and Eircom;
    - Basic Internet access offers must not be too expensive;
    - The pricing structure should promote allocative efficiency, i.e. be based on the different customers' willingness to pay;
    - The pricing structure should not be too complex to monitor.
- Considering these objectives and having removed the pricing methodologies that do not maximise customer benefits (those that set a too high price for high-usage customers and those that set a too low differential in prices between high usage and low usage customers) or that do not reflect cost drivers (per Mbps charge =0), TERA has identified 4 methodologies which could be used to achieve the above objectives: tiered pricing, logarithmic pricing, logarithmic pricing based on industry average and package pricing.
- The logarithmic approach gives visibility to stakeholders since the formula is known in advance and only one factor needs to be updated when traffic varies. The main issue with the logarithmic approach is that the difference in €/customer between low-usage customers and high-usage customers may be low depending on how the log formula is set. However, the formula can be easily modified. This approach may be seen as too prescriptive (as strictly based on a given formula);
- The logarithmic approach can be implemented in two ways:
    - An approach whereby each OAO pays according to its own throughput (approach A). If the difference between OAOs average throughput increases over time (which seems to the case based on operators' response to the call for input), this approach will keep a constant cost difference per user between OAOs.
    - An approach whereby the logarithmic curves is designed to define a unique charge per Mbps applicable to each OAO (approach B). The

unique charge per Mbps is obtained from a logarithmic curve applied at the industry average throughput. This approach leads to lower bitstream prices for low usage customers since, when traffic increases, they will always benefit from the lower throughput unit cost. Because the same per Mbps charge applies to all OAOs, the risk of having a situation whereby OAOs aggregating traffic from other OAOs are paying more than if traffic was not aggregated is lower. However, it is important to bear in mind that where the combined peak usage is less than the sum of the individual peak usage levels there will still be a corresponding incentive to aggregate. Also, this approach provides less predictability for OAOs, especially those requiring high throughputs because the charge they will pay depends on the throughput of other OAOs. This approach is more complex and requires implementing a process to publish industry average throughputs.

- The “package” approach has the advantage of giving OAOs the ability to select their preferred package which requires less information about their preferences and also let them differentiate themselves. The main issue is that it may be difficult to monitor when traffic increases and when customer distribution moves. In line with the practice observed in the retail Irish broadband market, only 2 packages may be sufficient and would facilitate the monitoring of the approach;
- The “tiered pricing” approach combines the disadvantages of the first two approaches in that it is too prescriptive and may be difficult to monitor. It does not provide as much visibility as the logarithmic approach does since the definition of “tiers” may be often updated and may be set artificially.
- TERA therefore recommends using the “package” approach or the “logarithmic” approach. There are both sufficiently flexible to maximise customer benefits. If the logarithmic approach is preferred, then approach A should be preferred as it provides greater predictability.
- It is important to note that this assessment is based on the assumption that OAOs are targeting customers with different willingness to pay/ utility derived from broadband. If this is not the case, a uniform “per port” pricing structure would be appropriate.
- CGA-BMB and NGA Bitstream Plus currently have different prices per Mbps. The difference in price is today €✂/Mbps/month but the difference in cost is €✂/Mbps/month. Apart from this and apart from the local loop, CGA-BMB and NGA Bitstream Plus do not exhibit cost differences. There are however differences in terms of average throughput because average throughput for NGA Bitstream Plus is much higher than for CGA-BMB. But these throughput differences are already factored in the recommended approaches above.
- It is important to note that pursuant to ComReg Decision document D11/14, Eircom’s CGA-BMB pricing is subject to cost-orientation, while NGA Bitstream

Plus is subject to a margin squeeze obligation pursuant to ComReg Decision document D03/13. This is discussed further in section 2.1.2.

2 Introduction

2.1 Context

2.1.1 ComReg's Call for Input on current and future projections on throughput

In March 2014, ComReg published a Call for Input (ComReg Document No.14/18) requesting views from interested parties regarding the future evolution of broadband usage and the implications for throughput rates. Based on the submissions received, industry expectations are that the relevant bitstream throughput levels will increase significantly in a relatively short-period of time which could mean significant increases in bitstream charges paid by OAOs and ultimately end-users.

While the recent decrease in Bitstream Managed Backhaul prices of Eircom Wholesale (see section 2.1.3 below) has somewhat alleviated this issue, it is likely that both the pricing structure and divergence for Current Generation Access ('CGA') and Next Generation Broadband Access ('NGA') pricing may be of concern going forward.

TERA has been selected by ComReg to review possible bitstream pricing structures and critique the relevant approaches identified. As noted in section 2.1.2, Eircom's CGA-BMB prices are subject to cost-orientation. It is Eircom's responsibility to ensure it meets its obligations. The purpose of this report is to assist ComReg to evaluate potential future pricing proposals that may be made by Eircom in the context of meeting its regulatory obligations.

2.1.2 Eircom's pricing obligations with respect to bitstream services

Eircom's bitstream services are regulated by ComReg which has imposed several price control obligations over the last years:

- *ComReg Decision D06/12, ComReg Document No 12/32 "Wholesale Broadband Access: Further specification to the price control obligation and amendment to the transparency obligation" dated 5 April 2012* – the objective of this decision is to prevent Eircom from setting Bitstream prices too low such that they could discourage investment in LLU or other infrastructure operators either investing or planning to invest. This decision applies to legacy bitstream (BIP) and Next Generation Bitstream (BMB) (both are generally grouped in what is called "Current Generation Bitstream" (CGB)) or "Current Generation Access" (CGA)). This decision does not apply to NGA Bitstream Plus. Currently, Eircom cannot set bitstream prices below the following levels:

Table 1 – Level of bitstream floors

€/month	ComReg Decision D06/11	ComReg Decision 11/14 (proposed but not applied
Monthly port cost – per port	4.55	4.34

Monthly backhaul cost – per port	1.33	1.57
Monthly backhaul cost – per Mbps	8.14	5.60

Source: TERA Consultants from ComReg's documents

- *ComReg Decision D11/14, ComReg Document No 14/73* – this decision impose upon Eircom a national cost orientation obligation for CGB which means that total revenues generated by Current Generation bitstream services should equal or be close to Eircom's HCA costs;
- *ComReg Decision D03/13, ComReg Document No 13/11 "Next Generation Access ('NGA'): Remedies for Next Generation Access Markets"* – the objective of this decision is to impose an economic replicability test between various wholesale models of provision of NGA (between bitstream and retail and between bitstream and VUA for example). This decision imposes for example a floor and a ceiling to NGA Bitstream Plus;
- ComReg has taken a number of decisions which prevent Eircom's bitstream prices from causing a margin squeeze (above decisions but also ComReg's decision 13/14 on bundles).

These decisions impose obligations upon Eircom on **the level of price** at which it sells bitstream (CGB or NGA). These decisions do not impose obligations upon Eircom on **the structure of price** at which it sells bitstream.

It is also important to remember that ComReg does not currently set the exact level of bitstream prices. Eircom has some freedom in setting these prices as long as they do not fall below the floors, they do not cause margin squeeze, they do not go above costs outside Large Exchange Areas (LEA) and respect the national cost orientation obligation. However, ComReg has recognised that in the LEA of Ireland, Eircom's bitstream prices were also constrained to some degree by alternative infrastructure competition (mainly from UPC and LLU operators).

2.1.3 Eircom's bitstream prices

Eircom's bitstream portfolio is made of three types of offers:

- CGA-BMB offers, which is a bitstream offer based on Eircom's NGN core network and Eircom's copper local loop,
- NGA Bitstream Plus, which is a bitstream offer based on Eircom's NGN core network and Eircom's NGA network,
- CGA-BIP, which is a bitstream offer based on Eircom's legacy core network and Eircom's copper local loop.

The pricing structure of CGA-BMB and NGA Bitstream Plus is a “two-part” tariff: a “per port” price and a “per Mbps” charge (“usage charge”). CGA-BIP offers are made of a single price component: a “per port” charge.

The following table shows how bitstream prices have evolved over the last few years. It is interesting to note that “per port” charges have almost never changed (1 change for CGA-BMB, 4 changes for BIP over 5 years) while “per Mbps” charges have often changed recently (9 changes concentrated over the last 2 years).

Table 2 – Eircom’s Bitstream price evolution (CGA-BMB, NGA Bitstream Plus and BIP) over the last 5 years

€/month	H1 2010	H2 2010	H1 2011	H2 2011	H1 2012	H2 2012	H1 2013	H2 2013	H1 2014
CGA BMB – 8 Mbps – port charge	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90
CGA BMB – 24 Mbps – port charge	7.65	7.65	7.65	7.65	7.65	**5.90**	5.90	5.90	5.90
Standalone CGA BMB – 8 Mbps – port charge								17.95	17.95
Standalone CGA BMB – 24 Mbps – port charge								18.95	18.95
NGA Bitstream Plus standalone – port charge								17.50	17.50
NGA Bitstream Plus POTS Based – port charge								5.98	5.98
CGA BMB – 8 Mbps – usage charge CGA BMB – 24 Mbps – usage charge	50	50	50	50	50	**30**	**30 with tiered pricing above 100kbps with 10 above 200 kbps**	**20**	**15**
Standalone CGA BMB – 8 Mbps – usage charge								20	**15**
Standalone CGA BMB – 24 Mbps – usage charge								20	**15**
NGA Bitstream Plus – Usage charge Best effort								20	**10**
NGA Bitstream Plus – Usage charge EF								25	**12.50**
NGA Bitstream Plus – Usage charge AF								30	**15**
1M Connect IP product (BIP)	9.48	9.48	9.48	9.48	9.48	9.48	9.48	9.48	9.48
“up to” 3M Expand IP product (BIP)	11.55	11.55	11.55	11.55	11.55	11.55	11.55	11.55	11.55

“up to” 7.1M Rapid IP product (BIP)	14	14	14	14	14	14	14	14	14
“up to” 12M Swift IP product (BIP)	16.95	**16.5**	16.5	16.5	16.5	16.5	16.5	16.5	16.5
“up to” 24M Sprint IP product (BIP)	38.5	38.5	38.5	**34.5**	34.5	**21.5**	21.5	21.5	21.5
“up to” 18M Turbo IP Plus product (BIP)	38.5	38.5	38.5	38.5	38.5	**24.5**	24.5	24.5	24.5

Source: TERA Consultants from Eircom’s bitstream price list

NB: price changes have not necessarily occurred in June or December of each year and therefore the table above provides a simplified view of price changes

The evolution of Eircom’s bitstream prices therefore indicates that the usage/per Mbps charge has changed several times. This needs obviously to be analysed in the context of the very fast evolution of bitstream throughputs over the last months because the higher bitstream throughputs, the lower expected cost per Mbps. The industry expectations (obtained as a result of ComReg’s Call for Input) are summarised below and show very fast increases in bitstream throughputs:

Table 3 – Planned evolution of bitstream throughputs

Year (kbps or %)	Eircom		BT		Sky		Vodafone		Imagine	
	CGA	NGA	CGA	NGA	CGA	NGA	CGA	NGA	CGA	NGA
Current	✂	✂	✂		✂	✂		✂		
+ 1 year	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂
+ 2 years	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂
Estimate of the Increase in bitstream charge supported by OAOs as a consequence of bitstream throughput evolution*	✂	✂	✂		✂	✂		✂		

*(€/month between year 0 and year 2 assuming existing rates)

Source: TERA Consultants from responses to the CFI

Based on existing bitstream prices, these throughputs increases would translate into significant price increases at the wholesale level (between +€✂ and +€✂/customer/month) which would probably be then translated at the retail level (although this would depend on the level of pass-through from OAOs). However, this assessment is incomplete because as bitstream throughputs increase, Eircom's cost per Mbps decreases and Eircom's level of prices are likely to decrease[2].

2.2 Objectives and structure of the report

In the context of rapid changes in bitstream prices and in throughput levels, the objective of this report is to:

- Analyse Eircom's bitstream cost drivers (see section 3) in order to determine how the relevant network costs change as throughputs increase. In particular, the report will identify to what extent the related costs are fixed and/or variable as the level of demand on the network increases and also the extent to which average backhaul costs differ between Larger Exchange Areas ('LEA') and non-LEA areas and the implications (if any) this might have for CGA and NGA backhaul pricing.
- Review and compare several recommended approaches (those recommended by OAOs in their response to the Call for Input by ComReg and those approaches identified by ComReg/TERA) in order to identify a preferred approach which balances the concerns raised by interested parties and ComReg's statutory objectives (see section 4).

[2] "likely" because they may also stabilize if broadband traffic increases much faster than leased lines and voice, more and more costs may be allocated to broadband

3 Cost volume relationships in Eircom's NG network

3.1 Presentation of Eircom's NGN network

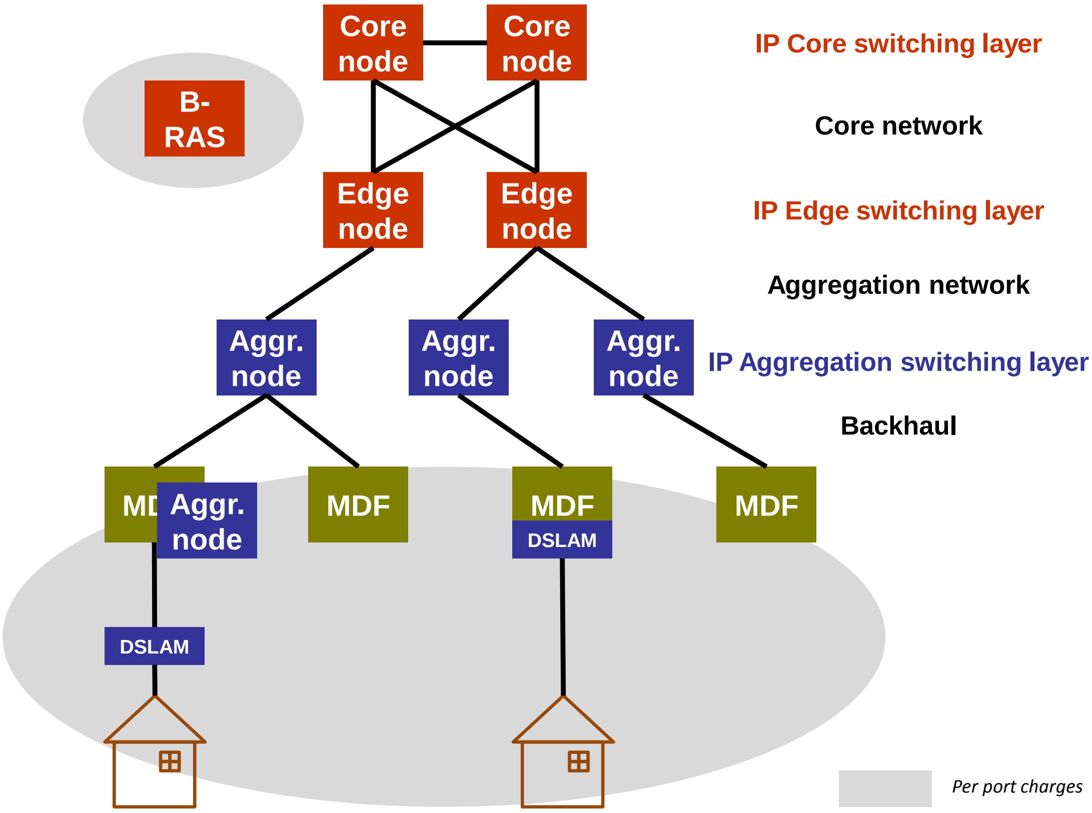
Eircom's bitstream services are provided over several platforms operated by Eircom:

- Combination of Copper local loop and Next Generation core / Ethernet network for CGA-BMB;
- Combination of FTTC (NGA) and Next Generation core / Ethernet network for BMB for NGA Bitstream Plus;
- Combination of Copper local loop and legacy core network (ATM) for BIP.

NB: in the rest of the report, BIP pricing is not discussed further mainly because the number of BIP lines is decreasing and was representing only ✂ of CGA lines in July 2013 but also because the pricing structure (a single "per port" charge) has not been commented on by OAOs. However, the analyses and recommendations of this report still hold for BIP offers and aligning BIP pricing with other pricing schemes may provide more transparency and simplicity to the industry.

The diagram below represents the network elements used to produce CGA-BMB and NGA Bitstream Plus offers. It is clear that both products share many network elements. However, it must be remembered that the network coverage of NGA Bitstream Plus is limited compared to the network coverage of CGA-BMB (✂ exchanges out of more than ✂) which could imply cost differences (see section 3.2.11 for more details).

Figure 1 - Eircom's network elements used to produce BMB and NGA bitstream offers



Source: TERA Consultants

Some network elements are directly sensitive to the number of customers. Generally speaking, they are physically close to the local loop. For these network elements, it is generally accepted that they should be recovered by a "per port" or "per customer" charge. There is no debate on how the costs of these network elements should be recovered. However, the debate in Ireland is focused on other network elements – traditionally recovered by a "per Mbps" charge – that is to say the backhaul. This report is therefore focusing on these latter network elements. The table below lists the relevant network elements used by CGA BMB and NGA Bitstream Plus and whether they are traditionally recovered by a "per port" or a "per Mbps" charge.

Table 4 – Network elements used by BMB and NGA Bitstream (in pink, network elements which are mainly considered in this report)

Type of network elements	CGA – BMB	NGA Bitstream Plus	Traditionally "per port" or "per Mbps"
D-Side copper	X	X	Per port
DSLAM at the cabinet		X	Per port
E-Side copper	X		Per port
E-Side fibre		X	Per port
DSLAM at the exchange	X		Per port
APT Network (trench, fibre, WDM)	X	X	Per Mbps
IP Aggregation router	X	X	Per Mbps & Per port[3]
IP aggregation routers to IP edge routers transmission (trench, fibre, WDM)	X	X	Per Mbps
IP Edge router	X	X	Per Mbps
Core network transmission (trench, fibre, WDM)	X	X	Per Mbps
IP Core router	X	X	Per Mbps
BRAS	X	X	Per port

Source: TERA Consultants

[3] NGA offers use 2 levels of aggregation nodes. The first level of aggregation nodes is recovered on a "per port" basis while the second level on a "per Mbps" basis, like for CGA

3.2 Cost drivers and Cost volume relationships

3.2.1 Distribution of costs

3.2.1.1 Which tool to use in order to assess cost volume relationships?

In order to assess how Eircom's core network costs increase when traffic increase, the most appropriate tool to use is ComReg's "NG Ethernet core model"[4]. This bottom-up LRIC (BU LRIC) cost model was first developed in 2009 by ComReg and was described in ComReg's consultation document "Further specification of the price control obligation, the transparency obligation and the access obligation in relation to the market for wholesale terminating segment of leased lines" (10 September 2010). Since then this model has been regularly updated.

Another option which could have been envisaged would have been to use Eircom's top-down accounting system. However, it would have been very difficult to conduct the relevant analyses as a top-down accounting system does not provide the ability to test the sensitivity of Eircom's actual costs to some parameters. In contrast a BU LRIC cost model provides this ability.

Also, ComReg's cost model which is used to set bitstream floors, could also have been used. However, this model calculates the cost of an OAO building its own network and purchasing wholesale leased lines from Eircom to construct its backhaul. Therefore, this model does not provide "true" cost-volume relationships as the backhaul charge in this latter model are more dependent on Eircom's leased lines pricing structure. Also, the bitstream floor cost model does not reflect Eircom's cost drivers but the cost drivers of an OAO while the issue at stake is how Eircom's network costs change when throughput increase.

3.2.1.2 ComReg's NG Ethernet core BU LRIC model

This BU LRIC cost model aims at modelling Eircom's Next Generation core network (which supports both CGA-BMB and NGA Bitstream Plus but not BIP) and is built to handle the forecasted demand for 3 services: voice, broadband and leased lines. It has already been used by ComReg in the context of leased lines costing and pricing. At this time, it has been fully audited by Eircom. It is based on detailed engineering rules which enable traffic inputs to be linked to the total cost of the network. To assess the network's cost volume relationships, sensitivity analyses are therefore performed by changing traffic inputs in the model.

The model also provides an analysis on how costs vary in the 17 regions of Eircom's core network (plus the "core" region).

[4] The version used is "NGN-Core-Model-vMulticast - 2013-12-12 1600 (stable version at 18 03 2014)"

On the basis of this BU LRIC cost model, the cost volume relationships will be identified for each network element first (see network topology in section 3.1):

- APT equipment (see section 3.2.3);
- IP Aggregation router (see section 3.2.4);
- IP Aggregation to IP Edge equipment – WDM (see section 3.2.5);
- IP Edge router (see section 3.2.6);
- Core Network equipment – WDM (see section 3.2.7);
- IP Core Router (see section 3.2.8);
- Trenches and fibre cables (see section 3.2.9).

As explained above, these network elements are traditionally recovered by a “per Mbps” charge.

The cost volume relationships will be also analysed in total for the network in section 3.2.10.

3.2.2 General considerations

It is important to keep in mind that trenches and fibre cables represent ✂% of the network costs (CAPEX+OPEX) whereas remaining ✂% are costs of links, costs of active equipment and commons costs (see Figure 2).

Figure 2 - Breakdown of core network costs (2014)

✂

Source: TERA Consultants from the NGN Ethernet BU-LRIC cost model

It is to be noted that in the “NG Ethernet core model”, OPEX (✂% of total costs for 2014) are assessed as a fixed amount allocated on the different assets based on an Equi-Proportionate Mark-Up (EPMU) approach.

3.2.3 Cost volume relationships for APT

The APT costs are assessed based on Eircom’s mix of sites configuration (two-site spur, 3-site chain…) for each region. These configurations are driven by the geography of the region and their design is not traffic-driven. As a consequence, when traffic increases, costs hardly increase (see Figure 3).

Figure 3 - Capex CVR for APT equipment (2014)

✂

Source: TERA Consultants from the NGN Ethernet BU-LRIC cost model

NB: the graph should be read as follows: when total traffic at the APT level is doubled compared to the 2014 traffic then ✂

3.2.4 Cost volume relationships for Aggregation routers

Aggregation routers costs include:

- Aggregation routers CAPEX;
- Corresponding building costs;
- CMS for Aggregation routers.

The number of Aggregation routers locations is taken from the topology of Eircom's network (not driven by the traffic – scorched node approach). If PE backhaul requirements per site exceeds the "max configuration" (✂GE), then additional aggregation routers are added.

The cost of each Aggregation router is then driven by its "GE and 10 GE port configuration". This configuration depends on the number of ports required for fibre, DSLAMs and PE backhaul:

- Number of fibre ports depends on the number of fibre access lines (non-traffic sensitive) which is mainly driven by the number of fibre leased lines;
- Number of DSLAM ports depends on the number of broadband lines per site (non-traffic sensitive);
- Number of PE backhaul ports depends on the backhaul traffic.

Building costs and CMS costs are driven by the number of aggregation routers. As a consequence, these are indirectly traffic sensitive.

The sensitivity analysis shows that when 2014 voice, broadband and leased lines traffic are multiplied by ✂, the aggregation routers costs are multiplied by ✂ (see Figure 4).

Figure 4– Capex CVR for Aggregation routers (2014)

✂

Source: TERA Consultants from the NGN Ethernet BU-LRIC cost model

NB: the graph should be read as follows: when total traffic at the Aggregation router level is doubled compared to the 2014 traffic then 2014 total CAPEX of aggregation routers increases from 100 to ✂

3.2.5 Cost volume relationships for WDM (IP Aggregation to IP Edge)

WDM costs in the IP aggregation to IP Edge transmission network level include:

- WDM CAPEX;
- Corresponding building costs;
- CMS for WDM equipment.

The WDM CAPEX is assessed as the sum of OADM, OTM, ILA, transponders and SFP costs. The dimensioning of these elements is traffic-dependent.

The space requirement and CMS requirement are driven by the number of OADM, OTM and ILA so indirectly driven by the traffic.

The sensitivity analysis shows that when 2014 voice, broadband and leased lines traffic are multiplied by ✂, the WDM costs in the IP aggregation to IP Edge transmission network level are multiplied by ✂ (see Figure 5).

Figure 5 - Capex CVR for WDM IP Aggregation to IP Edge equipment (2014)

✂

Source: TERA Consultants from the NGN Ethernet BU-LRIC cost model

NB: the graph should be read as follows: when total traffic at the IP aggregation to IP Edge transmission network level is doubled compared to the 2014 traffic then 2014 total CAPEX of WDM moves from 100 to ✂*.*

3.2.6 Cost volume relationships for Edge routers

Edge routers costs include:

- Edge routers CAPEX;
- Corresponding building costs;
- CMS for Edge routers.

The number of Edge locations is as in Eircom's network (✂ Edge locations per region).

The cost of each Edge router is driven by the number of 1GE and 10GE ports on the Edge routers (Aggregation routers ports, Edge ports, Core backhaul). These are driven by the traffic at Edge node level and by the traffic going to the "Core".

Building costs and CMS costs are only driven by the number of edge routers (not traffic sensitive).

The sensitivity analysis shows that when 2014 voice, broadband and leased lines traffic are multiplied by ✂, Edge routers costs are multiplied by ✂ (see Figure 6).

Figure 6 – Capex CVR for Edge routers (2014)

✂

Source: TERA Consultants

NB: the graph should be read as follows: when total traffic at the Edge router level is doubled compared to the 2014 traffic then 2014 total CAPEX of Edge routers moves from 100 to ✂.

3.2.7 Cost volume relationships for WDM (Core)

WDM costs at the core level include:

- WDM CAPEX;
- Corresponding building costs;
- CMS for WDM equipment.

The WDM CAPEX is assessed as the sum of OADM, OTM, ILA, transponders, SFP. The dimensioning of these elements is traffic-dependent.

The space requirement and CMS requirement are driven by the number of OADM, OTM and ILA so indirectly driven by the traffic.

The sensitivity analysis shows that when 2014 voice, broadband and leased lines traffic are multiplied by ✂, the WDM costs at core level are multiplied by ✂ (see Figure 7).

Figure 7 – Capex CVR for WDM Core equipment (2014)

✂

Source: TERA Consultants

NB: the graph should be read as follows: when total traffic at the WDM core level is doubled compared to the 2014 traffic then 2014 total CAPEX of WDM core moves from 100 to ✂.

3.2.8 Cost volume relationships for IP core routers

IP Core routers costs include:

- Core routers CAPEX;
- Corresponding building costs;
- CMS for Core routers.

The number of IP Core router locations is as in Eircom's network (✂ for the whole of Ireland). The cost of each IP Core router is driven by the technical traffic at IP Core nodes.

Building costs and CMS costs are only driven by the number of core routers (not traffic sensitive).

The sensitivity analysis shows that when 2014 voice, broadband and leased lines traffic are multiplied by ✂, the core routers costs are multiplied by ✂ (see Figure 8).

Figure 8 - Capex CVR for IP Core routers (2014)

✂

Source: TERA Consultants

NB: the graph should be read as follows: when total traffic at the IP core router level is doubled compared to the 2014 traffic then 2014 total CAPEX of IP core routers moves from 100 to ✂.

3.2.9 Cost volume relationships for Trenches

In the BU LRIC model, the "trenches" cost category (which includes trenches, ducts and cables) aggregates the demand for the following levels of the network:

- APT;
- IP Agg. To IP Edge;
- Core Network.

The capacity of one fibre cable (typically ✂ GE but can be more) and the number of fibre cables installed in trenches is so high (✂ or ✂ fibres) that huge amounts of traffic are needed to increase costs.

It can therefore be concluded that the design of trenches is driven by the geography of the network and is not traffic driven (see Figure 9):

Figure 9 - Capex CVR for Trenches (2014)

✂

Source: TERA Consultants

NB: the graph should be read as follows: when total traffic in trenches is doubled compared to the 2014 traffic then ✂.

3.2.10 Total network cost volume relationships

When all cost categories are aggregated (including OPEX and after having depreciated CAPEX), the total network annual cost evolves slightly with the traffic measured at the aggregation level (see Figure 10).

Without any traffic, the cost of the network is equal to M€ ✂per annum. **The incremental traffic cost is €✂per Mbps per annum (measured at the aggregation level)**. The cost / volume relationship is almost perfectly linear (R2=0.9997).

Figure 10 - Evolution of the total cost with the traffic measured at the aggregation level – in millions of Mbps (2014)

✂

Source: TERA Consultants

If the total network annual cost (annual cost with zero traffic + incremental costs related to traffic) is compared to the total traffic measured at the aggregation level, the average network cost is €✂ per Mbps per annum, i.e. €✂ per Mbps and per month (see Table 5).

Table 5 – Evolution of the cost per /Mbps measured at the aggregation level cost with the traffic (2014)

Total traffic measured at the aggregation level *"Base 100" 2014*	20	40	60	80	**100**	125	150	175	200	250	300	350	400	450	500
TOTAL cost (*Mn €*)	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂
€/Mbps/annum	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂	✂

Source: TERA Consultants

3.2.11 Cost per Mbps in NGA and non-NGA areas / LEA areas and non LEA areas

As explained in section 3.1, the NGA footprint is limited compared to the CGA footprint. This means that costs per Mbps for NGA may be different than cost per Mbps for CGA. To assess this, an analysis of how cost varies over the territory is needed.

The NGN Ethernet BU LRIC core network cost model is able to detail network costs in the ✂ network regions within Ireland (plus the "core region") as defined by Eircom. The model cannot provide a lower granularity (cost per exchange for example).

In order to assess the cost differences of one Mbps in NGA areas and in CGA, the NGN Ethernet BU LRIC core network cost model can therefore be used. However, only approximations can be performed. A preliminary analysis has therefore been performed in order to match the ✂ regions to the NGA areas.

To do so, the latest available list of NGA exchanges has been used as a starting point[5]. This list includes for each exchange the number of DSL lines. For each of the ✂ regions within the model, the number of NGA exchange lines and the number of non-NGA exchange lines has been calculated.

Regions with X% NGA exchange lines have been accounted for X% in the NGA areas and (1-X)% in the non-NGA areas (see Table 6).

Table 6 – Determination of NGA % for each region

✂

Source: TERA Consultants

Excluding the core region, the cost of the empty network (fixed costs when there is no traffic) is M€ ✂in the NGA areas (see Figure 11) and M€ ✂in non NGA areas (see Figure 12). The incremental traffic cost is €✂ per Mbps per annum in NGA areas and €✂ per Mbps per annum in non NGA areas.

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[5] February Confidential LEA list with NGA 2014.xls

It is to be noted that average incremental cost (€✂ per Mbps, see Figure 13) is lower than the incremental cost for the whole network as this analysis excludes the core region. If the core region is included, the incremental cost is circa €✂ per Mbps per annum (see section 3.2.10).

Figure 11 – Evolution of the NGA areas cost <u>excluding core region</u> with the traffic (2014)

✂

Source: TERA Consultants

Figure 12 – Evolution of the non-NGA areas cost <u>excluding core region</u> with the traffic (2014)

✂

Source: TERA Consultants

Figure 13 - Evolution of the all areas cost <u>excluding core region</u> with the traffic (2014)

✂

Source: TERA Consultants

If the total network cost (excluding the core region) is compared to the total traffic at aggregation level, the average network cost is €✂ per Mbps per annum for the NGA area (see Table 7) and €✂ per Mbps per annum for the non-NGA area (see Table 8). The significant gap is due to higher distances and lower economies of scale in the non-NGA areas as compared to the NGA areas.

The average network cost is €✂ per Mbps per annum <u>excluding the core</u> (see Table 9). This means that NGA areas are ✂ than the national average, or €1.0/Mbps/month.

Table 7 – Evolution of the €/Mbps cost in the NGA areas <u>excluding "core" region</u> with the traffic (2014)

Total traffic *"Base 100" 2014*	20	**100**	200	300	400	500
TOTAL cost *Mn €*	✂	✂	✂	✂	✂	✂
€/Mbps/annum	✂	✂	✂	✂	✂	✂

Source: TERA Consultants

Table 8 – Evolution of the €/Mbps cost in the non-NGA areas <u>excluding the “core” region</u> with the traffic (2014)

Total traffic *"Base 100" 2014*	20	**100**	200	300	400	500
TOTAL cost *Mn €*	✂	✂	✂	✂	✂	✂
€/Mbps	✂	✂	✂	✂	✂	✂

Source: TERA Consultants

Table 9 – Evolution of the national average €/Mbps cost <u>excluding the “core” region</u> with the traffic (2014)

Total traffic *"Base 100" 2014*	20	**100**	200	300	400	500
TOTAL cost *Mn €*	✂	✂	✂	✂	✂	✂
€/Mbps	✂	✂	✂	✂	✂	✂

Source: TERA Consultants

4 Appropriate methodology for bitstream managed backhaul pricing

4.1 Bitstream pricing and price differentiation

4.1.1 Economic theory

Before we assess a number of potential pricing structures in light of ComReg's objectives, it appears necessary to discuss the fundamentals of price discrimination. If all customers in Ireland had the same usage, had the same willingness to pay for broadband services and were deriving the same utility from broadband services, the most appropriate pricing structure for bitstream would be a single and unique "per port" charge for all users (potentially differentiated between CGA and NGA due to cost differences). Indeed, in a context where costs are mainly fixed (see section 3) and vary very slightly when traffic increases, the question at stake is how to allocate costs between the different customers.

However, it is obvious that Irish broadband customers have different usages, different willingness to pay and are deriving different utility from broadband. Economic theory suggests then that price discrimination can be used.

Economic theory identifies 3 types of price discrimination:

1. First-degree price discrimination (or perfect discrimination) whereby each customer is charged a different price depending on each customer's willingness to pay/ price elasticity. This is hardly practical given the amount of information required;
2. Second-degree discrimination whereby each customer "decides" the price it wants to pay depending on its usage and ability to pay (typically a two-part tariff such as the one in place for CGA-BMB);
3. Third-degree discrimination whereby different prices are applied to different group of customers ("young", "teen-agers", "retired people", "families", etc.).

Economic theory generally focuses on price discrimination to assess whether it increases social welfare and customer welfare. It is generally said that a monopolist with no constraints on price levels would use price discrimination in a way which would decrease customer welfare. However, in the present context, because Eircom's bitstream prices are constraints (either by competition in LEA areas or by the national cost orientation which is going to be imposed or by margin squeeze obligations), customer welfare will not be significantly negatively affected (depending on customer preferences) by price differentiation because if prices increase for some customers, prices will have to decrease for others.

A 2009 Ofgem's report addressed the issue of price discrimination and in which circumstances it should be considered undue. It stated: *"In a monopoly setting, price discrimination can lead to higher prices for some consumers or consumer segments, relative to perfect competition, reducing consumer surplus and increasing producer* *surplus. As noted, the motivation for firms to engage in price discrimination in this setting is higher margins. However, price discrimination can also benefit consumers, if it allows firms to lower prices for some consumers, relative to the equivalent uniform price and can therefore increase consumer welfare. This is especially likely to increase welfare overall if these lower prices expand demand. This can increase consumer surplus, particularly where this consequently expands demand or allows a new market to be served where it was not previously. […] This is a key factor in determining whether the overall impact of price discrimination on consumers and firms is good or bad. Vickers highlights that the more price discrimination expands demand, the more likely it is to be beneficial."*[6]

It is important to note that price discrimination here means a form of demand led pricing strategy where similar services are transacted at different prices by the same provider in order to maximize customer benefits with a view to increasing consumer demand. It seems preferable to name this type of pricing strategy 'a form of price differentiation' rather than 'a form of price discrimination' in order to avoid any confusion with the definition of discrimination in the context of:

- Regulation 10 of the Access Regulations[7] which transposes Article 10 of the Access Directive[8] which provides that ComReg may impose on an SMP operator obligations of non-discrimination in relation to access or interconnection to ensure that, in particular, that operator: *"(a) applies equivalent conditions in equivalent circumstances to other undertakings providing equivalent services, and (b) provides services and information to others under the same conditions and of the same quality as the operator provides for its own services or those of its subsidiaries or partners.".*
- Undue discrimination *"Undue discrimination can only arise where different treatment is given to persons in similar circumstances, or where the same treatment is given to persons in different circumstances and there is a lack of objective justification for the treatment given".*[9]

Indeed, in this report, the main proposed pricing strategies give same treatment (same price) to operators in similar circumstances (similar average throughput). They are therefore not unduly discriminatory in the sense of Article 10 of the Access Regulations. Therefore, this report uses the term 'price differentiation' to avoid any confusion.

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[6] https://www.ofgem.gov.uk/ofgem-publications/38360/addressing-undue-discrimination-impact-assessment.pdf

[7] European Communities (Electronic Communications Networks and Services) (Access) Regulations 2011 (S.I. No. 334 of 2011)

[8] Directive 2002/19/EC on access to and interconnection of electronic communications networks and associated facilities OJ 2002 L 108/7

[9] See ComReg 0666

As a consequence, if price differentiation is likely to expand demand, it is likely to be beneficial. In the present case, it is likely that price differentiation would expand demand by allowing lower prices for some customers (those with low willingness to pay – which can be low-usage customers which therefore derive low utility from broadband or high-usage customers who want higher usage but are less willing to pay for that usage) **and by ensuring other customers are not facing too high prices because bitstream prices are overall constrained (by competition or by regulation).**

As a consequence, the issue at stake in this report is what is the best price differentiation approach to be applied for bitstream pricing? In other words, how to best allocate bitstream costs between the different groups of users, in a context where there are different group of users with different consumption patterns/willingness to pay/utility derived from broadband. As explained in the introduction, the level of bitstream prices is not directly at stake here because it is already constrained by competition and ComReg's decisions.

4.1.2 What does the Irish broadband market tell us on customers' preferences?

Without detailed market information it is difficult to know whether price differentiation would allow demand to expand and what is customers' willingness to pay. However, a brief analysis of the broadband market in Ireland can provide some elements.

It can be intuitively considered that consumers have a downward sloping demand curve for their broadband throughput requirements (i.e., as they marginally increase their broadband usage their relative willingness to pay for that increase is not linear). This may not be true in all cases as we do not know whether high usage users are users with high revenues or not (this may be the case as high usage is generally related with high level of education which itself is generally related with high revenues). For example, retired people may have low usage (because they only use emails) but may be very inelastic to broadband prices (because emails are important for them).

Looking at existing pricing strategies at the retail level, it appears that price differentiation is present in broadband markets in Ireland because most operators are proposed capped broadband offers and unlimited broadband offers.

Table 10 – Difference in € between low usage customers and high usage customers

€ VAT included	Cheapest broadband offer	Most expensive broadband offer	Difference in €
Eircom	€30 (Eircom solo Essential)	€40 (Eircom solo unlimited)	€10 VAT incl. €8.1 VAT excl.
	€25.4 (Eircom broadband Advanced)	€30.5 (Eircom broadband Advanced Unlimited)	€5 VAT incl. €4.1 VAT excl.
	€35.6 (Eircom broadband Next Generation Broadband Velocity)	€40.5 (Eircom broadband Next Generation Broadband Ultimate)	€5 VAT incl. €4.1 VAT excl.
Vodafone	€35 (Simply broadband max – unlimited allowance)		N/A
UPC	€30 (fibre 60 chat limited)	€37 (fibre 60 chat)	€7 VAT incl. €5.7 VAT excl.
Sky	€30 (Sky Broadband Lite)	€40 (Sky Broadband Unlimited)	€10 VAT incl. €8.1 VAT excl.
Imagine	€19 (Up to 10 Mbps)		N/A

Source: TERA Consultants from operators' website

This price differentiation may be due to:

- Operators' observation that there are different group of customers with different willingness to pay for broadband;
- Existing bitstream pricing structure which has influenced the whole market.

The former reason seems more plausible 1) because UPC and LLU operators are not influenced directly by Eircom's bitstream pricing 2) Eircom's current pricing structure does not facilitate the building of offers such as Vodafone's unlimited offer.

This quick analysis shows that a €4 to €8/customer/month difference would seem necessary to allow customers with high willingness to pay and customers with low willingness to pay to both subscribe to broadband offers in Ireland[10]. If the gap is higher, customers with high willingness to pay may be excluded and if the gap is lower, customers with low willingness to pay may be excluded.

As a consequence, if broadband customers in Ireland have different willingness to pay and if price elasticity is related to usage, there may be reasons to introduce a per usage charge so that low usage customers pay less in total than high usage customers. Unfortunately it is not known whether these conditions

[10] NB: in Ireland most customers do not subscribe to out of bundle broadband offers so the analysis is a simplified analysis

are met but looking at pricing strategies at the retail level, it appears that these conditions could be met.

It is important to keep in mind that OAOs are paying Eircom's bitstream services in aggregate for all their customers. They are not paying per customer profile (since the latter cannot be easily identified in NGN networks). This means that if an operator proposes 2 types of offers (as can be seen in the table above), it will not be billed for bitstream for each type of offers separately but in aggregate. However, it is still obvious from Table 3 that there are differences between OAOs in aggregate (between Sky/Vodafone and BT/Eircom for example).

4.1.3 Focus on existing price differentiation strategies

To our knowledge, in other European Western countries, two types of bitstream price structures are used:

- A single "per port" charge (such as BIP in Ireland). This is the case in the Netherlands and Denmark for example.
- A combination of a "per port" and a "per Mbps" charge (such as BMB in Ireland). This is the case in the UK and in France for example.

It is possible that the issue at stake in Ireland has not appeared in other countries because OAO's throughput profiles in other countries might be more homogeneous. Indeed, in France, for example, all OAOs and Orange are selling the same type of offers to all customers (with unlimited Voice, 24 Mbps and IPTV). When OAO profiles are homogeneous, it is much simpler to set a bitstream price structure which satisfies OAOs as explained in previous sections.

It is however interesting to note that two pricing experiences are relevant in the present context:

1. First of all, leased lines pricing in Ireland sets implicitly a different "per Mbps" price to the different customers. Indeed, NGN Ethernet WSEA logical leased lines prices are constructed as the sum of a "per port" component and a component which recovers the cost of Eircom's NGN Ethernet core network (calculated with the BU-LRIC cost model described above). This latter component is calculated using a gradient which implies that low speed lines are supporting a higher "per Mbps" cost than high speed lines but are still cheaper per customer. For example:
    a. The price of a 100 Mbps WSEA logical Same Site High Density is only 33% higher than the price of a 10 Mbps WSEA logical Same Site High Density (and not 1,000%). Therefore, the cost per Mbps is 7.5 higher in the latter case;
    b. The price of a 1,000 Mbps WSEA logical Same Site High Density is only 79% higher than the price of a 100 Mbps WSEA logical Same Site High

Density (and not 1,000%). Therefore, the cost per Mbps is 5.5 higher in the latter case;

c. The price of a 10,000 Mbps WSEA logical Same Site High Density is only 53% higher than the price of a 1,000 Mbps WSEA logical Same Site High Density (and not 1,000%). Therefore, the cost per Mbps is 6.5 higher in the latter case.

2 Second, in Denmark, a logarithmic curve is applied to derive bitstream prices. The pricing structure is only made of a "per port" component but this "per port" component varies depending on the headline speed selected by OAOs. This is therefore not a uniform "per port" pricing structure. This variation is obtained thanks to a logarithmic curve (which is in fact exactly the same as applying a gradient). As a consequence of this, the price of a 10 Mbps offer is 2.6 times higher than the price of a 1 Mbps offer. The cost per Mbps is 4 times higher in the latter case.

Figure 14 – Example of gradient used in Denmark for bitstream pricing

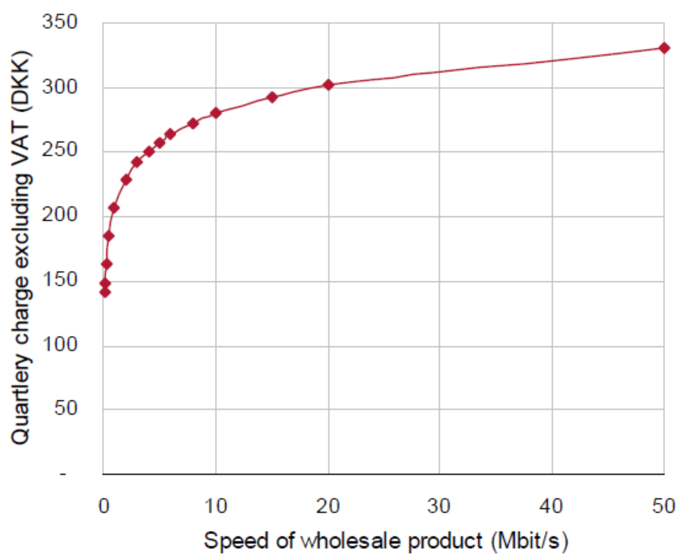


Figure 3.8: Pricing curve for the quarterly fee for Ethernet BSA products at the PoI2/PoI3 level in the network by downstream speed [Source: NITA[6]]

Source: DBA

These two examples are important to understand that a pricing structure can be used to modify the cost structure and to better expand the demand and meet customers' willingness to pay. Indeed, the use of a gradient or a pricing curve is used to match what customers are ready to pay for. Even if no scientific calculations of customers' willingness to pay are conducted, these methodologies attempt to achieve the objective of maximising customer welfare.

These methodologies also generate some differentiation between OAOs: an OAO with 10 customers at 10 Mbps (leased lines or broadband) will pay much more for the use of the network than an OAO with 1 customer at 100 Mbps while they make the same use of the network. However, the linear approach is also introducing some price differentiation in so far as it seeks to recover a large element of fixed and common costs on a per port and per Mbps basis from a customer base with significantly diverse usage profiles. In the example above the first OAO with 10 customers has a lower cost per customer (although the aggregate contribution to the overall network costs is higher) than the second OAO. **It is clear from practices in the retail market (see section 4.1.2) that the first OAO will probably earn more revenues because it has 10 times more customers while its prices are not 10 times lower.**

However, it is important to keep in mind that in the NGN WSEA logical leased line pricing system and in the Danish bitstream pricing system, there are retail offers directly comparable to the wholesale offers (i.e. the 10Mbps WSEA offers corresponds to a 10Mbps retail offer). In the present case, a single offer at the retail level may correspond to different customer profiles (there are 200kbps throughput offers at the retail level).

4.2 ComReg's objectives

4.2.1 List of statutory objectives

European directives and the Irish Communications Regulation Act list ComReg's objectives:

1. Any obligation imposed must be based on the nature of the problem identified (Regulation 8(6) of the Access Regulations);
2. Any obligation imposed must be proportionate and justified in light of the objectives laid down in section 12 of the Act of 2002 and Regulation 16 of the Framework Regulations (Regulation 8(6) of the Access Regulations);
3. Any obligation must only be imposed following consultation in accordance with Regulation 12 and 13 of the Framework Regulations (Regulation 8(6) of the Access Regulations);
4. Promote competition and in particular encourage efficient investment in infrastructure and promote innovation (Section 12 of the Communications Regulations Act);
5. Contribute to the development of the internal market (Section 12 of the Communications Regulations Act);
6. Promote the interests of users within the Community and in particular to encourage access to the internet at a reasonable cost to end-users (Section 12 of the Communications Regulations Act);
7. Take into account the investment made by the operator which ComReg considers relevant and allow the operator a reasonable rate of return on adequate capital employed, taking into account any risks involved specific to a

particular new investment network project (Regulation 13(2) of the Access Regulations);

8. Ensure that any cost recovery mechanism or pricing methodology that is imposed serves to promote efficiency and sustainable competition and maximise consumer benefits (Regulation 13(3) of the Access Regulations);
9. Promote regulatory predictability by ensuring a consistent regulatory approach over appropriate review periods (Regulation 16 of the Framework Regulations)
10. Take due account of the variety of conditions relating to competition and end-users that exist in the various geographic areas within the State (Regulation 16 of the Framework Regulations).

4.2.2 How the statutory objectives translate in the context of Bitstream Managed Backhaul pricing

Among these objectives, many objectives are not relevant to the present issue:

- The first two objectives are achieved in this report as this report aims at defining a pricing structure which is based on the nature of the problem identified and which is proportionate and justified;
- The third objectives is not directly relevant here;
- The bitstream pricing structure does not impact the internal market and therefore the fifth objective is not relevant;
- The seventh objective relates to the level of prices not to the structure of prices;
- The tenth objective will be discussed when assessing whether CGA and NGA can have different prices but is not directly relevant in this section.

Four objectives remain therefore relevant in the present context:

- *"Promote competition and in particular encourage efficient investment in infrastructure and promote innovation"* can be interpreted as:
    - the need for the pricing structure to send signals which encourage efficient investment in infrastructure ("encourage efficient investment in infrastructure"). This objective means that the pricing structure must reflect to a certain extent cost drivers, otherwise the usage of the network and the revenues generated by this usage will not be related to the evolution of costs; and
    - the need for the pricing structure to give some flexibility to OAOs and Eircom, in order to promote pricing innovation;
- *"Promote the interests of users within the Community and in particular to encourage access to the internet at a reasonable cost to end-users"* implies that basic Internet access offers must not be too expensive;

- *"Ensure that any cost recovery mechanism or pricing methodology that is imposed serves to promote efficiency and sustainable competition and maximise consumer benefits"* includes 3 sub-objectives:
    - *"Promote efficiency"* means promoting allocative, productive or dynamic efficiency:
        - **Allocative efficiency** is "*maximised when there is an optimal distribution of goods and services taking into account costs of supply and consumers' preferences*".[11] In the electronic communications sector, operators can incur significant fixed and common costs and these need to be recovered in some ways. Allocative efficiency is achieved where different prices are set based on different consumers' willingness to pay as explained in section 4.1.
        - **Productive efficiency** is maximized when firms fully exploit their economies of scale and scope and produce with the most cost efficient set of inputs (including technologies) available to them while maximizing the outputs. This is achieved through the different price control obligations imposed by ComReg (see section 2.1.2) which provide incentives for Eircom to increase its efficiency.
        - **Dynamic efficiency** refers to the ability and incentives of operators to continue to invest in the services they currently provide and to innovate by launching new or improved services. This is achieved through the different price control obligations imposed by ComReg (see section 2.1.2) which promote competition. This is similar to the first objective above.
    - *"Promote sustainable competition"* is mainly achieved through margin squeeze tests.
    - *"Maximise consumer benefits"* is achieved by maximising the difference between the amount the consumer would be willing to pay for the product and the actual price of the product. This is therefore similar to maximising allocative efficiency and to maximising productive efficiency.
- *"Promote regulatory predictability by ensuring a consistent regulatory approach over appropriate review periods"* means that the preferred pricing structure must not be too prescriptive and too complex to monitor given the uncertainties.

The table below lists the objectives at stake:

[11] Ofcom, Wholesale mobile voice call termination statement, March 2011, p.173.

Table 11 – TERA's interpretation of ComReg's key objectives

Objective #1	The pricing structure should reflect to a certain extent cost drivers
Objective #2	The pricing structure should give some flexibility to OAOs and Eircom
Objective #3	Basic Internet access offers should not be too expensive
Objective #4	The pricing structure should promote allocative efficiency, i.e. be based on the different customers' willingness to pay
Objective #5	The pricing structure should not be too complex to monitor and should be predictable

Source: TERA Consultants

It is important to note that the choice of a relevant pricing structure will not impact the ability for OAOs to compete with Eircom since this is the role of technical and economic replicability obligations (such as margin squeeze tests).

Also it is important to remember that due to the obligations imposed by ComReg and listed in section 2.1.2, Eircom is not required to set prices at its costs for each product. However, it is constrained by ComReg's obligations and by competition. Once a pricing structure is defined, then it will be important to verify that Eircom's obligations are met (floors, margin squeeze test, cost orientation, etc.).

4.2.3 Pre-requisites for the selected pricing structure

Having a "per Mbps" charge seems preferable to a situation where the pricing structure is made of a single "per port" charge. Indeed, a "per Mbps" charge gives incentives to OAOs, and ultimately end-users to monitor traffic generated on Eircom's network. Without a "per Mbps" component, OAOs and ultimately end-users will have no incentives to limit their usage which could lead to congestion in the network, or if Eircom invest sufficiently, high increases in broadband costs to too high levels for end-users.

Currently, BIP products do not have a "per Mbps" component and this may need to be revised as has been raised recently by some OAOs.

Once a "per Mbps" component is introduced in the pricing structure, then:

- If this component is above the variable cost per Mbps of the network (only €✂/Mbps/month as shown in section 3.2.10), then this means that the component recovers also some fixed and common costs. As a consequence, the "per Mbps" component may need to be decreased over time when traffic increases. This means the pricing structure is a little bit more complex to monitor (but not impractical);

- If this component is below the variable cost per Mbps of the network, then OAOs and ultimately end-users are paying too low a level compared to the costs they are generating and therefore their incentives to make a reasonable use of the network are low. Objective #1 is not met.

As a consequence, a “per Mbps” component is necessary and should be equal or above the variable cost per Mbps of the network (which is relatively low compared to existing rates as shown in section 3). If it is strictly above the variable cost per Mbps, a frequent update of rates may be required when traffic increases because the cost per Mbps should decrease.

4.3 List of identified methodologies

There is in reality an infinite number of pricing structures available for bitstream. **The best approach from a theoretical point of view is the Ramsey-Boiteux pricing approach** which allocates costs to the different groups of end-users depending on their willingness to pay, i.e. price elasticity. Indeed, with such a pricing strategy, having in mind that Eircom’s prices are constrained, all types of users are paying in proportion to their price elasticity and therefore the maximum number of customers is subscribing.

However, such an approach requires a very detailed knowledge of the customers’ willingness to pay and as a consequence is very difficult to implement (and never has been implemented). This means second best approaches need to be identified.

Based on the existing bitstream pricing structure in Ireland, experience from other countries and discussions with the industry, ComReg has identified 8 “second best approaches”.

These are listed hereafter:

1 Pricing structure with a “per port” and a “per Mbps” component, the “per Mbps” component being set at variable network costs;

2 Pricing structure with a single “per Mbps” component (for the backhaul network, as there is still a “per port” charge for the other network elements);

3 Logarithmic per Mbps charge (as proposed by Sky in response to the call for input);

4 Logarithmic per Mbps charge based on industry average throughput;

5 Tiered pricing approach where different usage patterns have different “per Mbps” charge (the higher the usage, the lower the per Mbps charge);

6 Capped pricing approach, similar to the tiered pricing approach but above a certain usage, the incremental traffic price is set at zero;

7 Different package pricing structures where several “per port / per Mbps” couples are proposed to OAOs and OAOs choose the packages they prefer;

8. Tiered pricing approach based on total OAOs network.

NB: it is important to note that it seems not feasible for OAOs to identify different profiles of throughput per customer in their network. As a consequence, the word “usage” refers to the average usage of each OAO.

4.4 Analysis of methodologies

4.4.1 Introduction

The 8 “second best approaches” listed above will be assessed along the 5 objective repeated below:

Table 12 – TERA’s interpretation of ComReg’s key objectives

Objective #1	The pricing structure should reflect to a certain extent cost drivers
Objective #2	The pricing structure should give some flexibility to OAOs and Eircom
Objective #3	Basic Internet access offers should not be too expensive
Objective #4	The pricing structure should promote allocative efficiency, i.e. be based on the different customers’ willingness to pay
Objective #5	The pricing structure should not be too complex to monitor and should provide predictability

Source: TERA Consultants

For each pricing structure, an example will be used. For this example, it will be assumed that Eircom’s network supports an average usage per customer of 200kbps at peak hour and that the average cost of the core network (for the backhaul element) at this speed is 10€/month/customer (this is assumed to be the level of bitstream floors). It is also assumed that the variable cost per Mbps is €3 (in reality this is ✂).

It is also assumed that there are 3 different customer profiles in the market:

- Profile 1: between 100 and 175 kbps at peak hour, i.e. 137,5 kbps in average (50% of customers);
- Profile 2: between 175 and 250 kbps at peak hour, i.e. 212,5 kbps in average (38% of customers);
- Profile 3: between 250 and 600 kbps at peak hour, i.e. 425 kbps in average (12% of customers).

The average traffic is therefore 200kbps.

Two OAOs are also buying bitstream services:

- OAO 1 has 7,727 customers and an average traffic per customer of 137,5 kbps;
- OAO 2 has 2,500 customers and an average traffic per customer of 425 kbps.

Therefore, the two OAOs generate the same amount of traffic.

4.4.2 Pricing structure with a "per port" and a "per Mbps" component, the "per Mbps" component being set at variable network costs

Example

The variable cost per Mbps is €3, which means that the following pricing structure is proposed under this option:

- Per Mbps charge of €3;
- Per Port charge of 10 – 200/1024 x 3 = €9.41.

The results of this pricing approach are summarized in the table below:

Table 13 – Results of the pricing approach for the different profiles

Profile	Description of the profile	€/customer/month or €/OAO/month
Profile 1	137,5 kbps	€9.82
Profile 2	212,5 kbps	€10.04
Profile 3	425 kbps	€10.66
OAO 1	7,727 customers and an average traffic per customer of 137,5 kbps	€75,860
OAO 2	2,500 customers and an average traffic per customer of 425 kbps	€26,648

Source: TERA Consultants

Because of the very low "per Mbps" charge the difference between cost per user is very limited.

Key objectives achievement

Objective #1	++	The pricing structure exactly reflects cost drivers
Objective #2	-	The pricing structure allows OAOs to provide different types of offers but because of the low "per Mbps" charge, price will not be very different
Objective #3	--	The cost for low profile users is very high

Objective #4	-	Compared to price differences at the retail level in Ireland (see Table 10), it is likely that this approach does not reflect customers' willingness to pay
Objective #5	++	The pricing structure is very simple and does not require any update over time (except if the number of customer increases fast).

Source: TERA Consultants

4.4.3 Pricing structure with a single "per Mbps" component (for the backhaul network, as there is still a "per port" charge for the other network elements)

Example

The following pricing structure is proposed under this option:

- Per Mbps charge of 10/(200/1024) = €51.2;
- Per Port charge of €0.

The results of this pricing approach are summarized in the table below:

Table 14 – Results of the pricing approach for the different profiles

Profile	Description of the profile	€/customer/month or €/OAO/month
Profile 1	137,5 kbps	€6.90
Profile 2	212,5 kbps	€10.60
Profile 3	425 kbps	€21.30
OAO 1	7,727 customers and an average traffic per customer of 137,5 kbps	€53,123
OAO 2	2,500 customers and an average traffic per customer of 425 kbps	€53,123

Source: TERA Consultants

The gap between profiles is significant because of the absence of a "per port" charge.

Key objectives achievement

Objective #1	--	The pricing structure does not reflects cost drivers

Objective #2	+	The pricing structure allows OAOs to provide different types of offers with OAOs targeting low revenue users and OAOs targeting high revenue users
Objective #3	++	The cost for the low profile users is very low
Objective #4	-	Compared to price differences at the retail level in Ireland (see Table 10), it is likely that this approach does not reflect customers' willingness to pay, especially if traffic between low usage customers and high usage customer diverge.
Objective #5	--	The pricing structure requires regular updates because the cost per Mbps will decrease over time. This does not provide sufficient predictability.

Source: TERA Consultants

4.4.4 Logarithmic per Mbps charge

Example

The following pricing structure is proposed under this option:

- Per Mbps charge is equal to 1.92 x LN (throughput in kbps), i.e.
  - €70,2 / Mbps @ 137,5 kbps;
  - €49.5 / Mbps @ 212,5 kbps;
  - €27.5 / Mbps @ 425 kbps.
- Per port charge €0.

The results of this pricing approach are summarized in the table below:

Table 15 – Results of the pricing approach for the different profiles

Profile	Description of the profile	€/customer/month or €/OAO/month
Profile 1	137,5 kbps	€9.4
Profile 2	212,5 kbps	€10.3
Profile 3	425 kbps	€11.6
OAO 1	7,727 customers and an average traffic per customer of 137,5 kbps	€72,861
OAO 2	2,500 customers and an average traffic per customer of 425 kbps	€28,974

Source: TERA Consultants

The gap between profiles is limited to €2.

Key objectives

Objective #1	--	The pricing structure does not reflects cost drivers because of the cost structure identified in section 3.2.10
Objective #2	+	The pricing structure allows OAOs to provide different types of offers with OAOs targeting low revenue users and OAOs targeting high revenue users. Incentives to aggregate can be lowered with this approach. However, where the combined peak usage is less than the sum of the individual peak usage levels there will still be a corresponding incentive to aggregate.
Objective #3	+	The cost for the low profile users is high. This can however easily be adapted. Also, if traffic diverges between low usage customers and high usage customers (i.e. if the difference between their throughputs increases), then the logarithmic approach does not increase as much the difference between cost per user.
Objective #4	++	Compared to price differences at the retail level in Ireland (see Table 10), it is likely that this approach does not reflect customers' willingness to pay. But it can easily be adapted.
Objective #5	+	The pricing structure requires regular updates because the cost per Mbps will decrease over time but the update will only relate to the "1.92" value. However, this approach provides lots of predictability for OAOs.

Source: TERA Consultants

NB: Since drafting this report Eircom has identified to ComReg that it is considering introducing a pricing structure derived using a logarithmic approach as follows:

- Per Mbps charge is equal to ✂
- Per port charge of €5.9[12].

The Eircom proposal has been assessed by TERA in a separate note but the results of this pricing approach are summarized in the table below:

Table 16 – Results of the pricing approach for the different profiles

Profile	Description of the profile	€/customer/month or €/OAO/month

[12] This is the price for 24 Mbps offers. The price for 8 Mbps offers is €4.9

Profile 1	137,5 kbps	✂
Profile 2	212,5 kbps	✂
Profile 3	425 kbps	✂[13]
OAO 1	7,727 customers and an average traffic per customer of 137,5 kbps	✂
OAO 2	2,500 customers and an average traffic per customer of 425 kbps	✂

Source: TERA Consultants

The gap between profiles is limited to €✂.

4.4.5 Logarithmic per Mbps charge based on industry average throughput

Example

The same pricing curve as in the previous approach is proposed:

- Per Mbps charge is equal to 1.92 x LN (throughput in kbps);
- Per port charge €0.

However, based on the industry average throughput, a single per Mbps charge is derived, i.e. 1.92 xLN (200) / (200kbps/1024kbps) = €52.

In this case, the results of this pricing approach are summarized in the table below:

Table 17 – Results of the pricing approach for the different profiles

Profile	Description of the profile	€/customer/month or €/OAO/month
Profile 1	137,5 kbps	€7.0
Profile 2	212,5 kbps	€10.8
Profile 3	425 kbps	€21.6
OAO 1	7,727 customers and an average traffic per customer of 137,5 kbps	€53,953
OAO 2	2,500 customers and an average traffic per customer of 425 kbps	€53,955

[13] The average revenue per user is €✂and not €10 like in other examples so a direct comparison in absolute value cannot be conducted

Source: TERA Consultants

NB: Since drafting this report Eircom has identified to ComReg that it is considering introducing a pricing structure derived using a logarithmic approach as follows:

- Per Mbps charge is equal to ✂
- Per port charge of €5.9[14].

If we apply this formula with the industry average throughput, this gives a value for the per Mbps charge of €✂, i.e. €✂/Mbps. As a consequence, Profile 1 will pay €✂/customer/month, profile 2 €✂and profile 3 €✂. The gap between profiles will be €✂. It is interesting to note that if each profile increases by ✂%, then the gap will become €✂, while under the former logarithmic approach, it will become €✂. The gap is therefore more stable under the former approach.

Key objectives achievement

Objective #1	--	The pricing structure does not reflects cost drivers
Objective #2	++	The pricing structure allows OAOs to provide different types of offers with OAOs targeting low revenue users and OAOs targeting high revenue users. As the same per Mbps charge applies to all OAOs, the risk of having a situation whereby OAOs aggregating traffic from other OAOs are paying more than if traffic was not aggregated is lower. However, it is important to have in mind that where the combined peak usage is less than the sum of the individual peak usage levels there will still be a corresponding incentive to aggregate.
Objective #3	++	The cost for the low profile users can be low
Objective #4	-	Compared to price differences at the retail level in Ireland (see Table 10), it is likely that this approach does not reflect customers' willingness to pay looking forward, especially if traffic between low usage customers and high usage customer diverges a lot. Indeed, if traffic diverges or if the gap between OAOs throughputs stays the same in %, then the charge paid by high usage customers will increase a lot.
Objective #5	-	This is difficult to predict as the price depends on industry average throughput and not own OAO throughput. For an OAO launching a new service requiring lots of bandwidth, its

[14] This is the price for 24 Mbps offers. The price for 8 Mbps offers is €4.9

		charge could increase too much (compared to Eircom's incremental cost). A process to publish industry average throughputs is needed.

Source: TERA Consultants

4.4.6 Tiered pricing approach

Example

Tiered pricing can be implemented in a wide number of ways.

Figure 15 – Examples of tiered pricing approach implementation

€/month	Example 1	Example 2
Per port charge	3	8
Per Mbps below 200 kbps	40	11
Per Mbps between 200 and 300 kbps	23	8
Above 300 kbps	3	3

NB: values are set to make sure an average cost of €10 per customer is recovered

Source: TERA Consultants

Results are provided below:

Figure 16 – Results of the tiered pricing approach

€/month	Example 1	Example 2
Profile 1	8.37	9.48
Profile 2	11.09	10.25
Profile 3	13.42	11.30
OAO 1	64,688	73,234
OAO 2	32,646	27,324
Ratio	2.0	2.7

Source: TERA Consultants

Key objectives achievement

Objective #1	+	The pricing structure does not fully reflect cost drivers but all per Mbps charges are above the average variable cost of the network
Objective #2	+	The pricing structure allows OAOs to provide different types

		of offers with OAOs targeting low revenue users and OAOs targeting high revenue users
Objective #3	+	The cost for the low profile users can be set at an adequate level, depending on the definition of tiers
Objective #4	+	Compared to price differences at the retail level in Ireland (see Table 10), this approach can meet the different customers willingness to pay.
Objective #5	--	The approach is difficult to monitor as the definition of tiers is arbitrary and requires regular updates (no visibility in the long term).

Source: TERA Consultants

4.4.7 Capped pricing approach

Example

Like tiered pricing, capped pricing can be implemented in a wide number of ways. Two examples are provided:

Figure 17 – Examples of tiered pricing approach implementation

€/month	Example 1	Example 2
Per port charge	3	8
Per Mbps below 250 kbps	40,0	11,4
Above 250 kbps	0	0

NB: values are set to make sure an average cost of €10 per customer is recovered

Source: TERA Consultants

Results are provided below:

Figure 18 – Results of the capped pricing approach

€/month	Example 1	Example 2
Profile 1	8.37	9.48
Profile 2	11.09	10.25
Profile 3	13.42	11.30
OAO 1	64,688	73,234
OAO 2	32,646	27,324
Ratio	2.0	2.7

Source: TERA Consultants

Key objectives achievement

Objective #1	--	The pricing structure does not reflects cost drivers NB: in reality, the very low per Mbps charge calculated in section 3.2.10 means that setting the price at zero or at €0.3 is almost equivalent. This also means that in practice, capped pricing and tiered pricing strategies are equivalent
Objective #2	+	The pricing structure allows OAOs to provide different types of offers with OAOs targeting low revenue users and OAOs targeting high revenue users
Objective #3	--	The pricing structure allows OAOs to provide different types of offers with OAOs targeting low revenue users and OAOs targeting high revenue users. However the fact that the incremental Mbps cost zero above a certain level means high usage customers costs subsidise low usage customers.
Objective #4	+	The cost for the low profile users can be set at an adequate level, depending on the definition of tiers and therefore can reflect differences in customers' willingness to pay
Objective #5	--	The approach is difficult to monitor as the definition of tiers is arbitrary and requires regular updates (no visibility in the long term).

Source: TERA Consultants

4.4.8 Different package pricing structures

Example

This approach consists in proposing several (per port, per Mbps) couples and letting OAOs select their preferred couple. This is a type of 2nd-degree price differentiation. OAOs are therefore free to choose the best couple they prefer.

For example, the following 3 couples can be proposed:

- Package 1:
  - Per port: €5
  - Per Mbps: €26
- Package 2:
  - Per port: €6
  - Per Mbps: €20

- Package 3:
  - Per port: €7
  - Per Mbps: €15

NB: each package must be constructed so that @ 200kbps, the total cost is equal to €10.

Depending on their profiles, OAOs will select the package they prefer.

The results of this pricing approach are summarized in the table below:

Table 18 – Results of the pricing approach for the different profiles

Profile	Description of the profile	€/customer/month or €/OAO/month
Profile 1	137,5 kbps	€8.4
Profile 2	212,5 kbps	€10.3
Profile 3	425 kbps	€13.4
OAO 1	7,727 customers and an average traffic per customer of 137,5 kbps	€65,201
OAO 2	2,500 customers and an average traffic per customer of 425 kbps	€28,974

Source: TERA Consultants

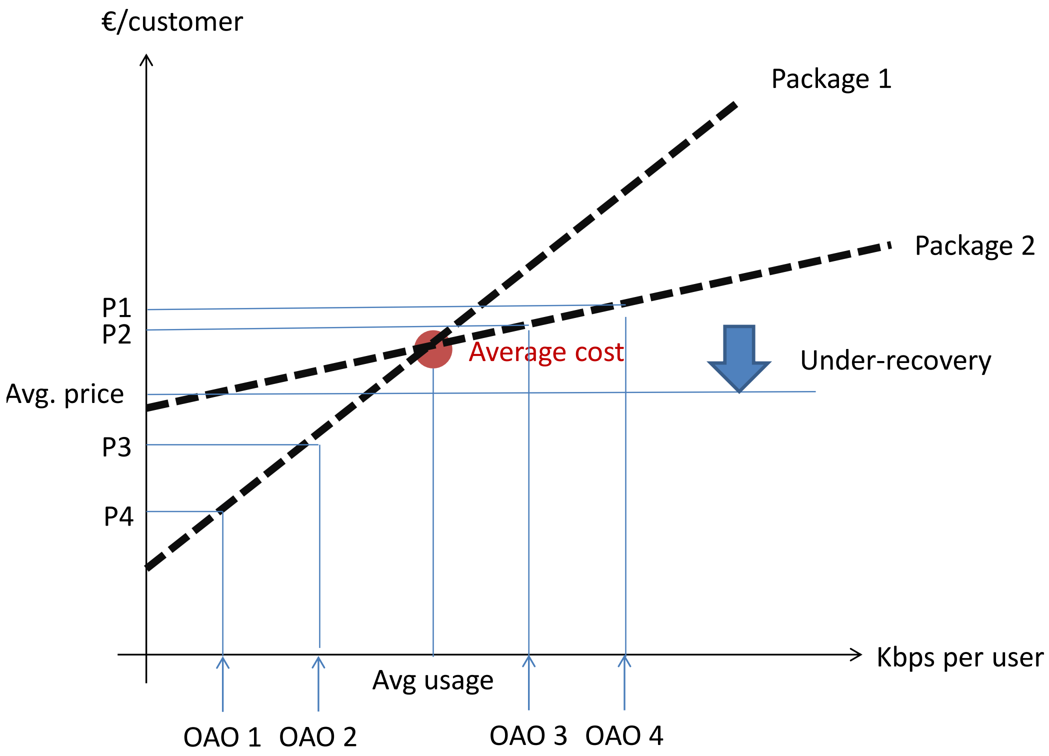
Key objectives achievement

Objective #1	+	The pricing structure does not fully reflect cost drivers but all per Mbps charges are above the average variable cost of the network
Objective #2	+	The pricing structure provides lots of flexibility to OAOs.
Objective #3	++	The pricing structure allows OAOs to provide different types of offers with OAOs targeting low revenue users and OAOs targeting high revenue users.
Objective #4	+	The cost for the low profile users can be set at an adequate level, depending on the definition of packages and therefore can reflect differences in customers' willingness to pay
Objective #5	-	Once the average throughput and the average cost per customer is known, the packages are relatively easy to define. However, depending on the distribution of profiles, cost recovery is not necessarily met as illustrated in the

		graph below. For example, the following 3 packages (3; 36) – (6;20) – (9;5) generate a 10% loss. However, if the “per port” components are sufficiently close, the loss is limited. The issue is the same for most of the other approaches (for example logarithmic approaches) but this is further exacerbated by the fact that OAOs can choose themselves and favour certain behaviours which can add uncertainty.

Source: TERA Consultants

Figure 19 – Risk of under-recovery with this pricing structure: the average price (P1, P2, P3 and P4) is always lower than the average cost



Source: TERA Consultants

NB: the risk of under or over recovery exists for all the approaches presented here. However, while the risk is related to the uncertainty on the level of throughputs looking forward, the risk is here exacerbated by the fact that OAOs can make decisions which are slightly more complex to forecast.

4.4.9 Tiered pricing approach based on total OAOs network

Example

Under this approach, two OAOs with the same amount of traffic pay the same amount to Eircom wholesale. However, above 1,000 Gbps, the price per Mbps decreases and above 2,000 Gbps the price per Mbps further decreases. For example:

- Between 0 and 1,000 Gbps, €20/Mbps;
- Between 1,000 and 2,000 Gbps €10/Mbps;
- Above 2,000 Gbps, €5/Mbps.

Key objectives achievement

Objective #1	+	The pricing structure does not fully reflect cost drivers but all per Mbps charges are above the average variable cost of the network
Objective #2	++	The pricing structure provides lots of flexibility to OAOs because the price is not set per user.
Objective #3	-	The pricing structure allows OAOs to provide different types of offers with OAOs targeting low revenue users and OAOs targeting high revenue users because the price is not set per user. However this may generate too high costs for OAOs targeting high usage customers (as with the first approach). Indeed, two OAOs may have same amount of traffic but OAO1 may have twice less customers, which means it could have twice the cost per user, which is probably too high for what high users can bear.
Objective #4	-	The cost for the low profile users can be set at an adequate level, depending on the definition of packages and therefore can reflect differences in customers' willingness to pay. However, small OAOs will have more difficulties in competing and this may reduce competition and decrease customer welfare in the long term. But it also encourages economies of scale.

		Also, this approach may generate too high costs for OAOs targeting high usage customers (as with the first approach, see section 4.4.2).
Objective #5	-	Setting the thresholds will be very difficult and subject to debate.

Source: TERA Consultants

4.5 Conclusion: TERA's recommended methodology

Among all these approaches, some can be identified as inappropriate:

- The Pricing structure made of a "per port" and a "per Mbps" component with the "per Mbps" component set at variable costs generate too high costs for low usage customers which will not maximise customer welfare;
- The pricing structure with a single "per Mbps" component generates too high costs for high usage customers which would not maximize customer welfare. Same happens for the tiered pricing approach based on total OAOs network;
- The capped pricing approach does not reflect cost drivers;

The 3 remaining approaches (logarithmic, "package", tiered pricing) can all be calibrated to meet ComReg's objectives:

- The logarithmic approach gives visibility to stakeholders since the formula is known in advance and only one factor needs to be updated when traffic varies. The calibration can be conducted to provide a high or a low cost difference between high usage and low usage customers. This approach is a form of 2nd degree price differentiation strategy but lighter compared to the current pricing approach used by Eircom (which generate greater price differences). This approach may also be seen as too prescriptive. It also requires careful monitoring to avoid under or over recovery of costs. Two sub-approaches can be implemented:
    - An approach whereby each OAO pays according to its own throughput. If the difference in traffic between OAOs with low usage and between OAOs with high usage increases, the logarithmic approach provides a stable difference over time: taking the extreme value in average throughput today and in 2 years as given in Table 3, the difference in cost per user would allow decrease from €✂ to €✂ for example. However, if the difference converges, then cost difference may decrease too much.
    - An approach whereby the logarithmic curves is designed to define a unique charge per Mbps applicable to each OAO. The unique charge

per Mbps is obtained from a logarithmic curve at industry average throughput. This approach provides less predictability for OAOs because the charge they will pay depends on the throughput of other OAOs. Also, this requires implementing a process to publish industry average throughputs.

- The "package" approach has the advantage of giving OAOs the ability to select their preferred package which requires less information about their preferences and also let them differentiate themselves. If the difference in traffic between low usage customers and high usage customers increases, OAOs will continue to use different packages. But if it converges, then OAOs will use the same package. The main issue is that it may difficult to monitor when traffic increases and when customer distribution moves. In line with the practice observed in the retail Irish broadband market (see section 4.1.2), only 2 packages may be sufficient and would facilitate the monitoring of the approach;
- The "tiered pricing" approach combines the disadvantages of the first two approaches in that it is too prescriptive and may be difficult to monitor. It does not provide as much visibility as the logarithmic approach does since the definition of "tiers" may be often updated and may be defined artificially.

TERA therefore recommends using the "package" approach or the "logarithmic" approach. There are both sufficiently flexible to maximise customer benefits. The logarithmic approach is probably more predictable but only when it directly used to derive charges for OAOs (the other approach whereby the industry average throughput and the logarithmic curve are used to produce an per Mbps charge is not preferred).

4.6 CGA versus NGA

CGA-BMB and NGA Bitstream Plus currently have different prices per Mbps. The difference is today €5/Mbps/month.

It has been analysed in section 0 that, ✂.

Outside this, CGA-BMB and NGA Bitstream Plus do not exhibit cost differences. There are however differences in terms average throughput because average throughput for NGA Bitstream Plus is much higher than for CGA-BMB. But this throughput differences are already factored in the recommended approaches in section 4.5: higher average throughput customer profile will pay more but not proportionately with this throughput.

As a consequence, the same approaches as for CGA-BMB are recommended, with the maximum allowance of €✂ lower per Mbps. However, as noted in section 2.1.2, there is no obligation on Eircom's NGA Bitstream Plus pricing to be cost-oriented.

5 Annexes

5.1 Comparison between WBA floor model and BU-LRIC cost volume relationships

The cost volume relationships described in section 3 of this report have been conducted on the basis of the BU-LRIC cost model of Eircom's NGN Ethernet core network.

However, ComReg also uses another cost model to set bitstream floors (the "WBA floor model"). This cost model calculates the cost that an OAO buying LLU would bear. This OAO would purchase its own DSLAMs, aggregation routers, BRAS but would buy backhaul from Eircom wholesale (it buys WSEA leased lines).

The cost-volume relationships are different between the NG Ethernet BU-LRIC core network cost model (see Figure 20) and the WBA floors model (see Figure 21) but the shapes are different:

- In the NG Ethernet BU-LRIC core network cost model, there is almost a linear relation between the level of costs and the traffic. The "per Mbps" component is equal to €✂/Mbps;
- In the WBA floor model, the relation is non-linear but can be considered as linear after a certain amount of traffic. The "per Mbps" component is equal to €✂/Mbps (see section 2.1.2).

Figure 20 - Cost curve – NG Ethernet core model

✂

Source: TERA Consultants

Figure 21 - Cost curve – WBA floor model

✂

Source: TERA Consultants

5.2 Costs allocated to broadband

It has been concluded from the cost volume relationship analysis in section 3 that the cost of the network is slightly sensitive to the total traffic increase (see §3.2.10).

The aim of this section is to assess the impact of a broadband traffic increase on the costs allocated to broadband, voice and leased lines services, when costs are allocated based on the capacity used by each service.

The result of increasing the broadband traffic (with "frozen" voice and leased lines traffic) is a significant increase in the costs allocated to broadband (see Table 19).

Table 19 – Evolution of the total annual costs (depreciated capex + opex) allocated to the broadband with the broadband traffic (2014)

✂

Source: TERA Consultants

Obviously, because it has been shown in section 3 that total network costs vary slightly when traffic increases, this analysis means that costs allocated to leased lines and voice would decrease significantly.

This increase in costs allocated to broadband is therefore much more important than the increase in total costs of the network. This is because in a capacity based allocation approach, if the broadband traffic increases, the share of costs allocated to broadband increases and the share of costs allocated to voice and leased lines decreases (see figure 22 below).

Figure 22 - Evolution of the costs allocated to broadband voice and leased lines when broadband traffic increases (2014)

✂

NB: the graph should be read as follows: the green line represents the costs allocated to leased lines, the red line represents the costs allocated to broadband + leased lines and finally, the blue line represents the costs allocated to broadband + leased lines + voice (i.e. total costs)

Source: TERA Consultants

In this example, despite a stable evolution of costs, the share of costs allocated to leased lines is almost divided by ✂ when the broadband speed per customers increases from 20kbps to 500kbps.