Development of a Price Squeeze Model

Price Squeeze Model Descriptive Manual

December 2020

Contents

1. Introduction

This manual describes the modelling approach, structure and calculation process followed in the development of the Price Squeeze Model (hereinafter the 'PSM' or 'the model') commissioned to Axon Partners Group Consulting (hereinafter, 'Axon' or ' Axon Consulting') by the Hellenic Telecommunications & Post Commission (hereinafter, ' the EETT').

This document has been conceived for a consultation process and therefore all the contents are potentially subject to change based on the feedback received from stakeholders.

The primary aim of the PSM is to assess the economic replicability of the SMP operator's retail tariffs in markets 3a and 3b by a reference operator.

This manual has been split among the following sections:

▶ **Architecture of the model,** describing the general structure of the PSM

▶ **Detailed blocks of the model,** providing indications on the functionalities of the different modules of the PSM

Please note that this model has been developed following the methodology approved by the EETT[1]. The following table summarises the main aspects of the approved methodology:

Methodological Issue	Approach Adopted
Reference operator	Adjusted Equally Efficient Operator (EEO) approach, with a 20% market share[2]
Relevant Markets	Markets 3a and 3b
Relevant Products	▶ All new products (ex-ante control)

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[1] 'Margin Squeeze Test, Methodological Framework' EETT, Aug 2020, Source: https://www.eett.gr/opencms/export/sites/default/admin/downloads/Consultations/telecoms/PCMethodFramework.pdf

[2] It should be noted that the new methodology defines potential variations of ±5% for the 20% market share.

Methodological Issue	Approach Adopted
	▶ Flagship products (ex-post control)
Aggregation level	Product by product analysis
Cost Standard	LRIC+
Relevant downstream costs	▶ Own network costs ▶ Termination of traffic to/from other networks ▶ Retail costs ▶ G&A costs
Geographical Scope	National territory with the exception of the areas where services are provided subject to state-aid funding initiatives
Reasonable margin	WACC
Time modelling for costs	Static approach

Exhibit 1.1: Summary of the methodological framework. [Source: Axon Consulting]

Please note that the above methodological aspects were already subject to consultation and, therefore, are not under discussion at this stage.

2. Architecture of the model

The model developed follows a modular architecture divided into calculation blocks to ease its conceptualisation. A high-level diagram of the blocks considered in the model and their relationship is presented in the figure below.
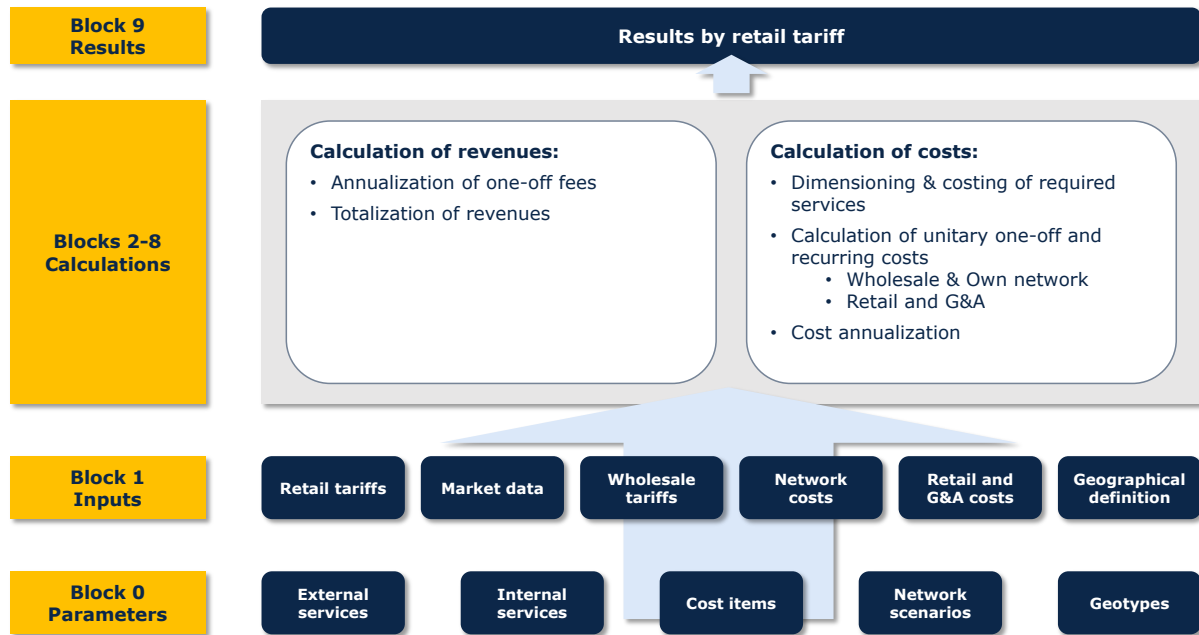

Exhibit 2.1: Structure of the model [Source: Axon Consulting]

As seen in this figure, the model's main functions (i.e. inputs, calculations and outputs) can be mapped to several function blocks. These are:

▶ **Block 0 – Parameterisation,** defines the main variables (e.g. the names of the services, cost items) that are used throughout the model.

▶ **Block 1 – Model inputs**, includes the main inputs (e.g. retail tariffs, number of customers, wholesale rates) to be considered by the model when performing the margin squeeze test.

▶ **Block 2 – External services demand calculation**, calculates the demand of the external services and the revenues per retail tariff.

▶ **Block 3 – Internal services demand calculation**, calculates the demand of the internal services.

▶ **Block 4 – Network and wholesale dimensioning and costing**, calculates the cost items required to provide the service to the end users and calculate the total network and wholesale costs.

▶ **Block 5 – Allocation of network and wholesale costs to internal services**, allocate the costs from the cost items to the internal services.

▶ **Block 6 – Calculation of retail and G&A costs**, calculates the retail costs per external service and the G&A costs per retail tariff.

▶ **Block 7 – Calculation of unitary costs per retail tariffs**, consolidates the own network, wholesale, retail and G&A costs of the retail tariffs.

▶ **Block 8 – Annualisation of customer-dependent one-off costs,** annualizes the customer-related one-off costs over the effective customer lifetime.

▶ **Block 9 - Results**, summarizes and shows the final results per retail tariff produced by the PSM.

Each of these blocks is presented in detail in the sections below.

3. Detailed blocks of the model

3.1. Block 0 – Parameterisation

3.1.1 External services parameterisation

The definition of the external services parameters in which the retail tariffs will be disaggregated is done in worksheet '0A PAR EXTERNAL SERVICES'. An external service is defined as a product that a retail user may purchase, within a bundle or stand-alone, from its service provider. For example, a customer that has a double-play composed of voice plus ADSL 24 Mbps will make use of the respective external services, for instance a PSTN access plus a 24 Mbps broadband product.

The characterization of each external service includes the following:

▶ **Category,** providing the nature of the external service such as access, xDSL, or telephony.

▶ **Description,** providing details on the nature of the service category, such as the different broadband speeds.

▶ **Unit consumption,** providing the mean of measurement of the external service.

▶ **Variable,** generating a unique name for its further use in the model.

In the following Exhibit 3.1, an illustrative excerpt of external services defined in the PSM is presented.

Category	Description	Unit consumption	Variable
Access	PSTN	Lines	Access.PSTN
Access	ISDN	Lines	Access.ISDN
Access	PSTN/ADSL	Lines	Access.PSTN/ADSL
Access	ISDN/ADSL	Lines	Access.ISDN/ADSL
Access	ADSL (without line)	Lines	Access.ADSL (without line)
Access	PSTN/VDSL	Lines	Access.PSTN/VDSL
Access	ISDN/VDSL	Lines	Access.ISDN/VDSL
Access	VDSL (without line)	Lines	Access.VDSL (without line)
Access	FTTH	Lines	Access.FTTH

Exhibit 3.1: Excerpt from the external services definition (Sheet '0A PAR EXTERNAL SERVICES')
[Source: Axon Consulting]

3.1.2 Internal services parameterisation

The internal services parameters are defined in worksheet '0B PAR INTERNAL SERVICES'. An internal service is defined as a product required by a reference operator to provide the external services to its retail customers. For example, although a xDSL retail service is billed by line, the network dimensioning needs to consider the traffic generated on the network.

The characterization of each internal service includes the following

▶ **Category**, providing the nature of the internal service such as access, xDSL, broadband or voice.

▶ **Description**, providing details on the nature of the service category, such as the different broadband speeds and the means of provision.

▶ **Unit consumption**, providing the mean of measurement of the internal service.

▶ **Variable**, generating a unique name for its further use in the model.

▶ **Geotype split type**, indicating the driver that should be used to disaggregate the demand by geotype for each internal service.

In the following Exhibit 3.2, an illustrative excerpt of internal services defined in the PSM is presented.

Category	Description	Unit consumption	Variable	Geotype split type
Telephony	Fixed call termination Voice Only	Minute	Telephony.Fixed call termination Voice Only	Copper access line
Telephony	Fixed call termination ADSL LE	Minute	Telephony.Fixed call termination ADSL LE	ADSL-LE
Telephony	Fixed call termination ADSL CAB	Minute	Telephony.Fixed call termination ADSL CAB	ADSL-CAB
Telephony	Fixed call termination VDSL LE	Minute	Telephony.Fixed call termination VDSL LE	VDSL-LE
Telephony	Fixed call termination VDSL CAB	Minute	Telephony.Fixed call termination VDSL CAB	VDSL-CAB
Telephony	Fixed call termination FTTH	Minute	Telephony.Fixed call termination FTTH	FTTH

Exhibit 3.2: Excerpt from the internal services definition (Sheet '0B PAR INTERNAL SERVICES')
[Source: Axon Consulting]

3.1.3 Cost items parameterisation

The parameterisation of the cost items that are going to be dimensioned and costed in the following worksheets is done in worksheet '0C PAR COST ITEMS'. A cost item refers to any cost component (recurring or one-off) that the reference operator may have to hold to provide providing an external service.

The characterization of each cost item includes the following:

▶ **Category**, providing the nature of the cost item such as wholesale, own network, retail or G&A costs.

▶ **Subcategory**, providing a general reference to the cost item source, such as bitstream, WLR or FTTH.

▶ **Name**, providing the specifics on the cost item to be costed.

▶ **Driver**, providing the volume unit that defines the demand of each cost item.

▶ **Type**, providing a recognition on whether the costs are directly associated to a service or are common to several services.

▶ **Units**, providing the mean of measurement of the cost item.

▶ **One-off customer dependent costs apply for new customers**, indicating whether the one-off costs of certain cost items should be borne by the new customers.

▶ **Variable**, generating a unique name for its further use in the model.

An excerpt of the cost items list used in the model is shown in the following exhibit:

Category	Subcategory	Name	Driver	Type	Units	One-off customer dependent costs applies for new customers	Variable name
Wholesale	International call termination	International	traffic	Direct	Minutes	YES	CI.Wholesale.International call termination.International
Wholesale	Fixed call termination	to fixed	traffic	Direct	Minutes	YES	CI.Wholesale.Fixed call termination.to fixed
Wholesale	Mobile call termination	to mobile	traffic	Direct	Minutes	YES	CI.Wholesale.Mobile call termination.to mobile
							blank
Wholesale	Full ULL	Activation PSTN	Customers/Lines	Direct	Lines	YES	CI.Wholesale.Full ULL.Activation PSTN
Wholesale	Full ULL	Disconnection PSTN	Customers/Lines	Direct	Lines	YES	CI.Wholesale.Full ULL.Disconnection PSTN
Wholesale	Full ULL	Rental PSTN	Customers/Lines	Direct	Lines*month	YES	CI.Wholesale.Full ULL.Rental PSTN
Wholesale	Full ULL	Activation ISDN	Customers/Lines	Direct	Lines	YES	CI.Wholesale.Full ULL.Activation ISDN

Exhibit 3.3: Excerpt from the cost items definition (Sheet '0C PAR COST ITEMS') [Source: Axon Consulting]

3.1.4 Scenario parameterisation

The definition of the different configurations for network resources categories and the network scenario deployments[3] is done in worksheet '0D PAR NW SCENARIOS'. Specifically, these categories aim to cover the network dimensioning from the customer premises (i.e. access section) up to the reference operator's Point of Presence (PoP) (i.e. including the backhaul connection from the SMP operator's premises), whilst core and

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[3] Detailed explanations of the scenarios considered in the model are provided in the next part of this sub-section.

backbone dimensioning is carried out regardless of the configuration defined, since it does not affect the scenario selection.

The dimensioning configurations have been defined as follows:

Dimensioning configurations	LLU & COLLOCATION	WLR	FTTH	NO GAMMA BITSTREAM	OKSYA-DSLAM	OKSYA-BRAS	INTERCONNECTION
1	ADSL LE	ADSL+VDSL+NAKED DSL VPU Light NO GAMMA	VPU FTTH	ADSL+ VDSL	ADSL + VDSL + FTTH	ADSL + VDSL	DIRECT ALL
2	ADSL-LE + VDSL-LE	ADSL-CAB + VDSL+NAKED DSL VPU Light NO GAMMA		ADSL-CAB + VDSL-CAB	ADSL-LE + VDSL-LE + FTTH	ADSL-CAB + VDSL-CAB	
3	ADSL + VDSL VPU-NO GAMMA	ADSL-CAB + VDSL+NAKED DSL VPU Light GAMMA		VDSL + ADSL-CAB	ADSL-LE + FTTH	VDSL + ADSL-CAB	
4	ADSL + VDSL VPU-GAMMA	ADSL-CAB + VDSL-CAB+NAKED DSL VPU Light NO GAMMA			FTTH		
5		ADSL-CAB + VDSL-CAB+NAKED DSL VPU Light GAMMA					
6		NAKED DSL VPU Light NO GAMMA					
7		NAKED DSL VPU Light GAMMA					

Exhibit 3.4: Dimensioning configurations [Source: Axon Consulting]

It should be noted that the use of the expressions CAB and LE in the dimensioning configurations and scenario descriptions, as well as in the following illustrations, refers to the placement of the MSAN. Specifically, xDSL CAB refers to the placement of the MSAN in an outdoor cabinet, whereas xDSL LE refers to the placement of the MSAN in a local exchange. Regarding the GAMMA and NO GAMMA handover, they refer to the point in the network that the access connection from the subscriber premises reaches. Particularly, the GAMMA expression refers to a connection from the subscriber premises up to a local exchange, whereas the NO GAMMA expression refers to a connection up to an OTE BRAS.

The network scenarios are defined considering actual network configuration constraints and OTE's current network deployment status. The dimensioning configurations per network scenario deployment are shown in the following exhibit:

Scenarios	LLU & COLLOCATION	WLR	FTTH	NO GAMMA BITSTREAM	OKSYA - DSLAM	OKSYA - BRAS	INTERCONNECTION
1	ADSL-LE + VDSL-LE	ADSL-CAB + VDSL-CAB+NAKED DSL VPU Light NO GAMMA	VPU FTTH	ADSL-CAB + VDSL-CAB	ADSL-LE + VDSL-LE + FTTH	ADSL-CAB + VDSL-CAB	DIRECT ALL
2	ADSL LE	ADSL-CAB + VDSL+NAKED DSL VPU Light NO GAMMA	VPU FTTH	VDSL + ADSL-CAB	ADSL-LE + FTTH	VDSL + ADSL-CAB	DIRECT ALL
3	-	ADSL+VDSL+NAKED DSL VPU Light NO GAMMA	VPU FTTH	ADSL+ VDSL	FTTH	ADSL + VDSL	DIRECT ALL
4	ADSL + VDSL VPU-GAMMA	NAKED DSL VPU Light GAMMA	VPU FTTH	-	ADSL + VDSL + FTTH	-	DIRECT ALL
5	ADSL + VDSL VPU-NO GAMMA	NAKED DSL VPU Light NO GAMMA	VPU FTTH	-	ADSL-LE + VDSL-LE + FTTH	ADSL-CAB + VDSL-CAB	DIRECT ALL

Exhibit 3.5: Definition of scenarios with dimensioning configurations [Source: Axon Consulting]

In order to facilitate the understanding of the network configuration combinations per network scenario deployment, illustrative representations of all the scenarios are depicted in detail in the following paragraphs.

Scenario 1

Scenario 1 can be described as xDSL-LE_DIRECT + xDSL-CAB_INDIRECT-NO GAMMA and is depicted in Exhibit 3.6. As it can be observed, the scenario is characterised by its access (i.e. LLU, WLR, VPU Light and FTTH solutions), data transmission and backhaul (i.e. own network and ethernet) solutions.
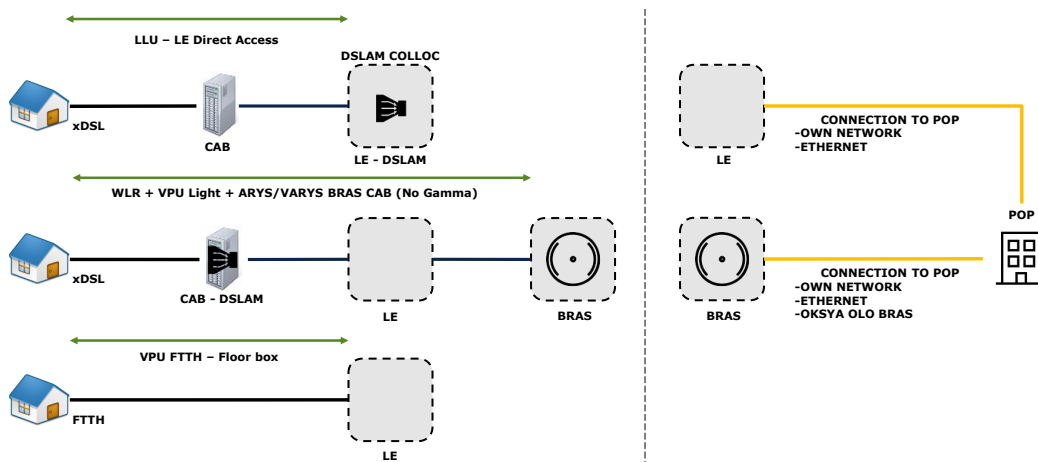

Exhibit 3.6: Illustrative representation of the network configurations for scenario 1 [Source: Axon Consulting]

Access

According to the mapping of the network configurations shown in Exhibit 3.5, the access with LLU configuration is the ADSL LE + VDSL LE, providing both ADSL and VDSL services by connecting the end point of the network at the subscriber's premises to the

local exchange by means of an LLU and collocating the necessary equipment for the xDSL provision, as shown in Exhibit 3.7.
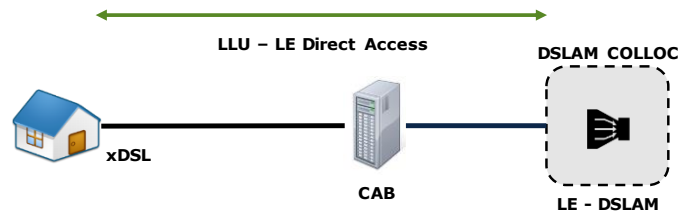

Exhibit 3.7: Illustrative representation of the LLU configuration for scenario 1 [Source: Axon Consulting]

Regarding the WLR configuration (ADSL-CAB + VDSL-CAB + NAKED DSL VPU Light NO GAMMA), the access part of the scenario is implemented with the use either of a WLR for the voice plus bitstream wholesale broadband access services or VPU Light BRAS (No Gamma) solution for the naked broadband services, provided at BRAS level, as shown in Exhibit 3.8.
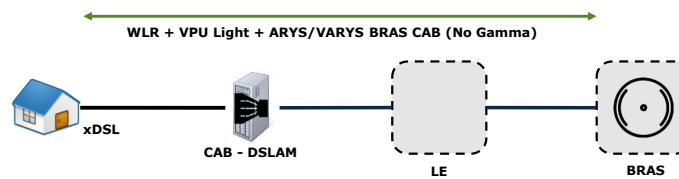
Exhibit 3.8: Illustrative representation of WLR access configuration for scenario 1 [Source: Axon Consulting]

As for the FTTH configuration, the scenario is implemented with a VPU FTTH - Floor Box service that connects the Floor Box at the customer's premises with the LE, as shown in Exhibit 3.9.
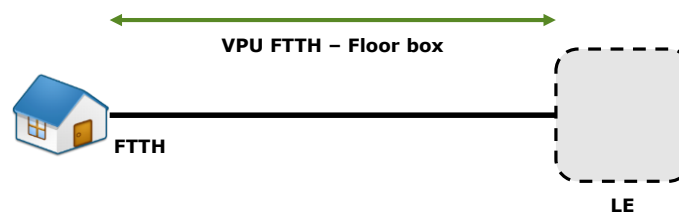
Exhibit 3.9: Illustrative representation of FTTH configuration for scenario 1 [Source: Axon Consulting]

Backhaul

The data transmission is implemented by means of a DSLAM bitstream on the xDSL CAB WLR connection (ARYS/VARYS BRAS CAB) or by a VPU Light BRAS solution (No Gamma) on the broadband naked accesses, as shown in Exhibit 3.10.
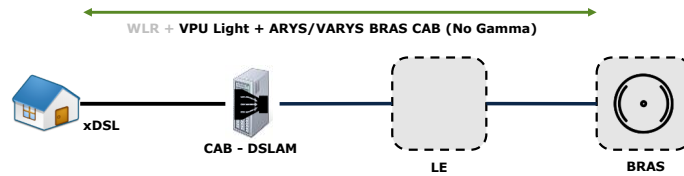

Exhibit 3.10: Illustrative representation of WLR data transmission configuration for scenario 1 [Source: Axon Consulting]

Regarding FTTH, the data transmission is implemented with the same configuration as in the access section, which is a VPU FTTH, as shown in Exhibit 3.9.

Regarding the backhaul configuration, the connection to the PoP is deployed differently for LLU, WLR and FTTH. For the LLU and the FTTH case, it is either deployed with own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively) at the LE or an Ethernet solution. For the WLR case, the connection to the PoP is implemented from the BRAS considering own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively), or a wholesale solution, by means of an Ethernet or an OKSYA to the PoP connection (more details on the backhaul solutions are presented in section 3.5). The backhaul configurations are shown in Exhibit 3.11.
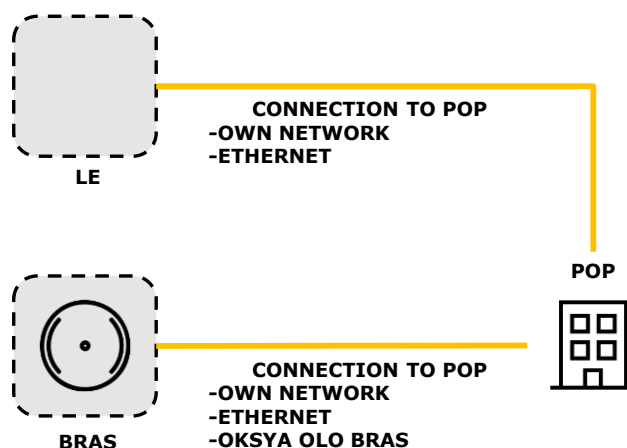

Exhibit 3.11: Illustrative representation of the backhaul configurations for scenario 1 [Source: Axon Consulting]

Scenario 2

Scenario 2, which can be described as ADSL-LE_DIRECT + VDSL-LE_INDIRECT-NO GAMMA + xDSL-CAB_INDIRECT- NO GAMMA, is depicted in Exhibit 3.12.
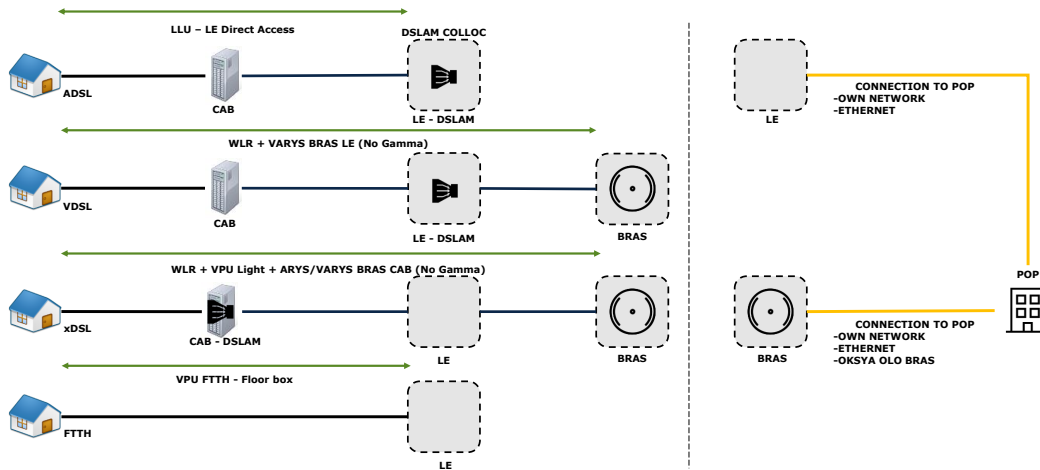

Exhibit 3.12: Illustrative representation of the network configurations for scenario 2 [Source: Axon Consulting]

Access

According to the mapping of the network configurations shown in Exhibit 3.5, the access with LLU configuration is the ADSL LE, providing only ADSL services by connecting the end point of the network at the subscriber's premises to the local exchange by means of an LLU and collocating the necessary equipment for the ADSL provision, as shown in Exhibit 3.13.
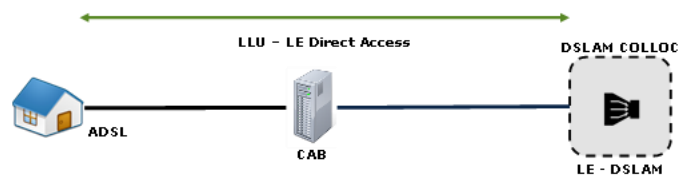

Exhibit 3.13: Illustrative representation of the LLU configuration for scenario 2 [Source: Axon Consulting]

Regarding the WLR configuration (ADSL-CAB + VDSL+NAKED DSL VPU Light NO GAMMA), there are two implementation cases for this scenario. In the first case, the access is implemented with a WLR solution on the VDSL provided by the local exchange up to the BRAS as shown in Exhibit 3.14.
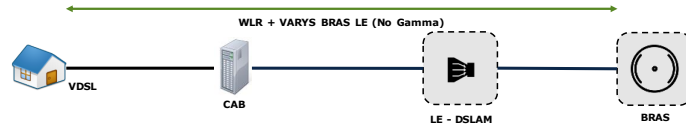

Exhibit 3.14: Illustrative representation of VDSL WLR access configuration for scenario 2 [Source: Axon Consulting]

In the second case, the access is implemented with a WLR on the ADSL and VDSL provided through the cabinet, and a VPU Light BRAS (No Gamma) solution on the broadband naked lines. This second case provides the connections at BRAS level, as shown in Exhibit 3.15.
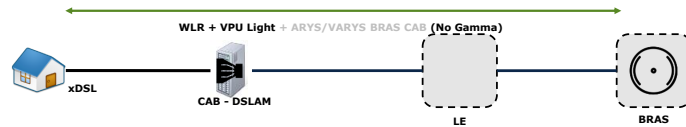

Exhibit 3.15: Illustrative representation of naked DSL WLR access configuration for scenario 2 [Source: Axon Consulting]

As for the FTTH configuration, the scenario is implemented with a VPU FTTH - Floor Box service that connects the Floor Box at the customer's premises with the LE, as shown in Exhibit 3.16.
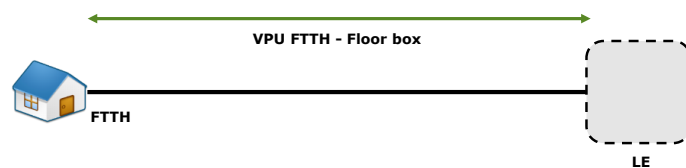

Exhibit 3.16: Illustrative representation of FTTH configuration for scenario 2 [Source: Axon Consulting]

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Backhaul

Regarding the WLR data transmission configuration (ADSL-CAB + VDSL+NAKED DSL VPU Light NO GAMMA), there are two implementation cases for this scenario. One for both ADSL and VDSL handed at BRAS level and one for the VDSL handed at BRAS level. The xDSL case is implemented with the use of a BRAS bitstream solution (ARYS/VARYS BRAS CAB). For the case of the broadband naked lines, the VPU light BRAS solution (No Gamma) also provides the connection at BRAS level, as shown in Exhibit 3.17.

Exhibit 3.17: Illustrative representation of WLR No Gamma data transmission configuration for scenario 2 [Source: Axon Consulting]

On the other hand, the VDSL case is implemented with the use of a BRAS-LE bitstream (VARYS BRAS LE – No Gamma) solution, which is also provided by a BRAS, as shown in Exhibit 3.18.
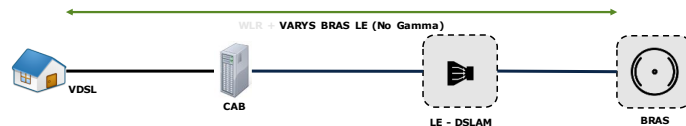

Exhibit 3.18: Illustrative representation of WLR No Gamma data transmission configuration for scenario 2 [Source: Axon Consulting]

Regarding FTTH, the data transmission is implemented with the same configuration as in the access section, which is a VPU FTTH, as shown in Exhibit 3.16.

Regarding the backhaul configuration, the connection to the Point of Presence from the local exchange with own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively) or a wholesale solution, by means of an Ethernet connection. For the WLR, the connection to the PoP is implemented from the BRAS considering own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively), or a wholesale solution, by means of an Ethernet or an OKSYA to the PoP connection. The backhaul configuration is shown in Exhibit 3.19.
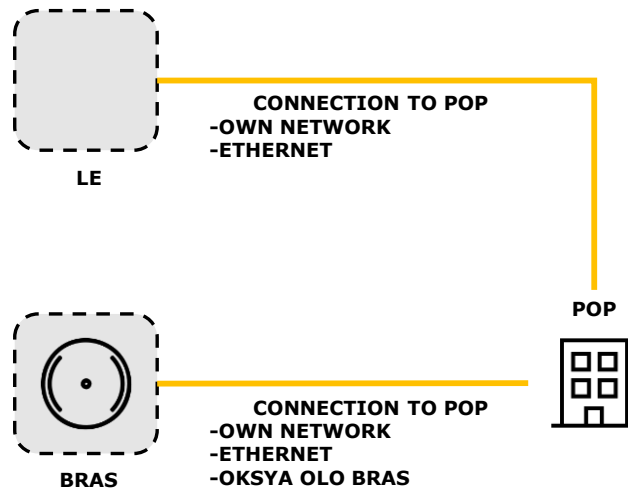
Exhibit 3.19: Illustrative representation of the backhaul configurations for scenario 2 [Source: Axon Consulting]

<u>**Scenario 3**</u>

Scenario 3, which can be described as xDSL_INDIRECT-NO GAMMA, is depicted in Exhibit 3.20.
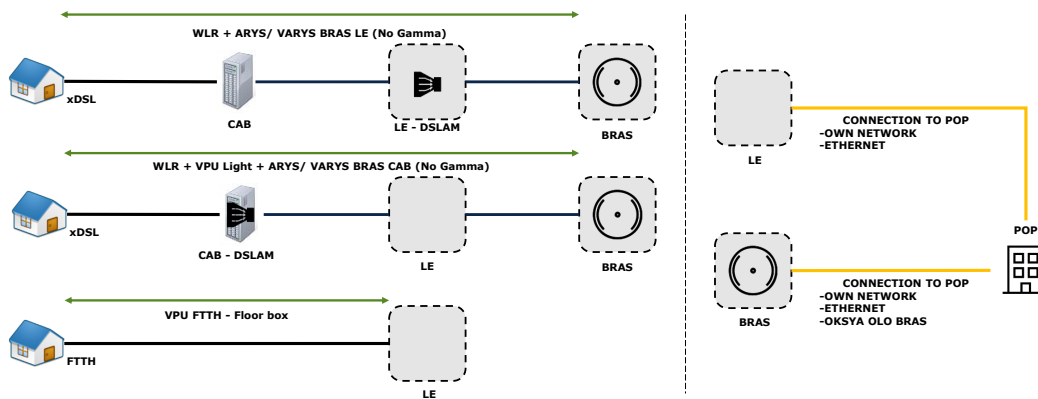

Exhibit 3.20: Illustrative representation of the network configurations for scenario 3 [Source: Axon Consulting]

<u>Access</u>

For this scenario, there is no LLU configuration, as all the connections are provided through indirect access. Regarding the WLR configuration (ADSL+VDSL+NAKED DSL VPU Light NO GAMMA), there are two implementation cases for this scenario. In the first

case, the access is implemented with a WLR solution on the ADSL and VDSL provided by the local exchange up to the BRAS as shown in Exhibit 3.21.
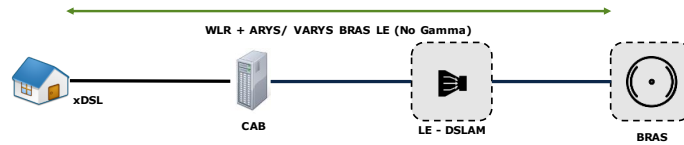

Exhibit 3.21: Illustrative representation of xDSL WLR no gamma access configuration for scenario 3 [Source: Axon Consulting]

In the second case, the access is implemented with a WLR on the ADSL and VDSL provided through the cabinet, and a VPU Light DSLAM (No Gamma) solution on the broadband naked lines. This second case also provides the connections at BRAS level, as shown in Exhibit 3.22.
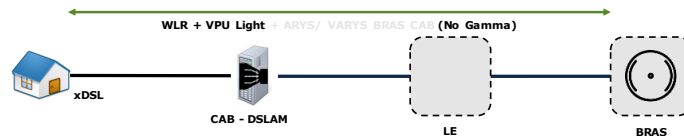

Exhibit 3.22: Illustrative representation of naked DSL WLR no gamma access configuration for scenario 3 [Source: Axon Consulting]

Regarding the FTTH configuration (VPU FTTH), the scenario is implemented with a VPU FTTH - Floor Box service that connects the Floor Box at the customer's premises with the LE, as shown in Exhibit 3.23.
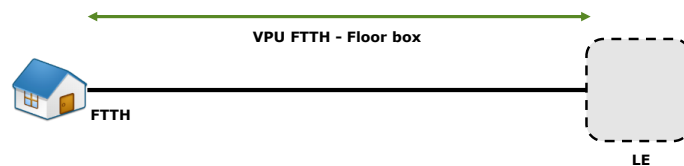

Exhibit 3.23: Illustrative representation of FTTH configuration for scenario 3 [Source: Axon Consulting]

Backhaul

Regarding the WLR data transmission, there are two implementation cases concerning both ADSL and VDSL. In the first case, the service is provided by a BRAS LE bitstream (ARYS/VARYS BRAS LE) solution (No Gamma), which is provided by a BRAS (i.e. the MSAN is located in a LE), as shown in Exhibit 3.24.
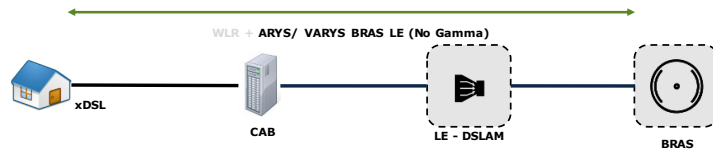
Exhibit 3.24: Illustrative representation of xDSL WLR no gamma data transmission configuration for scenario 3 [Source: Axon Consulting]

In the second case, the services are provided from the cabinet using a BRAS CAB bitstream (ARYS/VARYS BRAS CAB) solution. For the VPU Light, as it follows a BRAS (No Gamma) solution, its connection is therefore covered from the BRAS.
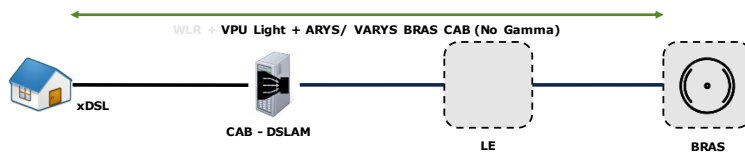

Exhibit 3.25: Illustrative representation of naked DSL WLR no gamma data transmission configuration for scenario 3 [Source: Axon Consulting]

Regarding FTTH, the data transmission is implemented with the same configuration as in the access section, which is a VPU FTTH, as shown in Exhibit 3.23.

Regarding the backhaul configuration, the connection to the Point of Presence is deployed from the local exchange with own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively) or a wholesale solution, by means of an Ethernet connection. For the services handed over at BRAS level, the connection to the PoP is implemented from the BRAS considering own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively), or a wholesale solution, by means of an Ethernet or an OKSYA to the PoP connection, as shown in Exhibit 3.26.
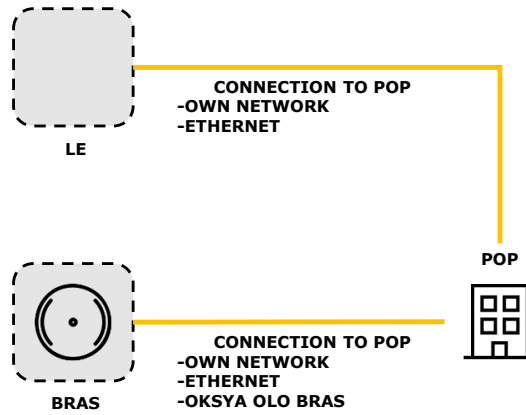
Exhibit 3.26: Illustrative representation of the backhaul configurations for scenario 3 [Source: Axon Consulting]

Scenario 4

Scenario 4, which can be described as xDSL-LE_DIRECT + xDSL-CAB_INDIRECT-GAMMA (VPU), is depicted in Exhibit 3.27. A detailed presentation of the access and backhaul configurations is provided in the following.

Exhibit 3.27: Illustrative representation of the network configurations for scenario 4 [Source: Axon Consulting]

This scenario's LLU access configuration corresponds to two different implementations. The first implementation case refers to an LLU service that connects the end point of the network at the subscriber's premises, with the corresponding LE as shown in Exhibit 3.28.
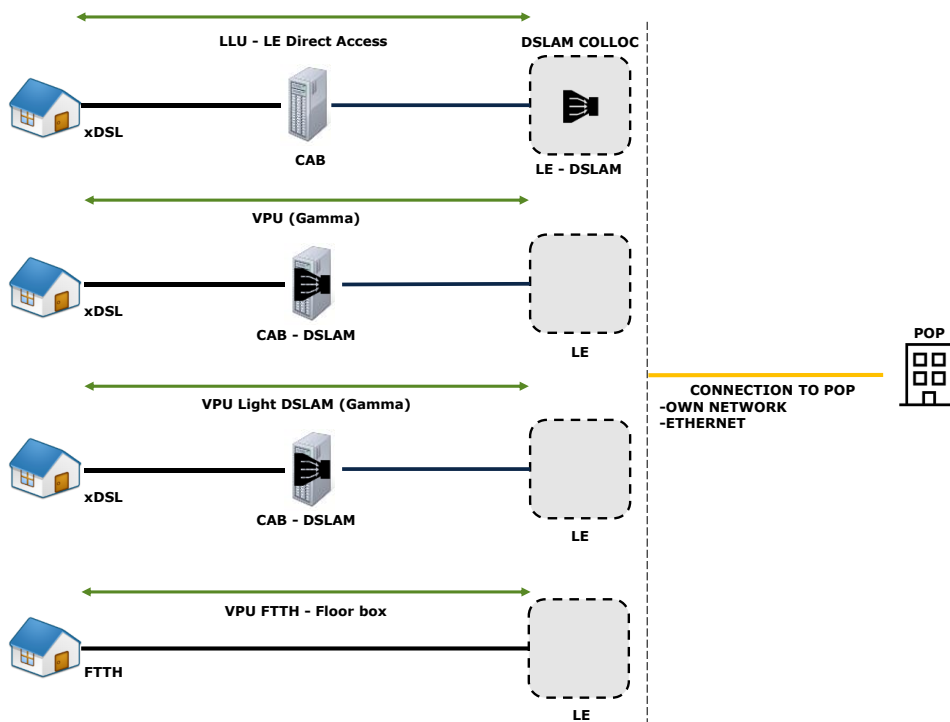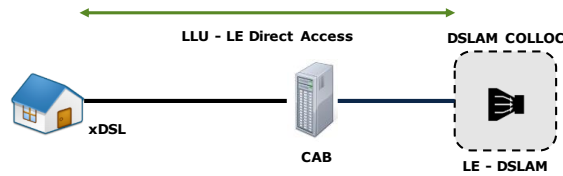

Exhibit 3.28: Illustrative representation of the LLU configuration for scenario 4 [Source: Axon Consulting]

The second implementation is performed via a VPU DSLAM (Gamma) solution, providing the service from the corresponding LE as shown in Exhibit 3.29.
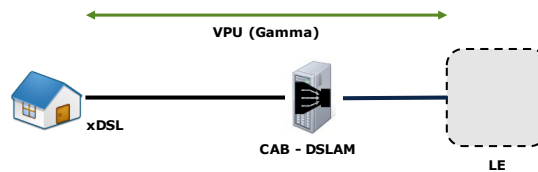
Exhibit 3.29: Illustrative representation of the VPU access configuration for scenario 4 [Source: Axon Consulting]

As for the WLR configuration (NAKED DSL VPU Light GAMMA), this scenario just considers the naked broadband lines connected by means of a VPU Light DSLAM solution (Gamma) to the corresponding LE as shown in Exhibit 3.30.
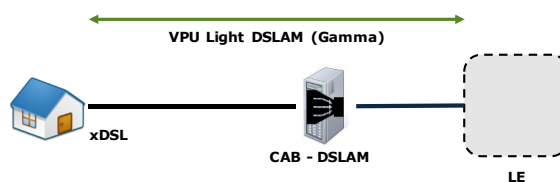
Exhibit 3.30: Illustrative representation of the WLR configuration for scenario 4 [Source: Axon Consulting]

Regarding the FTTH configuration (VPU FTTH), the scenario is implemented with a VPU FTTH - Floor Box service that connects the Floor Box at the customer's premises with the LE, as shown in Exhibit 3.31.

Exhibit 3.31: Illustrative representation of FTTH configuration for scenario 4 [Source: Axon Consulting]

Backhaul

The data transmission for both VPU and VPU light are provided with their implicit gamma solution, being the broadband connections handed over at the corresponding local exchange.

Regarding FTTH, the data transmission is implemented with the same configuration as in the access section, which is a VPU FTTH, as shown in Exhibit 3.31.

Regarding the backhaul configuration, the connection from the local exchange to the Point of Presence is deployed either with own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively) at the LE or a wholesale solution, by means of an Ethernet connection, as shown in Exhibit 3.32.
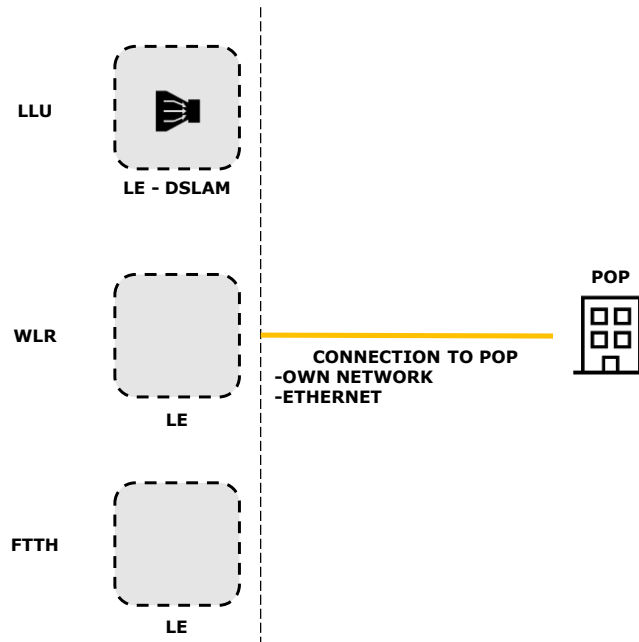
Exhibit 3.32: Illustrative representation of the backhaul configurations for scenario 4 [Source: Axon Consulting]

<u>**Scenario 5**</u>

Scenario 5, which can be described as xDSL-LE_DIRECT + xDSL-CAB_INDIRECT-NO GAMMA (VPU), is depicted in Exhibit 3.33.
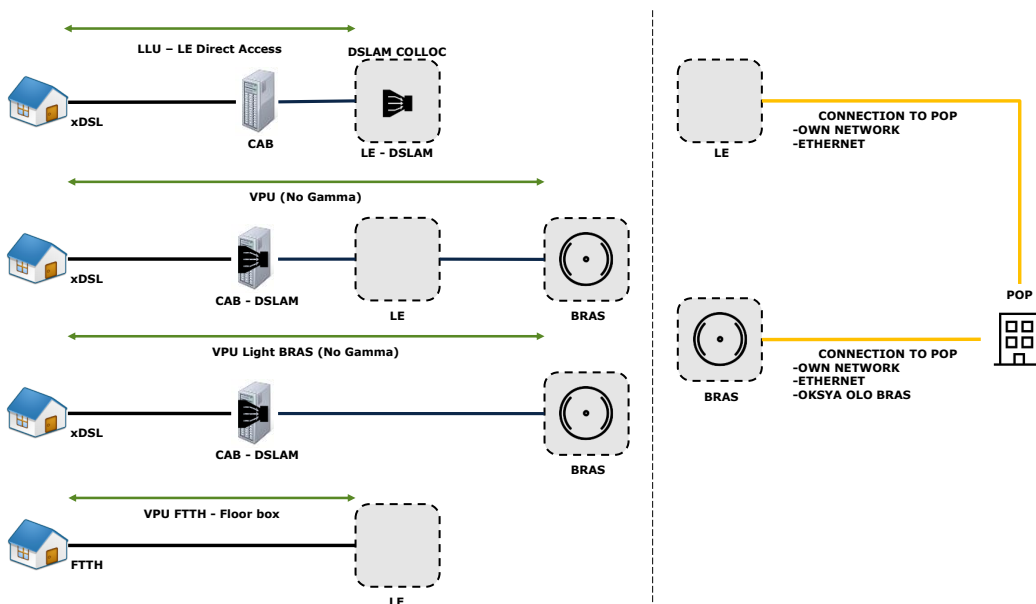
Exhibit 3.33: Illustrative representation of the network configurations for Scenario 5 [Source: Axon Consulting]

This scenario's LLU access configuration corresponds to two different implementations. As in Scenario 4, the first implementation case refers to an LLU service that connects the end point of the network at the subscriber's premises, with the corresponding LE as shown in Exhibit 3.34.
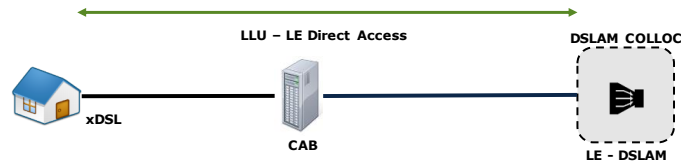
Exhibit 3.34: Illustrative representation of the LLU configuration for Scenario 5 [Source: Axon Consulting]

The second implementation is performed via a VPU BRAS (No Gamma) solution, providing the service to the corresponding BRAS as shown in Exhibit 3.35.
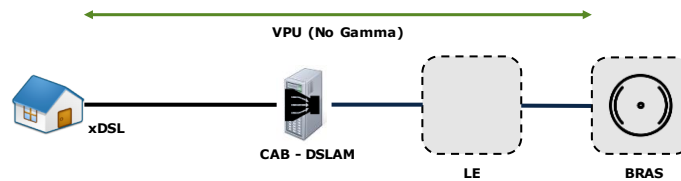
Exhibit 3.35: Illustrative representation of the VPU access configuration for Scenario 5 [Source: Axon Consulting]

As for the WLR configuration (NAKED DSL VPU Light NO GAMMA), this scenario just considers the naked broadband lines connected by means of a VPU Light BRAS solution (No Gamma) up to the corresponding BRAS, as shown in Exhibit 3.36.
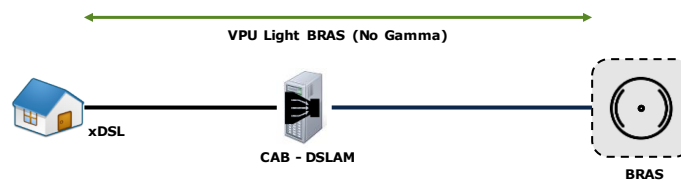
Exhibit 3.36: Illustrative representation of the WLR configuration for Scenario 5 [Source: Axon Consulting]

Regarding the FTTH configuration (VPU FTTH), the scenario is implemented with a VPU FTTH - Floor Box service that connects the Floor Box at the customer's premises with the LE, as shown in Exhibit 3.37.
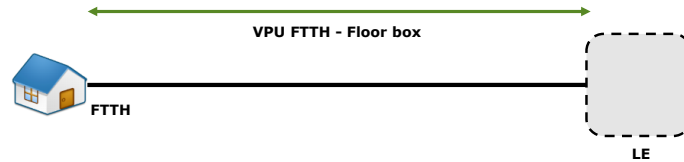

VPU FTTH - Floor box

FTTH

LE
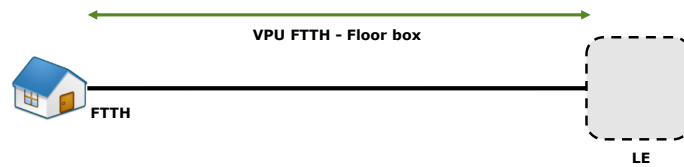
Exhibit 3.37: Illustrative representation of FTTH configuration for scenario 5 [Source: Axon Consulting]

Backhaul

The data transmission for both VPU and VPU light are provided with their implicit no gamma solution, being the broadband connections handed over at the corresponding BRAS.

Regarding FTTH, the data transmission is implemented with the same configuration as in the access section, which is a VPU FTTH, as shown in Exhibit 3.37.

The connection from the local exchange to the Point of Presence, which affects the FTTH-VPU lines and the xDSL LE lines, is deployed either with own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively) at the LE or a wholesale solution, by means of an Ethernet connection. The connection to the Point of Presence from the BRAS for the VPU and VPU Light solutions considers own means with co-location (physical or distant with the use of a SYMEFS or OKSYA PRM solution respectively), or a wholesale solution, by means of an Ethernet or an OKSYA to the PoP connection. The available backhaul configurations are shown in Exhibit 3.38.
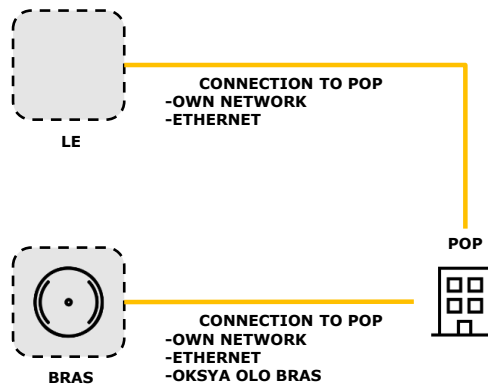
Exhibit 3.38: Illustrative representation of the backhaul configurations for scenario 5 [Source: Axon Consulting]

<u>**Scenario dimensioning and costing**</u>

During the dimensioning and costing step of each scenario, the model calculates for each access network and backhaul configuration the required items and their corresponding cost. In case more than one backhaul solutions are considered for a backhaul configuration, the model calculates the necessary items and corresponding costs for all backhaul solutions, and then determines the most cost-effective option per local exchange configuration. Subsequently, the model calculates the total cost of each scenario according to these network configuration costs. In the same vein, the model determines which scenario is the most cost effective for each of the geotypes defined in section 3.1.5. This process is detailed in sections 3.5.3 and 3.5.4.

3.1.5 Geotype Parameterisation

The geotypes considered in the model are defined in worksheet '0E PAR GEOTYPES'. The categorization of the geotypes serves to dimension network elements and wholesale services required for each geotype differently. In general, the geotypes characterize the types of the local exchanges according to the following two parameters:

▶ **Type of co-location available:** Physical co-location, distant co-location or no co-location is available.

▶ **VDSL availability:** access from Local Exchange (LE), from Street Cabinet (CAB), or no VDSL access available (NONE).

The considered geotypes are presented in the following exhibit:

#	Geotype
1	PHYSICAL-CAB
2	PHYSICAL-LE
3	DISTANT-CAB
4	DISTANT-LE
5	DISTANT-NONE
6	NO COLLOC-CAB
7	NO COLLOC-LE
8	NO COLLOC-NONE
9	blank
10	blank

Exhibit 3.39: The table that defines the geotypes used in the model [Source: Axon Consulting]

Therefore, the nomenclature used in the definition of the local exchange configurations presented above is described below:

▶ **PHYSICAL - CAB:** Local exchanges with physical collocation availability and VDSL access from a street cabinet connected to the local exchange.

▶ **PHYSICAL - LE:** Local exchanges with physical collocation availability and VDSL access provided directly from the local exchange.

▶ **DISTANT - CAB:** Local exchanges with distant collocation availability and VDSL access from a street cabinet connected to the local exchange.

▶ **DISTANT - LE:** Local exchanges with distant collocation availability and VDSL access provided directly from the local exchange.

▶ **DISTANT - NONE:** Local exchanges with distant collocation availability and no VDSL access provided.

▶ **NO COLLOC - CAB:** Local exchanges with no collocation availability and VDSL access from a street cabinet connected to the local exchange.

▶ **NO COLLOC - LE:** Local exchanges with no collocation availability and VDSL access provided directly from the local exchange.

▶ **NO COLLOC - NONE:** Local exchanges with no collocation availability and no VDSL access provided.

3.2. Block 1 – Model inputs

The table below lists the inputs that are considered in the model:

Input type	Description
Retail tariffs	List of the retail tariffs offered by the incumbent operator and their relevant data such as market price and access line type (section 4.1 of the user manual).
Market data	List of data regarding the reference operator, such as the market share and the demand for the whole Greek market (section 4.2 of the user manual).
Wholesale tariffs	List of the wholesale tariffs and the corresponding one-off and recurrent fees, as they are published in the latest wholesale pricelists (section 4.3 of the user manual).
Drivers and inputs for own network	Inputs required for the dimensioning and costing of the network, such as unitary costs, useful lives, fixed and operational costs (section 4.4 of the user manual).
Retail and G&A	Data necessary for the modelling of retail and commercial costs, inputs for the calculation of G&A costs, as well as data regarding the customers such as the churn rate and customer life of the access customers (section 4.5 of the user manual).
Geographical characterisation	Data regarding the number of exchanges and the lines they serve per each geotype, as well as data on the transmission and backbone links (section 4.6 of the user manual).
Own network unitary costs per cost item	The necessary inputs from EETT's bottom up models to reflect the own network costs (section 4.7 of the user manual).

Exhibit 3.40: Summary of the inputs considered in the model [Source: Axon Consulting]

The model's inputs, a guide for their introduction in the model as well as their sources are described in detail in the User manual.

3.3. Block 2 – External services demand calculation

3.3.1 Usage of external services by retail tariffs

Worksheet '2A CALC EXT SERV DEMAND' calculates the total consumption of the external services per retail tariff according to information input in the retail tariffs definition (i.e. worksheet '1A INP RET TARIFFS'). For instance, a 50Mbps double play retail tariff would reflect an access line plus a 50Mbps broadband service plus and the tariff associated monthly voice traffic.

3.3.2 Retail tariffs customer life

The retail tariffs' customer lives are calculated in worksheet '2B CALC CUSTOMER LIFE'. The worksheet calculates the number of lines of each access type and service offered (e.g. xDSL) per retail tariff recognizing its access nature, and maps to each of them the corresponding customer life calculated in worksheet '1F INP RET COSTS'.

3.3.3 Retail tariffs revenues calculation

The retail tariffs' revenues - from both one-off and monthly sources per user - are calculated in worksheet '2C CALC RET REVENUES'. This revenues calculation is based on the retail tariffs information input in worksheet '1A INP RET TARIFFS' and the customer life from worksheet '2B CALC CUSTOMER LIFE' (section 3.3.3). The total revenues per month are calculated based on the following formula[4]:

$$T\_REV = MON\_FEE + ((NEW\_CUST \cdot ACT\_FEE)/CL)/12$$

Where:

▶ *T_REV* is the vector of total revenues per month as an annualization on the activation fees plus the monthly fees of a tariff,

▶ *MON_FEE* is the sum of the vectors of monthly fees and the additional charge for minutes consumed outside a tariff (from worksheet '1A INP RET TARIFFS'),

---

[4] "·" is the symbol of the matrix multiplication and will be used in the formulas henceforth. For numerical multiplications, the symbol "*" is used instead.

▶ *NEW_CUST* is the vector of percentages of new customers of the tariff over its total customers (from worksheet '1A INP RET TARIFFS'),

▶ *ACT_FEE* is the activation fees vector of the retail tariffs (from worksheet '1A INP RET TARIFFS'),

▶ *CL* is the vector of effective customer average life per retail tariff calculated in worksheet '2B CALC CUSTOMER LIFE' (section 3.3.2).

3.4. Block 3 – Internal services demand calculation

3.4.1 Mapping from external services to internal services

The relationship between external services and internal services is defined in worksheet '3A MAP ES2IS'. An external service forms a relationship with each of the internal services that can provide it (e.g. fixed to fixed telephony forms relationships with both no-xDSL and xDSL internal services as they can provide it). To define these relationships, all pairs with a relation (one external service and one internal service) are input with their relationship factor in the table 'LIST OF RELATIONSHIPS'.

Particularly, the relationship factor is in fact the ratio of each internal service used to provide a specific external service. Depending on the external service, the calculation of the ratio is the product of combinations of the following parameters. Whenever no specific parameter is relevant for the definition of the ratio, the field is filled as 'blank':

▶ **Usage factor:** It represents the number of times a service makes use of a specific internal service.

▶ **Technology:** It refers to the type of access technology connected to the internal service (i.e. no-xDSL, ADSL, VDSL and FTTH)[5].

▶ **Geotype split:** It is the ratio of the type of lines per access technology (e.g. number of VDSL CAB lines divided by total number of VDSL lines from worksheet '1G INP GEO').

▶ **Bandwidth/Contention ratio:** It is the division of the actual average speed (that corresponds to an external service's nominal speed, from worksheet '1B INP MARKET') by the corresponding contention ratio (from worksheet '1D INP NW').

A snapshot of the 'LIST OF RELATIONSHIPS' table is shown in the following exhibit:

---

[5] It should be noted that the inputs of this parameter are used for the calculation of the values of other parameters and not for the direct calculation of the ratio.

LIST OF RELATIONSHIPS
This table calculates the ratio of internal service for each external service

External Service	Internal Service	Usage factor	Technology	Geotype split	Bandwidth/ Contention ratio	Ratio	X	Y
Telephony.to fixed	Telephony.Fixed call termination Voice Only	0,38	blank	1,00	blank	0,38	1	37
Telephony.to fixed	Telephony.Fixed call termination ADSL LE	0,47	adsl	0,69	blank	0,33	2	37
Telephony.to fixed	Telephony.Fixed call termination ADSL CAB	0,47	adsl	0,31	blank	0,15	3	37
Telephony.to fixed	Telephony.Fixed call termination VDSL LE	0,15	vdsl	0,24	blank	0,04	4	37
Telephony.to fixed	Telephony.Fixed call termination VDSL CAB	0,15	vdsl	0,76	blank	0,11	5	37
Telephony.to fixed	Telephony.Fixed call termination FTTH	0,00	ftth	1,00	blank	0,00	6	37

Exhibit 3.41: Illustrative excerpt of the mapping of internal services to external services [Source: Axon Consulting]

3.4.2 External services - internal services relationship

The transformation of the 'LIST OF RELATIONSHIPS' table (worksheet '3A MAP ES2IS', section 3.4.1) to a matrix is done in worksheet '3B MAT ES IS'. Particularly, the relationships can be observed by external service (vertical axis) and internal service (horizontal axis). This mapping is possible by using the function embedded in Visual Basic as 'array2mat' that allows for a linear to matrixial conversion.

The code used within the function '*array2mat*' is presented in the following exhibit:

```
(General)

Function array2mat(x, y, number, values, size_x, size_y)

ReDim mat(size_y - 1, size_x - 1) As Double


For i = 1 To number

If x(i) = "" Then
Else
mat(y(i) - 1, x(i) - 1) = values(i)
End If

Next i
array2mat = mat

End Function
```

Exhibit 3.42: Function 'array2mat' defined in Visual Basic [Source: Axon Consulting]

3.4.3 Internal services demand per external service

The demand per external service for internal service is obtained in worksheet '3C CALC INT SERV DEMAND'. This demand has been calculated using the following formula:

$$D\_IS = MOD\_ES \cdot M\_ES2IS$$

Where:

▶ *D_IS* is the matrix of the demand per external service for internal service,

▶ *MOD_ES* is the vector of the modelled operator's demand per external service in worksheet '1B INP MARKET',

▶ *M_ES2IS* is the matrix of the external and internal services relationships in worksheet '3B MAT ES IS' (section 3.4.2).

3.4.4 Internal services demand per geotype

The internal services demand per geotype is obtained in worksheet '3D CALC INT SERV DEM GEO'. This worksheet first calculates the percentages of each access technology line type per geotype according to the following formula:

$$GEO\_PER \,=\, GEO\_LINES \,/\, T\_LINES$$

Where:

▶ *GEO_PER* is the percentage of an access technology line type in a specific geotype,

▶ *GEO_LINES* is the number of lines of an access technology line type in a specific geotype (from worksheet '1G INP GEO'),

▶ *T_LINES* is the total number of lines of an access technology line type in all geotypes (from worksheet '1G INP GEO').

The internal services demand has been calculated using the following formula:

$$D\_ISGEO = TD\_IS * GEO\_PER$$

Where:

▶ D_ISGEO is the internal services demand per geotype,

▶ TD_IS is the total demand per internal service in worksheet '3C CALC INT SERV DEMAND' (section 3.4.3)

▶ GEO_PER are the previously calculated percentages of the line types.

3.5. Block 4 – Network and wholesale dimensioning and costing

This section describes the procedure for the dimensioning and costing of the network in the model. The general procedure followed is outlined in the following:

▶ **Own network costs calculation:** In this step, the model calculates the own network costs per internal service input in worksheet '1H INP COST RES AND SERV'.

▶ **Geotype driven costs definition:** In this step, the different network configurations for local access, backhaul and interconnection are dimensioned and costed according to their definitions in worksheet '0D PAR SCENARIO' (section 3.1.4).

▶ **Calculation of costs per scenario:** In this step, the cost items' costs are calculated for each of the scenarios defined in worksheet '0D PAR SCENARIO' (section 3.1.4), according to the network configuration and own network costs calculated in the previous steps.

▶ **Scenario selection**: After following the above procedure and the scenarios' costs are obtained, the most cost-effective (optimal) scenario per geotype is selected. For each geotype, the model identifies the available optimal combinations between wholesale and own network solutions.

▶ **Non-geotype driven costs definition:** In this step, the core related costs are calculated (e.g. backbone network, core platforms).

The general calculation blocks for each of the cost items definition sections are described below:

▶ **Drivers:** The internal services to be used for dimensioning are selected according to the dimensioning configurations defined in worksheet '0D NW SCENARIOS' (section 3.1.4). Then, the corresponding demand is input (i.e. per geotype number of lines, traffic in Kbps or minutes consumed) from the internal services demand per geotype defined in worksheet '3D CALC INT SERV DEM GEO' (section 3.4.4).

▶ **Supporting data:** Data necessary for the supporting calculations of some of the network configurations.

▶ **Supporting calculations:** The intermediate calculations needed for the dimensioning are developed in this block.

▶ **Cost items dimensioning:** The amount of cost items required under each specific network configuration is obtained from the outcomes of the supporting calculations block (or directly from the drivers).

▶ **Cost items costing:** The cost of each cost item corresponding to a network configuration. The costs are obtained by multiplying the amount of cost items calculated in the previous step with the corresponding cost item cost calculated in worksheet '1E INP MAP COST CONSOL'.

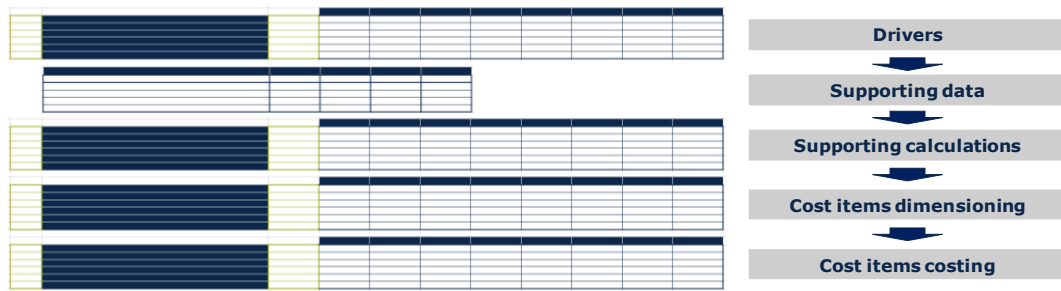Exhibit 3.43 below shows the standard high-level calculation processes followed.

**Exhibit 3.43: General frame or structure followed in the dimensioning and costing processes
[Source: Axon Consulting]**

The dimensioning and costing worksheets are described in the following sub-sections.

3.5.1 Own network costs calculation

The calculation of the unitary own network costs per cost item and internal service is done in worksheet '4A MAT OWN NW COSTS IS'. Specifically, this worksheet produces a matrix with the annual costs of the own network cost items (horizontal axis) extracted from the EETT's Bottom-Up models from worksheet '1H INP COST RES AND SERV' used by the internal services (vertical axis).

3.5.2 Geotype driven costs definition

The dimensioning and calculation of the own network and wholesale costs dependent on the geotype configuration are presented in worksheets '4B CALC LOCAL ACCES', '4C CALC BACKHAUL' and '4D CALC INTERCONNECTION' The details on each network dimensioning blocks are presented in the following paragraphs.

Local access

The dimensioning and costing of the Local Loop Unbundling (LLU), Virtual Partial Unbundling (VPU), Co-location, Wholesale Line Rental (WLR), VPU Light and VPU FTTH is conducted in worksheet '4B CALC LOCAL ACCESS'.

In order to explain in detail the dimensioning and costing algorithms, we provide illustrative representations in the form of flowcharts in the following subsection.

LLU

The algorithm for the dimensioning and costing of the cost items that correspond to LLU access is depicted in Exhibit 3.44:
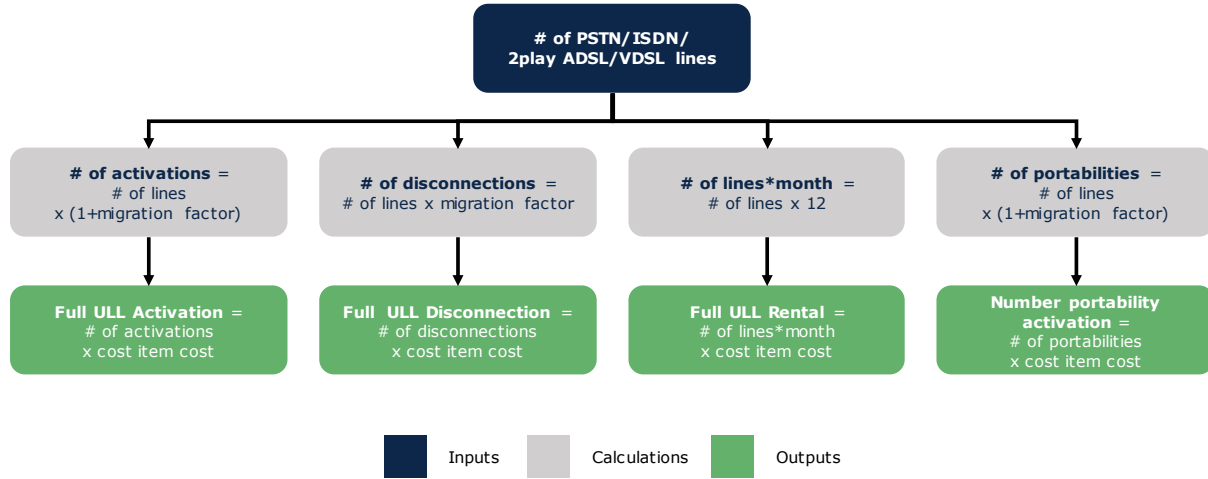

Exhibit 3.44: Illustrative representation of the dimensioning and costing algorithm of LLU access [Source: Axon Consulting]

VPU

The algorithm for the dimensioning and costing of the cost items that correspond to VPU access is depicted in Exhibit 3.45:
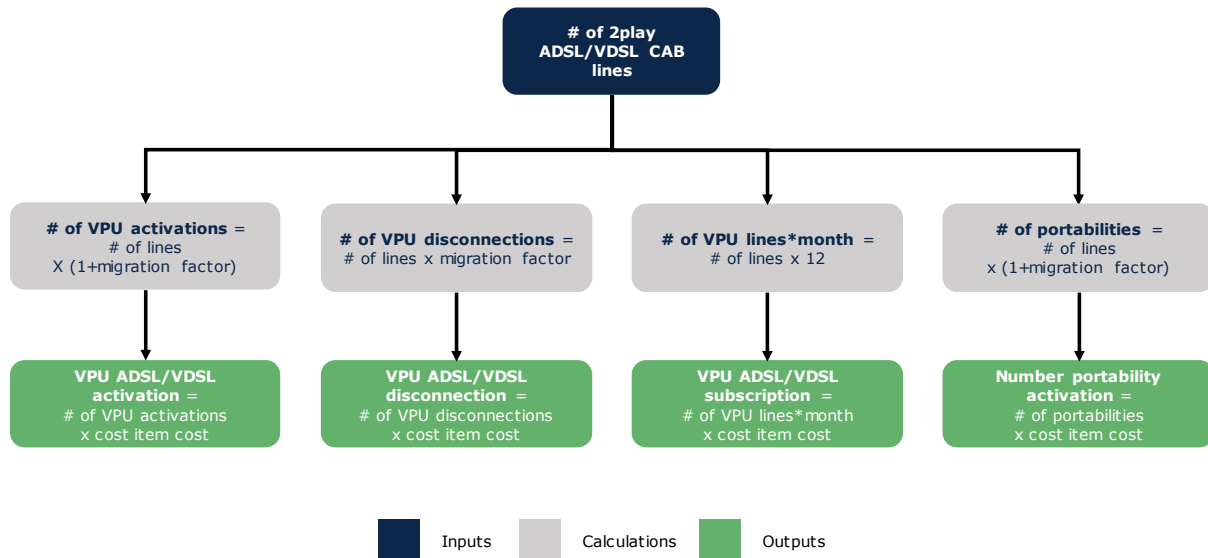

Exhibit 3.45: Illustrative representation of the dimensioning and costing algorithm of VPU access[Source: Axon Consulting]

Physical co-location

The algorithm for the dimensioning and costing of the cost items that correspond to physical co-location access is depicted in Exhibit 3.46. It should be noted that apart from the presented cost items, the physical co-location costing includes the per-line costs of the necessary own network cost items extracted from EETT's BULRIC models.

Exhibit 3.46: Illustrative representation of the dimensioning and costing algorithm of physical co-location [Source: Axon Consulting]

Distant co-location

The algorithm for the dimensioning and costing of the cost items that correspond to distant co-location is depicted in Exhibit 3.47.

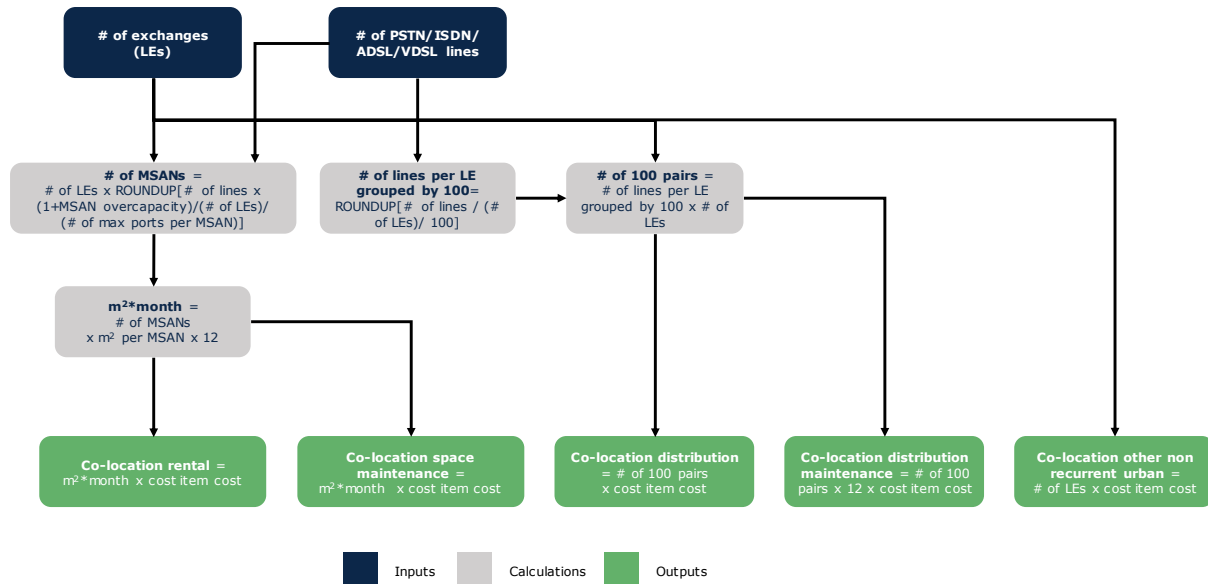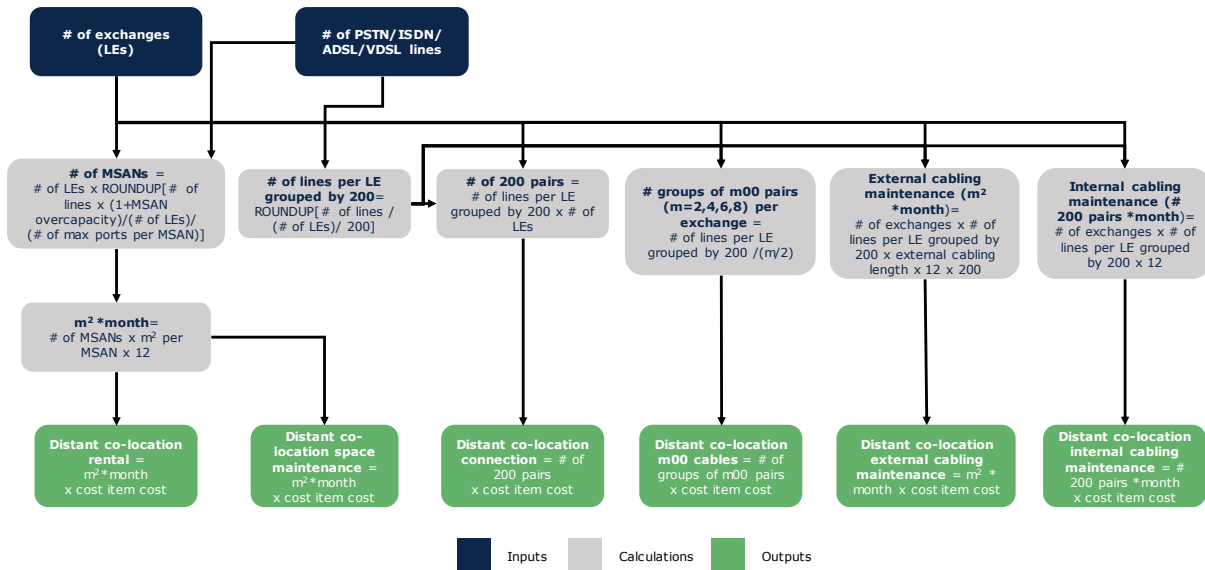**Exhibit 3.47: Illustrative representation of the dimensioning and costing algorithm of distant co-location [Source: Axon Consulting]**

WLR

The algorithm for the dimensioning and costing of the cost items that correspond to WLR access is depicted in Exhibit 3.48.
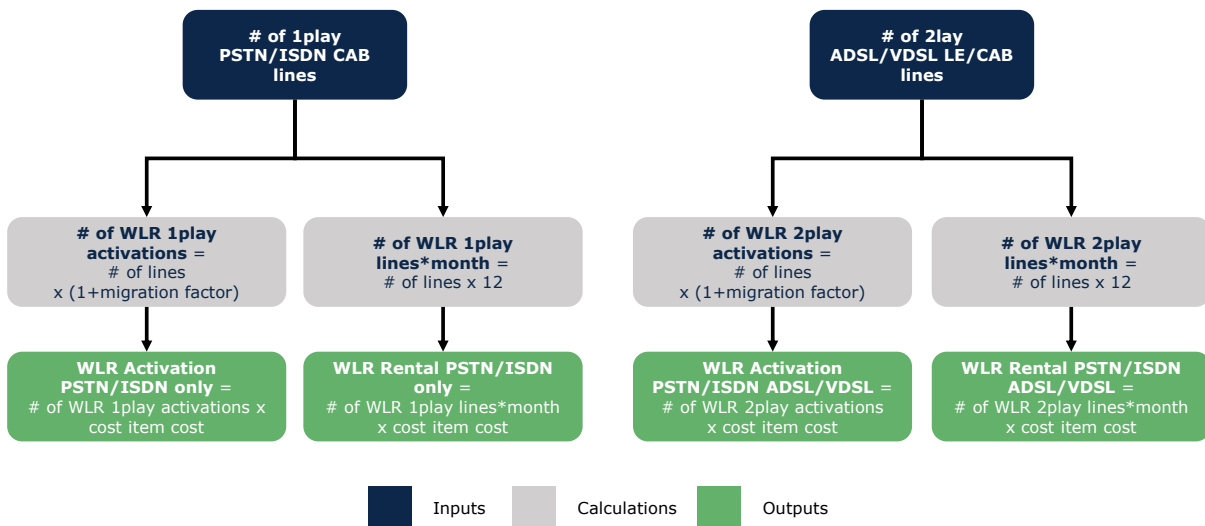
Exhibit 3.48: Illustrative representation of the dimensioning and costing algorithm of WLR access [Source: Axon Consulting]

VPU Light

The algorithm for the dimensioning and costing of the cost items that correspond to VPU Light access is depicted in Exhibit 3.49.

Exhibit 3.49: Illustrative representation of the dimensioning and costing algorithm of VPU Light access [Source: Axon Consulting]

FTTH

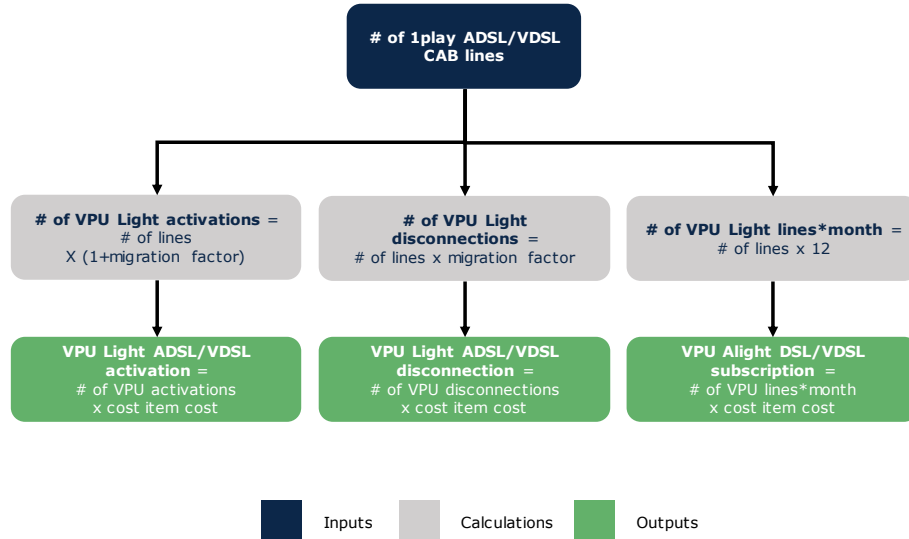The algorithm for the dimensioning and costing of the cost items that correspond to VPU FTTH access is depicted in Exhibit 3.50.
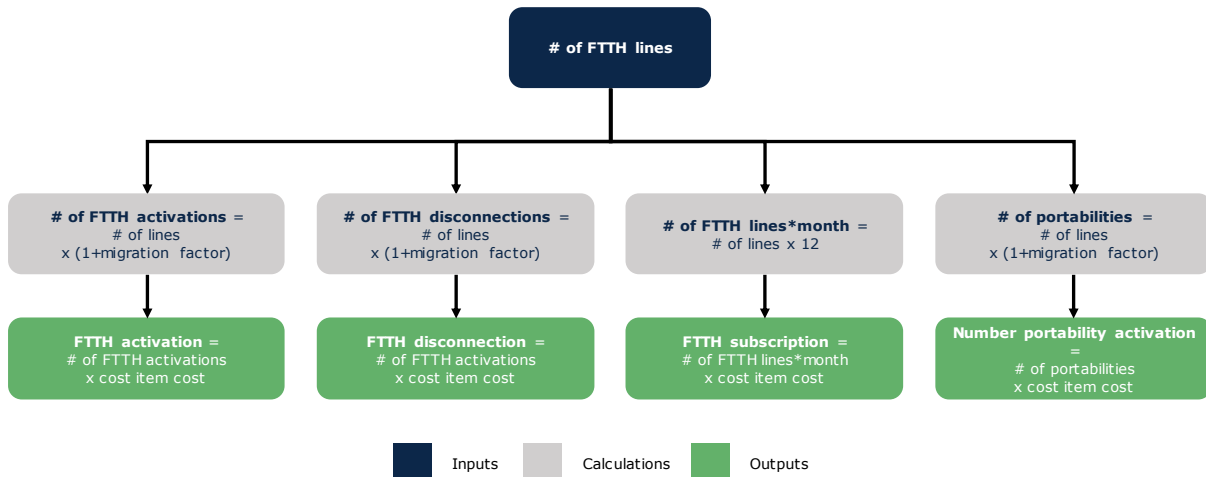

Exhibit 3.50: Illustrative representation of the dimensioning and costing algorithm of VPU FTTH access [Source: Axon Consulting]

Backhaul

The dimensioning and costing of the data transmission and backhaul is implemented in worksheet '4C CALC BACKHAUL'. In order to provide a better understanding of the process, the dimensioning and costing algorithms are provided in the following subsections.

BRAS bitstream

The BRAS or No Gamma bitstream solution refers to an xDSL connection (ARYS/VARYS BRAS CAB or LE in the corresponding wholesale product), which is provided by either an outdoor cabinet (i.e. the MSAN is located in the cabinet) or by an LE (i.e. the MSAN is located in the local exchange).

The algorithm for the dimensioning and costing of the cost items that correspond to BRAS bitstream is depicted in Exhibit 3.56.

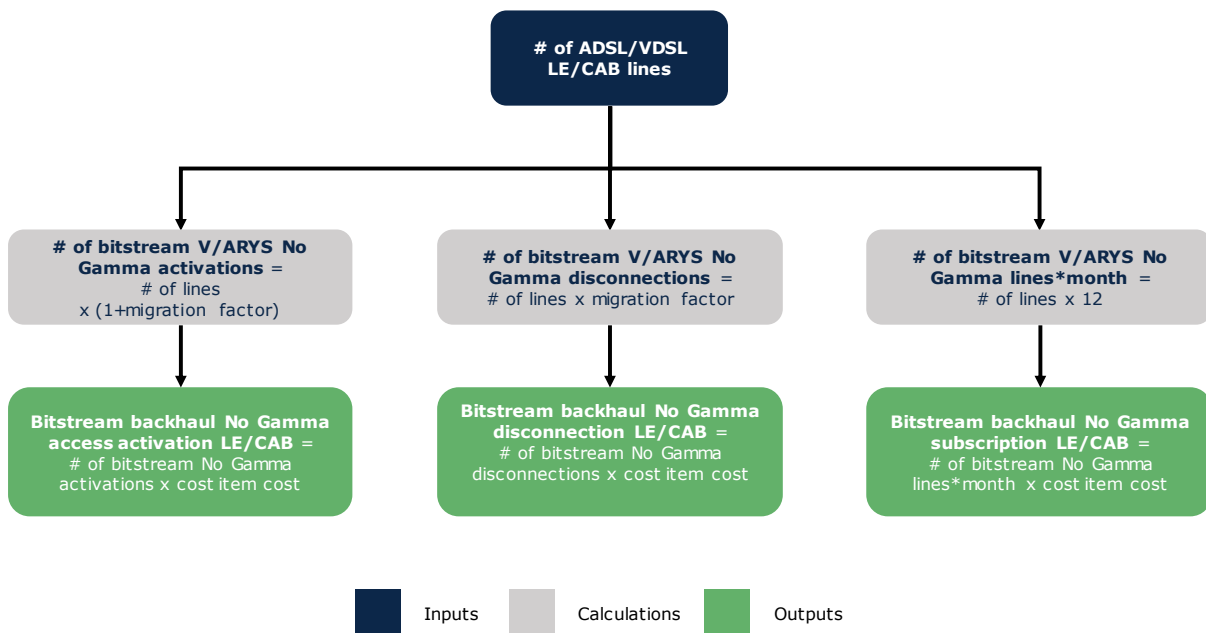**Exhibit 3.51: Illustrative representation of the dimensioning and costing algorithm of No Gamma bitstream [Source: Axon Consulting]**

OKSYA

The OKSYA DSLAM/BRAS services refer to the backhaul connection from an LE or a BRAS up to a PoP. As mentioned previously in section 3.1.4, the model determines the most cost-effective combination of wholesale products and own network solutions. Therefore,

for the backhaul connections the model dimensions and costs not only the backhaul connections for the OKSYA solutions, but also Ethernet as well as combinations of OKSYA with own network solutions. It should be noted that in order to determine the total cost of own network solution, the model sums the most cost-effective co-location solution out of the SYMEFS and OKSYA PRM options with the costs for own network fibre deployment. For ease of understanding, the possible backhaul configurations are illustrated in the following exhibit:
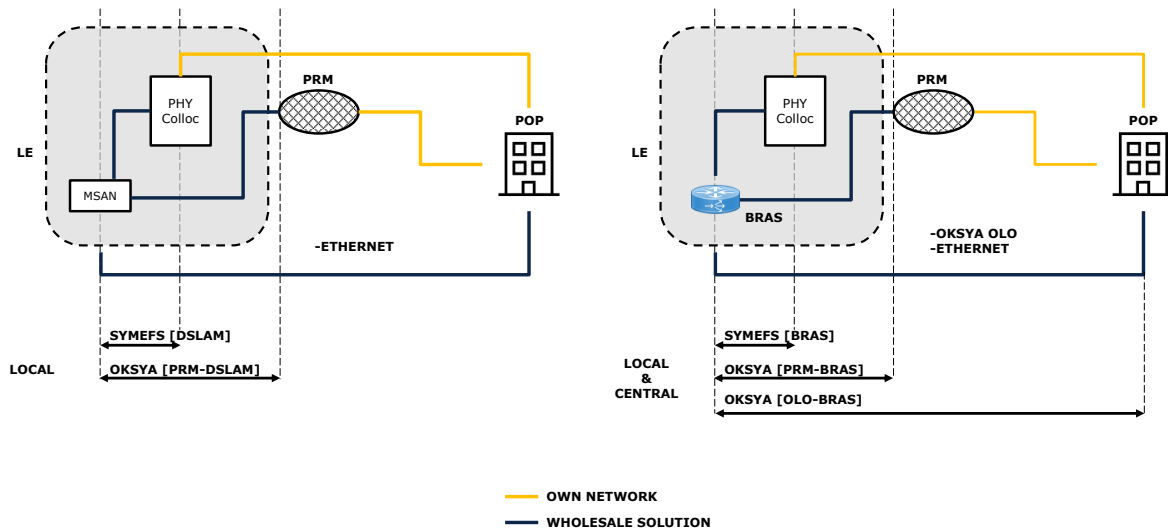
Exhibit 3.52: Illustrative representation of OSKYA-DSLAM and OKSYA–BRAS configurations [Source: Axon Consulting]

As it can be observed in Exhibit 3.52 above, the available backhaul options in the OKSYA scenarios are:

- OKSYA DSLAM

    - SYMEFS [DSLAM] combined with own network fibre deployment, whenever the physical collocation is available.
    - OKSYA [PRM-DSLAM] combined with own network fibre deployment, whenever the distant collocation is available.

- OKSYA BRAS

    - SYMEFS [BRAS] combined with own network fibre deployment, whenever the physical collocation is available.
    - OKSYA [PRM-BRAS] combined with own network fibre deployment, whenever the distant collocation is available.
    - OKSYA [OLO-BRAS], providing a full connection up to the PoP.

- Ethernet

For the combination of wholesale with own network solutions, the model first determines which of the SYMEFS or OKSYA PRM solution is the most-cost effective, and then sums it with the own network fibre deployment costs. Subsequently, this solution is compared with the optimal OKSYA OLO (if applicable) and the Ethernet solution to determine the most cost-effective of them.

Therefore, if the model determines that the most cost-effective solution is the own network solution (e.g. SYMEFS [BRAS] combined with own network fibre deployment) then the resulting configuration can be illustrated as in the following figure:
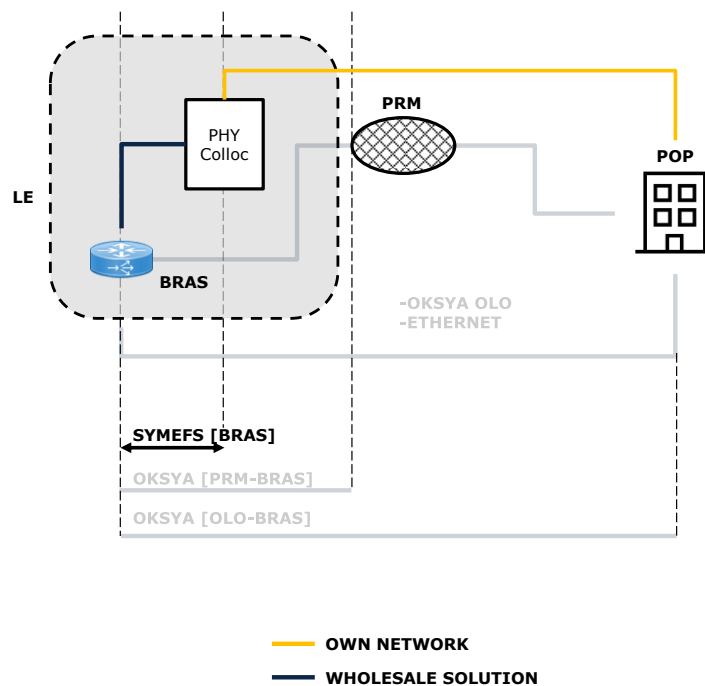
Exhibit 3.53: Illustrative representation of most cost-effective local transmission configuration (SYMEFS [BRAS] + own network example) [Source: Axon Consulting]

In order to explain in detail the dimensioning and costing algorithms for backhaul, we provide illustrative representations in the form of flowcharts.

OKSYA

The algorithm for the dimensioning and costing of the cost items that correspond to OKSYA OLO is depicted in Exhibit 3.54. It should be noted that this algorithm is common for the calculation of all the OKSYA OLO products for both Central and Local cases.
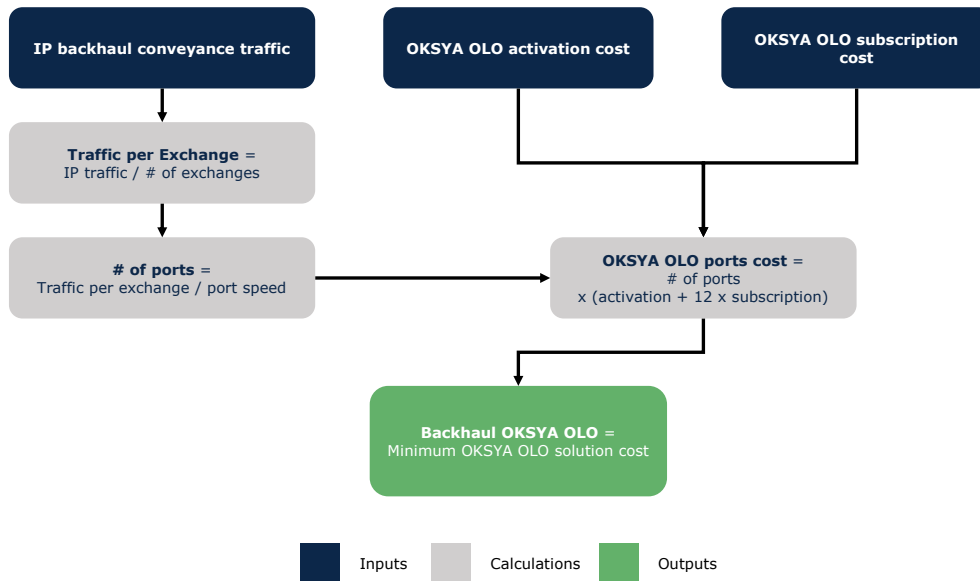
Exhibit 3.54: Illustrative representation of the dimensioning and costing algorithm of OKSYA OLO services[Source: Axon Consulting]

Own network

As explained previously, the own network solution consists of a wholesale physical or distant co-location solution (i.e. SYMEFS or OKSYA PRM respectively) and the own network fibre backhaul deployment. Particularly, for each geotype the model determines the availability of the colocation type (i.e. physical or distant) and then it determines the most cost-effective of the available options (SYMEFS solutions for physical co-location and OKSYA PRM solutions for distant co-location). The algorithm for the dimensioning and costing of the cost items that correspond to the co-location solutions is depicted in Exhibit 3.55.
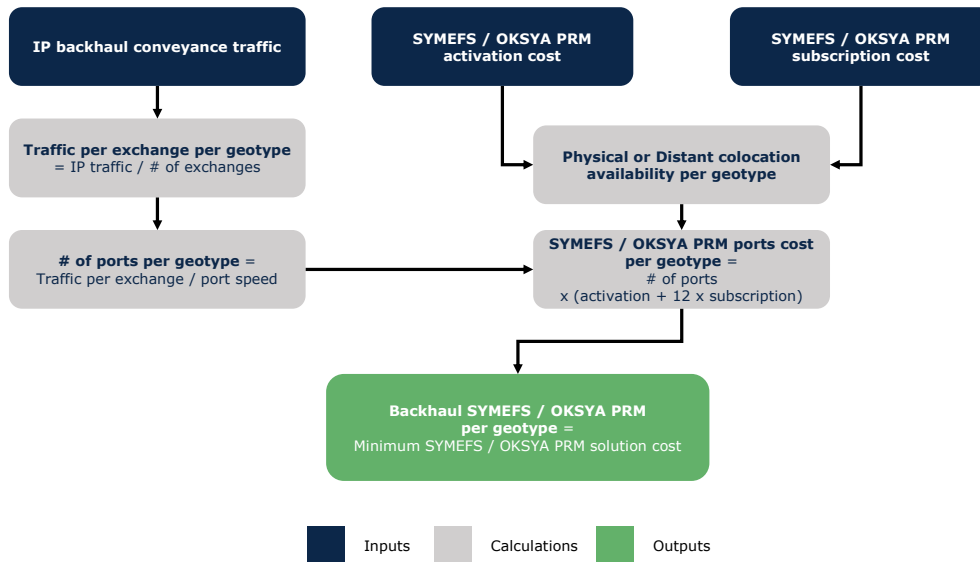
Exhibit 3.55: Illustrative representation of the dimensioning and costing algorithm of SYMEFS and OKSYA PRM services[Source: Axon Consulting]

Subsequently, the model calculates for each geotype the costs for own network fibre backhaul deployment, which are added to the previously calculated costs of the corresponding most cost-effective co-location solution. The algorithm for the dimensioning and costing of the cost items that correspond to own network backhaul solution is depicted in Exhibit 3.56.
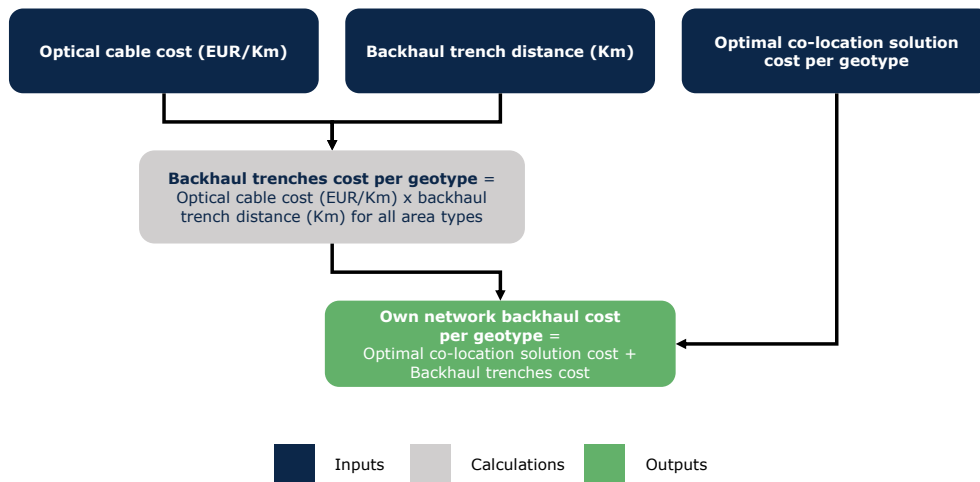
Exhibit 3.56: Illustrative representation of the dimensioning and costing algorithm of own network backhaul [Source: Axon Consulting]

Ethernet

The algorithm for the dimensioning and costing of the cost items that correspond to Ethernet backhaul is depicted in Exhibit 3.57.
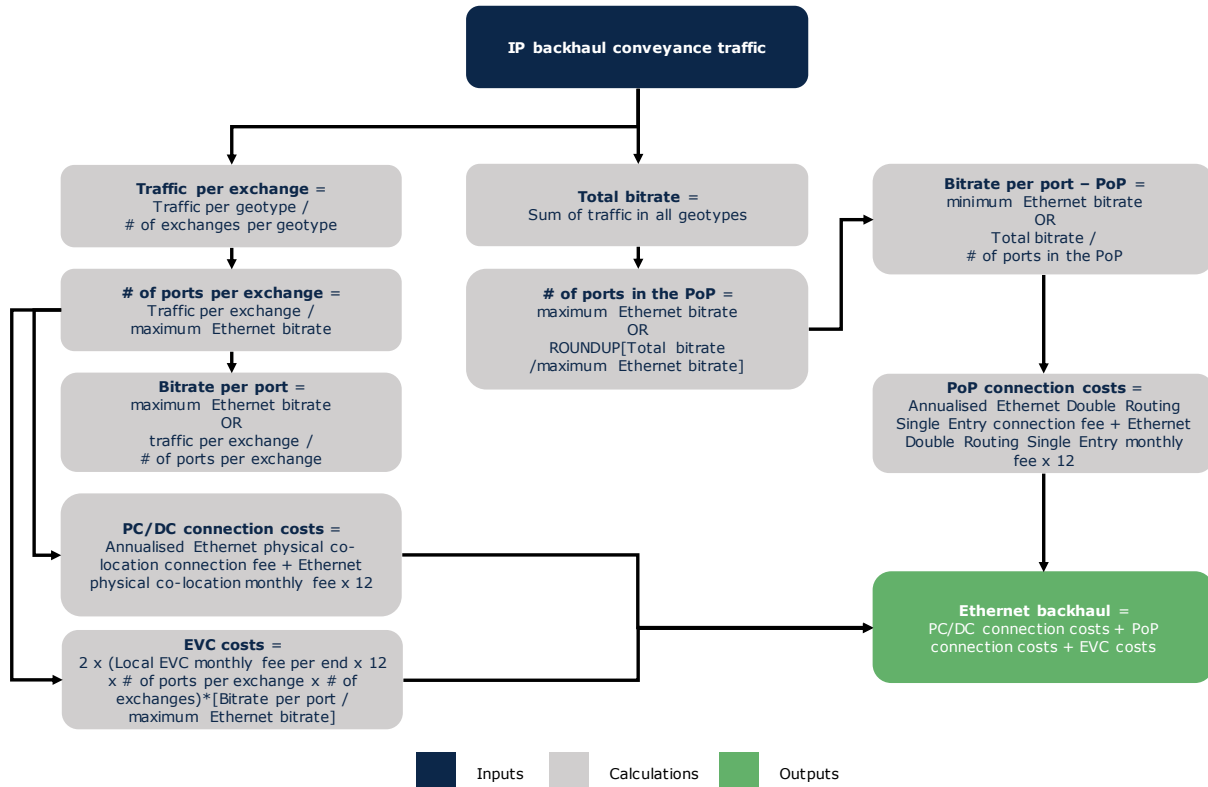
Exhibit 3.57: Illustrative representation of the dimensioning and costing algorithm of Ethernet backhaul [Source: Axon Consulting]

Interconnection

The costing of the voice related interconnection costs is implemented in worksheet '4D CALC INTERCONNECTION'. In order to explain the costing algorithm of interconnection, we provide an illustrative representation in the form of flowchart in Exhibit 3.58.

| Inputs | Calculations | Outputs |
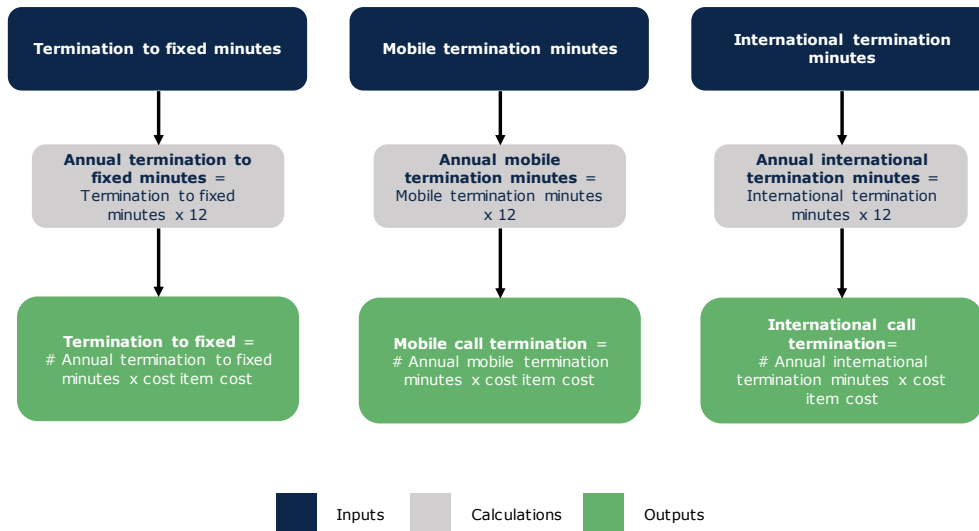
Exhibit 3.58: Illustrative representation of the costing algorithm of interconnection [Source: Axon Consulting]

3.5.3 Calculation of costs per scenario

The calculation of the cost items' costs per scenario (as defined in worksheet '0D PAR NW SCENARIOS', section 3.1.4) and geotype is implemented in worksheet '4E CONSOL SCEN COST'. The aim of this worksheet is to consolidate separately for all scenarios the cost items costs obtained in the previous worksheets, by geotype (horizontal axis) and cost item (vertical axis). In order to simplify the calculation process, the network scenarios parameterisation matrix from worksheet '0D PAR NW SCENARIOS' is replicated in this worksheet. The overall calculation logic is depicted in the following exhibit:
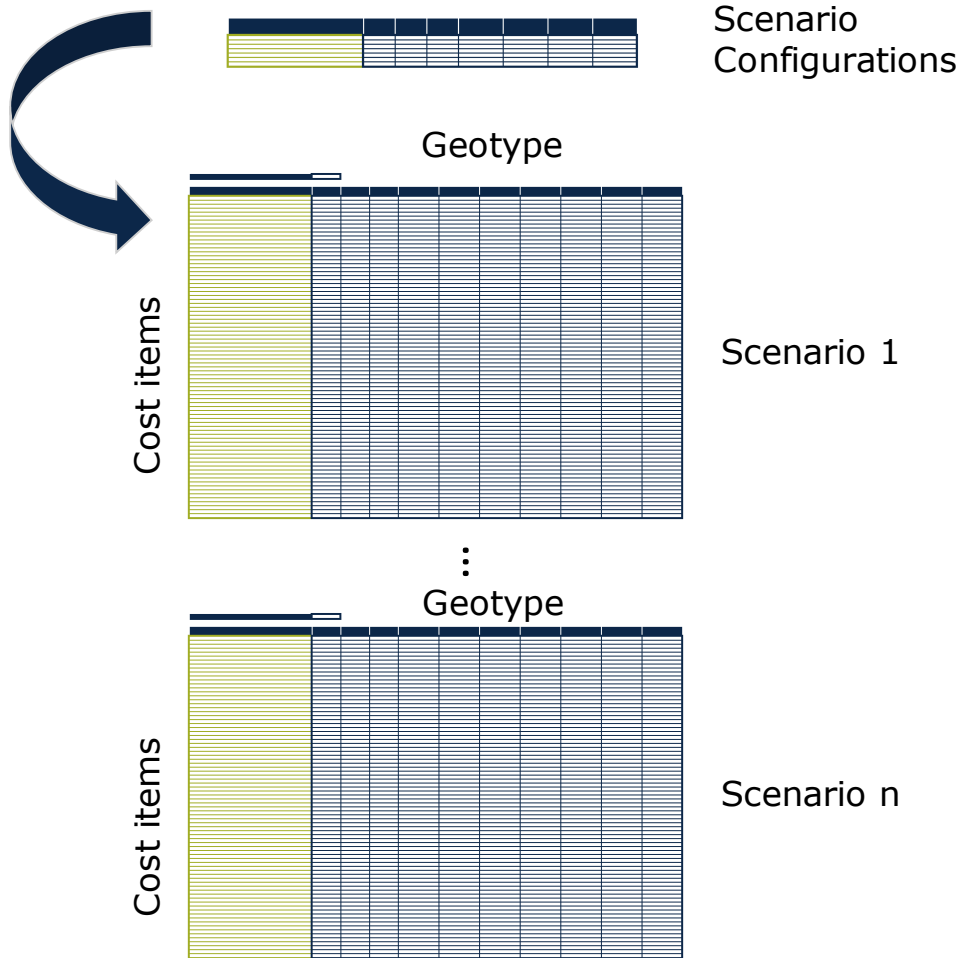
Exhibit 3.59: Consolidation of costs per scenario and cost item [Source: Axon Consulting]

This step is required to simplify the aggregation of the cost items obtained in the network dimensioning worksheets and further obtain the most cost-efficient scenario on the next steps.

3.5.4 Scenario selection

The identification of the most cost-effective (optimum) scenario is done in worksheet '4F CALC SCEN SELECTION'. Initially, the worksheet consolidates the total costs per scenario and geotype, as calculated in the previous worksheet. Subsequently, it identifies the availability of each scenario per geotype in the form of a binary matrix. Finally, a matrix with the total costs per available scenario is calculated, and the optimum scenarios for each geotype are selected.

Following the optimum scenario selection, this worksheet calculates the allocation factors of the network configurations per access type and geotype based on the applicable scenarios. This calculation is based on the access line type percentages calculated in worksheet '3D CALC INT SERV DEM GEO' (Section 3.4.4).

3.5.5 Non-geotype driven costs definition

The dimensioning and calculation of the own network and wholesale costs non-dependent on the geotype configuration are presented in worksheets '4G CALC OWN NW CORE', '4H CALC CORE LINKS' and '4I CONSOL CORE COSTS'. The details on dimensioning blocks are presented in the following paragraphs.

Own network core dimensioning and costing

The dimensioning and costing of the modelled operator's own network core costs are calculated in worksheet '4G CALC OWN NW CORE'. These own network core costs are divided in the international connectivity, the core platforms, and the centrex platforms. Their dimensioning and costing are described in the following subsections.

International connectivity

The cost of the international connectivity traffic is the result of the product of the unitary international connection cost per Mbps per traffic and per router and the corresponding internal services' traffic demand. Additionally, it considers the total cost of the routers for internet connectivity as the product of the router unit cost and the number of routers necessary to serve the above traffic.

In order to provide clearer indications in the dimensioning and costing algorithm of the internet connectivity cost items, we provide an illustrative representation in the form of a flowchart in Exhibit 3.60.

Exhibit 3.60: Illustrative representation of the dimensioning and costing algorithm of own network internet connectivity [Source: Axon Consulting]

Core platforms

The cost of the core platforms and common costs is calculated as the product of each of the own core network elements unit costs per internal service (as calculated in worksheet '4A MAT OWN NW COSTS IS', section 3.5.1) and the corresponding internal services total demand (worksheet '3C CAL INT SERV DEMAND', section 3.4.3).

In order to explain costing algorithm of the own core platforms and common costs, we provide an illustrative representation in the form of flowchart in Exhibit 3.61.

Exhibit 3.61: Illustrative representation of the dimensioning and costing algorithm of own network core platforms and common costs [Source: Axon Consulting]

Centrex platforms

The centrex platforms costs calculation is based on the internal services demand on such services, the centrex platforms' unit costs and the number of users per platform type. In order to explain the dimensioning and costing algorithm of the centrex platforms, we provide an illustrative representation in the form of flowchart in the exhibit below.

Exhibit 3.62: Illustrative representation of the dimensioning and costing algorithm of centrex platforms [Source: Axon Consulting]

Core links network

For the connection of the modelled operator's Points of Presence, the consideration of a country-wide backbone network is necessary. This backbone network can be developed based either on Ethernet leased lines or own optical fibre backbone network. The calculation of the costs of the two options is implemented in worksheet '4H CALC CORE LINKS' and described in the following.

Ethernet leased lines

The Ethernet leased lines costs' calculation is based on the voice and broadband backhaul conveyance traffic, the available Ethernet EVC bitrate options, the backbone link distances and the connection fees. In order to explain the dimensioning and costing algorithm of the Ethernet leased lines for backbone links, we provide an illustrative representation in the form of flowchart in Exhibit 3.63.
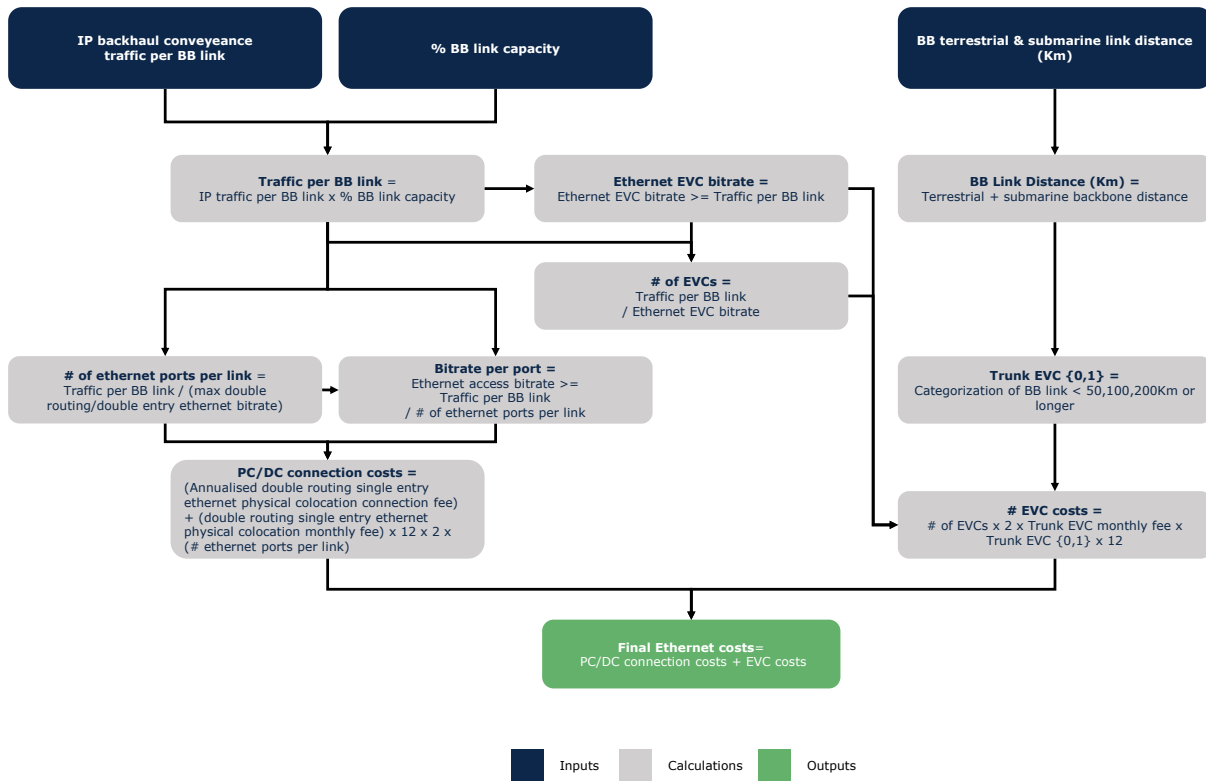
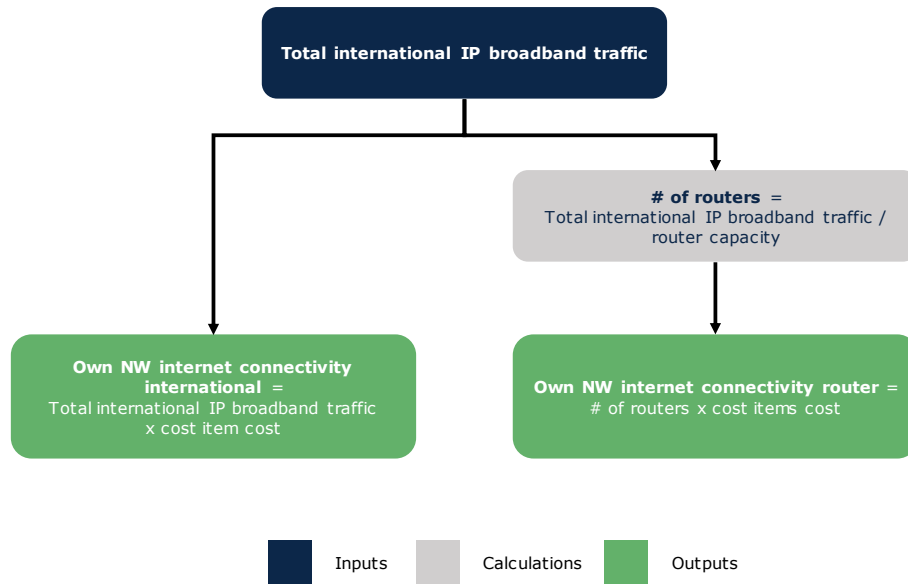**Exhibit 3.63: Illustrative representation of the dimensioning and costing algorithm of own core Ethernet leased lines costs [Source: Axon Consulting]**

Own optical fibre backbone

The own optical fibre backone link costs' calculation is based on the backbone terrestrial and link distance, the corresponding optical cable cost and its maintenance, depending on its nature. In order to explain in detail the dimensioning and costing algorithm of the own optical fibre backbone links, we provide an illustrative representation in the form of flowchart in Exhibit 3.64.
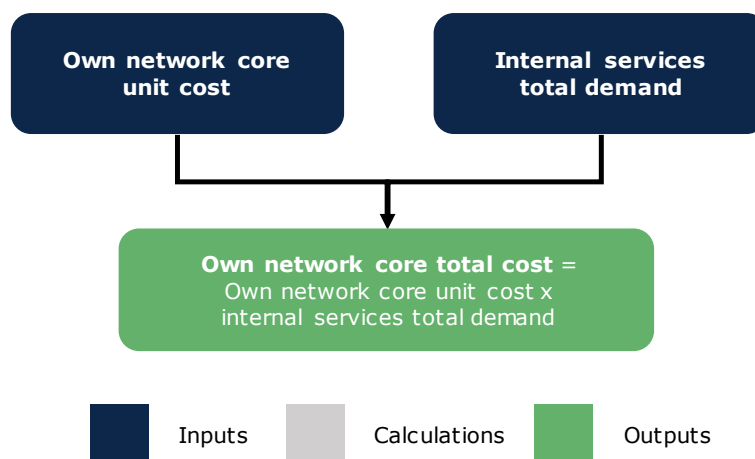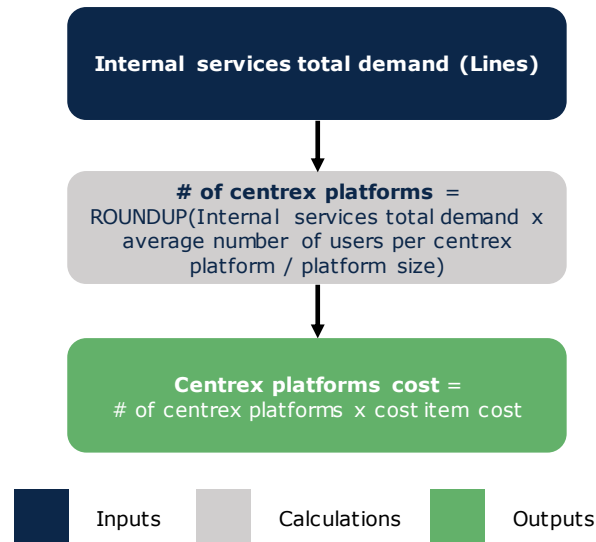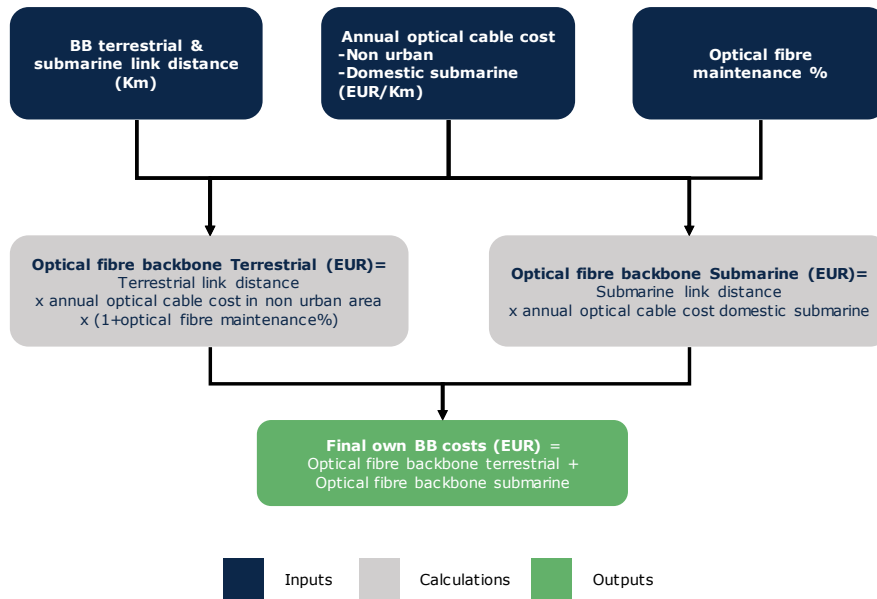
Exhibit 3.64: Illustrative representation of the dimensioning and costing algorithm of own backbone costs [Source: Axon Consulting]

Following the calculation of both backbone options, the model determines which option is the most cost effective per link in order to be considered for the corresponding own core network cost item cost of the modelled operator.

3.5.6 Consolidation of core network costs

The consolidation of the core network costs of the modelled operator is performed in worksheet '4I CONSOL CORE COSTS'. Particularly, own network core costs are summed with the core link costs calculated in worksheets '4G CALC OWN NW CORE' and '4H CALC CORE LINKS' respectively.

3.5.7 Consolidation of network costs

The consolidation of the cost items' costs for each geotype and optimum scenario is implemented in worksheet '4J CONSOL NW AND WH COSTS', considering then the non-geotype dependent costs calculated in worksheet '4I CONSOL CORE COSTS'. Particularly, this worksheet defines a table that aggregates the cost items' costs calculated in the previous worksheets.

3.6. Block 5 – Allocation of network and wholesale costs to internal services

3.6.1 Mapping from cost items to internal services

The relationships between cost items and internal services are defined in worksheet '5A MAP CI2IS'. This worksheet follows an approach similar to the one in worksheet '3A MAP ES2IS' for the definition of relationships between external and internal services (section 3.4.1). Thus, to define these relationships, all pairs with a relation (one cost item and one internal service) are input with their relationship factor in the table 'LIST OF COST ITEMS AND INTERNAL SERVICES RELATIONSHIPS'.

Particularly, the relationship factor is in fact the ratio of each internal service used to provide a specific cost item. That is, the sum of the ratios of an internal services group that provides a cost item equals to one (1). The calculation of the ratios is based on the following parameters:

▶ **Allocation factor:** Refers to the allocation factors calculated in worksheet '4F CALC SCEN SELECTION' (section 3.5.4) or allocation factors based on the cost usage of certain elements (for instance, the core network platforms).

▶ **Driver units:** It is the product of the allocation factor and the total demand of the corresponding internal service, found in worksheet '3C CALC INT SERV DEMAND' (section 3.4.3) .

Then, the ratio is calculated for each group of internal services per cost item. A snapshot of this worksheet is shown in the following exhibit:

LIST OF COST ITEMS AND INTERNAL SERVICES RELATIONSHIPS
This table calculates the ratio of internal services for each cost item

Cost item	Internal Service	Driver	Allocation Factor (Needed if different from 1 only)	Driver units	Ratio	X	Y
CI.Wholesale.FTTH.Activation FTTH 30 Mbps	FTTH.FTTH Access 30 Mbps	Customers/Lines		177	1,00	78	52
CI.Wholesale.FTTH.Activation FTTH 50 Mbps	FTTH.FTTH Access 50 Mbps	Customers/Lines		47	1,00	79	53
CI.Wholesale.FTTH.Activation FTTH 100 Mbps	FTTH.FTTH Access 100 Mbps	Customers/Lines		116	1,00	80	54
CI.Wholesale.FTTH.Activation FTTH 200 Mbps	FTTH.FTTH Access 200 Mbps	Customers/Lines		460	1,00	81	55
CI.Wholesale.FTTH.Activation FTTH 300 Mbps	FTTH.FTTH Access 300 Mbps	Customers/Lines		0	1,00	82	56
CI.Wholesale.FTTH.Activation FTTH 500 Mbps	FTTH.FTTH Access 500 Mbps	Customers/Lines		0	1,00	83	57
CI.Wholesale.FTTH.Activation FTTH 1000 Mbps	FTTH.FTTH Access 1000 Mbps	Customers/Lines		0	1,00	84	58

Exhibit 3.65: Excerpt of the 'LIST OF COST ITEMS AND INTERNAL SERVICES RELATIONSHIPS' table [Source: Axon Consulting]

3.6.2 Cost items - internal services relationship

The transformation of the 'LIST OF COST ITEMS AND INTERNAL SERVICES RELATIONSHIPS' table (worksheet '5A MAP CI2IS', section 3.6.1) to a matrix is done in

worksheet '5B MAT CI2IS'. Particularly, the relationships can be observed by cost item (vertical axis) and internal service (horizontal axis). This mapping is possible by using the function defined in Visual Basic as 'array2mat' and described in detail in section 3.4.2.

3.6.3 Allocation of cost items to internal services

The allocation of the network and wholesale cost item costs to internal services is implemented in worksheet '5C CALC IS NW AND WH COSTS'. This allocation has been done by using the following formula:

$$MAT\_CI2IS = MAP\_CI2IS \cdot TC\_IS$$

Where:

▶ MAT_CI2IS is the matrix for the allocation of network and wholesale cost item costs to internal services,

▶ MAP_CI2IS is mapping matrix from cost items to internal services acquired in the previous worksheet,

▶ TC_IS is the vector of the corresponding total costs of each cost item calculated in worksheet '4J CONSOL NW AND WH COSTS' (section 3.5.7).

3.7. Block 6 – Calculation of retail and G&A costs

3.7.1 Retail costs calculations

The costs calculation at external service level is conducted in worksheet '6A CALC ES RET COSTS'. This cost has been obtained by using the following formula:

$$RET_{COSTS} = (RET_{OPEX} + RET_{CAPEX} * WACC) * (1 + MARKUP)$$

Where:

▶ RET_{COSTS} is the matrix of the retail costs of the external services per cost item costs at external service level,

▶ RET_{OPEX} are the unitary OPEX retail costs defined in worksheet '1F INP RET COSTS',

▶ RET_{CAPEX} are the unitary CAPEX retail costs defined in worksheet '1F INP RET COSTS',

▶ $WACC$ is the reference operator's weighted average cost of capital in worksheet '1B INP MARKET',

▶ $MARKUP$ is the mark-up used on retail costs to reflect the operator's scale in worksheet '1B INP MARKET'.

3.7.2 Calculation of G&A and tariff specific retail costs

The calculation of the costs of the gifts and discounts, the general and administration (G&A) overheads as well as other additional costs of the retail tariffs is done in worksheet '6B CALC TARIFF GA & SPECIF COST'. The G&A overhead cost item cost has been calculated according to the following formula:

$$G\&A_{COST} = 12 * REV_{MONTHLY} * G\&A_{MARKUP} * (1 + G\&A_{RO_{MARKUP}})$$

Where:

▶ $G\&A_{COST}$ is the vector of G&A costs per retail tariff,

▶ $REV_{MONTHLY}$ are the monthly revenues per user per retail tariff in worksheet '2C CALC RET REVENUES' (section 3.3.3),

▶ $G\&A_{MARKUP}$ is the G&A costs mark-up over retail revenues in worksheet '1F INP RET COSTS',

▶ $G\&A_{RO_{MARKUP}}$ is the mark-up for the G&A costs applied to the reference operator in worksheet '1B INP MARKET'.

The cost item cost of the additional costs is calculated by annualising any monthly additional costs (i.e. $ADD_{COSTS} \cdot 12$) input in worksheet '1A INP RET TARIFFS'. As for the gifts and discounts cost item, it is calculated according to the following formula:

$$G\&D.ACC = MONTHS_{DISCOUNT} * DISCOUNT_{MONTHLY} + GIFT$$

Where:

▶ $G\&D.ACC$ refers to the gifts and discounts of each retail tariff,

▶ $MONTHS_{DISCOUNT}$ is the number of months that a retail tariff is offered with a discount in worksheet '1A INP RET TARIFFS',

▶ $DISCOUNT_{MONTHLY}$ is the monthly discount of a retail tariff in worksheet '1A INP RET TARIFFS',

▶ $GIFT$ is the one-off gift of a retail tariff in worksheet '1A INP RET TARIFFS'.

Subsequently, the model rearranges the tariff specific retail costs calculated previously by creating a normalised table with all the cost items (vertical axis) and the corresponding retail costs per retail tariff (horizontal axis).

3.8. Block 7 – Calculation of unitary costs per retail tariffs

3.8.1 Matrix from cost items to external services

The calculation of the total and unitary cost item costs per external service is done in worksheet '7A CALC ES NW AND WH COSTS'. Specifically, this worksheet produces two matrices with the total and unit cost for each cost item (vertical axis) used by the external services (horizontal axis). The total costs matrix has been calculated by using the following formula:

$$TC\_CI2ES = MAT\_CI2IS \cdot \frac{D\_IS}{TD\_IS}$$

Where:

▶ TC_CI2ES is the matrix of the total cost items costs per external service,

▶ MAT_CI2IS is the matrix for the allocation of network and wholesale cost item costs to internal services calculated in worksheet '5C CALC IS NW AND WH COSTS' (section 3.6.3),

▶ D_IS is the matrix of the demand per external service for internal service in worksheet '3C CAL INT SERV DEMAND' (section 3.4.3),

▶ TD_IS is the vector of the total demand per external service for internal service in worksheet '3C CAL INT SERV DEMAND' (section 3.4.3).

Subsequently, the model calculates the unitary cost item costs per external service, using the following formula:

$$UC\_CI2ES = \frac{TC\_CI2ES}{D\_ES} + RET\_COSTS$$

Where:

▶ UC_CI2ES is the matric of the unitary cost items costs per external service,

▶ TC_CI2ES is the matrix of the total cost items costs per external service,

▶ D_ES is the vector of the modelled operator's demand per external service in worksheet '1B INP MARKET',

▶ RET_COSTS is the matrix of the retail costs of the external services per cost item costs at external service level in worksheet '6A CALC ES RET COSTS' (section 3.7.1).

3.8.2 Consolidation of costs into retail tariffs

The consolidation of the unitary own network, wholesale, G&A and retail costs per retail tariff is implemented in worksheet '7B CONSOL RT UNIT COSTS'. Particularly, this worksheet creates a matrix with cost items' (horizontal axis) unitary costs for each retail tariff (vertical axis), by using the following the formula:

$$UC\_RT = UC\_CI2ES \cdot TOT_{CONSUMPTION} + RT_{SPEF}$$

Where:

▶ UC_RT is the matrix of the cost items unitary costs by retail tariff,

▶ UC_CI2ES is the matrix of the unitary cost items costs per external service in worksheet '7A MAT CI2ET' (section 3.8.1),

▶ $TOT_{CONSUMPTION}$ is the matrix of total access and voice consumption per external service per each retail tariff in worksheet '2A CALC EXT SERV DEMAND' (section 3.3.1).

▶ RT_{SPEF} is the matrix of the G&A and tariff specific retail costs per retail tariff in worksheet '6B CALC TARIFF GA & SPECIF COST' (section 3.7.2).

3.9. Block 8 – Annualisation of customer-dependent one-off costs

3.9.1 Cost annualisation

The calculation of the retail tariffs' customer-driven cost items monthly costs is implemented in worksheet '8A CALC COST ANNUALISATION'. For this calculation, the monthly cost is calculated by using the following formula:

$$MC\_RT = \begin{cases} \dfrac{\dfrac{PMT(WACC,CL,UC\_RT)}{12}}{} , if\ customer\ life\ applies \\ \dfrac{UC\_RT}{12} \quad , otherwise \end{cases}$$

Where:

▶ MC_RT is the matrix of each cost item's monthly cost (after annualization) by retail tariff,

▶ PMT is the formula that calculates the value based on constant payments and a constant interest rate.

▶ $WACC$ represents the weighted average cost of capital in worksheet '1B INP MARKET',

▶ CL is the vector of effective customer average life per retail tariff calculated in worksheet '2B CALC CUSTOMER LIFE' (section 3.3.2),

▶ UC_RT is the cost before the annualisation, particularly the matrix that aggregates the costs of all the cost items by retail tariff in worksheet '7B CONSOL RT UNIT COSTS' (section 3.8.2).

3.10. Block 9 - Results

3.10.1   Summary of outputs per retail tariff

The main output of the price squeeze model is presented in worksheet '9A OUT RT'. This worksheet displays revenues, costs and margins by retail tariff in the following blocks:

▶ **Yearly values:** this block represents the total yearly revenues, costs and margins. Additionally, it shows if the retail tariff passes or not the test, the number of customers and the margin percentages. A snapshot of this block is shown in the exhibit below:

MARGIN SQUEEZE TEST

		Tariff A	Tariff B	Tariff C
Tariff category		FTTH	VDSL	VDSL
Revenues	EUR/user/month	50,77	42,83	47,12
Costs	EUR/user/month	25,77	37,74	51,08
Margin	EUR/user/month	25,00	5,09	-3,96
Pass?		Yes	Yes	No
				1
% margin on revenue	%	49,24%	11,87%	-8,41%
% margin with only Direct costs	%	58,86%	37,28%	35,46%

Exhibit 3.66: Excerpt from the main annual output table [Source: Axon Consulting]

▶ **Summary of monthly revenues and costs per customer:** this block represents a summary of monthly revenues, costs and margins (including margins considering only direct costs). The costs have been split by category (i.e. retail, wholesale, own network, G&A and others) and differentiated by direct or indirect and common and joint costs. A part of this block is presented in the following exhibit:

SUMMARY OF THE MONTHLY REVENUES AND COSTS PER CUSTOMER

This table calculates a summarised version the per customer monthly revenues and costs for each Retail Tariff

Category	Unit			
Revenues	EUR/customer/month	**50,77**	**42,83**	**47,12**
Costs	EUR/customer/month	**25,77**	**37,74**	**51,08**
Retail	EUR/customer/month	**3,57**	**7,06**	**6,88**
Direct	EUR/customer/month	3,57	7,06	6,88
Indirect, Common & Joint Costs	EUR/customer/month	-	-	-
Wholesale	EUR/customer/month	**13,57**	**17,32**	**22,09**
Direct	EUR/customer/month	12,97	16,13	19,49
Indirect, Common & Joint Costs	EUR/customer/month	0,61	1,19	2,60
Own network	EUR/customer/month	**4,28**	**9,69**	**18,07**
Direct	EUR/customer/month	-	-	-
Indirect, Common & Joint Costs	EUR/customer/month	4,28	9,69	18,07
G&A	EUR/customer/month	**4,35**	**3,67**	**4,04**
Direct	EUR/customer/month	-	-	-
Indirect, Common & Joint Costs	EUR/customer/month	4,35	3,67	4,04
Others	EUR/customer/month	**-**	**-**	**-**
Direct	EUR/customer/month	-	-	-
Indirect, Common & Joint Costs	EUR/customer/month	-	-	-
Margin	EUR/customer/month	**29,35**	**8,75**	**0,08**
Margin with only Direct costs	EUR/customer/month	**34,24**	**19,64**	**20,75**

Exhibit 3.67: Extract from the summary of the monthly revenues and costs per customer output [Source: Axon Consulting]

► **Disaggregated monthly revenues and costs per customer:** In this part, the monthly revenues and costs per customer have been disaggregated to the subcategory level. The following exhibit shows an example of this block:

DETAILED MONTHLY REVENUES AND COSTS PER CUSTOMER

This table calculates a detailed version the per customer monthly revenues and costs for each Retail Tariff

Category	Unit			
REVENUES	EUR/customer/month	**50,77**	**42,83**	**47,12**
COSTS	EUR/customer/month	**25,77**	**37,74**	**51,08**
WHOLESALE COSTS	EUR/customer/month	**13,57**	**17,32**	**22,09**
Narrowband traffic-dependent	EUR/customer/month	**0,30**	**0,29**	**0,07**
Fixed call termination	EUR/customer/month	0,07	0,08	-
Mobile call termination	EUR/customer/month	0,08	0,11	0,03
International call termination	EUR/customer/month	0,14	0,10	0,04

Exhibit 3.68: Illustrative extract from the disaggregated output [Source: Axon Consulting]

3.10.2   Detailed data per retail tariff

The outputs for a single tariff are presented in worksheet '9B OUT RT DETAILED'. Particularly, this worksheet provides the same results as in worksheet '9A OUT RT', however allowing the user to view a single retail tariff at a time. A snapshot of this worksheet is shown in the following exhibit:

Retail tariff selection
Tariff B

selected.retail.tariff

MARGIN SQUEEZE TEST

		Tariff B
Revenues	EUR/user/month	42,83
Costs	EUR/user/month	37,74
Margin	EUR/user/month	5,09
Pass?		Yes
% margin on revenue	%	11,87%
% margin with only Direct costs	%	45,85%

Exhibit 3.69: Illustrative excerpt of the detailed data output for a single retail tariff in worksheet '9B OUT RT DETAILED' [Source: Axon Consulting