

Report for BIPT

BIPT's NGN/NGA model

Model version v1.0 documentation for industry players

23 December 2011

Ref: 17915-516



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Context and objectives

- Analysys Mason Limited ('Analysys Mason') has been commissioned to assist BIPT in developing and implementing a long-run incremental cost (LRIC) model for next-generation fixed networks in Belgium
- The objectives of the project are to develop a **bottom-up** cost model of a **next-generation core and access (fixed) network** to calculate the unit costs of the services provided on the network. The results of the model will be used to:
 - develop **business plans** of generic Internet service providers (ISPs) to **ensure the economic viability** of wholesale tariffs
 - determine appropriate tariffs for regulated fixed wholesale services (BRUO, BRIO, BROBA, etc.)
- This document is the technical model documentation accompanying the draft models and presents how the models work
- It should be read in conjunction with:
 - the industry presentation 'Draft NGN/NGA models' dated 13 December 2011 (ref. 17915-454), which describes notably modelling principles, next steps and issues for consultation
 - the model content list 'Bottom-up fixed network cost model for BIPT: list of model components – public version', dated 13 December 2011 (ref. 17915-454)
 - the draft model consultation document, presented in English, French and Dutch versions, dated 13 December 2011 (ref: 17915-454)

Introduction

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Service costing modules

Glossary

The model reflects an NGN/NGA operator with the same scale as Belgacom

- The fixed long-run incremental cost (LRIC) model reflects a next-generation network (NGN)/next-generation access (NGA) operator with the same scale as Belgacom
- The legacy voice, broadband and transmission platforms are not modelled:
 - the corresponding services are replaced by NGN/NGA equivalents
- In the NGN, voice is carried over Ethernet/IP, using dense wavelength division multiplexing (DWDM) transmission:
 - all services share the converged transmission resources
 - access gateways (AGW) provide time division multiplexing (TDM) to voice over Internet protocol (VoIP) conversion within the street cabinet or within the exchange
- Fibre to the cabinet (FTTC) deployments place active equipment (initially xDSL and later voice TDM-VoIP gateways) at the street cabinet
- The model consists of four separate 'online' network modules, presented in the following Excel files:
 - *Module 0 – Market.xls*
 - *Modules 1+2+3+4+6 – Core.xls*
 - *Modules 5+7 – Access.xls*
 - *Modules 20+21+22+23 – Service costing.xls*
- In addition, these modules use a number of inputs from 'offline' modules, which cannot be shared publicly or with the industry:
 - *Modules starting with 'Module 8 –', dealing with colocation services.xls*
 - *Module 9 – SNA.xls*
 - *Module 9 – Updated OneTimeFees BIPT NGA.xls*
 - *Modules 15+16+17 HMC IT OH.xls*
 - geographical analysis files (lines, clusters)
- In the service costing module, two costing approaches have been implemented for network services:
 - long-run average incremental cost (LRAIC+)
 - pure LRIC for voice termination

Instructions on how to install and run the model

- In order to run the model:
 - ensure that all network-related Excel files (*Module 0 – Market.xls*, *Modules 1+2+3+4+6 – Core.xls*, *Modules 5+7 – Access.xls* and *Modules 20+21+22+23 – Service costing.xls*) are saved in the same directory to preserve the inter-workbook links
 - open all four workbooks (in no particular order)
 - when prompted to update the linked information, choose ‘No’
 - when asked whether or not to enable any macros, click the ‘Enable macros’ box
 - check that all four workbooks are linked (using Edit → Links menu)
 - the model should be used in ‘manual’ calculation mode
- To run the model under the various costing approaches, the macro must be used:
 - click the ‘Run pure LRIC and LRAIC+’ macro button to run the model
 - the results of the model calculations can be viewed on the ‘Services needed’ worksheet of the *Modules 20+21+22+23 - Service costing.xls* workbook

All worksheets use a consistent cell format throughout all four workbooks

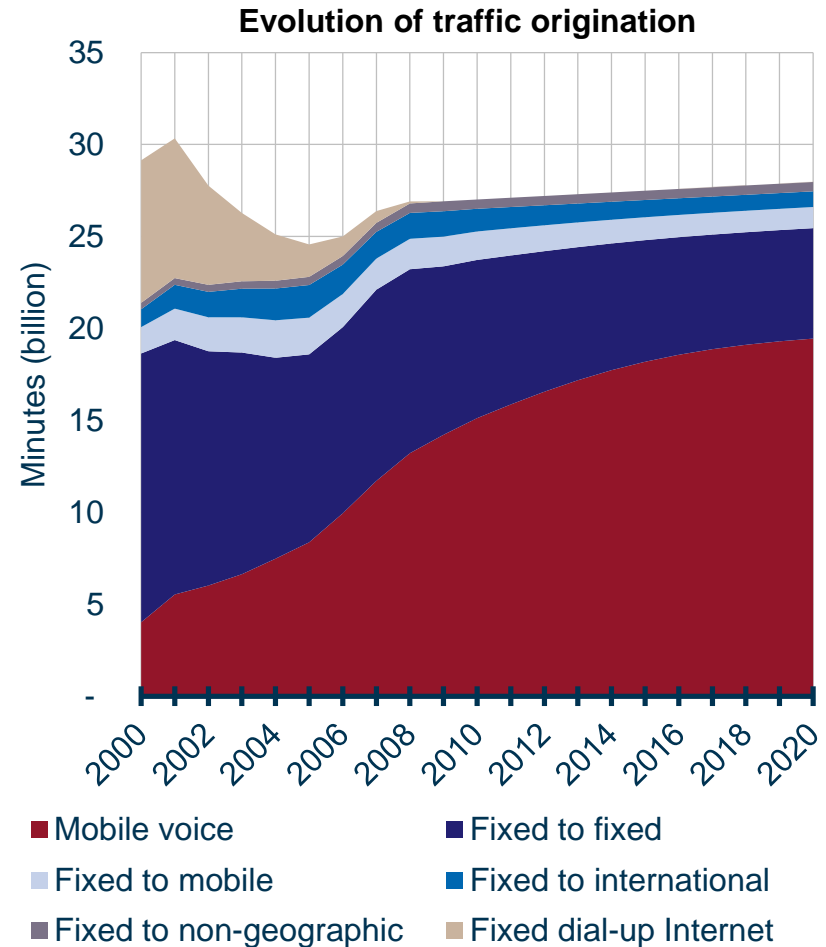
- This is to increase the transparency of the model, as well as making it easier to understand and modify
- A number of standardised cell formats are used to distinguish inputs, assumptions, calculations and links. The most important conventions are shown below

Cell type	Cell style	Notes
Input Parameter	100	An input to the model that it is expected the user will change (change at will)
Input Data	100	A piece of real data (only change if you have better data)
Input Estimate	100	An estimate used in the absence of real data (only change if you have a better estimate, or real data)
Input Calculation	100	An input to the model that has, none the less, been calculated from other inputs (e.g. interpolated input values)
Input Link	100	An input to this part of the model, which is linked to a source on this or another worksheet within this workbook
Input Link (different Workbook)	100	An input to this part of the model, which is linked to a source on a worksheet in a different workbook
Calculation	100	A calculation of the model
Total	123	A total (use if not part of a "Sub-total row" or a "Total row" in a table - see below)
Checksum	0.00	Aside calculation intended solely to cross check a result (and which therefore should not be referenced anywhere else in the model)
Output	100	A key result from this part of the model (in particular one that will be used elsewhere in the model)
Named range	<i>Name</i>	An Excel Name applying to one or more adjacent cells (use <u>I</u> nser <u>t</u> <u>N</u> ame <u>C</u> reate to actually create the Excel Names)
Note	Note	A note (NB smaller than standard font size)
Anonymised Input	100	A rounded value used to protect the confidentiality of real data

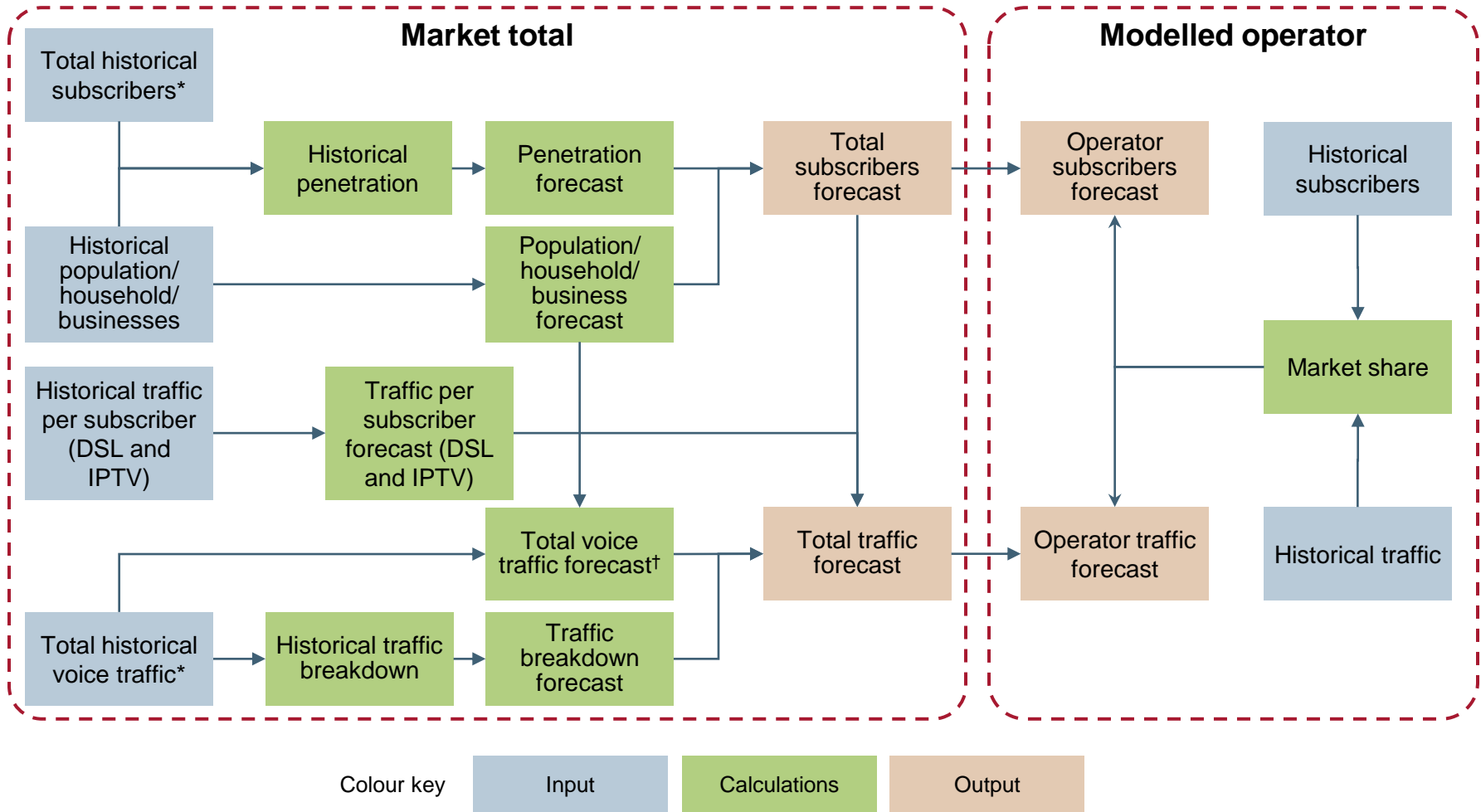
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The market module calculates market demand for both fixed and mobile services

- In the Belgian market:
 - traffic on fixed networks is declining
 - traffic on mobile networks is increasing
 - dial-up has disappeared almost completely
- Market demand for both fixed and mobile services is modelled based on data provided by BIPT's Market Statistics and (confidential) information provided by operators in response to the data request:
 - the data supplied by the operators is used to check the validity of the public information and provide other 'average' parameters
- The number of fixed subscribers in the market is calculated using a projection of future population, household and business penetration
- The number of mobile subscribers used in the NGN-NGA model is the same as in BIPT's latest mobile LRIC model
- The forecast traffic demand is determined by a projection of total voice origination, based on a long-term growth driven by population growth assumptions



High-level flow of calculations in the market module



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The market module generates a series of forecasts at the market level

Fixed connections

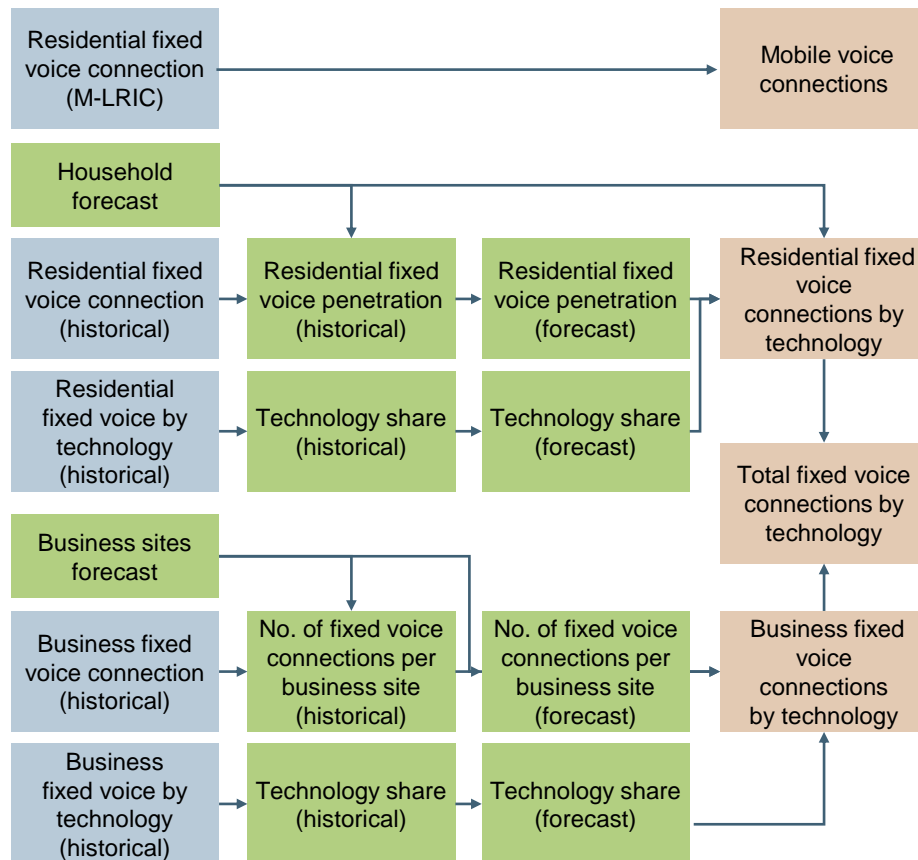
- Voice connections:
 - by residential and business
 - by technology (PSTN, cable, ISDN-2, ISDN-30 and voice over broadband)
- Broadband connections:
 - by residential and business
 - by technology (xDSL, fixed wireless access, cable and fibre)
- Business connectivity services:
 - leased lines – analogue, digital (by speed)
 - data transmission services – Ethernet virtual private network (VPN)
- Internet protocol television (IPTV) connections:
 - by type (linear broadcast, video on demand or VoD)

Fixed service usage

- Voice traffic:
 - fixed-to-fixed (incoming/outgoing)
 - fixed-to-mobile/mobile-to-fixed
 - fixed-to-international/international-to-fixed
 - fixed-to-non-geographic numbers
 - dial-up
- Business data connectivity throughput:
 - leased lines – analogue, digital (by speed)
 - data transmission services – Ethernet VPN

Voice connections

Voice connection forecasts



Mobile voice connections

- The number of mobile subscribers used in the NGN-NGA model is the same as in BIPT's latest mobile LRIC model

Fixed voice connections – residential

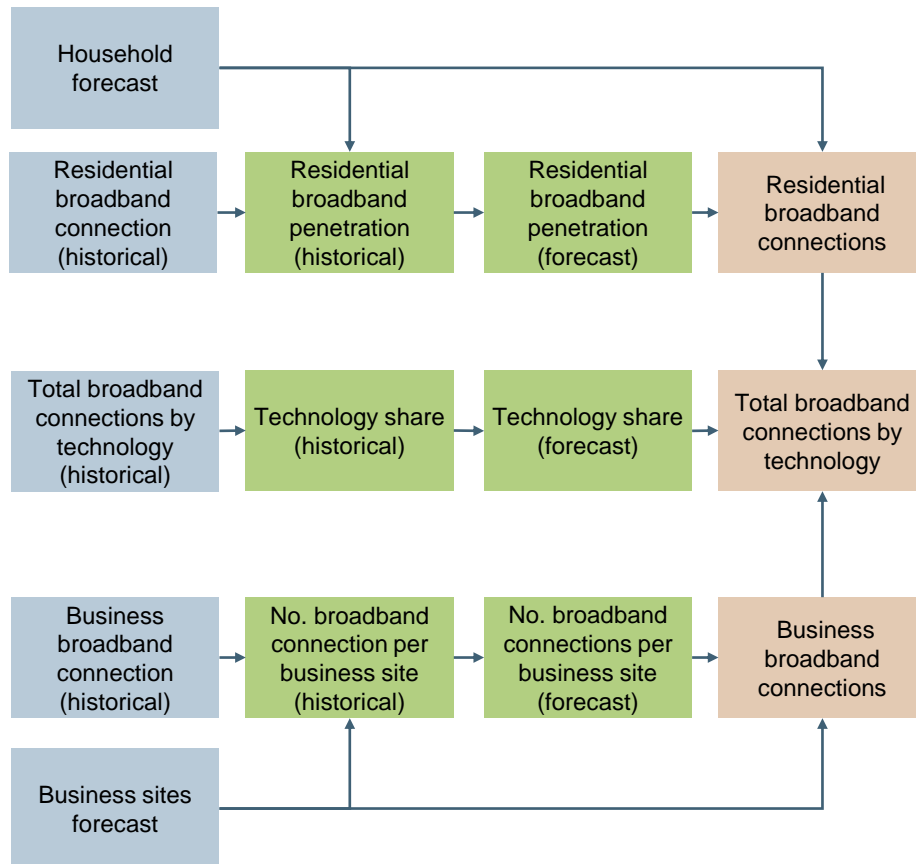
- The number of residential fixed voice connections is driven by the number of households in Belgium
- We have extrapolated the growth of household and fixed voice household penetration to forecast the number of residential fixed voice connections
- This market is further split in five different fixed voice technologies: PSTN, cable, ISDN-2, ISDN-30 and VoB. The technology shares are extrapolated from the historical figures

Fixed voice connections – business

- The number of business fixed voice connections is directly related to number of business sites in Belgium
- Similar to its residential counterpart, the number of business fixed voice connections is forecast by extrapolating the growth of the number of business sites and fixed voice business penetration
- This market is also split into the five aforementioned fixed voice technologies

Fixed broadband connections

Fixed broadband connection forecasts



Fixed broadband connections (residential)

- The number of residential fixed broadband connections is driven by the number of households in Belgium
- We have extrapolated the growth of household and fixed broadband household penetration to forecast the number of residential fixed broadband connections

Fixed broadband connections (business)

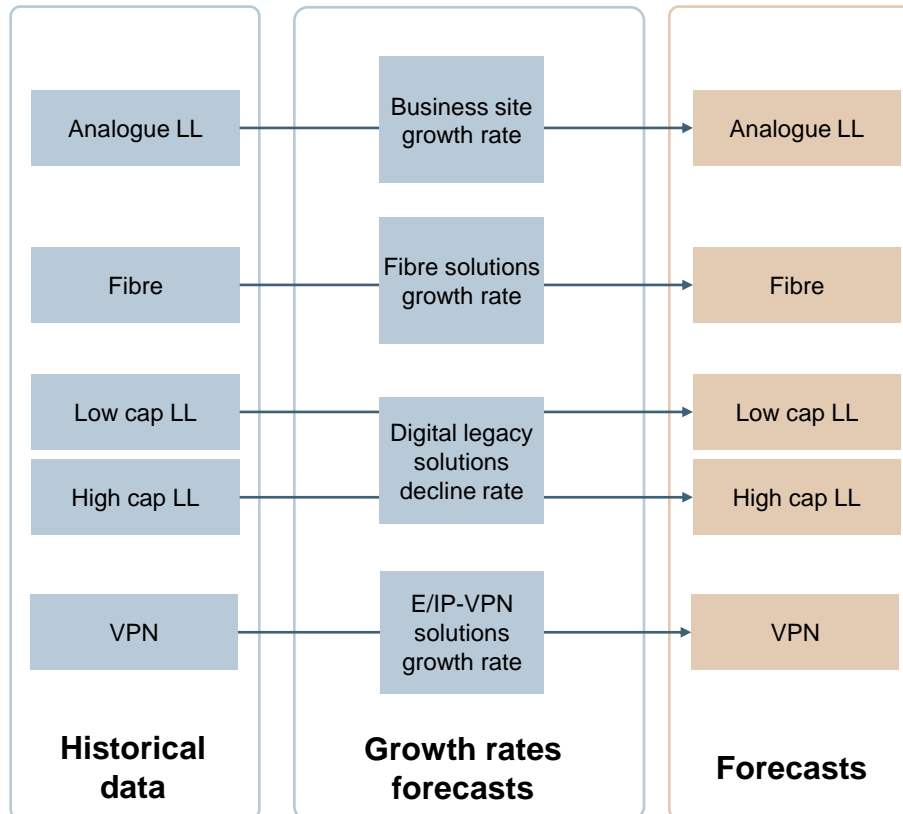
- The number of business fixed broadband connections is directly related to the number of business sites counts in Belgium
- Similar to its residential counterpart, the number of business fixed broadband connections is forecast by extrapolating the growth of the number of business sites and fixed broadband business penetration

Fixed broadband connections (total)

- The total market is further split into four different fixed broadband technologies: xDSL, fixed wireless access, cable and fibre. The technology shares are extrapolated from the historical figures

Business connectivity services

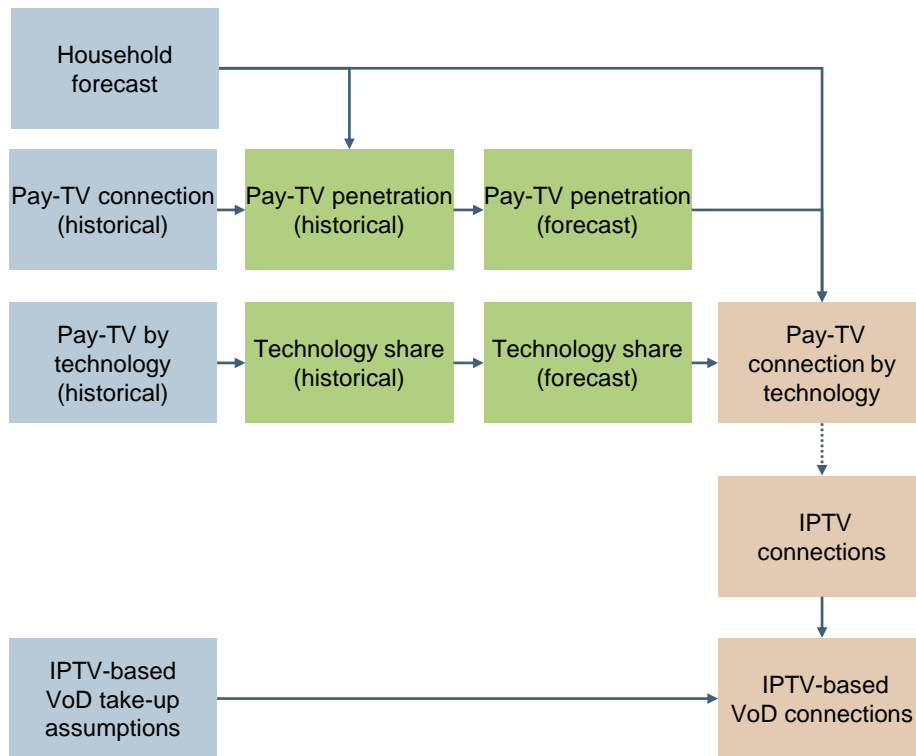
Business connectivity forecast



- In addition to business broadband (already included in fixed broadband connections), the following business connectivity solutions are modelled:
 - leased-line services
 - **analogue LL:** analogue leased lines
 - **fibre** (dark or wavelength)
 - **low cap LL:** low-capacity digital leased lines ($\leq 2\text{Mbit/s}$)
 - **high cap LL:** high-capacity digital leased lines ($>2\text{Mbit/s}$)
 - data transmission services
 - **E/IP-VPN:** Ethernet VPN and others (e.g. LAN-LAN)
- In the long term, it is assumed that the digital legacy solutions are migrated to E/IP-VPN solutions, which then grow in line with the business site growth rate
- The number of fibre solutions (i.e. dark fibre or wavelengths) is conservatively assumed to remain flat over time

IPTV and IPTV-based VoD

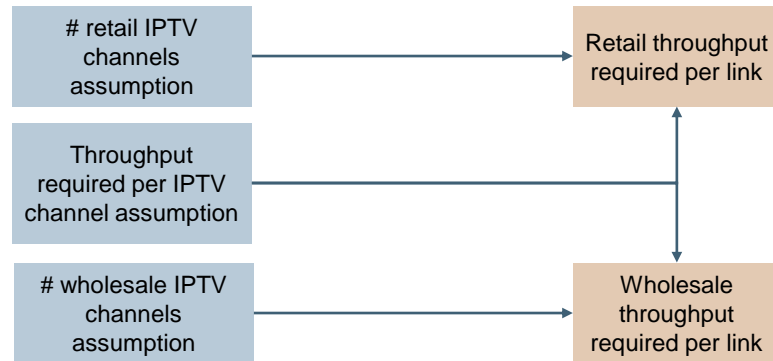
Linear and VoD IPTV forecast



- Combining household and pay-TV household penetration growth allows us to predict the future demand of pay TV in the Belgian market
- We have also calculated and extrapolated the technology share of the pay-TV market in Belgium, classified into four different categories:
 - cable TV
 - satellite TV
 - digital terrestrial television (DTT)
 - IPTV
- Multiplying the total pay-TV market with the IPTV technology share gives the total IPTV forecast
- Subsequently, the forecast for IPTV-based VoD connections can be obtained by assuming that an increasing proportion of broadcast IPTV customers will also subscribe to IPTV-based VoD services

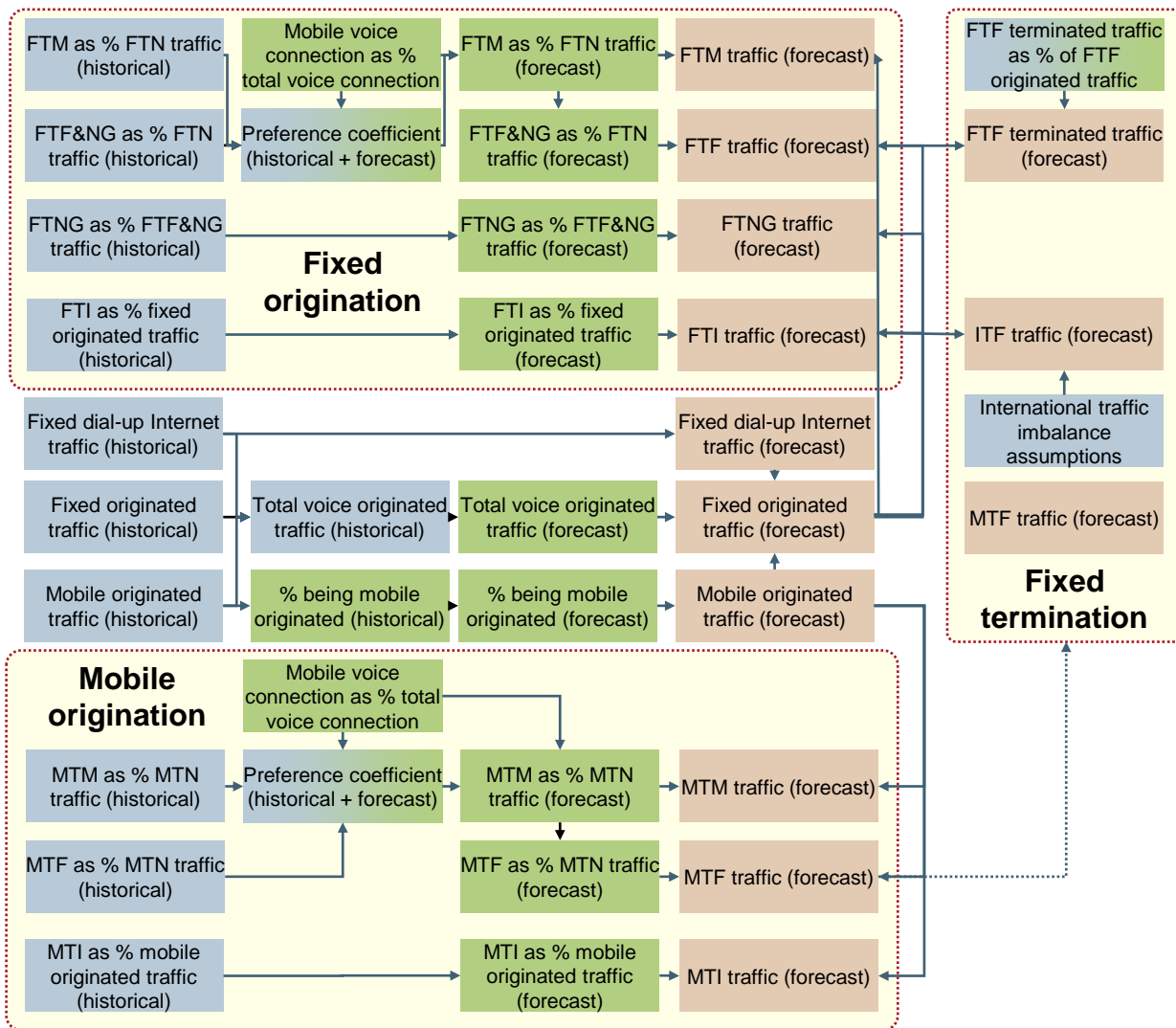
IPTV and IPTV-based VoD throughput

Linear and VoD IPTV throughput forecast



- The throughput per IPTV link is calculated separately for the retail and wholesale IPTV flows based on:
 - the number and throughput per standard definition (SD) channel
 - the number and throughput per high-definition (HD) channel
 - the number and throughput per 3D channel
- The throughput for VoD is an assumption per VoD subscriber

Voice traffic forecasts at a glance

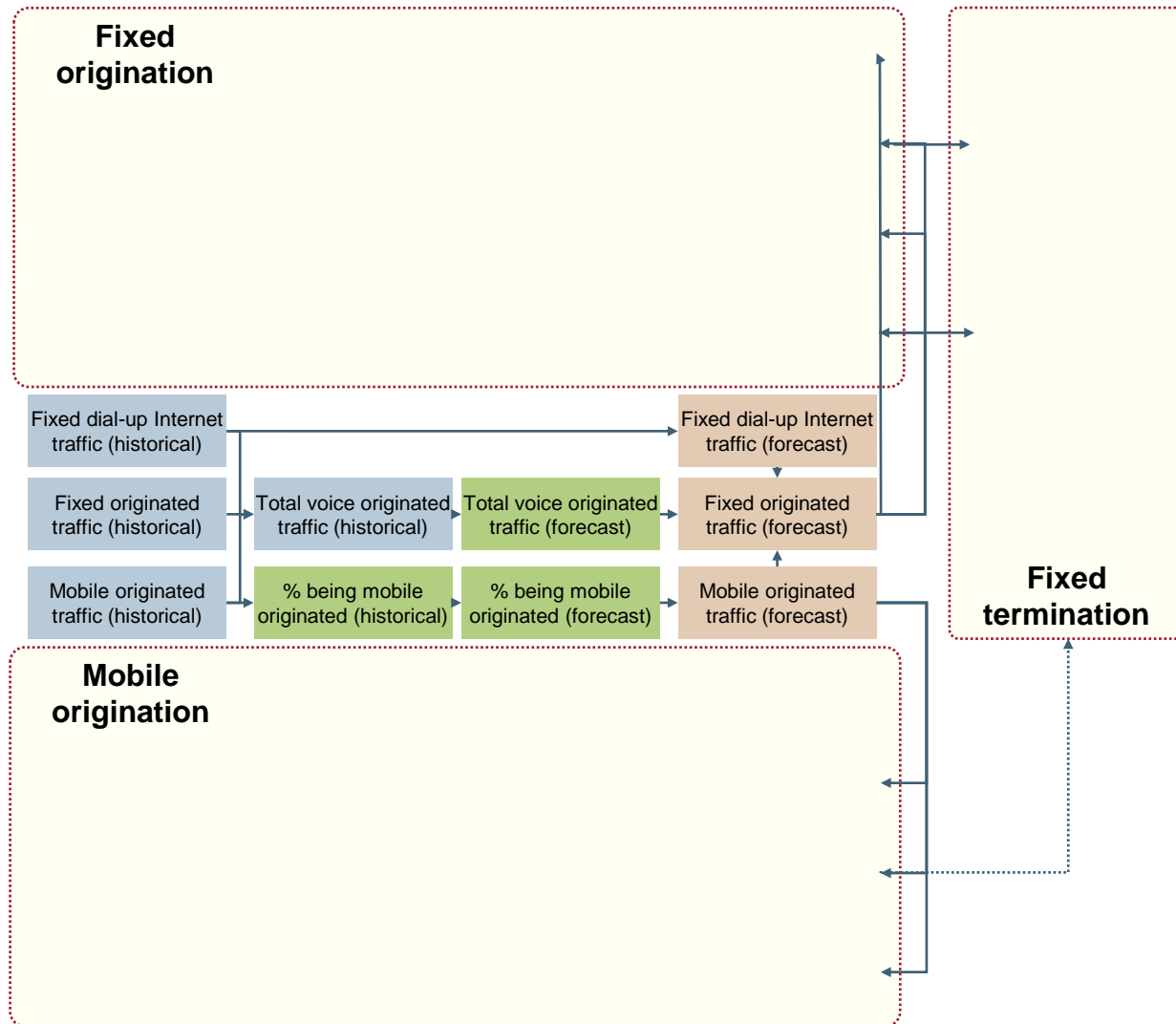


Details on the flow of calculations are provided in the following four slides

In the flow chart:

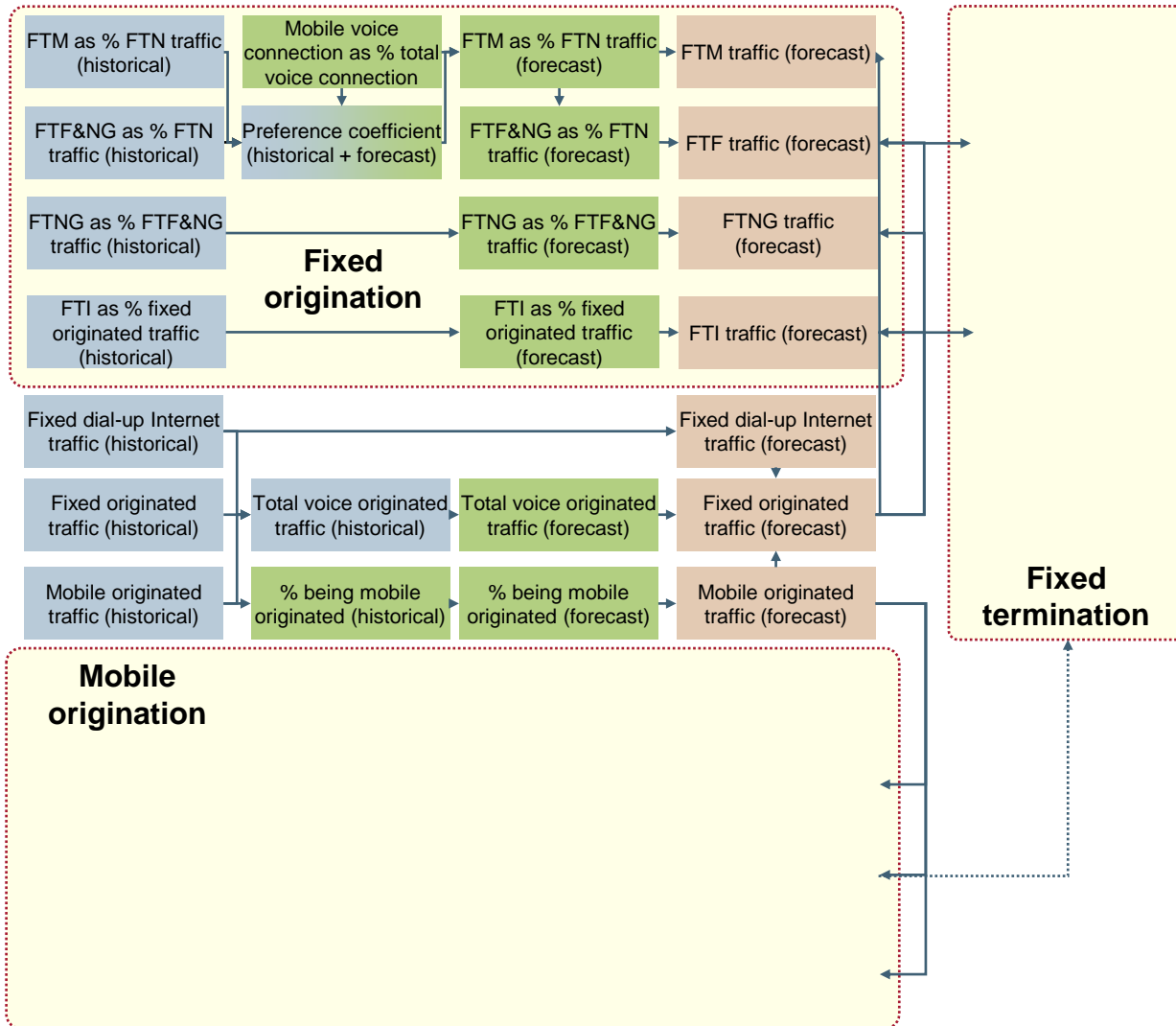
- FTI = fixed to international
- FTN = fixed to national
- FTM = fixed to mobile
- FTF&NG = fixed to fixed and non-geographic numbers
- FTF = fixed to fixed
- FTNG = fixed to non-geographic numbers
- MTI = mobile to international
- MTN = mobile to national
- MTM = mobile to mobile
- MTF = mobile to fixed
- ITF = international to fixed

Firstly, the origination traffic is split into three broad categories



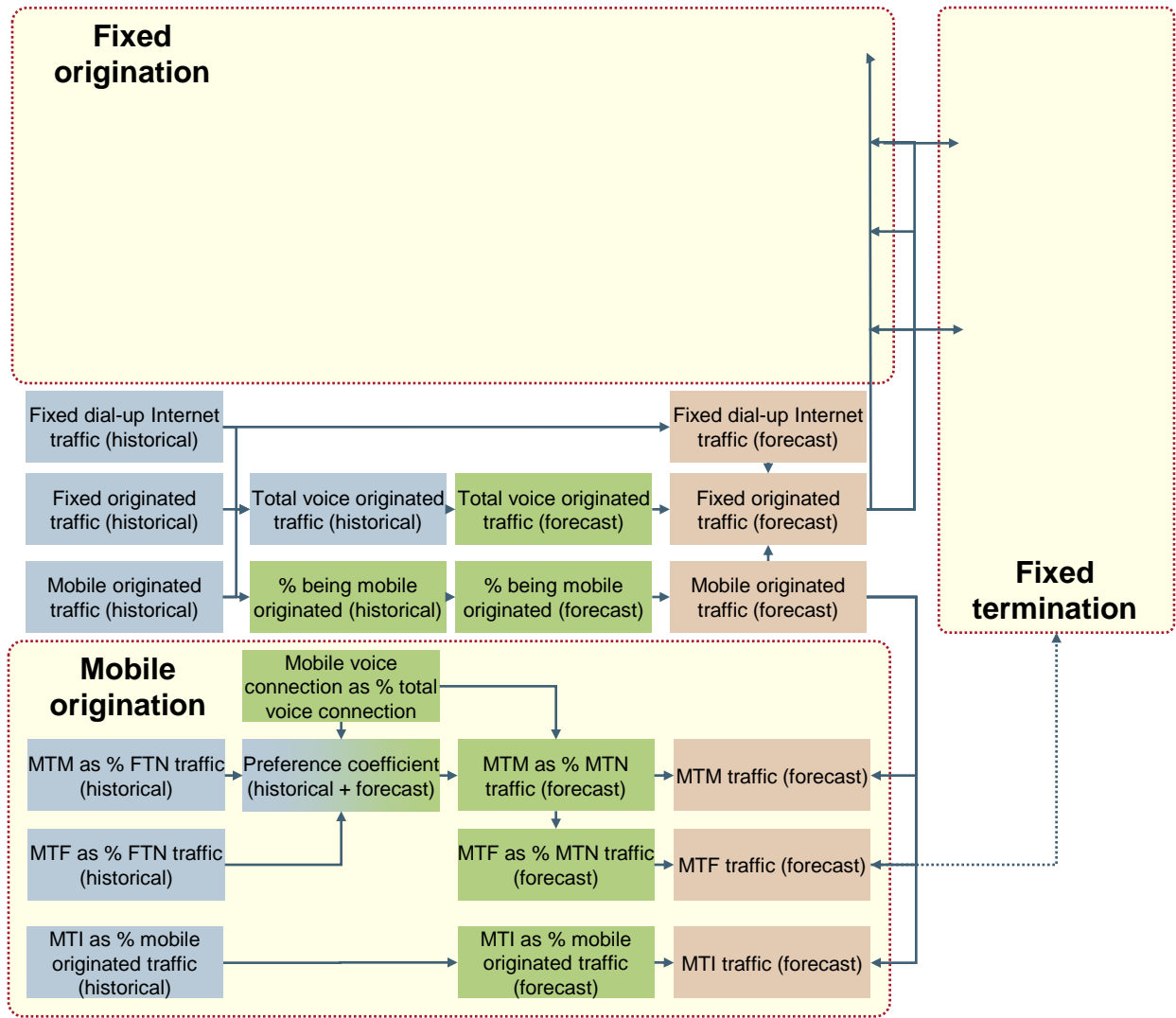
- BIPT provides historical data for the fixed to non-geographic traffic (used to estimate historical dial-up Internet traffic), fixed- and mobile-originated traffic
- We have extrapolated the sum of these traffic categories, as well as the share of mobile-originated traffic
- Multiplying these gives the forecast of mobile-originated traffic
- We have projected the dial-up Internet traffic directly to reflect the diminishing use of this service
- Fixed-originated traffic can be obtained by subtracting away the mobile-originated traffic from the total traffic (as the dial-up Internet traffic is assumed to go down to 0 from 2009)

Next, the fixed-originated traffic is further split into smaller sub-categories



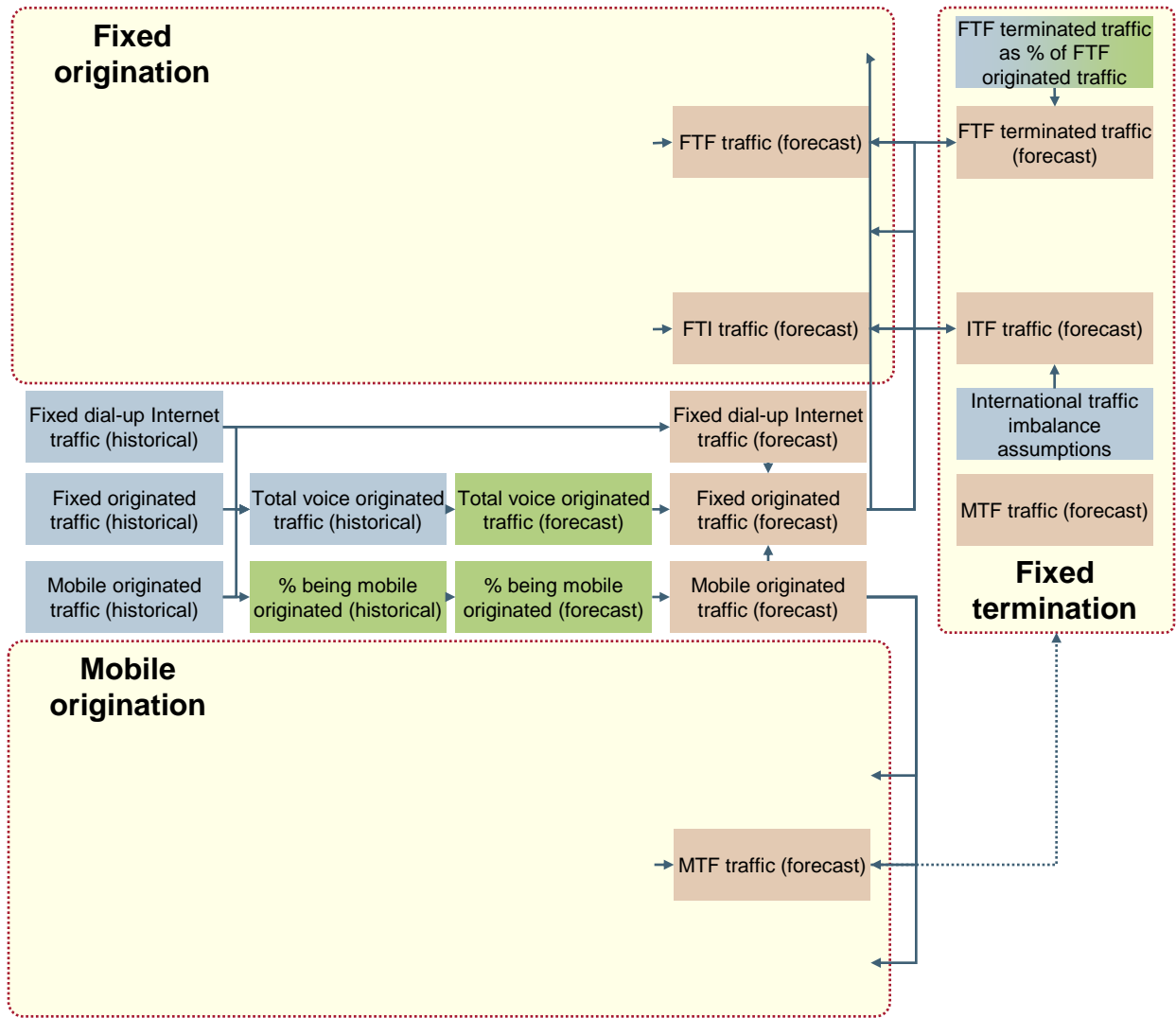
- FTM, FTF&NG and FTI traffic shares are forecast as percentages of the total fixed-originated traffic:
 - the fixed-originated traffic is first split into FTI and FTN traffic
 - FTN traffic is then further split into FTF&NG and FTM traffic
 - FTF&NG is then further split into FTF and FTNG
- The split between FTF and FTM traffic is directly related to the split between fixed and mobile connections
- However, the correlation is not perfect – fixed users are more likely to call a fixed telephone than a mobile telephone. Hence, a ‘preference coefficient’* is defined to capture this effect
- Multiplying these traffic shares with the total fixed-originated traffic obtained earlier gives the FTM, FTF, FTNG and FTI traffic forecasts

A similar sub-categorisation is performed on the mobile-originated traffic



- MTM, MTF and MTI traffic shares are forecast as percentages of the total mobile-originated traffic:
 - the mobile-originated traffic is first split into MTI and MTN traffic
 - MTN traffic is then further split into MTF and MTM traffic
- The split between MTF and MTM traffic is directly related to the split between fixed and mobile connections
- However, the correlation is not perfect – mobile users are more likely to call a mobile rather than a fixed telephone. Hence, a ‘preference coefficient’ is defined to capture this effect
- Multiplying these traffic shares with the total mobile-originated traffic obtained earlier gives the MTM, MTF and MTI traffic forecasts

Finally, the relevant origination traffic is collected to forecast the fixed-terminated traffic



- Three types of traffic generate fixed termination: FTF, ITF and MTF
- FTF-terminated traffic is forecast based on FTF-originated traffic and the share of FTF terminated as a proportion of FTF-originated traffic (excluding on-net traffic)
- ITF and FTI traffic are correlated – people who frequently make international calls are also more likely to receive calls from foreign destinations
- Hence, an ‘international traffic imbalance’ factor, defined as the ratio of ITF-to-FTI traffic, is assumed to estimate ITF traffic from the FTI traffic determined earlier
- MTF traffic is taken directly from previous mobile-originated forecasts

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Volumes are forecast for the modelled operator based on the total market demand and forecast market shares

Fixed connections

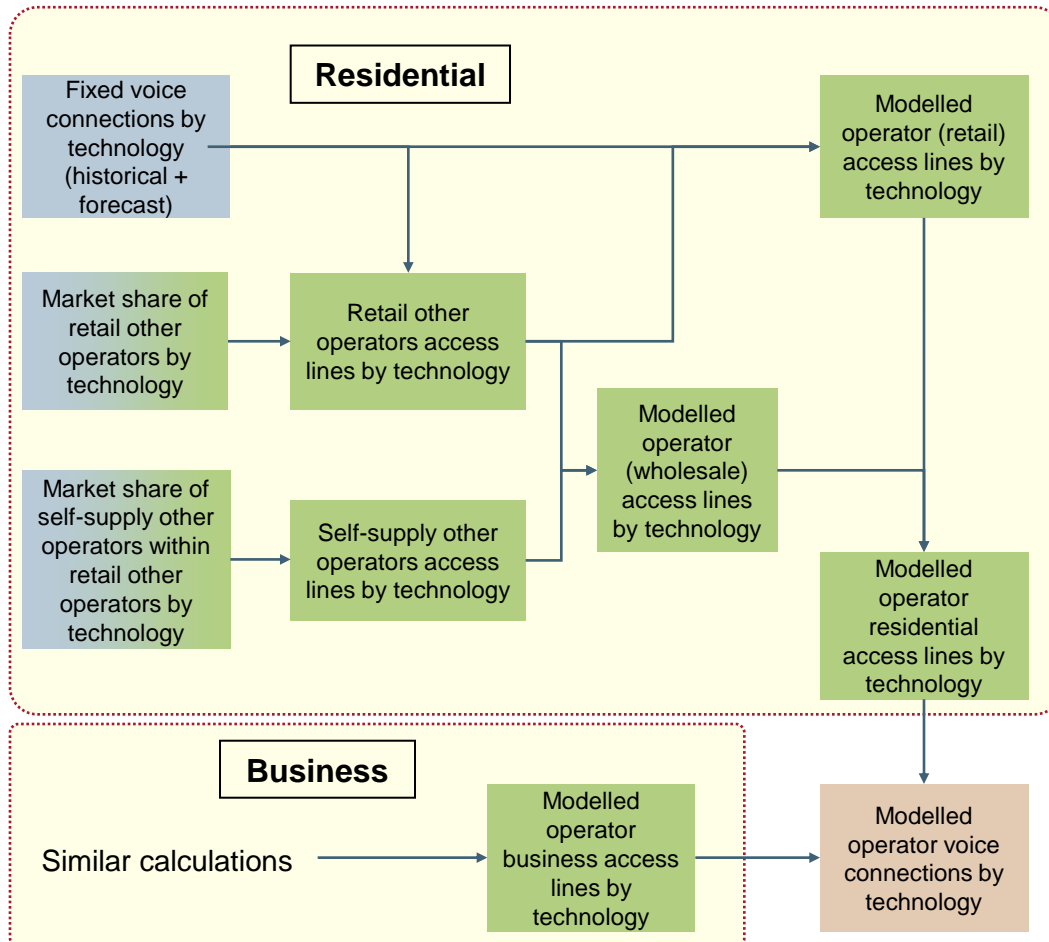
- Voice connections:
 - by residential and business
 - by technology (PSTN, cable, ISDN-2, ISDN-30 and VoB)
 - by retail and wholesale
- Broadband connections:
 - by retail and wholesale (resale, unbundling and bitstream)
- Business connectivity services:
 - leased lines – analogue, digital (by speed), fibre
 - data transmission services – Ethernet VPN
- IPTV connections:
 - by type (linear broadcast, VoD)
 - by retail and wholesale

Fixed service usage

- Voice traffic:
 - fixed-to-fixed (outgoing/incoming)
 - fixed-to-non-geographic numbers
 - dial-up
 - fixed-to-mobile/mobile-to-fixed
 - fixed-to-international/international-to-fixed
- xDSL broadband services backhaul requirement
- Business data connectivity throughput:
 - leased lines – analogue, digital (by speed)
 - data transmission services – Ethernet VPN
- IPTV services backhaul requirement:
 - by type (linear broadcast, VoD)

Market total fixed voice connections are split between the modelled operator and other operators

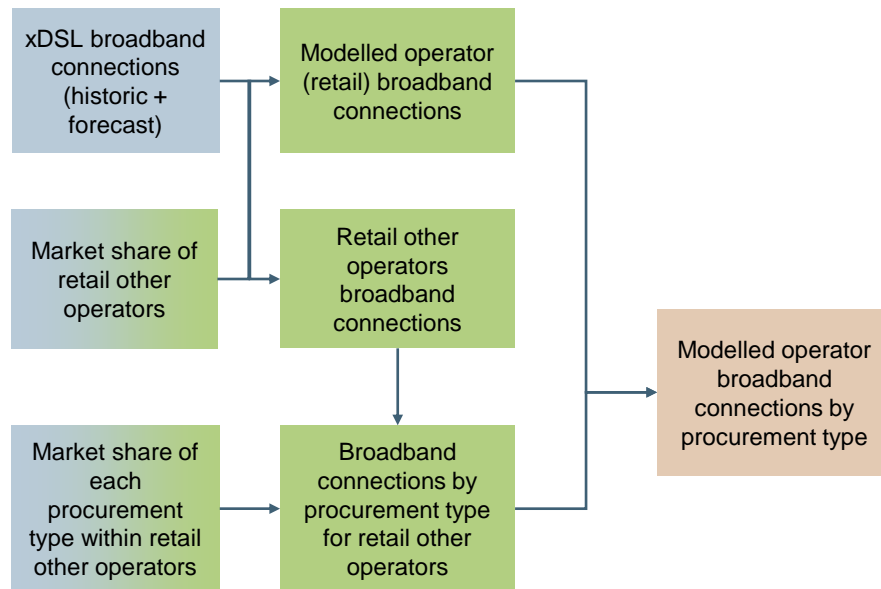
Re-categorisation of fixed voice connections



- The market total number of fixed voice connections needs to be split into connections provided by the modelled operator and connections provided by other operators
- This is done based on the market share (by technology) of:
 - retail other operators within the total market
 - self-supply other operators within the retail other operators
- These calculations give the number of retail and wholesale access lines for the modelled operator, which added up yield the total number of access lines (by technology) for the modelled operator

Market total fixed broadband connections are split between the modelled operator and other operators

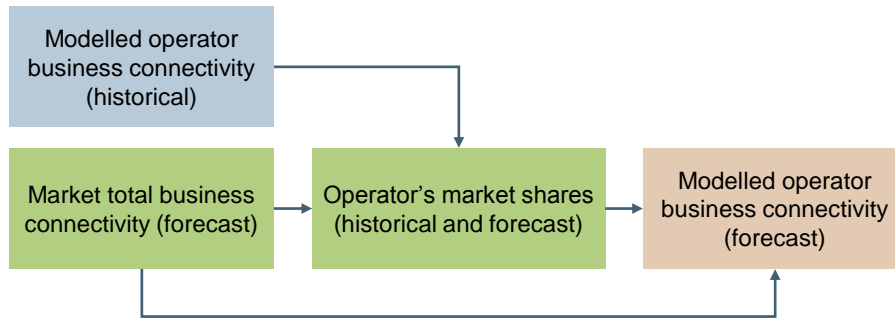
Re-categorisation of fixed broadband connections



- As not all procurement types generate traffic in the modelled operator's core network, the market total number of xDSL fixed broadband connections (all assumed to be provided, directly or not, by the modelled operator) calculated earlier need to be rearranged by procurement type:
 - fixed broadband connections based on the modelled operator's access lines
 - retail xDSL
 - resale
 - fixed broadband connections based on unbundled access lines
 - unbundling
 - fixed broadband connections based on resold wholesale connections
 - bitstream

Market total business connectivity services are split between the modelled operator and other operators

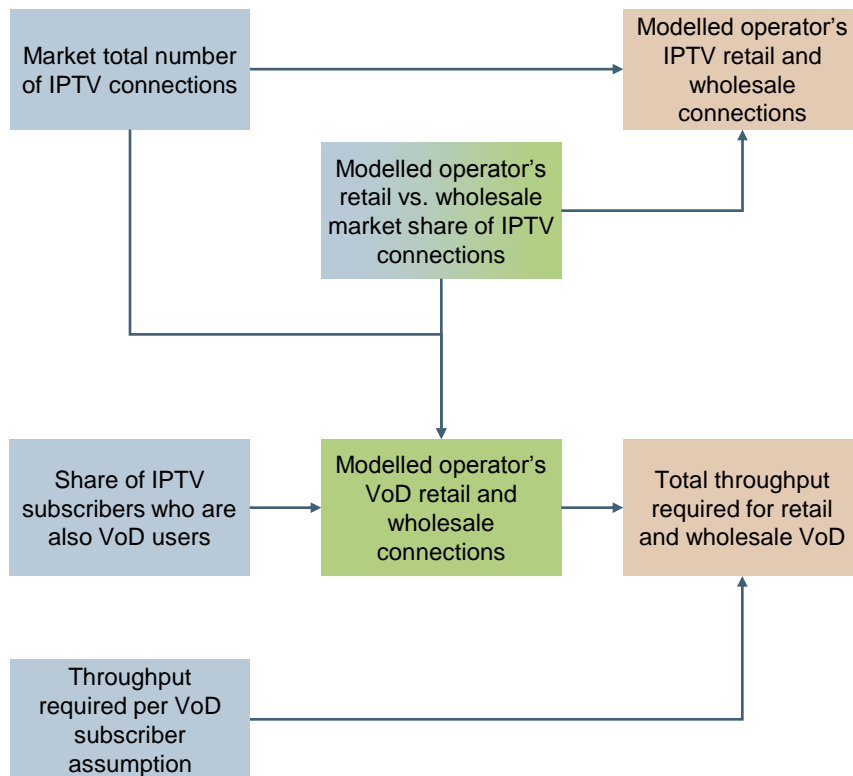
Business connectivity forecast



- The following leased-line services are modelled:
 - **analogue LL:** analogue leased lines
 - **fibre** (dark or wavelength)
 - **low cap LL:** low-capacity digital leased lines ($\leq 2\text{Mbit/s}$)
 - **high cap LL:** high-capacity digital leased lines ($> 2\text{Mbit/s}$)
- In addition, data transmission services are also forecast:
 - **E/IP-VPN:** Ethernet VPN and others (e.g. LAN-LAN)
- The market share of each of these services is obtained by comparing the number of connections of the modelled operator with the market total number of connections
- These market shares are extrapolated to obtain a long-term outlook of the modelled operator's business connectivity services
- Multiplying the market total service connections with corresponding market shares leads to the modelled operator's connections forecast:
 - certain services are excluded from the core model, to simplify the modelling of multiple platforms

IPTV connections and IPTV-based VoD throughput are split between the modelled operator and other operators

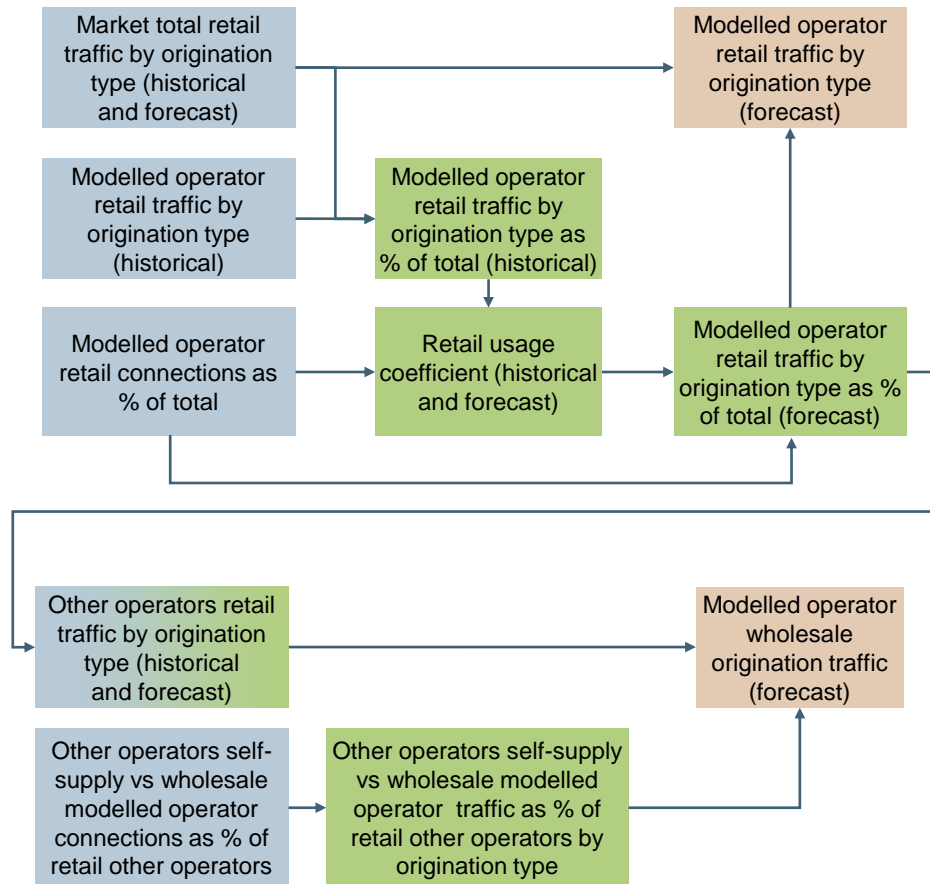
IPTV connections forecast



- The number of retail and wholesale IPTV connections for the modelled operator is driven by:
 - the total IPTV market connections
 - the share of each type of subscribers
- The throughput required for retail and wholesale VoD is driven by:
 - the number of retail and wholesale IPTV subscribers
 - the share of VoD users among IPTV subscribers
 - the throughput required per VoD user

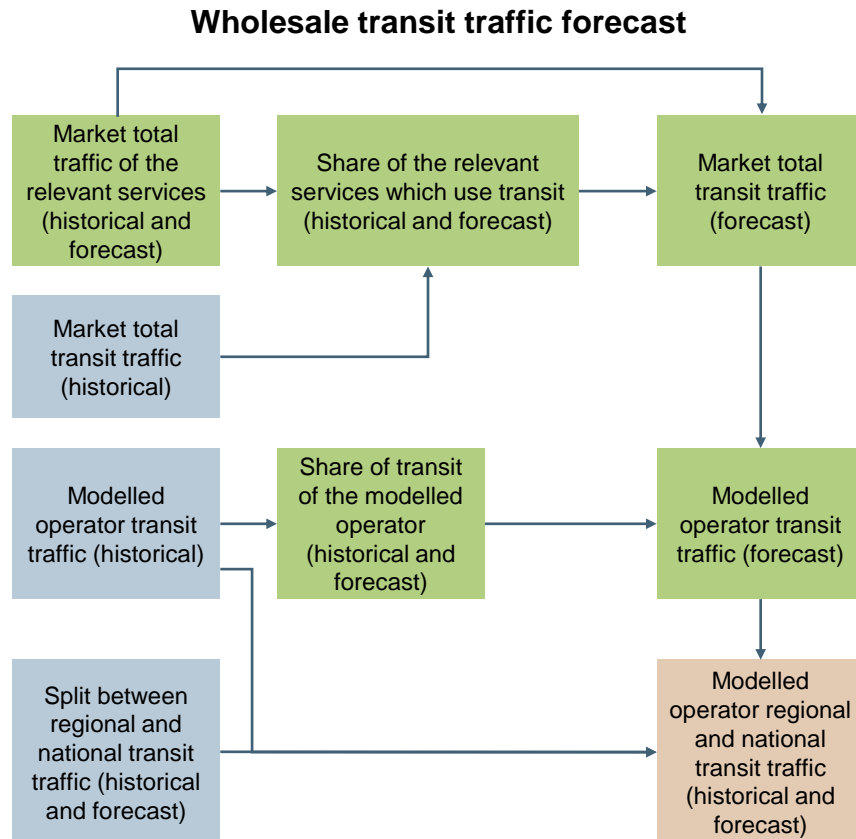
Retail and wholesale origination voice traffic is derived from the number of retail and wholesale subscribers

Retail and wholesale origination forecast



- An operator's traffic market share correlates strongly with its subscriber market share
- However, subscribers' usage patterns differ by operator and by call type. Hence, 'usage coefficients' are introduced to ensure the traffic market shares can be predicted accurately from the subscribers market shares:
 - an operator's usage coefficient of a particular retail origination service is defined as the ratio of its market share for that particular service to its market share of the retail fixed connections
- We have derived and forecast the usage coefficients using the modelled operator's shares of traffic and connections
- Multiplying these coefficients with the number of the operator's retail/wholesale fixed connections leads to the operator's retail/wholesale traffic forecast by origination type

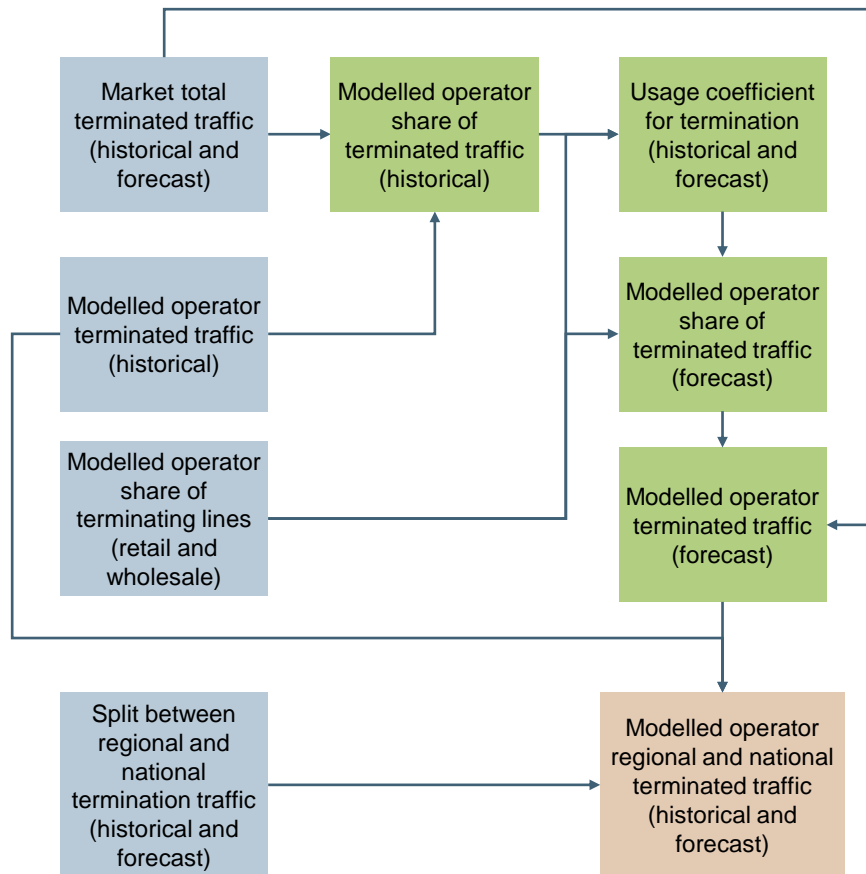
Wholesale transit voice traffic is modelled as a share of all other traffic types



- Wholesale transit services are generated by other operators using the modelled operator's network. It can be modelled as a share of the market services that can generate transit traffic. These relevant services are:
 - fixed to fixed (ordinary numbers)
 - fixed to non-geographic numbers
 - dial-up Internet
 - fixed to mobile
 - fixed to international
 - mobile to fixed
 - international to fixed
 - mobile to mobile (off-net)
 - mobile to international
 - international to mobile
- An extrapolation of the split between the regional and national transit traffic leads to a forecast of these two types of transit traffic

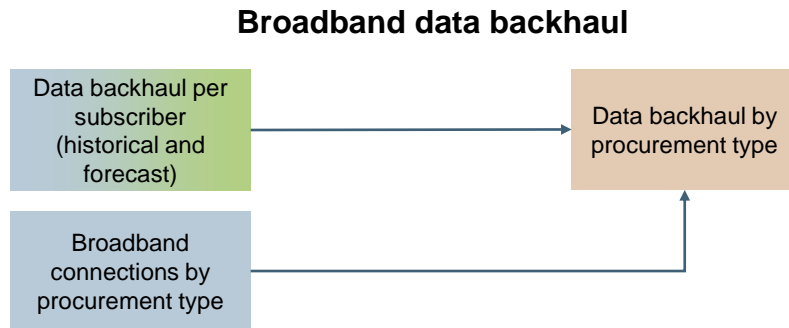
Wholesale termination voice traffic is derived from the number of retail and wholesale subscribers

Wholesale termination



- A similar methodology as for origination has been applied to forecast the wholesale fixed-terminated traffic for the modelled operator:
 - an operator's usage coefficient of termination is defined as the ratio of its market share for termination to its market share of fixed connections (wholesale + retail)
- We have derived and forecast the usage coefficient using the modelled operator's shares of traffic and connections
- Multiplying this coefficient with the share of the operator's number of retail/wholesale fixed connections gives the operator's share of termination
- Multiplying the operator's share of termination by the total terminated traffic gives the operator's terminated traffic
- The wholesale termination is further split into two categories:
 - regional incoming traffic (wholesale)
 - national incoming traffic (wholesale)

xDSL data backhaul is forecast based on historical trends



- The data backhaul per subscriber is forecast using an S-curve
- The data backhaul per subscriber is then multiplied by the number of broadband connections to obtain the total data backhaul by procurement type:
 - retail + resale and bitstream connections create a data backhaul need for the modelled operator
 - unbundling connections generate traffic carried by another operator and therefore do not create any data backhaul need for the modelled operator

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Demand conversion

NGN data connectivity

NGN voice connectivity

Ethernet/IP core

Service platforms

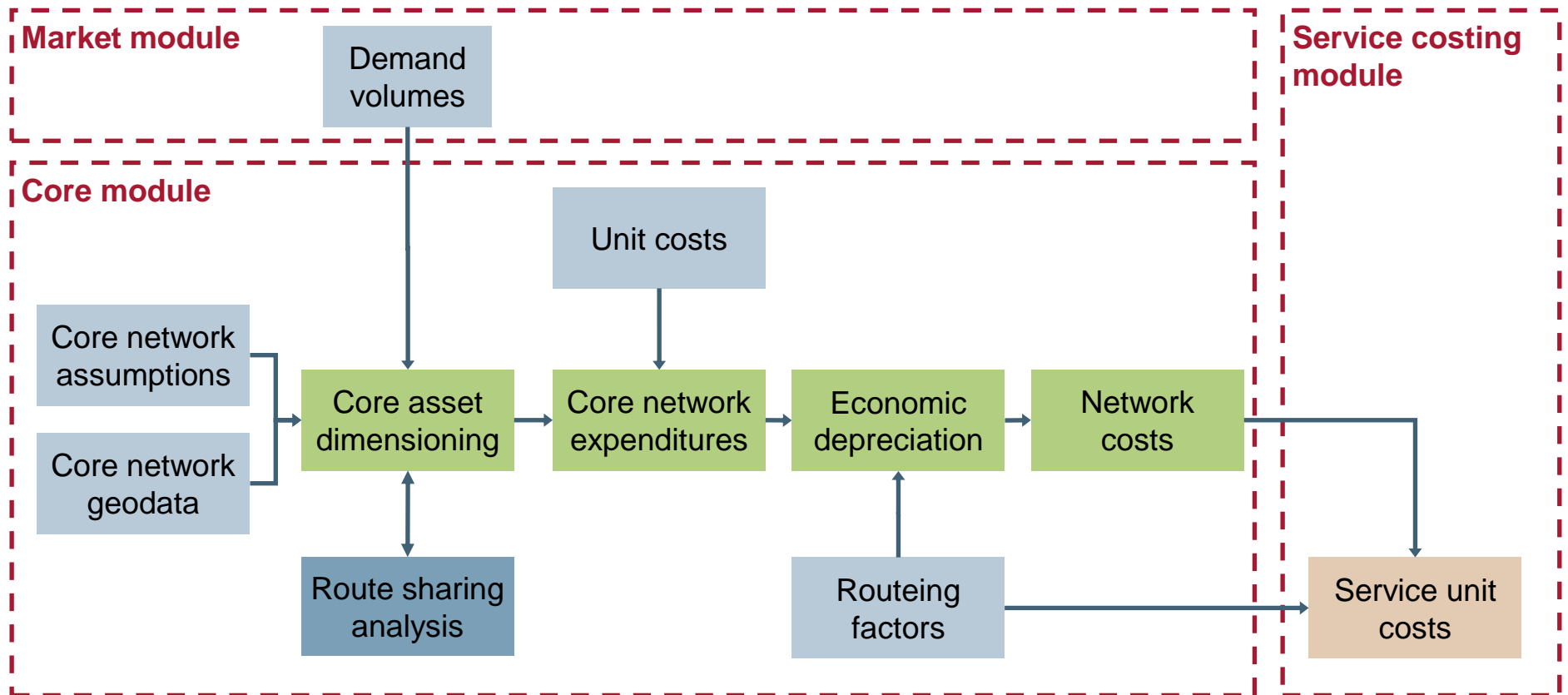
Access modules

Ancillary/common/overhead modules

Service costing modules

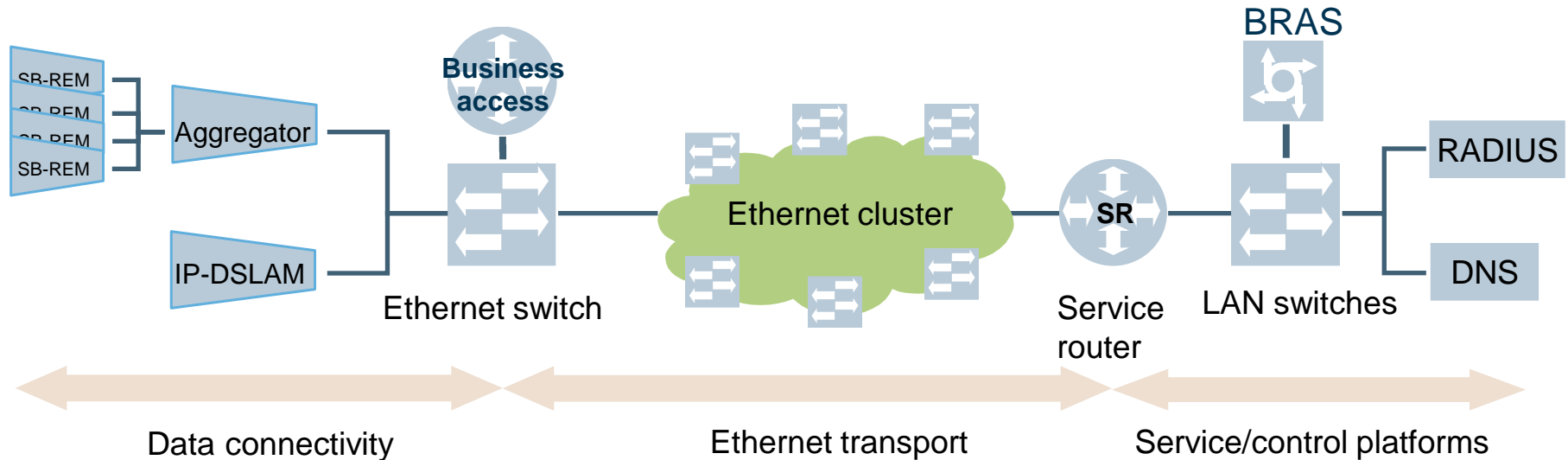
Glossary

High-level flow of calculations in the core module



The model assumes that an IP network is deployed to support all data traffic (xDSL, VPNs and IPTV) ...

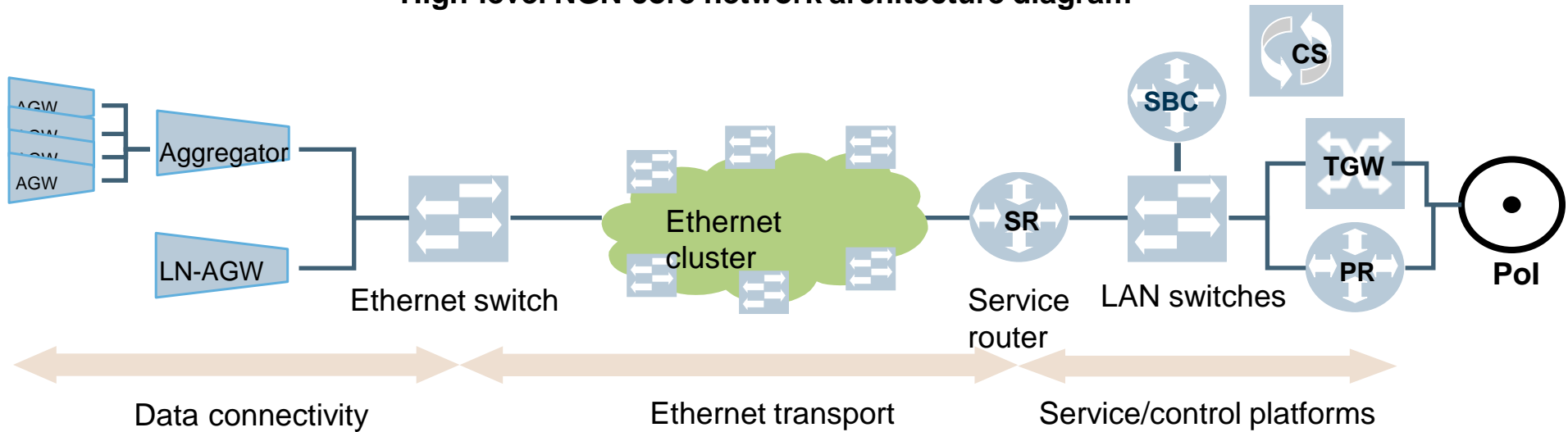
High-level IP core network architecture diagram



- A mix of disaggregated/monolithic IP DSLAMs is deployed in the street cabinets (remote optical platform or ROP)/local exchanges (LEX)-local distribution cabinets (LDC), respectively:
 - the DSLAMs deployed use IP rather than ATM for backhaul, under modern equivalent asset (MEA) principles
- Ethernet switches are deployed in the LEX and connect the DSLAMs to the core network

... and is upgraded to support NGN voice services

High-level NGN core network architecture diagram



AGW Provides PSTN port interface – in the street cabinets (ROP) or in the LEX/LDC – and translates TDM-based voice into VoIP

SBC Is used to police the IP connection between an external network and the call server controlled core voice network

CS Handles the call control while the IP network handles the user traffic

TGW Translates the TDM-based voice coming from TDM voice networks to IP for transit over the NGN core, used for SS7 interconnection

PR Provides routing to/from another NGN voice core, used for SIP interconnection

There are three types of nodes in the core network

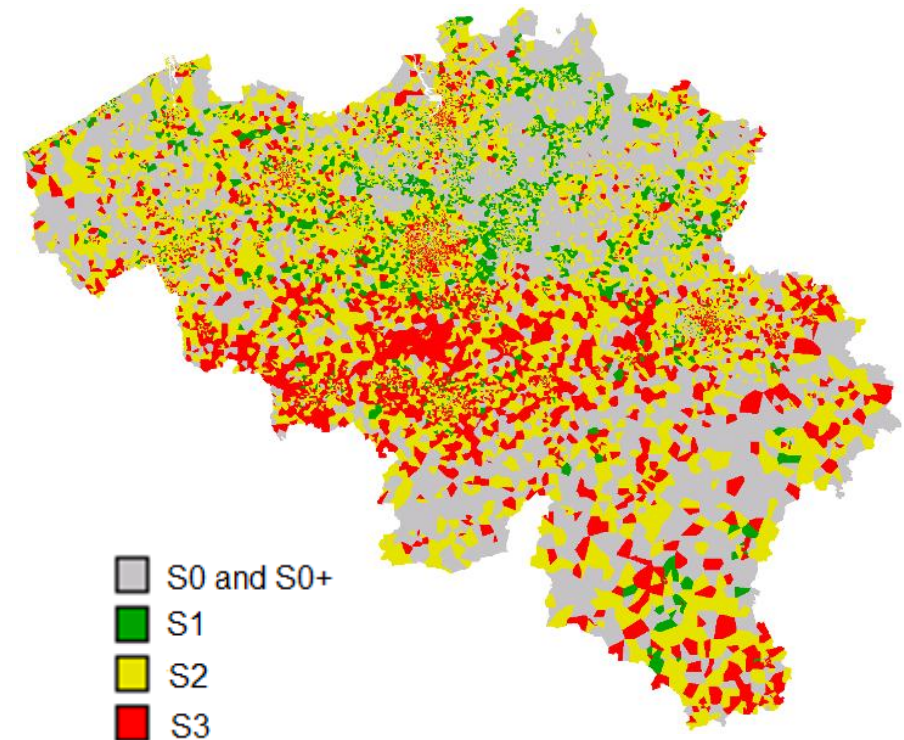
- The local exchanges (LEX) are made of three types of nodes:
 - service nodes and central service nodes (SN/CSN) – two CSN in Brussels and eight SN in Gent, Antwerp, Liège and Charleroi (two in each location) are the main nodes in the modelled operator's core network. They are linked by two core express rings
 - aggregation nodes (AN) are points where the wavelengths of one or more clusters are aggregated before being sent to the SN/CSN. They are located on one of four core rings, ending at two SN
 - there are 32 aggregation nodes in the modelled operator's core network
 - local nodes (LN) are all other LEX
 - there are 552 local nodes in the modelled operator's core network

Street cabinets (SC)

- Street cabinets are the aggregation points closest to the customers. They define the boundary between the core and access networks
- Street cabinets are divided in five geotypes, based on their size (number of active lines) and whether they were already upgraded to ROP in 2008 (year for which the latest BRUO/BROBA model could provide this distinction). The five geotypes are as follows:

S0 (Not VDSL eligible yet in 2008)	0
S1 (< 80 active lines)	2,896
S2 (\leq 180 active lines)	12,771
S3 (> 180 active lines)	5,149
S0+ (S0 in 2008, migrated at a later date to VDSL)	7,543

Map of SC geotypes



LEX and LDC

- LEX are larger aggregation points containing an Ethernet switch:

- they are divided in five geotypes, based on their size (number of active lines directly connected to the LEX and number of active lines connected to an SC whose parent is the same LEX)
- the five geotypes are as follows

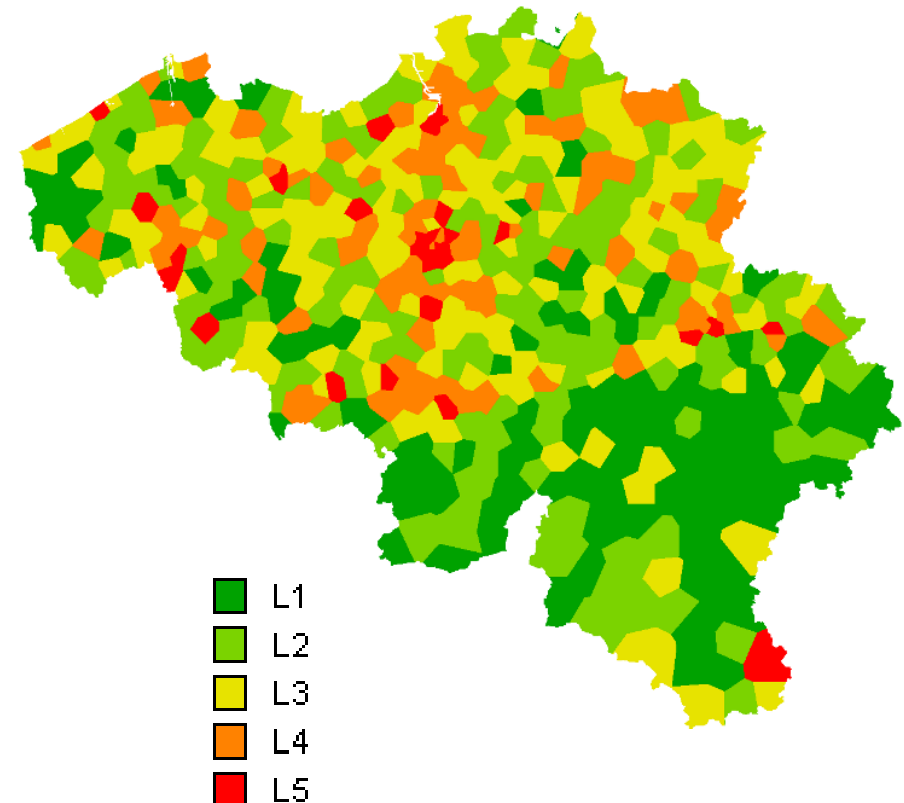
L1 (< 2200 active lines)	123
L2 (< 4400 active lines)	169
L3 (< 8800 active lines)	153
L4 (< 17600 active lines)	109
L5 (< 39000 active lines)	40

- LDC are another type of aggregation points that do not contain switches:

- they are divided in the same five geotypes as LEX
- the geotype of each LDC is the same as the geotype of its parent LEX (see below)

L1 (< 2200 active lines)	15
L2 (< 4400 active lines)	50
L3 (< 8800 active lines)	137
L4 (< 17600 active lines)	132
L5 (< 39000 active lines)	127

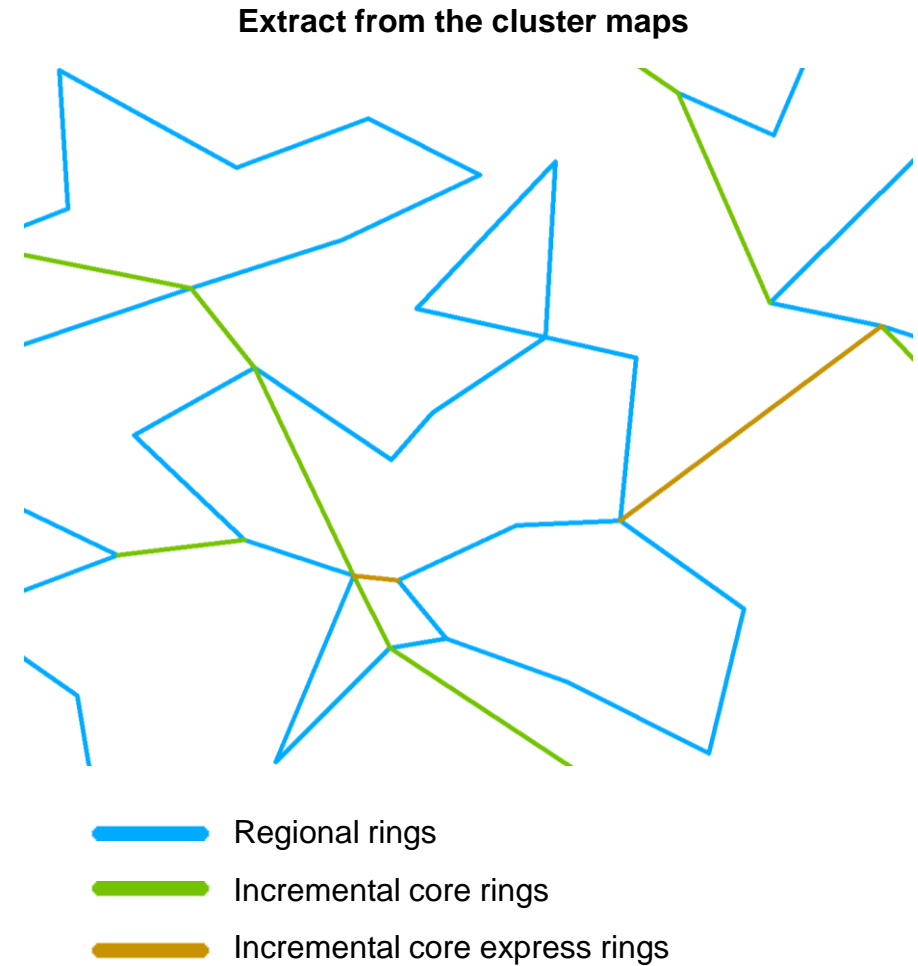
Map of LEX and LDC geotypes



Clusters

- All the LEX are connected to the ten SN/CSN by the clusters
- Clusters are dense wavelength division multiplexing (DWDM) loops, each made of two SN/CSN, none or two AN, and a number of LN

Cluster ID	Number of L1 LN and AN	Number of L2 LN and AN	Etc.
Cluster 1	1	3	
Cluster 57	-	-	



Distribution of lines

- Lines are allocated to their nearest aggregation point through a two-stage process:
 - the total number of lines is first divided into three types of lines (lines connected to LEX, LDC or ROP)
 - each type of line is then distributed across geotypes (such as LEX L1, LEX L2, etc.) in each of the three categories defined above
 - this is done separately for PSTN lines, xDSL lines and business locations
 - for business locations, it can be specified across which geotypes should the distribution be allocated in order to account for the greater demand for business services in dense geotypes
- Lines connected to an S0 street cabinet (i.e. before it is upgraded to an S0+ ROP) are accounted for separately to be connected directly to a LEX or LDC in the relevant geotype
- The number of active lines per type of node for each year is calculated based on the deployment profile described on the previous slide

Distribution of lines: allocation from SCs to clusters

- To calculate the number of ports required for connectivity and the capacity requirement by ROP/SC, LDC or LEX in each geotype, it is necessary to allocate each line to the relevant SC geotype, LEX geotype and cluster, so that the traffic generated by this line is accounted for properly
- ROPs/SCs are reattributed to a LEX geotype due to allocation matrices included in the Cov worksheet
- LEX, if they are LN or AN, are then allocated to one of 57 clusters

Number of ROPs/SCs

S0 (Not VDSL eligible)	-
S1 (< 80 active lines)	2,896
S2 (≤ 180 active lines)	12,771
S3 (> 180 active lines)	5,149
S0+ (S0 in 2008, mig)	1,078

Number of NGN LEX

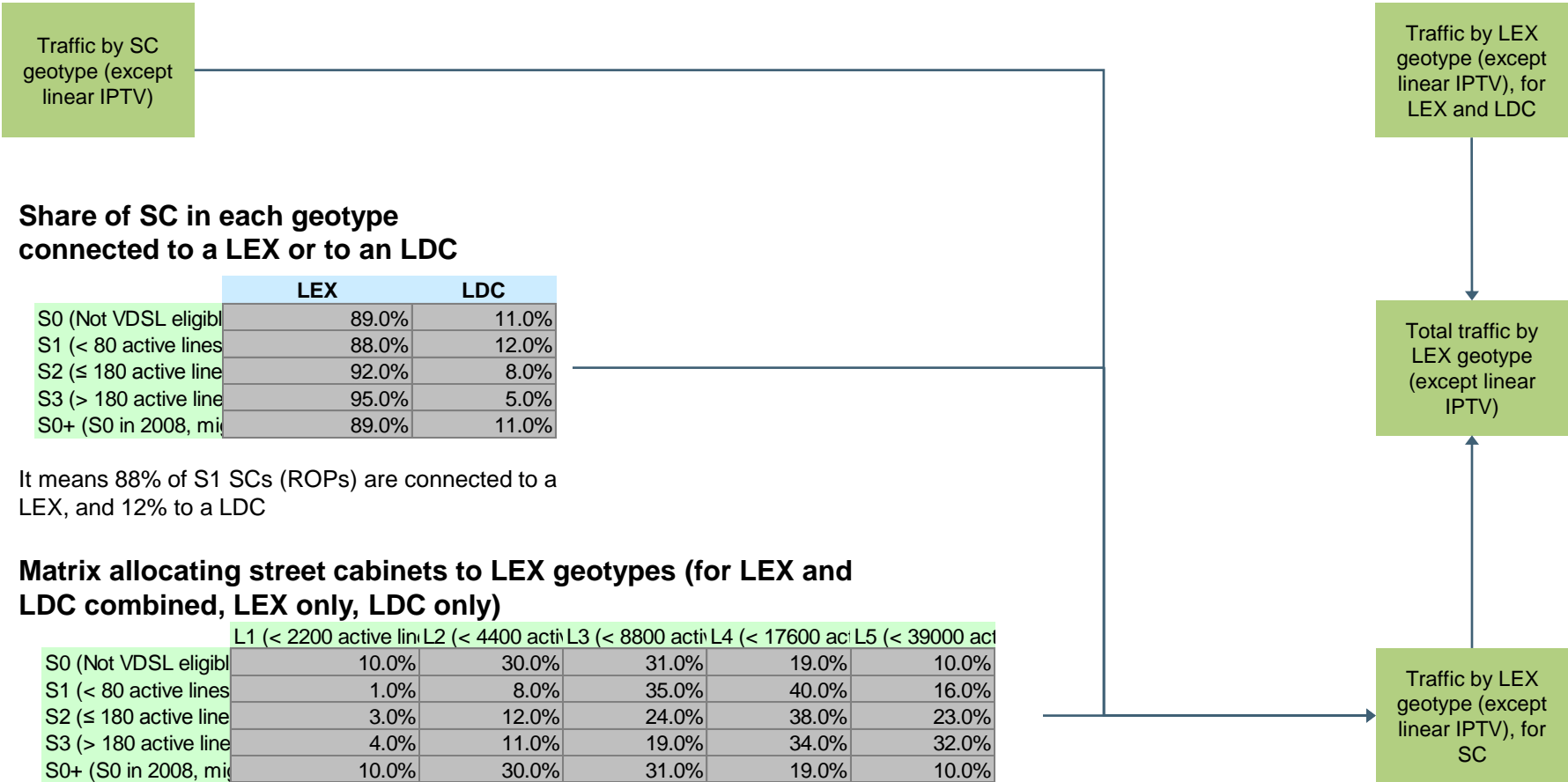
L1 (< 2200 active line)	123
L2 (< 4400 active line)	169
L3 (< 8800 active line)	153
L4 (< 17600 active lin)	109
L5 (< 39000 active lin)	40

Matrix indicating what percentage of ROPs/SCs in each SC geotype are connected to a LEX in each LEX geotype

Number of LEX (LN or AN) by cluster, by geotype

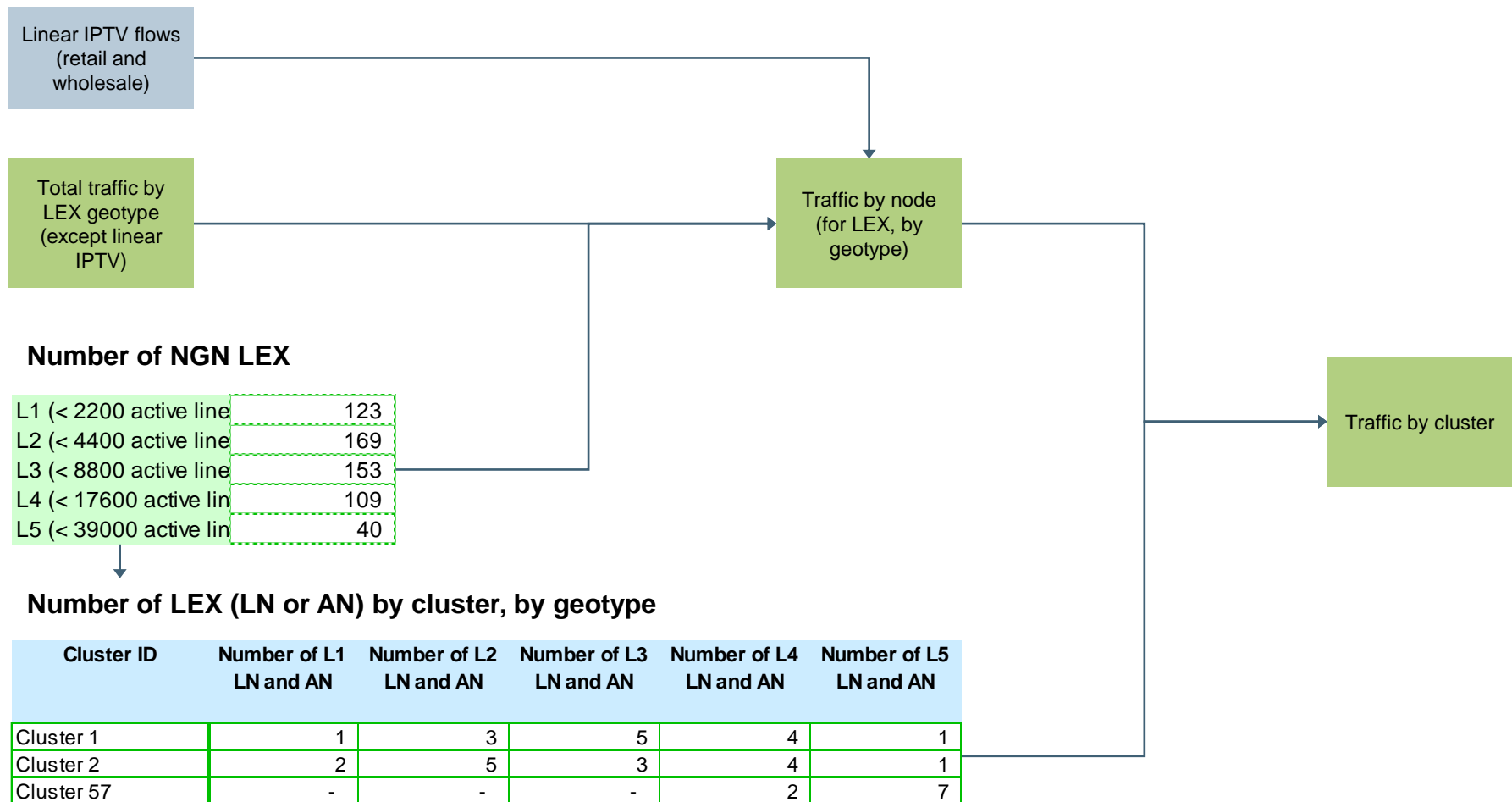
Cluster ID	Number of L1 LN and AN	Number of L2 LN and AN	Number of L3 LN and AN	Number of L4 LN and AN	Number of L5 LN and AN
Cluster 1	1	3	5	4	1
Cluster 2	2	5	3	4	1
Cluster 57	-	-	-	2	7

Traffic allocation: from SCs to LEX



In this case (SC to LEX only), it means that 1% of S1 SCs (ROPs) are connected to a LEX in the L1 geotype, 8% to a LEX in the L2 geotype, etc.

Traffic allocation: from LEX to clusters

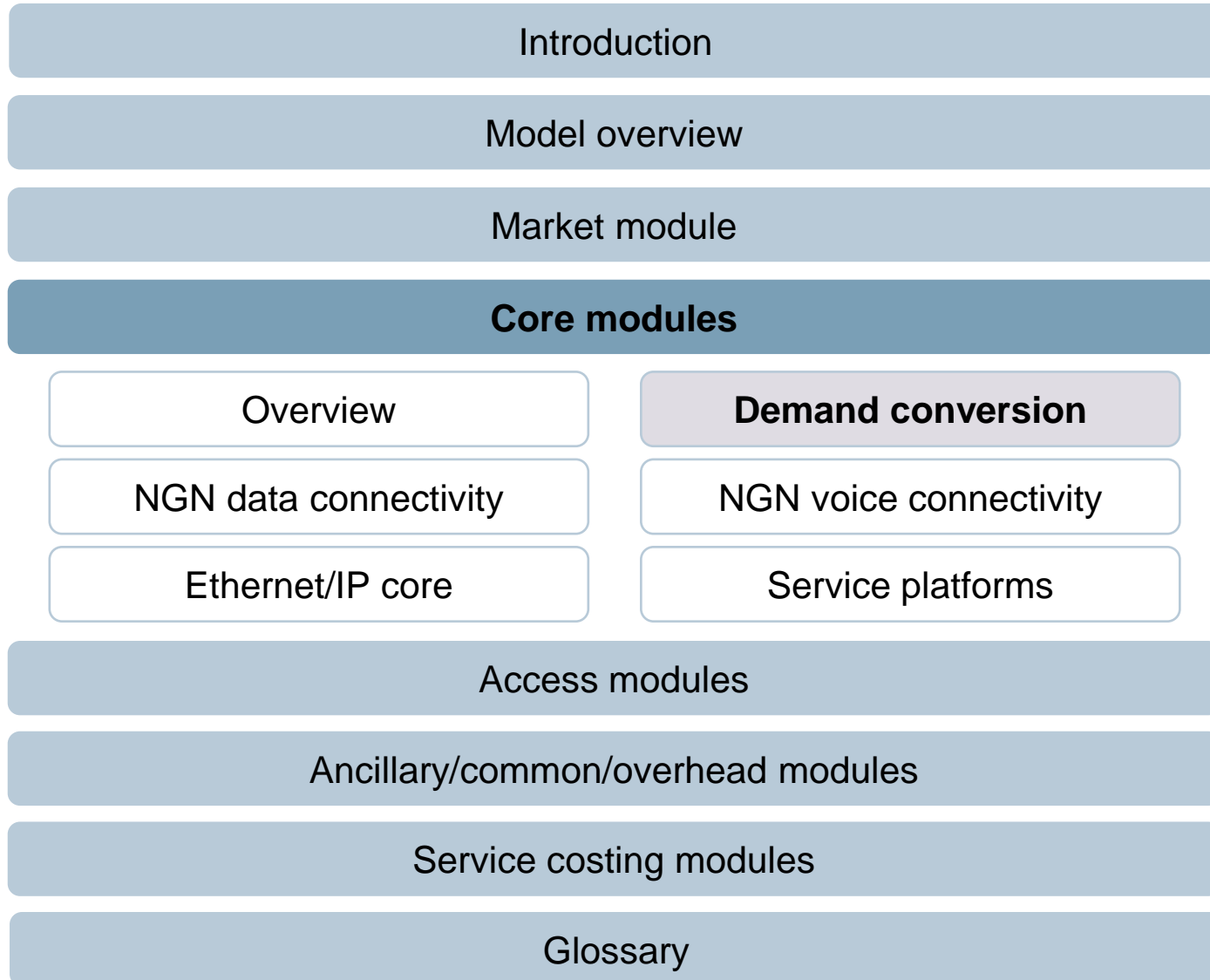


Network equipment deployment

- A timeframe has been defined for the deployment of network equipment, starting with the deployment of Ethernet switches
- It then follows a similar pattern for data and voice equipment, with equipment deployed as follows:

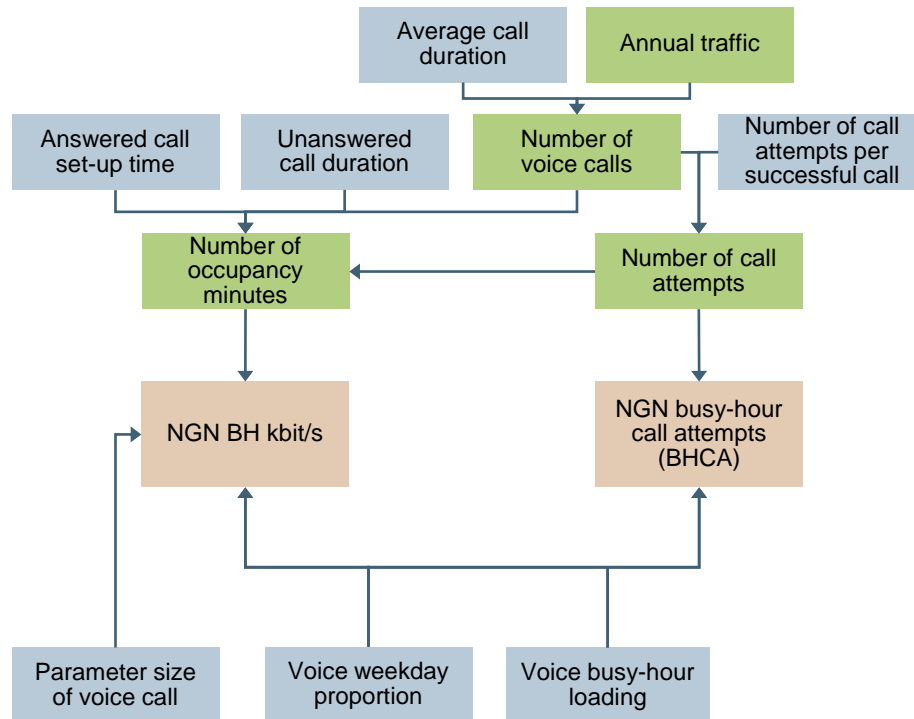
<i>Deployment order</i>	<i>Data equipment</i>	<i>Voice equipment</i>
1	IP-DSLAM	LEX-AGW
2	SB-REM aggregators	AGG-AGW
3	SB-REM DSLAMs	ROP-AGW

- All LEX and LDC (and the IP-DSLAM they contain) are entirely deployed in 2005 (for all geotypes)
- ROPs (and the SB-REMs they contain) are deployed from 2005, and S1, S2 and S3 are fully deployed by 2008, to match at this date the number of ROPs deployed in the BRUO/BROBA model. S0+ are deployed from 2009
- AGW in LEX and LDC are deployed from 2009 for all geotypes. They are all deployed by 2011 so the model can calculate a regulated tariff based on the relevant amount of voice traffic from this year onwards
- The deployment of AGW in ROP is defined as a period to reach the situation where all ROPs deployed in a given year contain an AGW. It starts in 2009 and ends in 2011 (i.e. from 2011 all ROPs deployed contain an AGW), for the same reason it ends in 2011 for AGW in LEX and LDC
- All these values flow into the 'Cov' worksheet to define the number of LEX, LDC and ROPs (with AGW)



The traffic demand forecasts from the market module are converted into busy-hour traffic

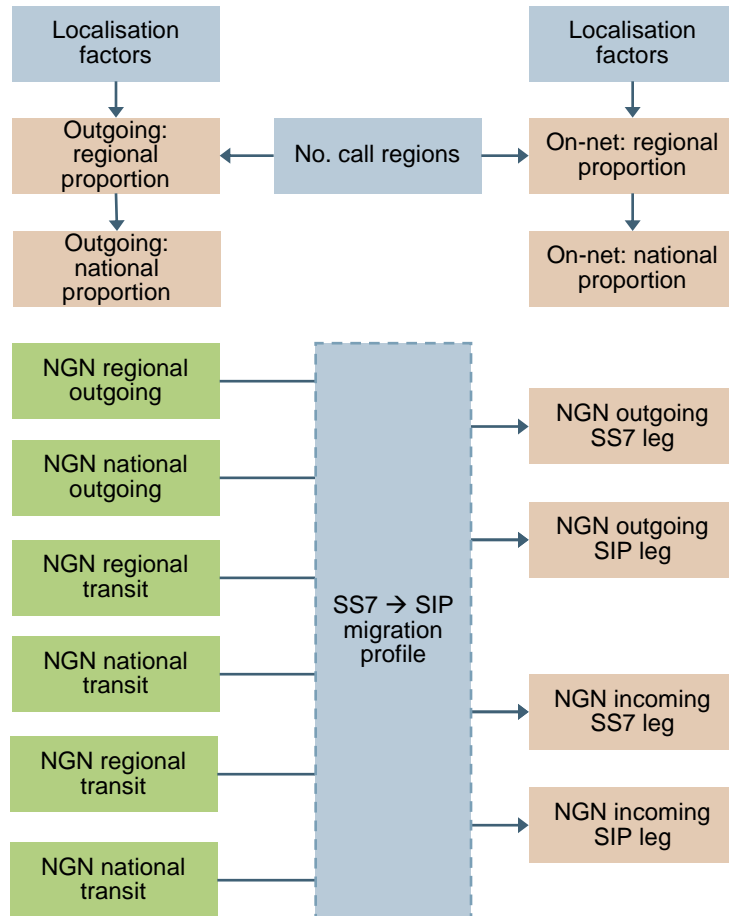
Busy-hour traffic conversion



- Using annual traffic calculated from the market module, the number of voice calls is obtained by estimating average call durations for each type of call
- The **number of call attempts** is derived by multiplying the number of voice calls with an average number of call attempts per successful call
- The **number of occupancy minutes** is determined by assuming answered call set-up time and unanswered call duration
- The annual occupancy minutes and call attempts are converted into **busy-hour kbit/s (BH kbit/s)** and **busy-hour call attempts (BHCA)** using appropriate busy-hour parameters and conversion ratios

Busy-hour traffic is then re-organised into network services traffic

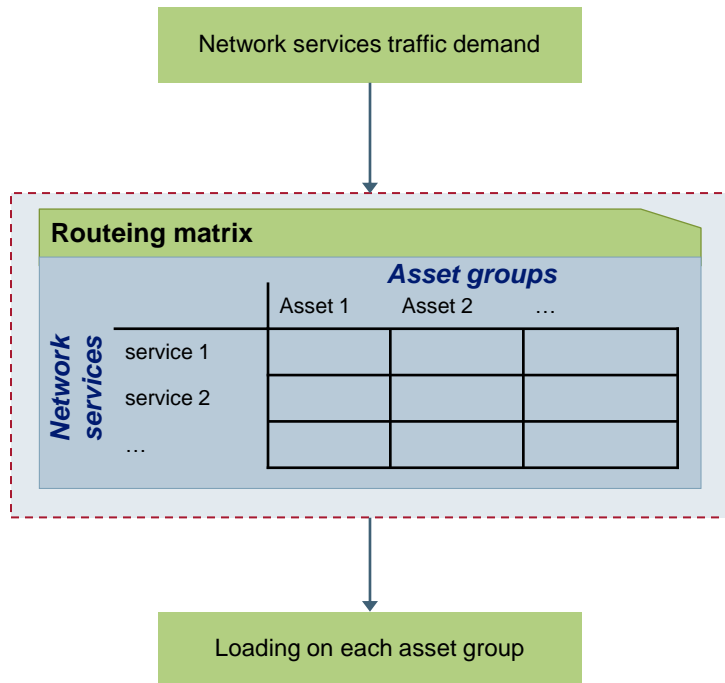
Network services traffic conversion



- **On-net** traffic is divided into two categories:
 - **regional** on-net calls, switched/routed at one core node
 - **national** on-net calls, switched/routed at two core nodes
 - localisation factors are used to take into account the greater likelihood to call someone in the same region
- **Outgoing** traffic is similarly divided into two categories
- The NGN interconnection **SS7 and SIP** network services are modelled separately using a SS7 → SIP migration profile

Finally, a routing matrix converts network services traffic into network loading by asset groups

Network loading conversion



- The routing matrix specifies the load of each service on each network asset group
- A snapshot of part of the routing matrix is shown below

Screenshot of routeing matrix

Network services	Nodes routing	IP Distribution transmission	IP Core transmission
		EthSw-SR	SR-SR
NGN Regional on-net calls	AGW-EthSw-SR-EthS	2	-
NGN National on-net calls	AGW-EthSw-SR-SR-E	2	1
spare	spare	-	-
NGN Regional outgoing calls	AGW-EthSw-SR...	1	-
NGN National outgoing calls	AGW-EthSw-SR-SR..	1	1
spare	spare	-	-
NGN Outgoing ss7 leg	...-SBC-<c>-TGW-oth	-	-
NGN Outgoing SIP leg	...-SBC-PR-other ope	-	-
spare	spare	-	-
NGN Regional incoming calls	...SR-EthSw-AGW	1	-
NGN National incoming calls	...SR-SR-EthSw-AGW	1	1

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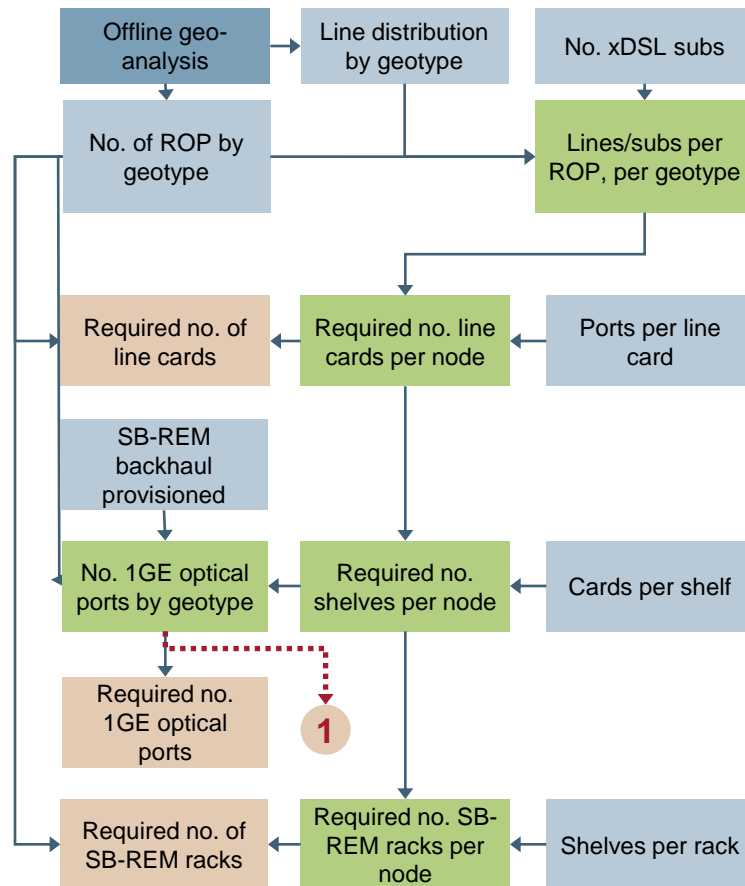
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SB-REM deployment

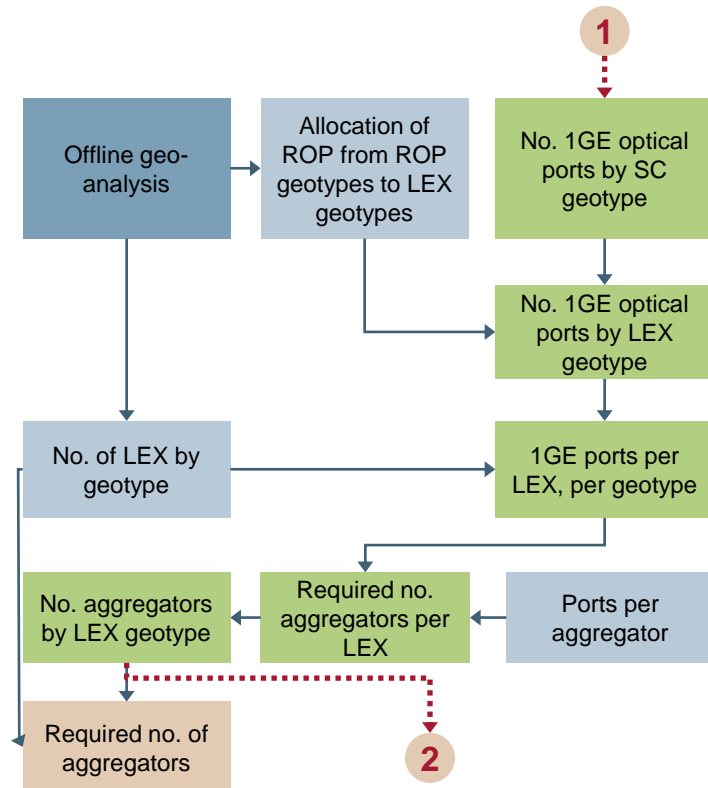
Calculation of the required number of line cards and SB-REM racks



- The number of DSL subscribers drives the required number of DSL ports, taking into account the line share of each node type
- A Monte Carlo factor is added to take into account the variability in exchange size
- Based on line card size, shelf space and rack space, the total number of line cards and SB-REM racks per node is calculated
- Multiplying these with the total number of ROP gives the total number of line cards and SB-REM racks required
- 1GE optical ports are used to connect each SB-REM shelf to an aggregator

SB-REM aggregators deployment

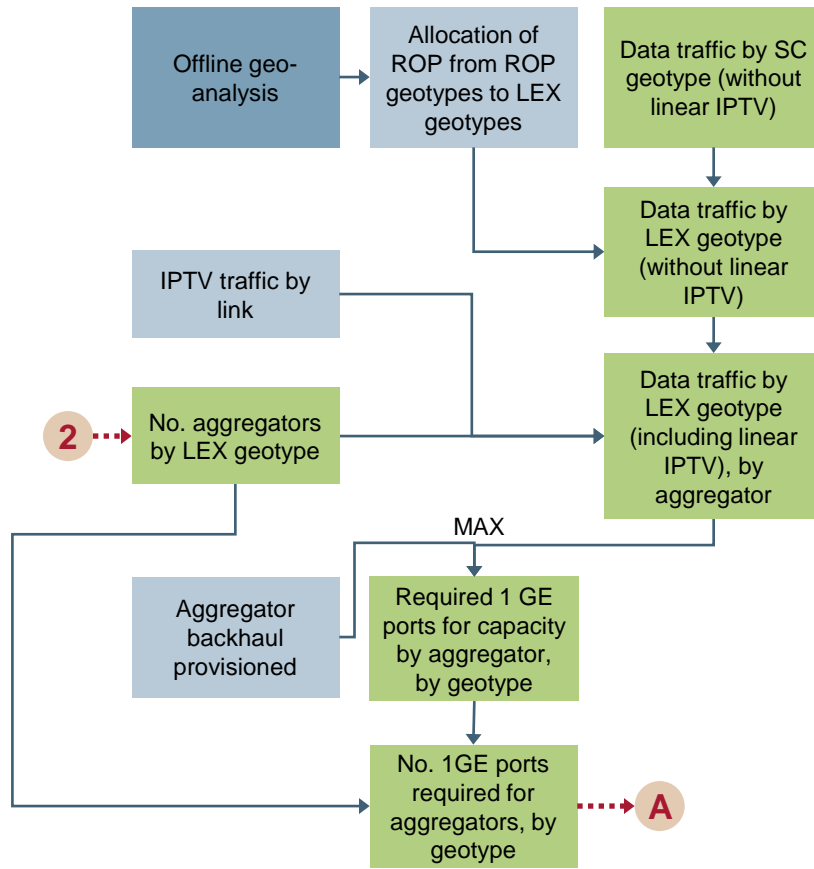
Calculation of the required number of SB-REM aggregators



- The number of aggregators-facing ports on SB-REM by SC geotype is reallocated by LEX geotypes using the appropriate allocation matrix to determine the number of SB-REM facing ports by LEX geotype
- This number is then divided by the number of LEX by geotype to obtain an average number of ports by LEX, by geotype
- Based on the number of ports by aggregator, a number of aggregators per LEX, by geotype, is calculated
- Multiplying these with the total number of LEX, by geotype, gives the total number of aggregators required

SB-REM aggregators core-facing ports

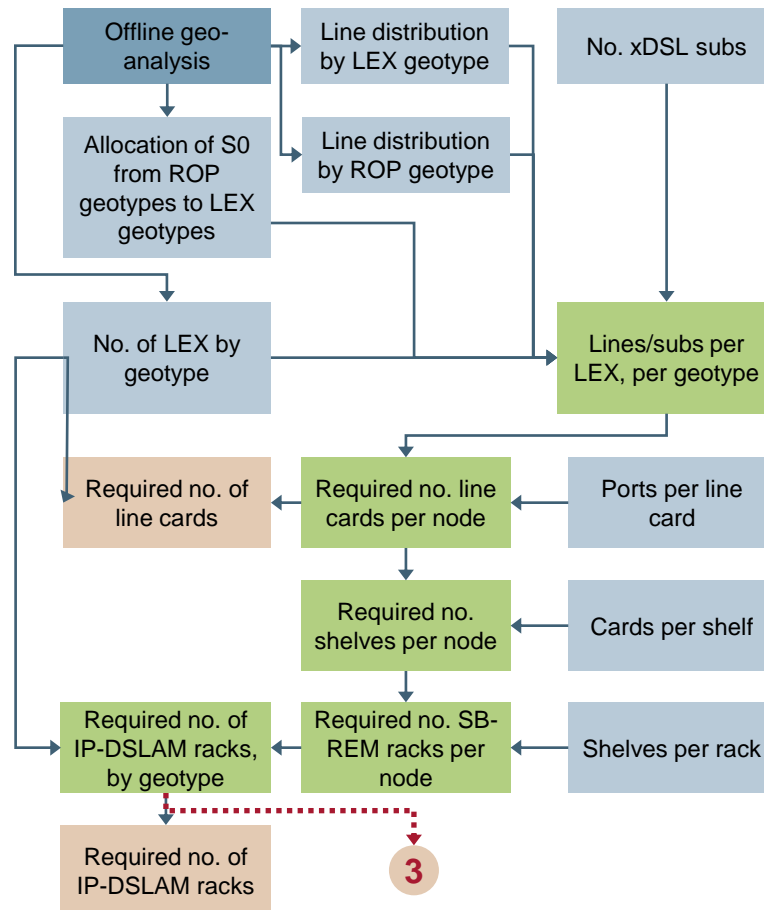
Calculation of the required number of SB-REM aggregators core-facing ports



- The data traffic (without linear IPTV) by SC geotype is reallocated to LEX geotypes using the appropriate allocation matrix to determine the data traffic (without linear IPTV) by LEX geotype
- This number is then divided by the number of aggregators by LEX geotype, and the linear IPTV traffic is added, to obtain an average data traffic (including IPTV) by aggregator, by LEX geotype
- A maximum of the backhaul provisioned by aggregator and the number of 1GE ports required for capacity is then used to determine the number of 1GE ports by aggregator, by geotype
- This number is finally multiplied by the number of aggregators by LEX geotype to determine the number of 1GE core-facing ports by LEX geotype

IP-DSLAM deployment

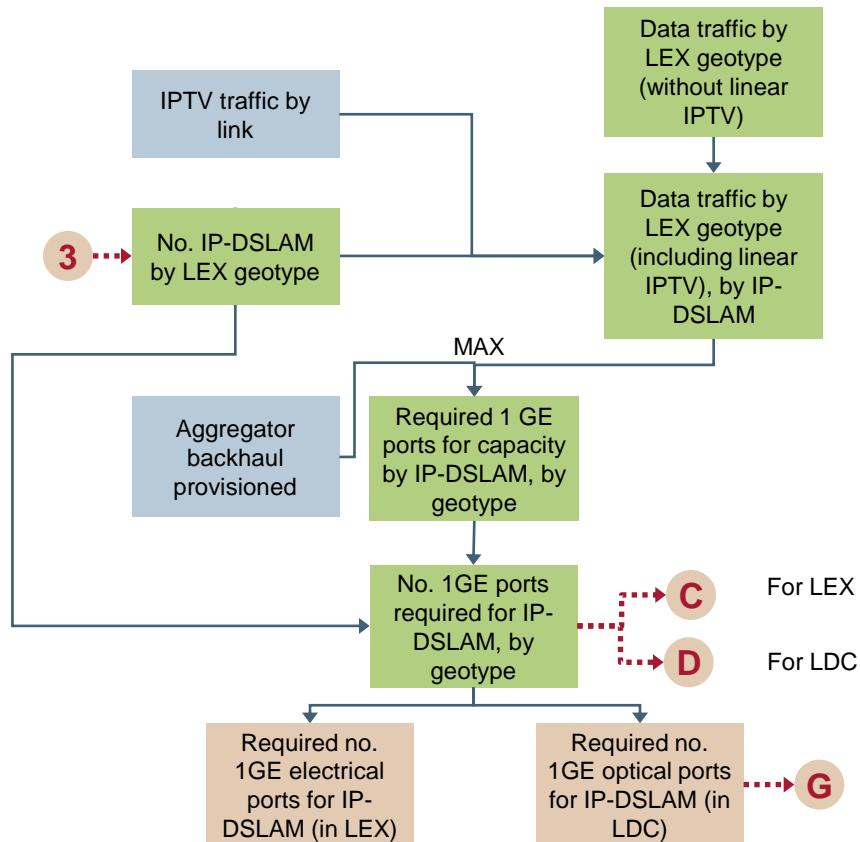
Calculation of the required number of line cards and IPDSLAM racks



- The number of xDSL subscribers connected to an S0 (SC not yet migrated to a ROP), which is itself connected to a LEX, is reallocated to LEX geotypes, added to the subscribers directly connected to the LEX, and the total is divided by the number of LEX to obtain the number of lines/subscribers by LEX, by geotype
- The number of ports per line card, cards per shelf and shelves per rack, and their utilisation factor are then used to calculate the number of line cards, shelves and racks per LEX. A Monte Carlo input is used for line cards and shelves to take into account the variability in exchange size
- Line cards and racks per LEX are then multiplied by the number of LEX, by geotype, to obtain the total number of line cards and racks required for LEX
- The exact same calculations are run for xDSL subscribers directly connected to an LDC or an S0 connected to an LDC
- The required number of line cards and racks for LEX and LDC are finally added together to obtain the total number of line cards and IP-DSLAM racks required

IP-DSLAM core-facing ports

Calculation of the required number of IP-DSLAM core-facing ports

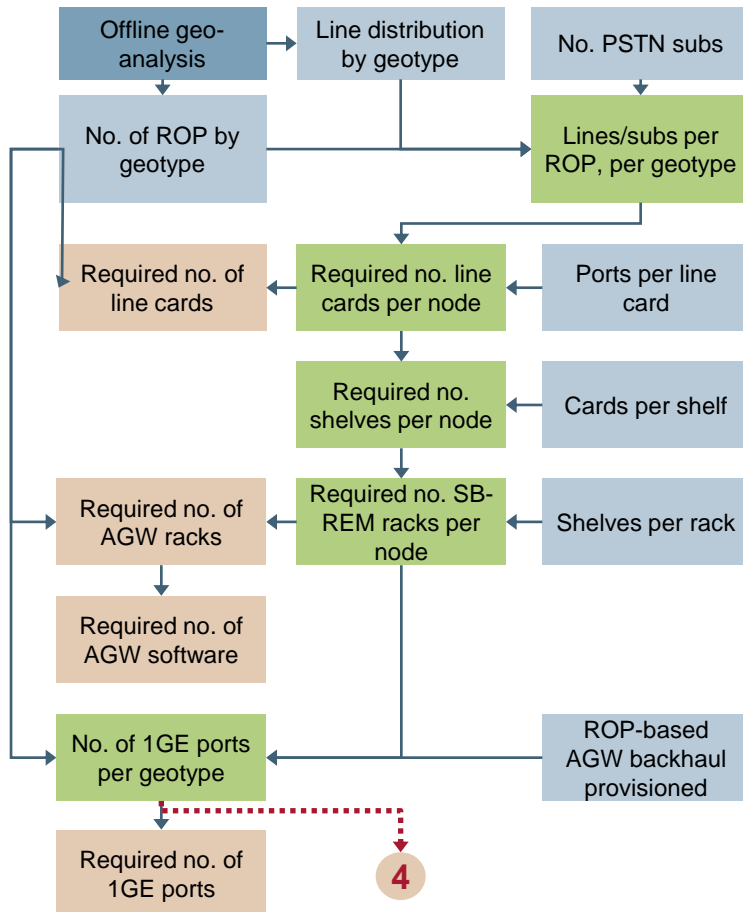


- The data traffic by geotype is divided by the number of IP-DSLAMs by geotype, and the linear IPTV traffic is added, to obtain an average data traffic by IP-DSLAM, by geotype
- A maximum of the backhaul provisioned by IP-DSLAMs and the number of 1GE ports required for capacity is then used to determine the number of 1GE ports by IP-DSLAM, by geotype
- This number is finally multiplied by the number of IP-DSLAMs by geotype to determine the number of 1GE core-facing ports by geotype
- This set of calculations is built twice, first for IP-DSLAM in LEX and then for IP-DSLAM in LDC

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ROP-based AGW deployment

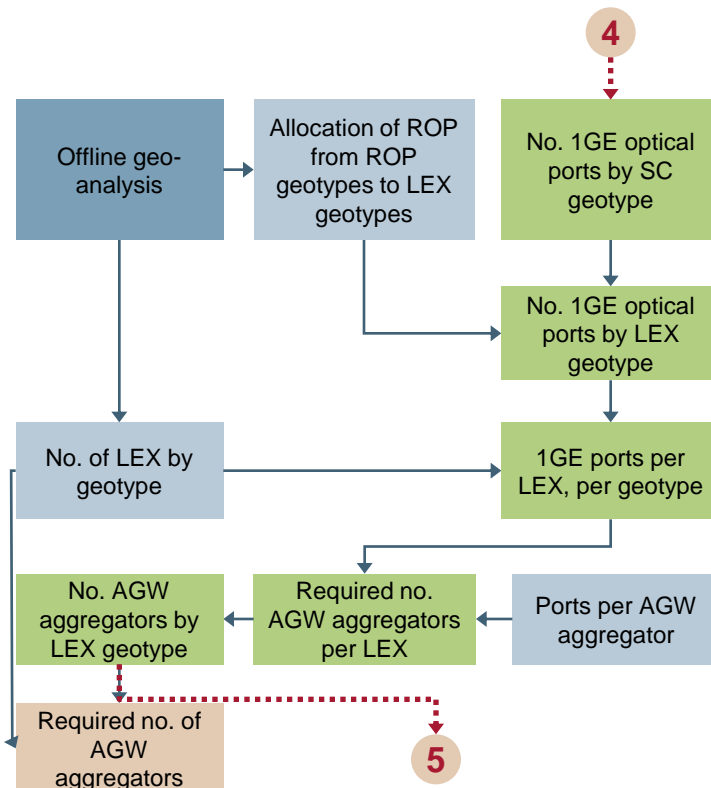
Calculation of the required number of line cards and ROP-based AGW racks and software



- ROP-based AGW line cards and racks are calculated in the same way as SB-REM line cards and racks are
- The differences are:
 - the number and distribution of PSTN lines is used instead of xDSL
 - the number and utilisation of ports per line card and shelves per rack
- A 1GE optical port is required for each rack, whereas it was for each shelf for SB-REM
- A software asset is required for each rack deployed

Deployment of AGW aggregators

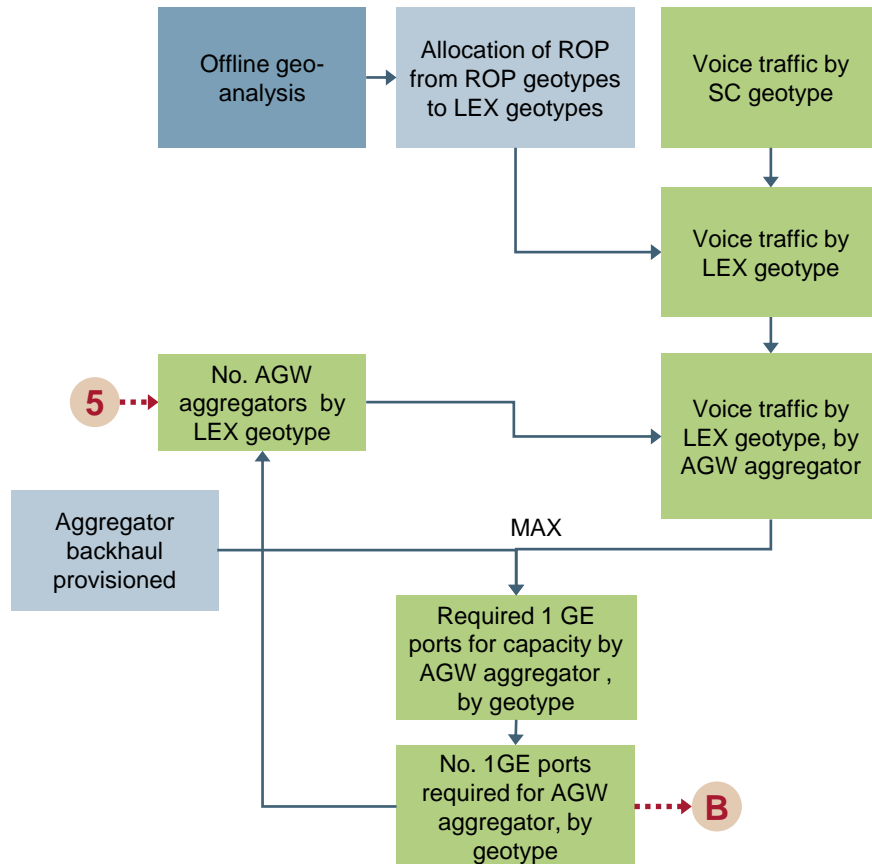
Calculation of the required number of AGW aggregators



- The deployment of AGW aggregators is determined in the same way as the deployment of SB-REM aggregators
- The number of AGW aggregators-facing ports on ROP-AGW by SC geotype is reallocated by LEX geotype using the SC-to-LEX allocation matrix described previously to determine the number of ROP-AGW-facing ports by LEX geotype
- This number is then divided by the number of LEX by geotype to obtain an average number of ports by LEX, by geotype
- Based on the number of ports by AGW aggregators, a number of aggregators per LEX is calculated
- Multiplying these by the total number of LEX, by geotype, gives the total number of AGW aggregators required

AGG aggregators core-facing ports

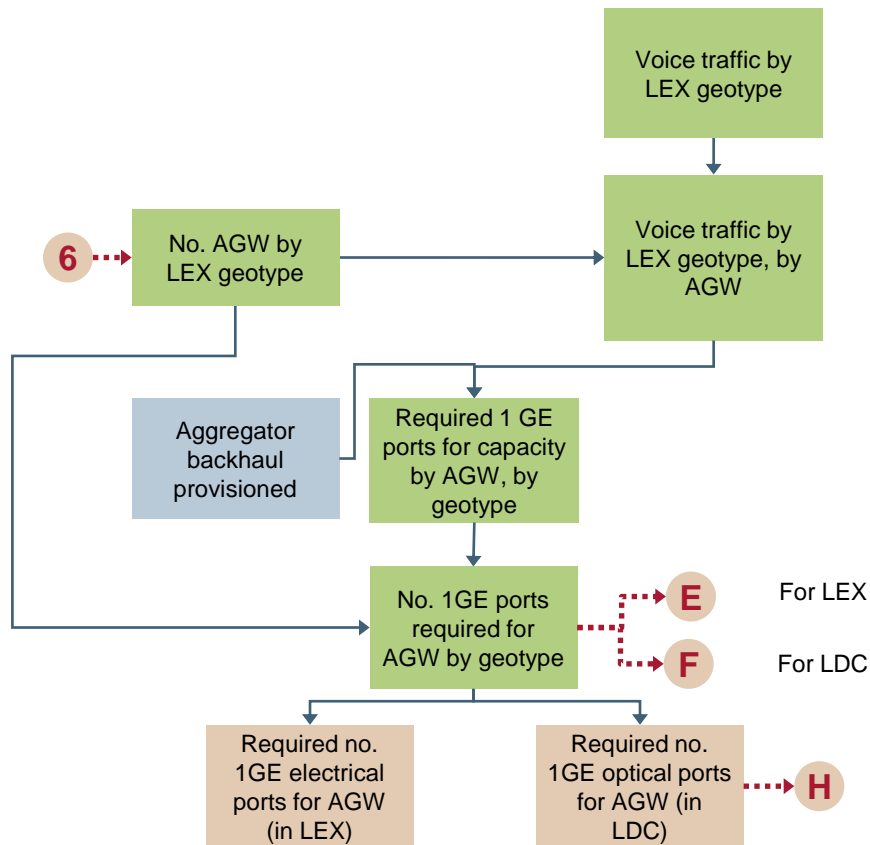
Calculation of the required number of AGW aggregators core-facing ports



- The number of AGW aggregators core-facing ports is calculated in the same way as the number of SB-REM aggregators core-facing ports, but using voice traffic instead of data traffic (and therefore ignoring linear IPTV)
- The voice traffic by SC geotype is reallocated by LEX geotype using the appropriate allocation matrix to determine the voice traffic by LEX geotype
- This number is then divided by the number of AGW aggregators by LEX geotype to obtain an average voice traffic by AGW aggregator, by LEX geotype
- A maximum of the backhaul provisioned by AGW aggregator and the number of 1GE ports required for capacity is then used to determine the number of 1GE ports by AGW aggregator, by geotype
- This number is finally multiplied by the number of AGW aggregators by LEX geotype to determine the number of 1GE core-facing ports by LEX geotype

Exchange-based AGW core-facing ports

Calculation of the required number of AGW core-facing ports

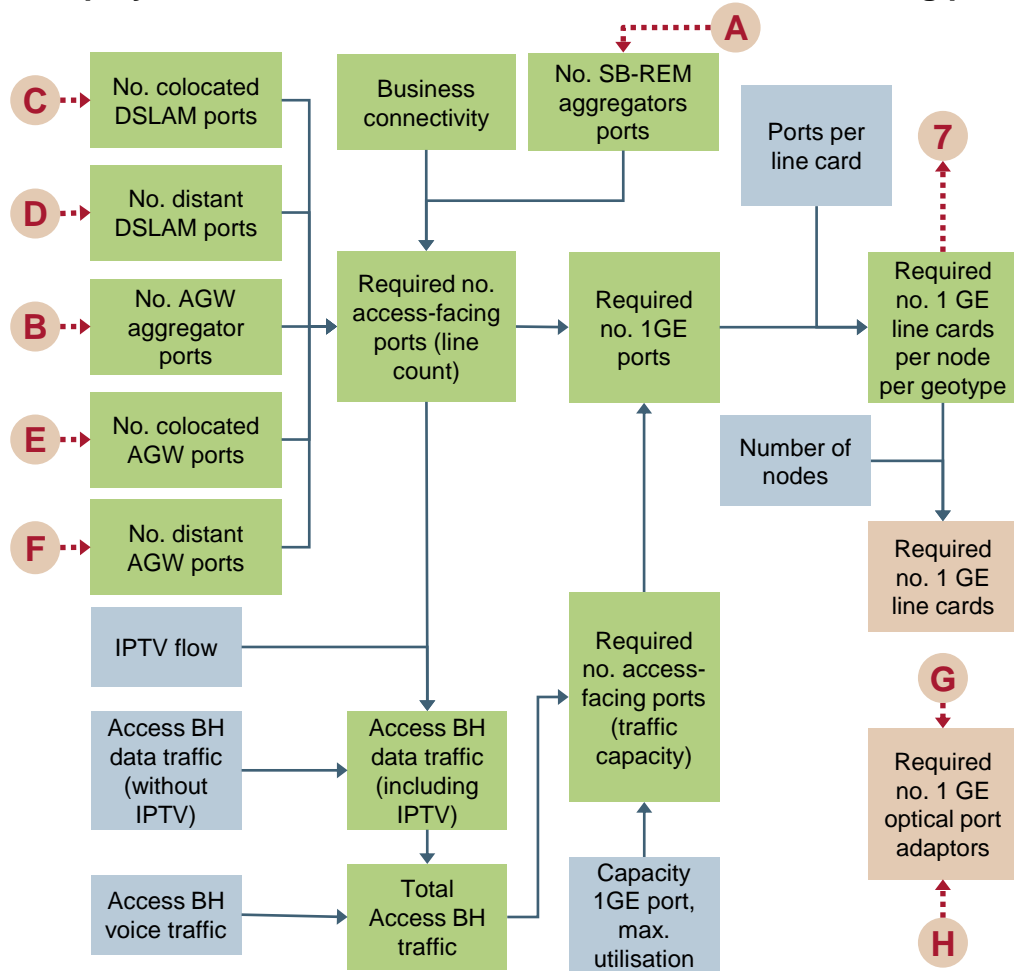


- The number of AGW core-facing ports is calculated in the same way as the number of IP-DSLAM core-facing ports, but using voice traffic instead of data traffic (and therefore ignoring linear IPTV)
- The voice traffic by geotype is divided by the number of IP-DSLAMs by geotype to obtain a voice traffic by AGW, by geotype
- A maximum of the backhaul provisioned by aggregator and the number of 1GE ports required for capacity is then used to determine the number of 1GE ports by AGW, by geotype
- This number is finally multiplied by the number of AGW by geotype to determine the number of 1GE core-facing ports by geotype
- This set of calculations is built twice, first for AGW in LEX and then for AGW in LDC

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Deployment of Ethernet switch access-facing ports and line-card count

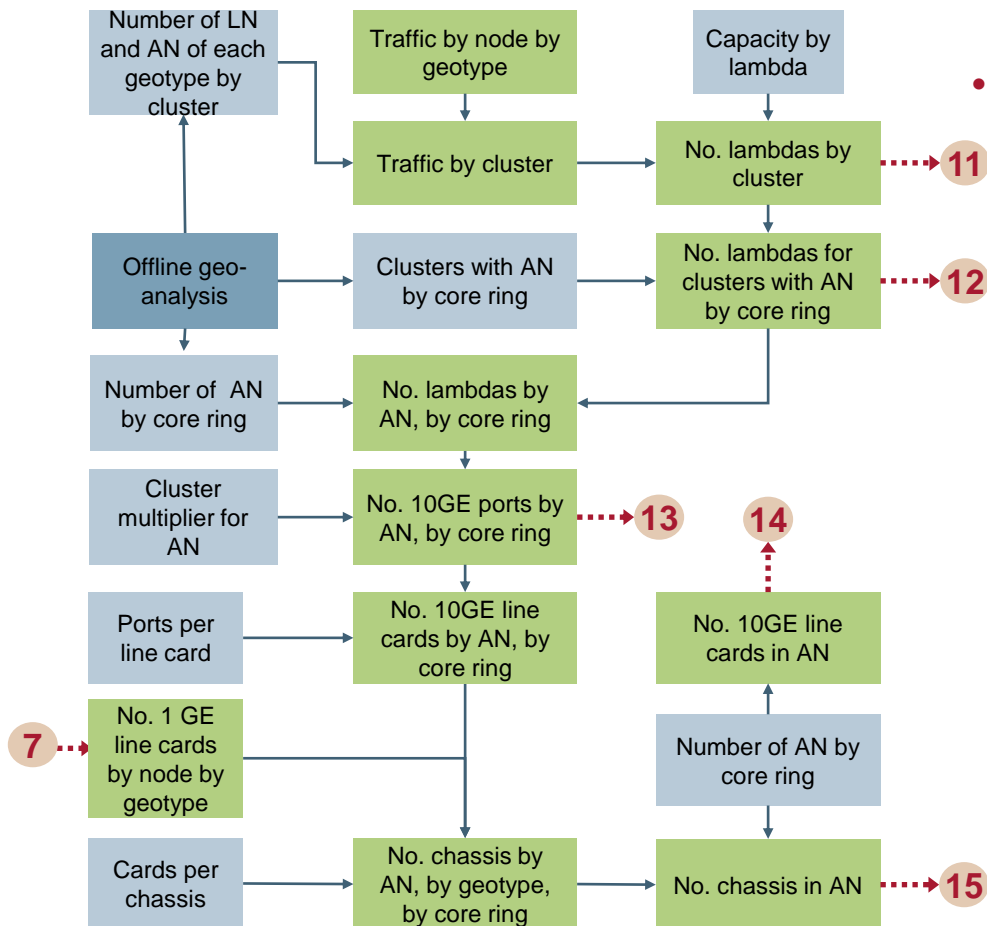
Deployment calculations for Ethernet switch access-facing ports



- The required number of 1GE access-facing ports (and cards) on the aggregation switches is initially determined by:
 - the number of IP-DSLAMs and AGW racks and SB-REM/AGW aggregators deployed – each requires at least a 1GE port on the aggregation switch
 - depending on geotype, an additional 1GE port may be deployed to support business connectivity
- In the case where total traffic on the access exceeds the capacity offered by the number of ports calculated, the required number of ports is driven by total traffic (capacity-driven) instead of by the number of IP-DSLAMs and AGW racks, and SB-REM/AGW aggregators, and business connectivity (count-driven)

Deployment of Ethernet switch cluster-facing ports and line-card/chassis count in AN

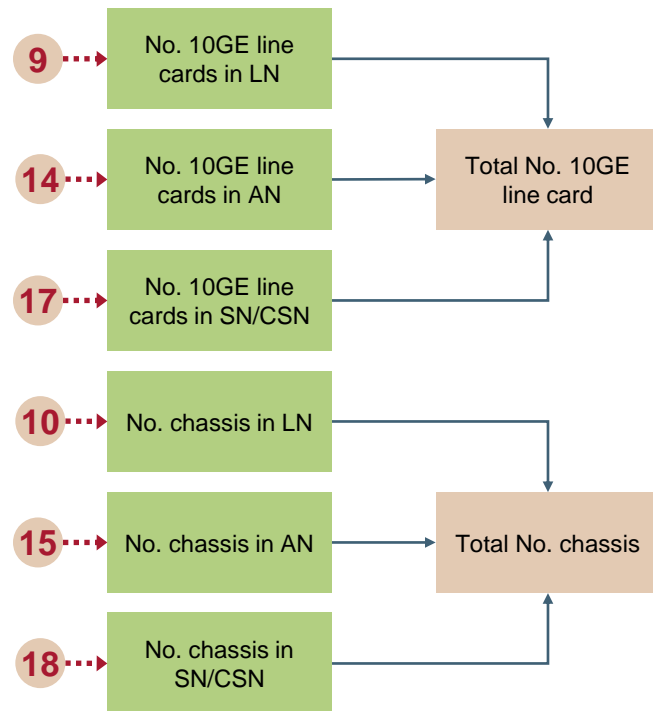
Cluster-facing ports in AN



- The number of 10GE cluster-facing ports by node for AN is determined based on the number of lambdas for clusters with AN on each core ring
- It then follows the same type of calculations used to determine the number of line cards and chassis for LN, but does this by core ring rather than by geotype

Ethernet switch total line cards and chassis count

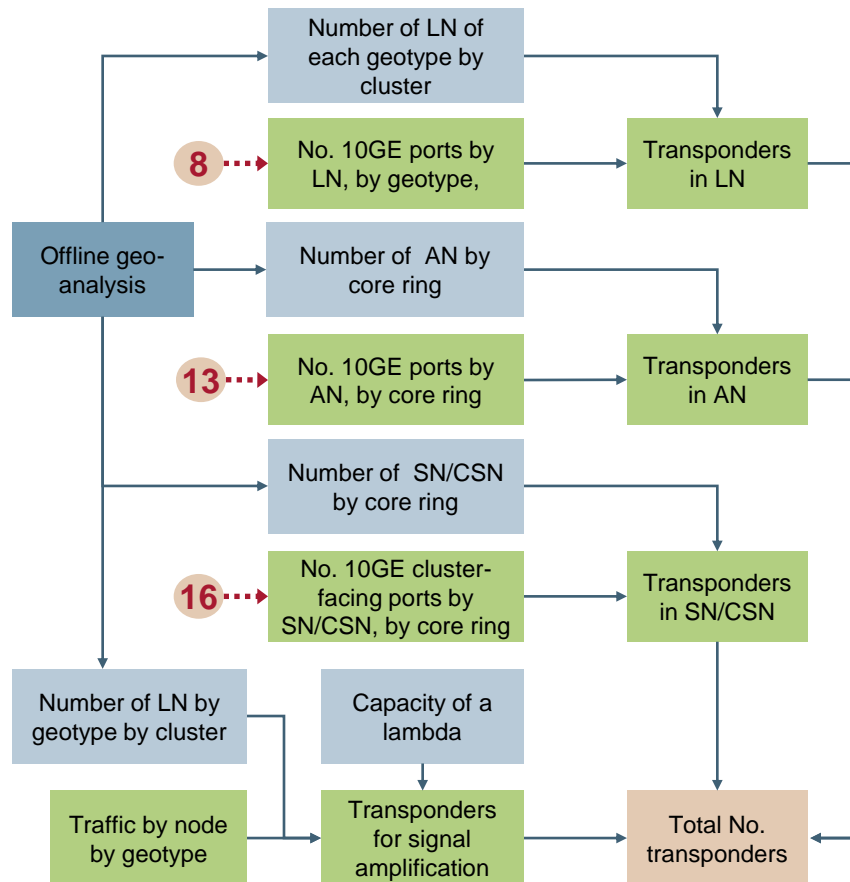
Ethernet switch line cards and chassis count



- Finally, the 10GE line cards and chassis counts of LN, AN and SN/CSN are added together to give the total number of 10GE line cards and chassis in Ethernet switches

Transponders in clusters

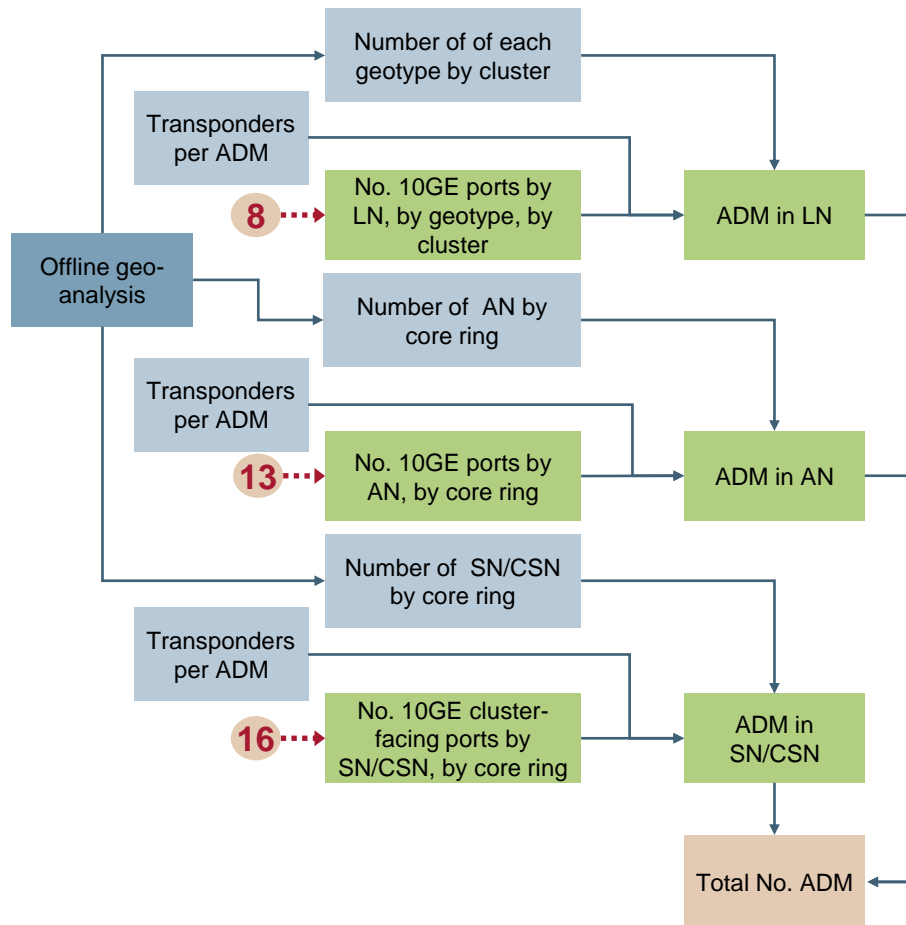
Transponders calculations



- One transponder is needed for each 10GE cluster-facing port of the Ethernet switches
- The number of LN, AN and SN/CSN is therefore multiplied by the relevant number of ports for each of these nodes (based on geotype and cluster or core ring) to obtain the number of transponders by type of node
- Additionally, transponders for signal regeneration (after eight LEX where a lambda does not go through the switch) are added to obtain the total number of transponders

ADM in clusters

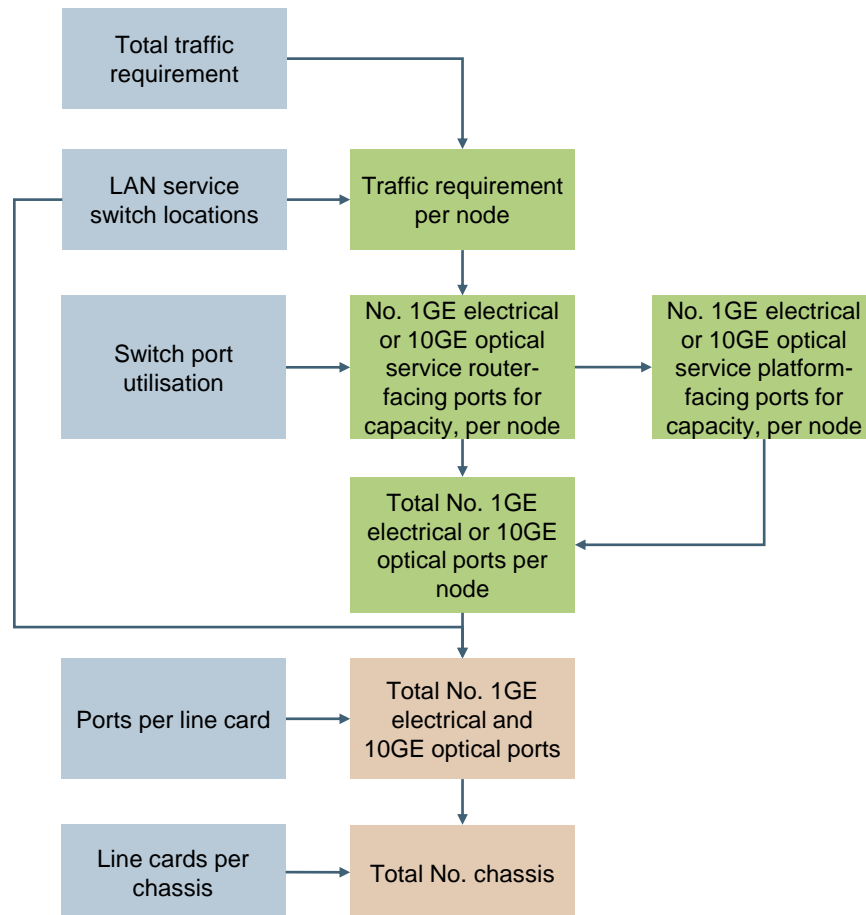
Transponder calculations



- The number of ADM required is calculated using a similar method as for transponders, but also taking into account the number of transponders that can fit on an ADM

LAN service switch units calculation

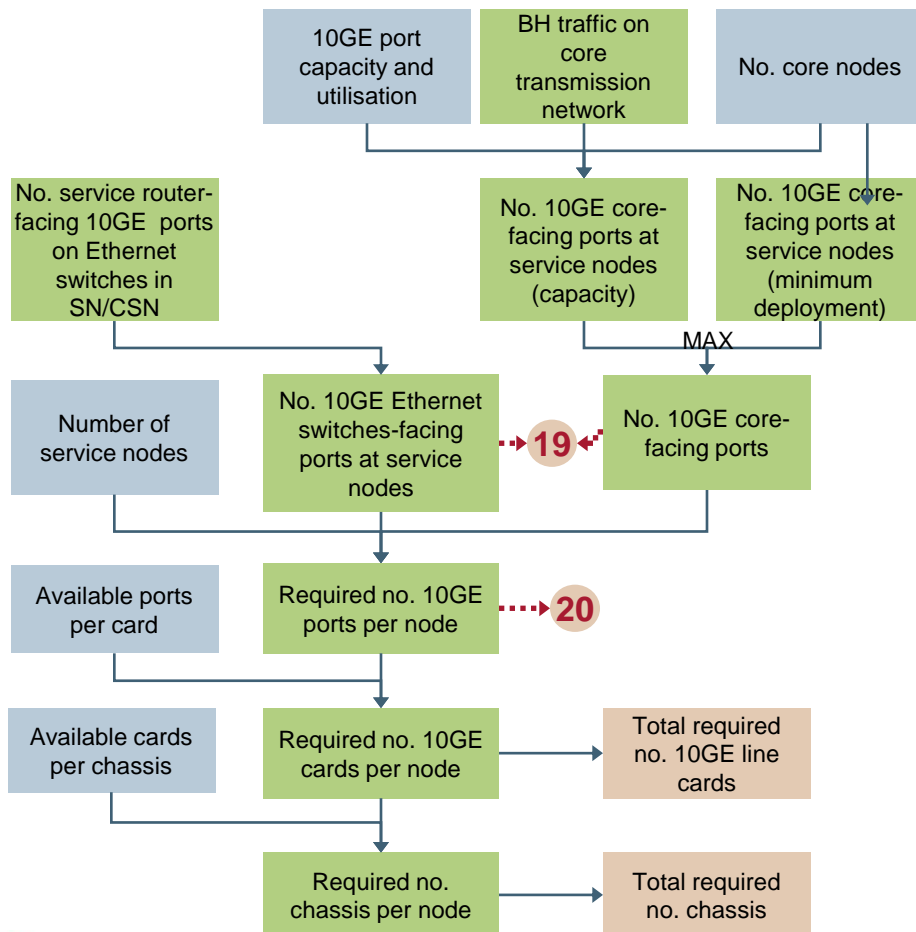
Calculation of LAN service switch units



- The total traffic requirement from services towards service routers is calculated by adding the xDSL, VoD and IPTV requirements
- A number of 1GE electrical or 10GE optical service router-facing ports is determined from the total traffic requirement, with a maximum of 2500Mbit/s to use 1GE ports, and 10GE ports used above this threshold
- The number of service platform-facing ports is identical to the number of service router-facing ports
- They are added to obtain a total number of ports on the LAN switch
- Line cards and chassis are then calculated based on ports per 1GE line card, ports per 10GE line card and line cards per chassis

Service router deployment

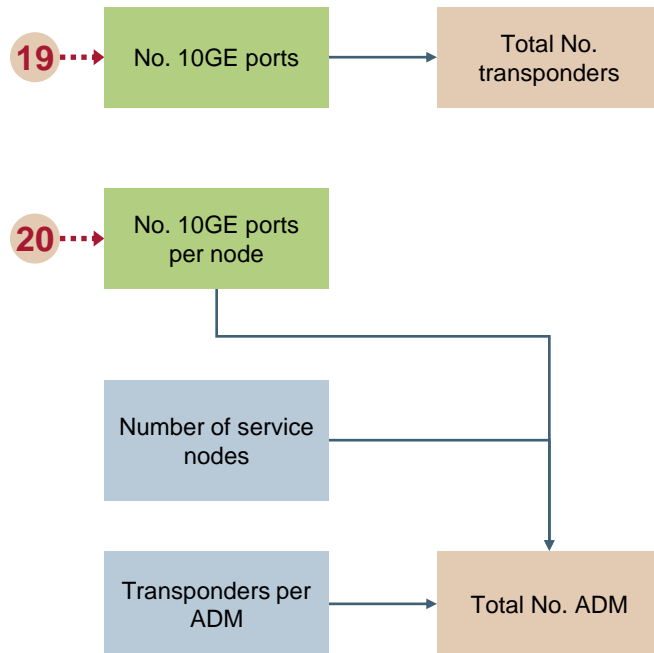
Calculation of the required number of service router ports and chassis



- Service routers are located in each of the 10 SN/CSN
- The deployment of core routers is driven by:
 - the number of Ethernet switches-facing ports at service nodes, which is equal to the number of service router-facing 10GE ports on Ethernet switches
 - the number of ports to other service routers, determined by core network traffic, 10GE port capacity, percentage of port utilisation, ports per card, and cards per chassis

Transponders and ADM for service routers

Transponders and ADM calculations



- One transponder is required for every 10GE port
- One ADM is required for every 40 transponders in each service node

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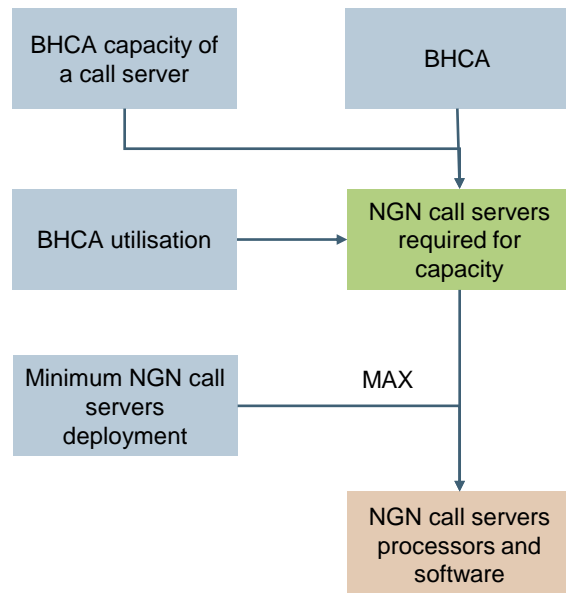
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NGN call servers

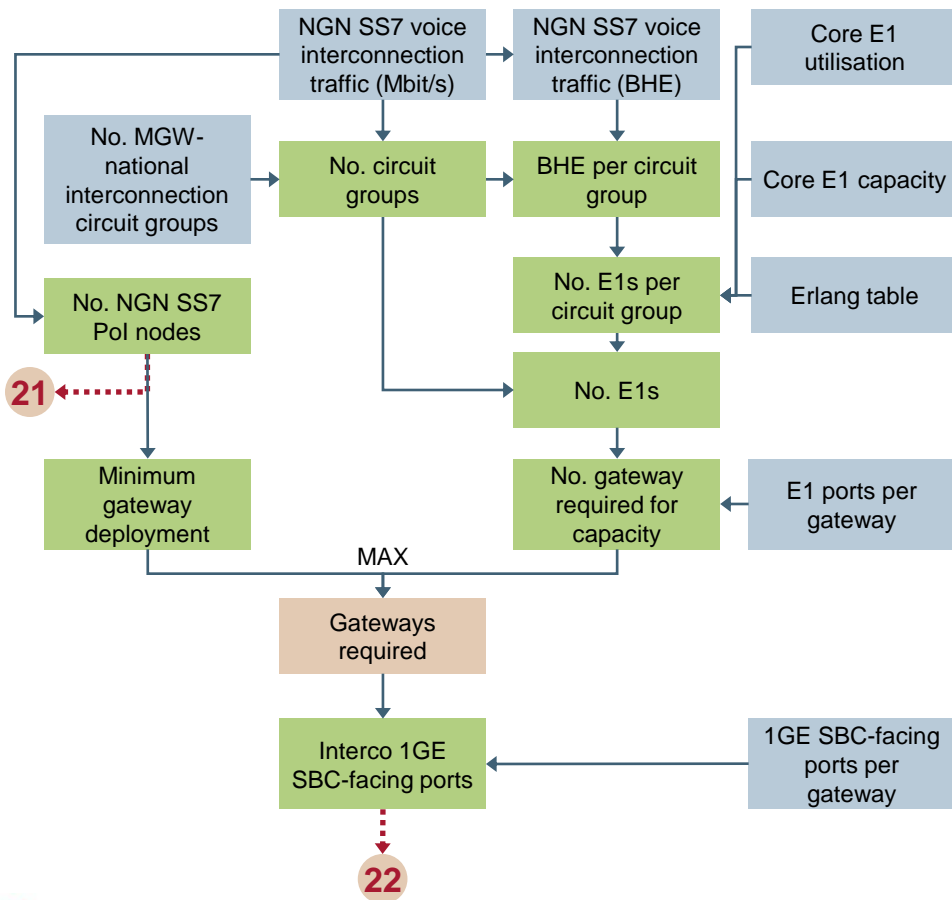
Calculation of NGN call servers



- A required number of call servers for capacity is calculated based on the BHCA, the BHCA capacity of a call server, and the BHCA utilisation of a call server
- The maximum of this value and of a minimum deployment (two) then gives the number of NGN call servers processors and software

Deployment of trunk gateways

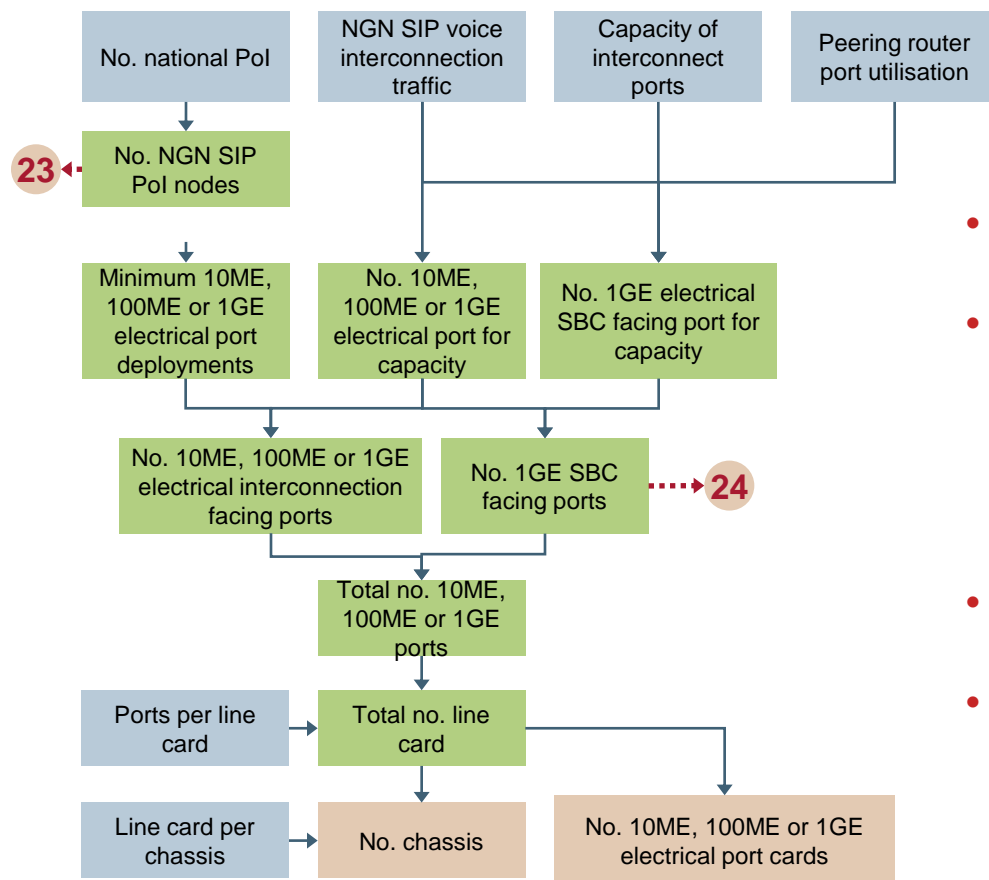
Trunk gateways



- A minimum of one gateway is required for each NGN SS7 Pol node
- Additional gateways are installed to accommodate interconnection traffic requirements. This is driven by:
 - NGN SS7 interconnection traffic
 - core E1 capacity and utilisation
 - E1 ports per gateway
- The number of 1GE SBC-facing ports can be obtained by assuming an average number of equipment per gateway

Deployment of peering routers

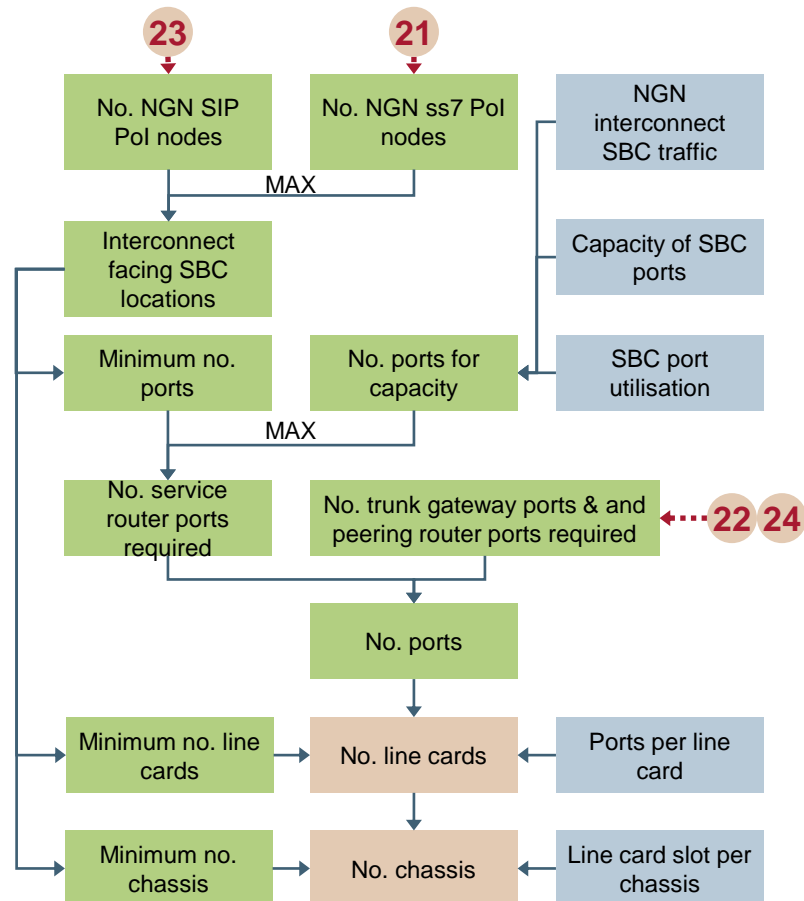
Deployment calculation of peering routers



- Depending on the user's choice, one of the following three types of electrical ports are considered:
 - 10Mbit/s
 - 100Mbit/s
 - 1Gbit/s
- A minimum of one peering router is required for each NGN SIP Pol node
- Additional peering routers are installed to accommodate interconnection traffic requirements. This is driven by:
 - NGN SIP interconnection traffic
 - interconnection port capacity
 - peering router port utilisation
- The number of electrical port cards can be obtained from the number of ports per line card
- Finally, the number of chassis can be calculated from the number of line cards per chassis

Deployment of interconnect-facing SBCs

Calculation of interconnect-facing SBCs



- Interconnect-facing SBCs are present at all points of interconnection
- SBC capacities are driven by SBC-routed interconnect voice traffic (outgoing, incoming and transit voice), assuming:
 - 1GE ports
 - minimum deployment of one port per SBC location
- The total number of ports required is the sum of:
 - the number of service router ports required
 - the number of trunk gateway ports required
 - the number of peering router ports required
- After obtaining the number of ports, the number of line cards and chassis can be obtained by assuming
 - two ports per card
 - two line cards per chassis
 - minimum deployment of one card/ one chassis per SBC location

Other elements

<i>Elements</i>	<i>Drivers</i>
Broadband remote access server (BRAS) units required per subscriber	xDSL connections, percentage of users online at the same time, BRAS utilisation factor and capacity
Domain name system (DNS)	Number of core IP nodes, minimum number of DNS per node
Remote authentication dial-in user server (RADIUS)	xDSL connections, percentage of users online at the same time, RADIUS utilisation factor and capacity
Network management system (NMS)	Number of types of network element, NMS required per type of network element
Clock system	Number of core nodes

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The model assumes that a FTTC/VDSL network is deployed and used to carry various NGA services

- **Architecture:**

- FTTC-VDSL technology using a new ROP is forecast to cover at least 85% of the population in Belgium
 - some locations served directly from the fibre node at the LEX/LDC without an intermediate street cabinet
- the modelled approach for copper distribution (i.e. copper between the street cabinet and the house) is as follows: fully buried copper cables with splices; no intermediate distribution points; direct and return copper path options
- FTTO on feeder network
- VoIP solution based on AGW in the ROP

- **Access geotyping:**

- dependent on the information included in BIPT's previous bottom-up access model and data available at the street-cabinet level

- **NGA Services:**

- retail and wholesale end-user access - voice, DSL, Fiber To The Office (FTTO)
- full and shared local loop unbundling (LLU) and sub-loop unbundling (SLU)
- leased/other access lines

Some key aspects of the modelled architecture have been modified since the industry presentation in May

- We have not adopted a multiple geotype model for the access network:
 - instead, we have modelled the national scale deployments based upon previous BIPT calculations for the number of kilometres of trench and cable in the feeder and distribution networks
- The adopted VoIP solution is linked to the evolution of Belgacom's PSTN-to-VoIP (access gateway) solution:
 - the active voice gateway equipment is located in the core calculation model (in the LEX/ROP)

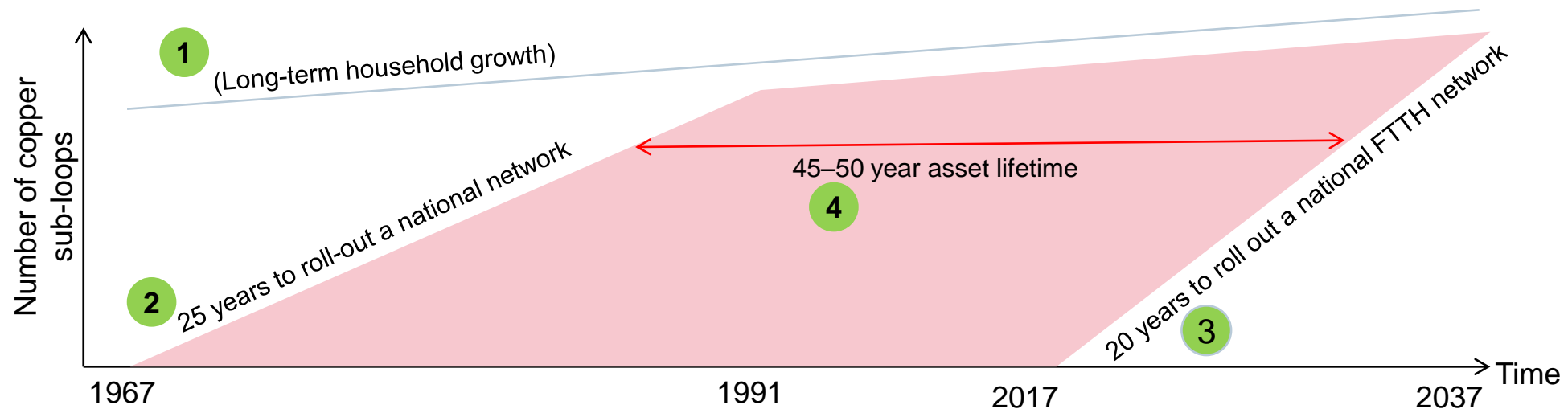
The new model takes inputs from the bottom-up access model built for BIPT in 2007

- The bottom-up access network model developed for BIPT in 2007:
 - was originally developed using a detailed bottom-up design algorithm
 - it calculated the volume (km and units) of copper and feeder trench, cable and splice assets using bottom-up geo-modelling
 - it was 'efficient' in comparison to Belgacom's actual copper access inventory
 - has been updated since 2007 with asset price indexes, volumes, weighted average cost of capital (WACC), very high bit-rate digital subscriber line (VDSL), etc.
- Our bottom-up calculation takes a number of inputs from the previous access model:
 - efficient deployment of kilometres of trench and cable
 - efficient number of cable splices
 - starting costs for installation and equipment
- We have not re-calculated a bottom-up geo-modelling of Belgacom's distribution and feeder network; instead, we rely on this previous work for important deployment quantities

The access model calculates costs across the entire deployment of network access assets for a single (long) period of operation

- Belgacom's access network consists of network elements with generally long lifetimes:
 - it is sometimes hard to establish a firm lifetime because assets have yet to be replaced
 - for example, some copper cables buried in the 1960s are still working (lifetime of 50+ years)
 - other copper cables deployed in the year 2000 are likely to be replaced with fibre before a 50-year period is complete
 - the modern equivalent asset of copper is not copper but fibre (therefore, the current – high – price of copper does not determine the replacement cost of the entire copper network)
 - therefore, modelling discrete, specified asset lifetimes and replacement costs is not appropriate
- Instead, the access model calculates costs across the entire deployment of network access assets for a single (long) period of operation. This relies upon:
 - a roll-out profile to reach full deployment of the legacy copper access network
 - plus extension of the copper network to account for long-term household growth in Belgium
 - a close-down profile which defines when the assets are to be retired (e.g. replaced by FTTH or something similar)
 - the costs of FTTH are not modelled
- This approach is best explained by the diagram on the following slide

The access module models mostly single-lifetime assets over a full-time period: the example of copper sub-loops



- 1 Steady long-term growth in the number of households in Belgium drives the expansion of Belgacom's copper network
- 2 A simple slope for the roll-out of the asset is assumed (in this case 4% deployment per annum)
- 3 It is assumed that Belgacom's copper network will be replaced by FTTH in the long term (2017–2037, at 5% per annum)
- 4 The actual lifetime of assets is not an input to the model, as most access assets are only deployed once (no replacement, only maintenance)

The full-period single-lifetime model is extended to other network elements, with different roll-outs and shut-downs

	<i>Roll-out years</i>	<i>Shut-down years</i>	<i>Extension</i>	<i>Notes</i>
Copper distribution and main distribution frame (MDF)	1967–1991	2017–2037	With household growth	
Street cabinet	1977–2003 2003–2017	2017–2037 2017–2037		Two generations of SCs are modelled to reflect process of replacement
Copper feeder	With SCs	As AGWs are activated in the ROP		It reduces as the voice gateway moves to ROP
Remote Optical Platform	2005–2011, then slowly to 2015	Not shut-down		It continues to be used as FTTH is deployed
Fibre feeder	With ROPs	Not shut-down		It is also used by other FTTO connections
FTTO/other fibre accesses	2005–2015	Not shut-down		Actual history and forecast of FTTO/other connections
Metallic line testing	With LEX (centralised) and SC (distributed)	With LEX and SC		

The number of elements active in each year is used to calculate capex (investment growth) and opex (expenses)

- The unit capital costs (capex) for each item of equipment are sourced from the previous BRUO model. These are separated into two parts (because of different cost trends):
 - installation costs (e.g. capitalised labour, deployment sub-contracts)
 - materials costs (cables, cabinets, hardware)
- The unit operating expenses (opex) for each item are estimated using a bottom-up approach. These are split into:
 - maintenance events (maintenance time, hourly manpower including allocated overheads, outsource maintenance/contractors, additional materials)
 - space rental (for street cabinets and ROPs)
 - power and aircon (kWh power and W/m² cooling)
- Long-run cost trends determine the underlying trend in these input costs. Typically, all costs are assumed to increase with underlying inflation. In addition, there are some specific (real-terms) trends:
 - installation costs around 0.5% higher than inflation, except trenching, which is around 1% higher
 - materials costs for SCs and ROPs are lower than inflation (by 0.8% and 0.2%, respectively)
 - materials costs for fibre-optic cable and the optical distribution frame (ODF) are much lower than inflation (by 7% to 12%, respectively)
- We have also increased the cost of copper cables by a total of 400% from 2004 to 2008 (*see next slide*)

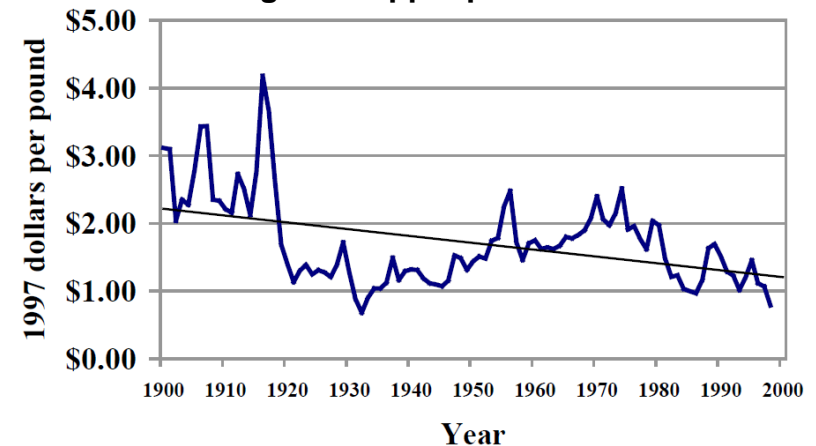
A short-run cost trend is applied to copper cables

- The short-run trend is obtained from recent observed copper prices:
 - this recent trend does not reflect the long-term trend which has been
 - slowly declining in real terms since the 1960s
 - approximately flat in nominal terms across most of the years of copper deployment
- Therefore, the short-run trend is applied to the materials costs of copper, but it is not applied to the economic depreciation of the copper investments:
 - this is because the recent copper cost trend does not represent the MEA price trend (or economic value) of copper
 - the (proportional) component of line rental did not increase by a factor of 4 from 2004 to 2008
 - the price of fibre (the modern equivalent replacement for copper) has not increased by a factor of 4
 - this recent trend is short-run only

Short-run copper price trend



Long-run copper price trend

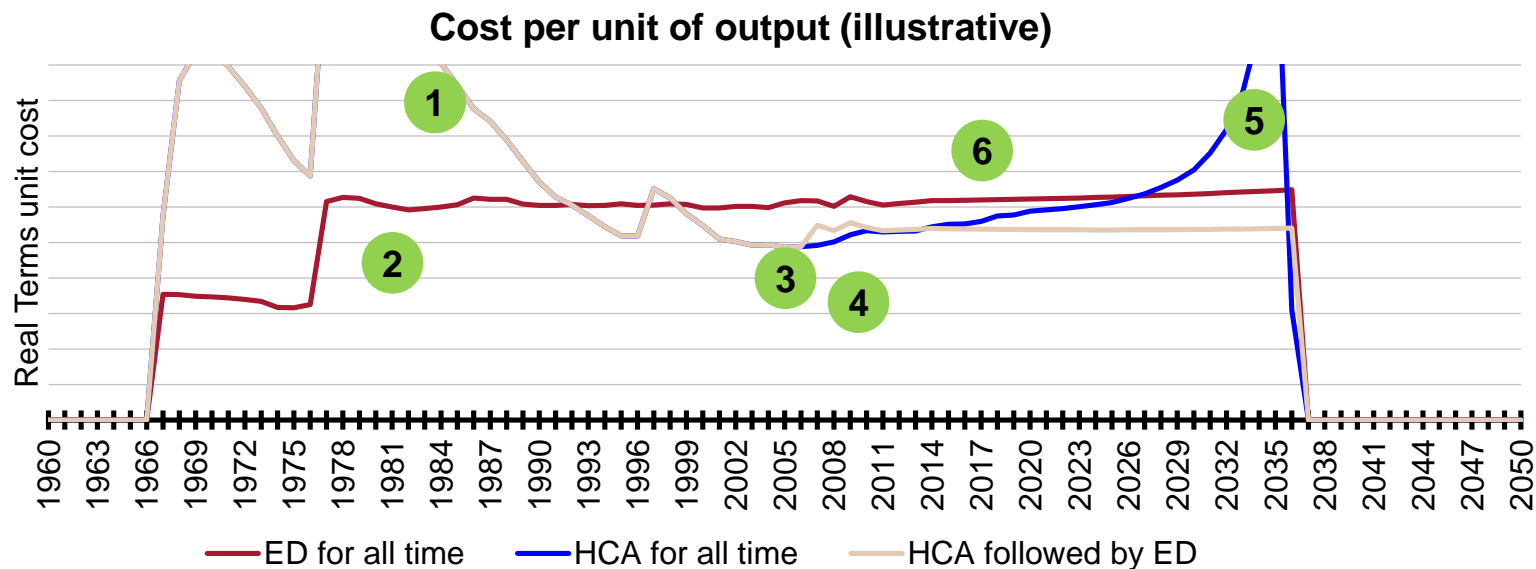


We have modelled the full lifecycle of the copper network in order to apply depreciation over its entire lifetime

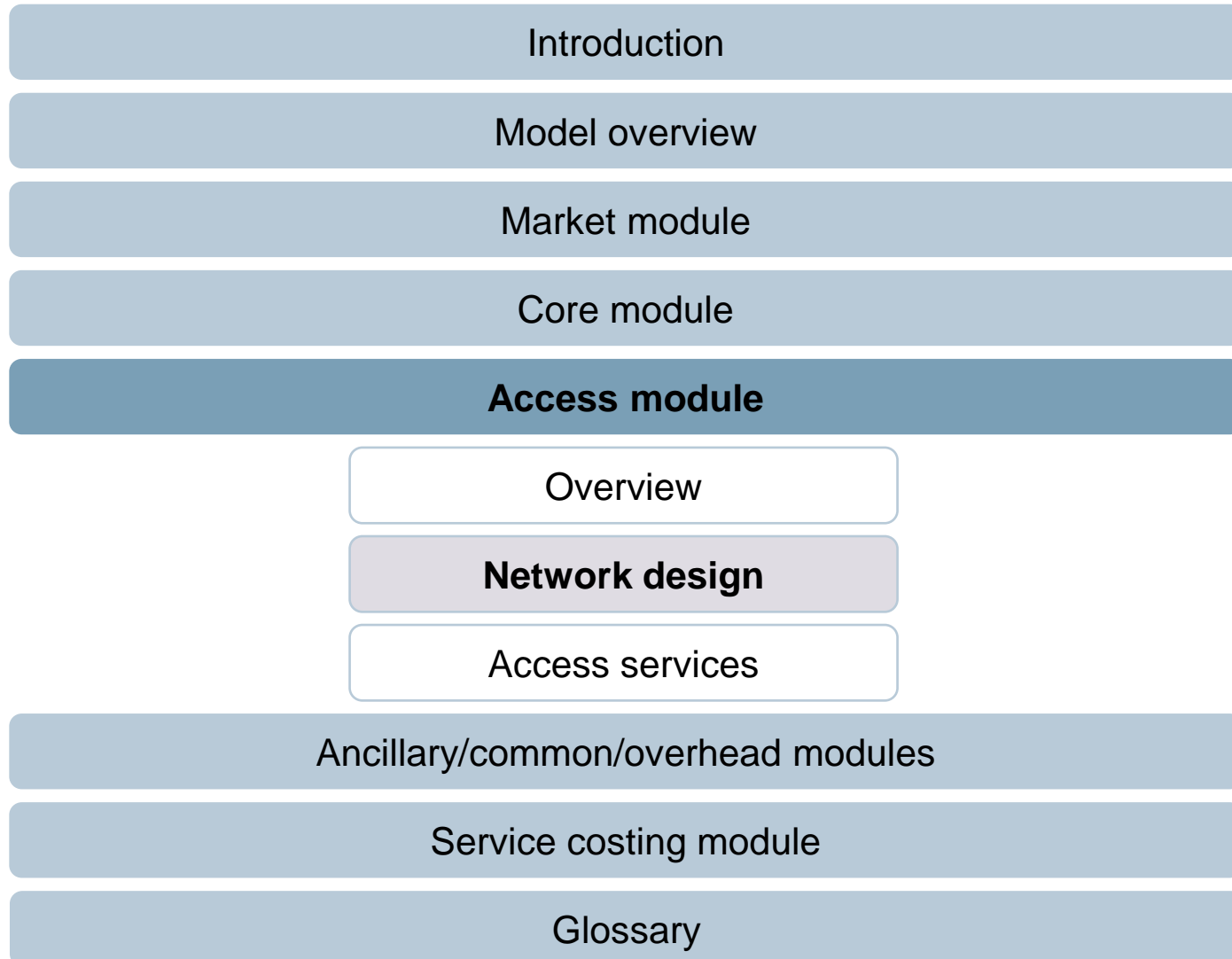
- The investment costs associated with Belgacom's access network are recovered from the output of the network (connected lines) over time
- The copper network is not being replaced with another copper network, therefore its cost recovery should be confined to connected copper lines
- The choice of depreciation method is linked to the way in which the copper access network was deployed:
 - before 1997, investments were undertaken by the Belgian government
 - straight-line accounting depreciation using historical book values was applicable to the business
 - we assume that no return on capital was required for this period (immediately sunk investments)
 - we assume that any unrecovered accounting costs were absorbed by the government
 - from 1997, investments were funded from capital markets
 - the commercial WACC applies to cost recovery from this point onwards
 - however, straight-line account was still the dominant form of cost recovery
 - in 2001, BIPT opened up Belgacom's copper access network to wholesale unbundling
 - from 2007, BIPT has applied cost-based access regulation, reflecting a (fully) competitive market
 - cost recovery in a competitive market reflects economic depreciation (e.g. DCF)
 - the remaining costs to be recovered after 2001 are treated with economic depreciation and recovered during the remaining lifetime of the assets, from the remaining output

The model uses successive depreciation with different cost recovery profiles

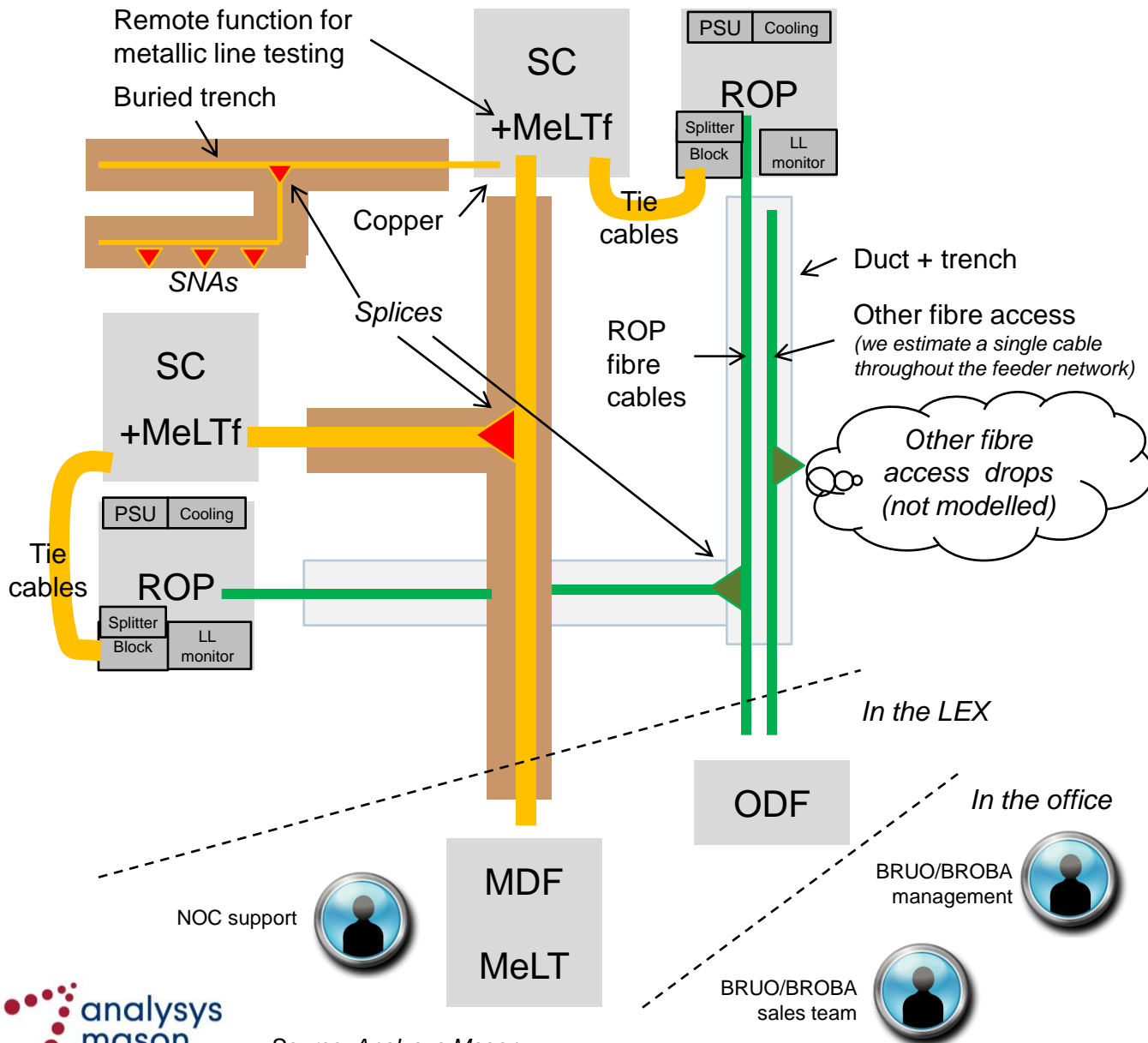
- 1 Historical cost accounting (HCA)-based costs show 'saw-tooth' behaviour as large deployments take place (with high book values); in this case we can see early copper access followed by street cabinets. Assets tend to become fully depreciated because financial lifetimes are shorter than active lifetimes
- 2 If Economic Depreciation was applied over all time, then there would be a smooth (in real terms) trend in the economic cost per unit of output (note: the increase in 1977 is when street cabinets are deployed)
- 3 In 2001, the cost-recovery method can move from accounting to economic costs
- 4 Accounting costs reach a minimum when many assets are fully depreciated
- 5 However, accounting costs start to rise as the number of connections decreases in later years
- 6 The assumed real-terms cost trends are very slightly increasing over time



Source: *Analysis Mason*



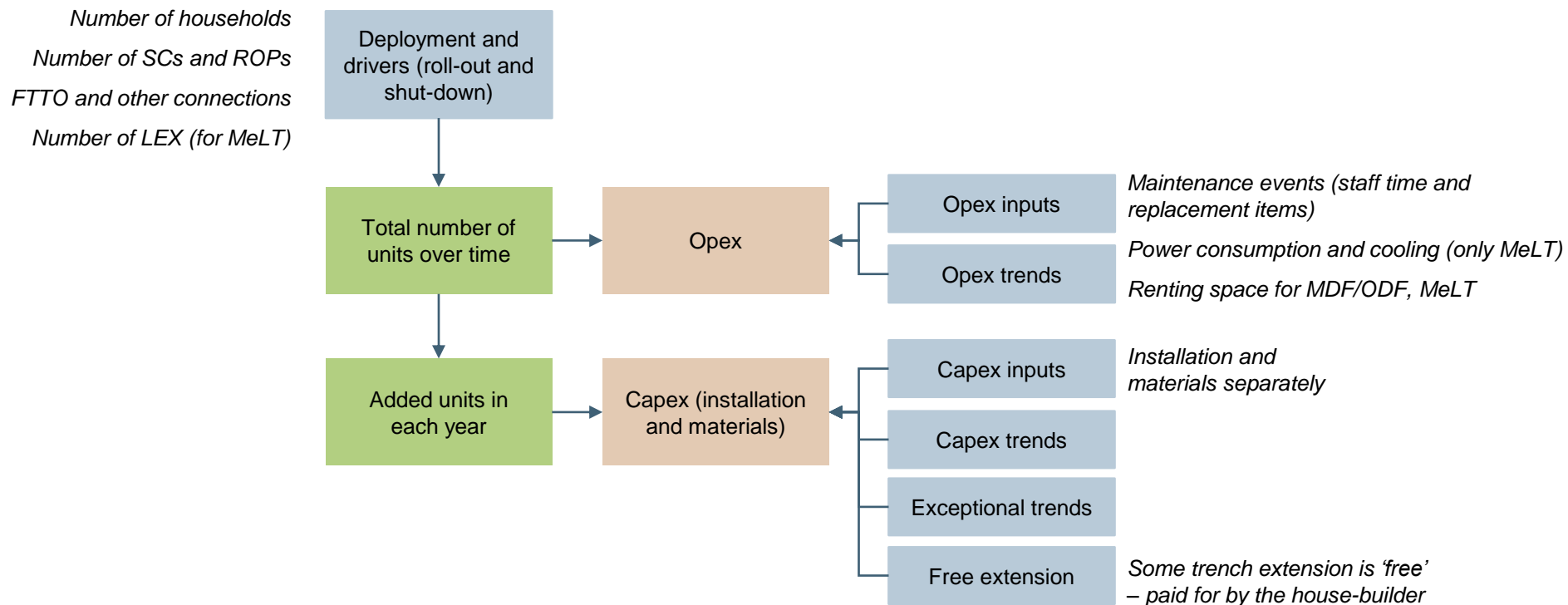
The access module models a large number of passive assets



Access assets
Distribution copper cable
Feeder copper cable
Distribution trench for copper (sidewalk)
Distribution trench for copper (street crossing)
Feeder trench for copper (sidewalk)
Feeder trench for copper (street crossing)
SC 600 pairs first generation
SC 1200 pairs first generation
SC 2400 pairs first generation
SC 600 pairs second generation
SC 1200 pairs second generation
SC 2400 pairs second generation
ROP splitter 48p card for PSTN/xDSL
Distribution copper splice
Feeder copper splice
MDF (per line)
SNA type 1 for new household connections
SNA type 2/3
FTTO/other access fibre
Feeder fibre
Spare
Spare
Distribution trench for business fibre (sidewalk)
Distribution trench for business fibre (street crossing)
Feeder trench for fibre (sidewalk)
Feeder trench for fibre (Street crossing)
Spare
Tiny ROP (inc PSU, Cooling, CU tie cables+blocks)
ROP standard (inc PSU, Cooling, CU tie cables+blocks)
ROP ocean (inc PSU, Cooling, CU tie cables+blocks)
Spare
FTTO/other business access fibre splice
Feeder fibre splice
Access-facing ODF (48 fibres)
Spare
Metal lines testing platforms
Metal lines testing function
Leased lines (for monitoring)
Spare
BRUO/WBA: management for wholesale access lines
BRUO/WBA: sales support for wholesale access lines
NOC: support staff for basic SLA in access products
Spare
Spare
Spare

[Assets.lst.access](#)

The calculation of expenditures works in a similar way for all access assets

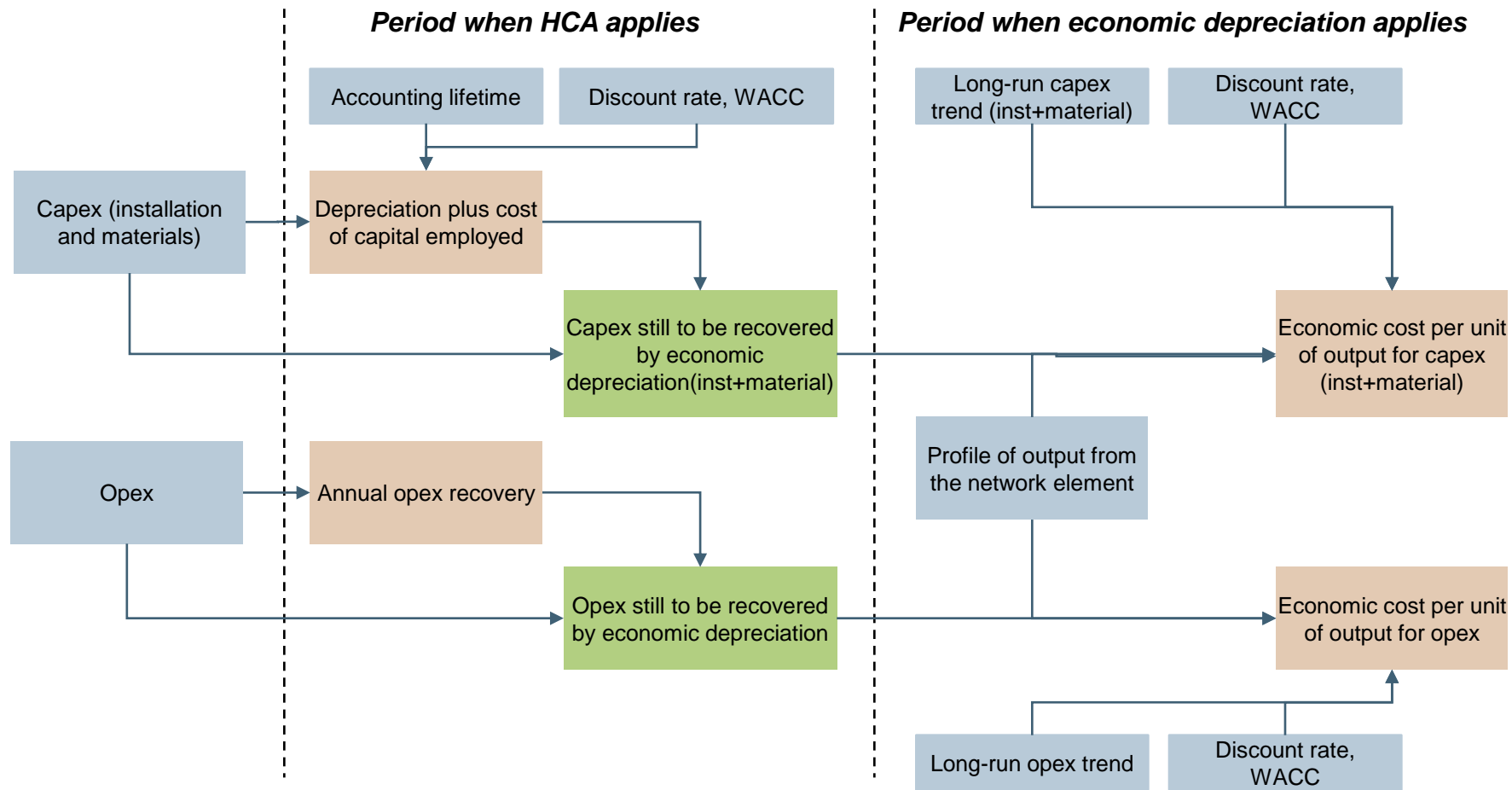


Deployment drivers are selected for each asset

- Some deployment drivers apply across the whole modelled period (e.g. households):
 - some are scaled by the roll-out profiles (e.g. households passed with copper)
- Some deployment drivers are specifically defined for each asset (e.g. SC first generation)
- Some deployment drivers have other roll-out profile applied to them (e.g. all SCs before AGW in SC)
- Some deployment drivers represent the cumulative number over time, from a certain date (e.g. small network adaptations or SNAs)

Assets	Units	Deployment driver
Distribution copper cable	metres	HH passed with copper
Feeder copper cable	metres	All SCs before AGW in SC
Distribution trench for copper (sidewalk)	metres	HH passed with copper
Distribution trench for copper (street crossing)	metres	HH passed with copper
Feeder trench for copper (sidewalk)	metres	All SCs before AGW in SC
Feeder trench for copper (street crossing)	metres	All SCs before AGW in SC
SC 600 pairs first generation	cabinets	SC first generation
SC 1200 pairs first generation	cabinets	SC first generation
SC 2400 pairs first generation	cabinets	SC first generation
SC 600 pairs second generation	cabinets	SC second generation
SC 1200 pairs second generation	cabinets	SC second generation
SC 2400 pairs second generation	cabinets	SC second generation
ROP splitter 48p card for PSTN×DSL	48 port cards	Lines needing SC splitters
Distribution copper splice	splices	HH passed with copper
Feeder copper splice	splices	All SCs before AGW in SC
MDF (per line)	connect ed lines	HH passed with copper
SNA type 1 for new household connections	#	Accumulated number of SNAs type 1
SNA type 2/3	#	Accumulated number of SNAs type 2/3
FTTO/other access fibre	metres	Fibre end user connections
Feeder fibre	metres	All ROPs
Spare	-	Spare
Spare	-	Spare
Distribution trench for business fibre (sidewalk)	metres	All ROPs
Distribution trench for business fibre (street crossing)	metres	All ROPs
Feeder trench for fibre (sidewalk)	metres	All ROPs
Feeder trench for fibre (Street crossing)	metres	All ROPs
Spare	-	Spare
Tiny ROP (inc PSU, Cooling, CU tie cables+blocks)	ROP	Tiny ROP
ROP standard (inc PSU, Cooling, CU tie cables+blocks)	ROP	ROP standard
ROP ocean (inc PSU, Cooling, CU tie cables+blocks)	ROP	ROP ocean
Spare	-	Spare
FTTO/other business access fibre splice	splices	Fibre end user connections
Feeder fibre splice	splices	All ROPs
Access-facing ODF (48 fibres)	#	All ROPs
Spare	-	Spare
Spare	-	Spare
Metal lines testing platforms	#	LEX (used for copper access)
Metal lines testing function	#	All SCs
Leased lines (for monitoring)	#	LEX (used for copper access)
Spare	-	Spare
	# 10,000 lines	
BRUO/WBA: management for wholesale access lines	supported	BRUO/BROBA lines supported
	# 10,000 lines	
BRUO/WBA: sales support for wholesale access lines	supported	BRUO/BROBA lines supported
NOC: support staff for basic SLA in access products	#	NOC staff
Spare	-	Spare
Spare	-	Spare
Spare	-	Spare

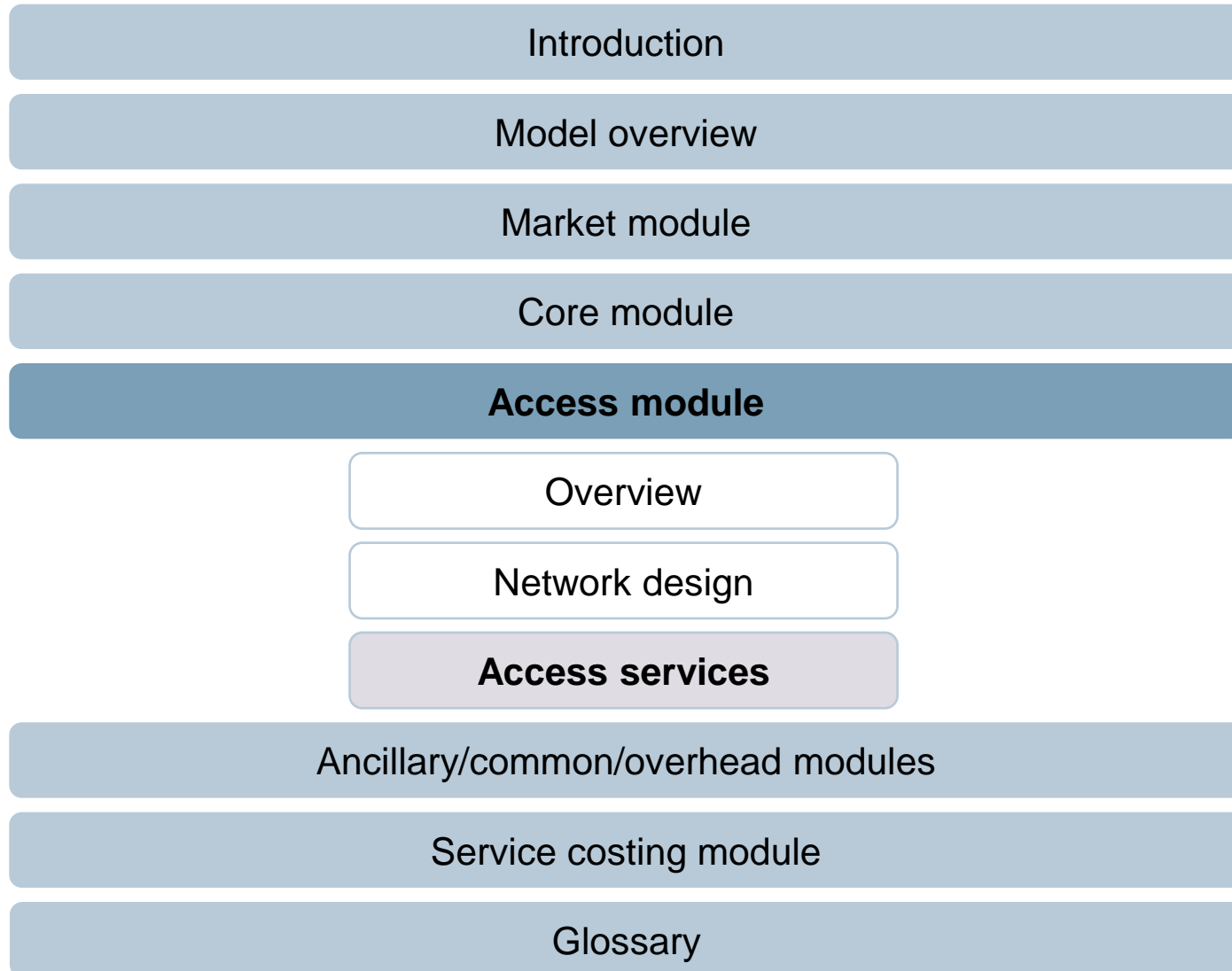
Cost annualisation follows a standard calculation for all network elements



The output profile from the network element is an important input to both economic depreciation and service costing

- 1. Feeder copper
 - used only where voice is conveyed to the LEX
- 2. Other fibre access connections exist in the feeder network
 - FTTO, mobile network, etc.
- 3. The feeder trench for fibre is used by both xDSL lines and other fibre access connections
 - we estimate that there is as much “other” fibre in the feeder network as there is “ROP feeder” fibre
 - therefore, these costs are roughly shared 50:50 in the long-term between xDSL and other connections (as other connections are forecast to increase)
- 4. Various fibre access network elements are ultimately used by FTTH, therefore a share of their costs are (increasingly) recovered from FTTH lines as copper distribution connections are replaced with fibre (2017-2037 and onwards)

Assets	Output driver
Distribution copper cable	Active copper lines (PSTN plus xDSL)
Feeder copper cable	Active copper lines connected to a SC with their voice switch in the LEX
Distribution trench for copper (sidewalk)	Active copper lines (PSTN plus xDSL)
Distribution trench for copper (street crossing)	Active copper lines (PSTN plus xDSL)
Feeder trench for copper (sidewalk)	Active copper lines connected to a SC with their voice switch in the LEX
Feeder trench for copper (street crossing)	Active copper lines connected to a SC with their voice switch in the LEX
SC 600 pairs first generation	Active copper lines connected to a SC (PSTN plus xDSL)
SC 1200 pairs first generation	Active copper lines connected to a SC (PSTN plus xDSL)
SC 2400 pairs first generation	Active copper lines connected to a SC (PSTN plus xDSL)
SC 600 pairs second generation	Active copper lines connected to a SC (PSTN plus xDSL)
SC 1200 pairs second generation	Active copper lines connected to a SC (PSTN plus xDSL)
SC 2400 pairs second generation	Active copper lines connected to a SC (PSTN plus xDSL)
ROP splitter 48p card for PSTN/xDSL	Active copper lines connected to a SC (PSTN plus xDSL)
Distribution copper splice	Lines using SC-ROP splitters
Feeder copper splice	Active copper lines (PSTN plus xDSL)
MDF (per line)	Active copper lines connected to a SC with their voice switch in the LEX
SNA type 1 for new household connections	Active copper lines (PSTN)
SNA type 2/3	Active copper lines for future Type 1 SNAs
FTTO/other access fibre	Active xDSL lines for future Type 2/3 SNAs
Feeder fibre	Other fibre access connections using feeder network
Spare	Active end user lines connected to a ROP (xDSL or future FTTH)
Spare	Spare
Spare	Spare
Distribution trench for business fibre (sidewalk)	Spare
Distribution trench for business fibre (street crossing)	Spare
Feeder trench for fibre (sidewalk)	Active feeder trench lines (xDSL on ROP, FTTH, FTTO)
Feeder trench for fibre (Street crossing)	Active feeder trench lines (xDSL on ROP, FTTH, FTTO)
Spare	Spare
Tiny ROP (inc PSU, Cooling, CU tie cables+blocks)	Active end user lines connected to a ROP (xDSL or future FTTH)
ROP standard (inc PSU, Cooling, CU tie cables+blocks)	Active end user lines connected to a ROP (xDSL or future FTTH)
ROP ocean (inc PSU, Cooling, CU tie cables+blocks)	Active end user lines connected to a ROP (xDSL or future FTTH)
Spare	Spare
FTTO/other business access fibre splice	Other fibre access connections using feeder network
Feeder fibre splice	Active end user lines connected to a ROP (xDSL or future FTTH)
Access-facing ODF (48 fibres)	Active end user lines connected to a LEX ODF (xDSL, direct xDSL, FTTH, FTTO)
Spare	Spare
Spare	Spare
Metal lines testing platforms	Active copper lines (PSTN plus xDSL)
Metal lines testing function	Active copper lines (PSTN plus xDSL)
Leased lines (for monitoring)	Active copper lines (PSTN plus xDSL)
Spare	Spare
Spare	Spare
BRUO/WBA: management for wholesale access lines	Wholesale BRUO/BROBA lines
BRUO/WBA: sales support for wholesale access lines	Wholesale BRUO/BROBA lines
NOC: support staff for basic SLA in access products	Active copper lines (PSTN plus xDSL)
Spare	Spare
Spare	Spare
Spare	Spare



Access network service components are then built up from the cost per line for each layer of the network

- These service components are ultimately combined in the service costing module to create the end wholesale and retail services

Assets	LLU raw copper	LLU shared pair	SLU raw copper	SLU shared pair	ROP Splitter	Splice	VDSL rental (passive part) on ROP	VDSL rental (passive part) on LEX/LDC	Splice	FTTO / other fibre access	Splice	SNAs for new households	New SNAs for remaining active xDSL connections
Distribution copper cable	1		1										
Feeder copper cable	1												
Distribution trench for copper (sidewalk)	1		1										
Distribution trench for copper (street crossing)	1		1										
Feeder trench for copper (sidewalk)	1												
Feeder trench for copper (street crossing)	1												
SC 600 pairs first generation			1										
SC 1200 pairs first generation			1										
SC 2400 pairs first generation			1										
SC 600 pairs second generation			1										
SC 1200 pairs second generation			1										
SC 2400 pairs second generation			1										
ROP splitter 48p card for PSTN/xDSL					1								
Distribution copper splice	1		1										
Feeder copper splice	1												
MDF (per line)	1							1				1	
SNA type 1 for new household connections													1
SNA type 2/3													1
FTTO/other access fibre										1			
Feeder fibre							1						
Splice													
Distribution trench for business fibre (sidewalk)										1			
Distribution trench for business fibre (street crossing)										1			
Feeder trench for fibre (sidewalk)							1			1			
Feeder trench for fibre (Street crossing)							1			1			
Tiny ROP (inc PSU, Cooling, CU tie cables+blocks)							1						
ROP standard (inc PSU, Cooling, CU tie cables+blocks)							1						
ROP ocean (inc PSU, Cooling, CU tie cables+blocks)							1						
FTTO/other business access fibre splice										1			
Feeder fibre splice							1			1			
Access-facing ODF (48 fibres)							1			1			
Splice													
Metal lines testing platforms	1		1										
Metal lines testing function	1		1										
Leased lines (for monitoring)	1												
Splice													
BRUO/WBA: management for wholesale access lines	1	1	1	1									
BRUO/WBA: sales support for wholesale access lines	1	1	1	1									
NOC: support staff for basic SLA in access products	1		1										
Splice													
Splice													
Splice													

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Customer premises equipment (CPE) in the access network

- As part of our access network cost modelling we have researched and estimated the (wholesale/supplier) cost of CPEs used in the modelled NGN and FTTC-VDSL network

CPE	2011 unit cost (EUR)	Price trend estimates
ADSL2+ modem	5	Has reached cost floor
VDSL2 modem	40	Will decline towards EUR5–10 as VDSL take-up matures
+ WiFi functionality added to modem	+10	Has reached cost floor
+ VoIP converted added to modem	+7	Could decline towards EUR5, depending on patent costs
IPTV decoder (standard definition)	30	Is approaching the cost floor from an initial high cost in 2007
IPTV decoder (high definition + DTV)	70	Is moving towards the cost floor in the coming two to three years
IPTV decoder (HD+DTV plus HDD)	100	Is today's high-end model, rapid cost declines in the next two to three years
Residential gateway STB / + VoIP	150/+7	Estimated to be the sum of today's high-end technologies, cost declines will follow in the coming years
ISDN adaptation device ADSL / VDSL	105/140	Cost declines will be observed in the VDSL components, but not anticipated to be significant in the (legacy) ISDN functionality

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Colocation

- We have updated:
 - hourly manpower costs (HMC) for Technicians and Commercial grades
 - common cost mark-up and IT mark-up
 - building-related costs:
 - real-estate management costs, such as rent and tax
 - internal facility management costs, such as security equipment
 - primary activities, i.e. costs directly related to colocation services, such as cost of the National Wholesale department
 - power-related inputs:
 - energy consumption
 - power equipment costs
 - power equipment footprint
 - cooling consumption
 - costs of maintenance

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Small network adaptation (SNA)

- We have modelled the volume and cost of small network adaptation (SNA) events
- The cost is estimated from BIPT's previous (2007) SNA calculation, updated for:
 - labour costs
 - materials price trends
 - IT and overheads mark-ups
 - a number of efficiency adjustments
- We model Type 1 and Type 2/3 SNAs separately because of their primary cause and cost differences
- Type 1 SNAs are needed to connect new houses, sub-divided flats, etc. to the copper distribution network:
 - we model these for all household growth after the completion of the national network (in 1991)
- Type 2/3 SNAs are needed for an average 7.5% of 'pre-2005' copper loops when they are upgraded for VDSL connectivity:
 - e.g. moving to direct pair in the same/different cable
- The treatment of SNAs in the expenditure and cost-recovery calculation is an important principle
- We currently only model the SNA expenditure and cost recovery from 2012 onwards
- Type 1 SNAs are needed to connect new houses to the network:
 - costs recovered **per active copper line from 2012**
- Type 2/3 SNAs are (eventually) needed for **all pre-2005 households**, for VDSL connectivity:
 - costs recovered per active xDSL line **from 2012**

Efficiency adjustments for SNA

- BIPT's previous SNA cost calculation has been modified with a number of efficiency adjustments estimated by Analysys Mason:
 - NTP (Network Termination Point) has been removed from Type 3 SNA
 - because this upgrade aspect is not the responsibility (to be paid by) of the OLO
 - average pit sizes have been reduced
 - because they appeared exceptionally large in our opinion
 - one transportation cost for Type 3 SNA
 - reduction of time taken to install NTP in new-build locations
 - because in various cases this will be easily accomplished by the technician, or mounted by the house-builder

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One-time fees

- We have updated:
 - the WACC
 - HMC for Technicians and Commercial grades
 - travel time based on indirect costs associated with network utility time
 - indirect NWS/CCA⁽¹⁾ staff in addition to minuted direct staff
 - mark-up formula for NWS/CCA staff (correction)
 - common cost mark-up and IT mark-up
 - equipment costs
- We have estimated CPS (carrier pre select) connection activity costs
- In some cases, the calculated costs go down (lower mark-ups, lower indirect staff)
- In other cases, the calculated costs go up (HMC overheads as an hourly standard increases the hourly cost of lower-grade staff more than the previous 6% equi-proportional mark-up (EPMU))
- Some of the (many) inputs to the one-time fee calculations appear odd or potentially excessive to us. These aspects will be tested in consultation

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HMC

IT costs

Overheads

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Improved service level agreements (ISLA)

- We have modelled the operational costs of improved service level agreements (ISLA)
- The total cost is based on Belgacom's proposed calculations updated for:
 - labour costs
 - an efficiency adjustment has been applied by applying the shift wages increase mark-up only to the wages part of the HMC
- An annual cost per line is calculated by:
 - estimating the average cost per trouble ticket
 - estimating the proportion of access lines that have a trouble ticket per annum (whether basic SLA or ISLA)
 - multiplying both numbers by each other to get an average ISLA servicing cost per annum per access line
- This calculation is done separately for business-oriented access lines (mainly SDSL) and residential-oriented access lines (other lines):
 - the difference in the average cost per line reflects the difference in the proportion of access lines that have a trouble ticket per annum

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Module 15: hourly manpower costs (HMC) for network activities

- An organisation the size of Belgacom has a large number of network staff involved in the design, deployment, installation, maintenance, operation and management of the network
- The average hourly wage rate for Belgacom's network engineers is:
 - EURxx per hour (calculated from an average 2009 salary of EURxx 000 per annum, based on 1725 working hours per annum)
 - a proportion of these hours (xx% according to Belgacom, 10% according to Analysys Mason estimates) are in training, breaks, absence, etc.
 - according to the European Working Conditions Observatory*, sickness absence in Belgium is considered high (approximately five days sick per annum, plus two other days absence = 3% of working days)
- In addition, outsourced labour and maintenance contracts are in place:
 - some of these outsource contracts cover explicit non-HMC costs (e.g. outsourced SNA work, outsourced power contracts added to colocation equipment)
- Remaining un-allocated outsourced contracts amount to:
 - an additional xx% (EURxx per hour) for Belgacom's passive network elements
 - an additional xx% (EURxx per hour) for Belgacom's active network equipment
 - an additional xx% for (EURxx per hour) civil works and road digging

Module 15: indexing HMC

- Hourly wage calculations refer to year 2009:
 - Belgacom has submitted the indexing formula which it is legally obliged to follow
 - Belgacom also increases all wages by a merit index. We do not apply this merit index on the long-run cost base of Belgacom (even if it is routinely applied to retained individuals' salaries)
 - excluding the merit index, the nominal wage index is approximately inflationary, and equal to:
 - 2009–2010 = 0.5%
 - 2010–2011 = 2.68%
 - 2011–2012 = 2.34%

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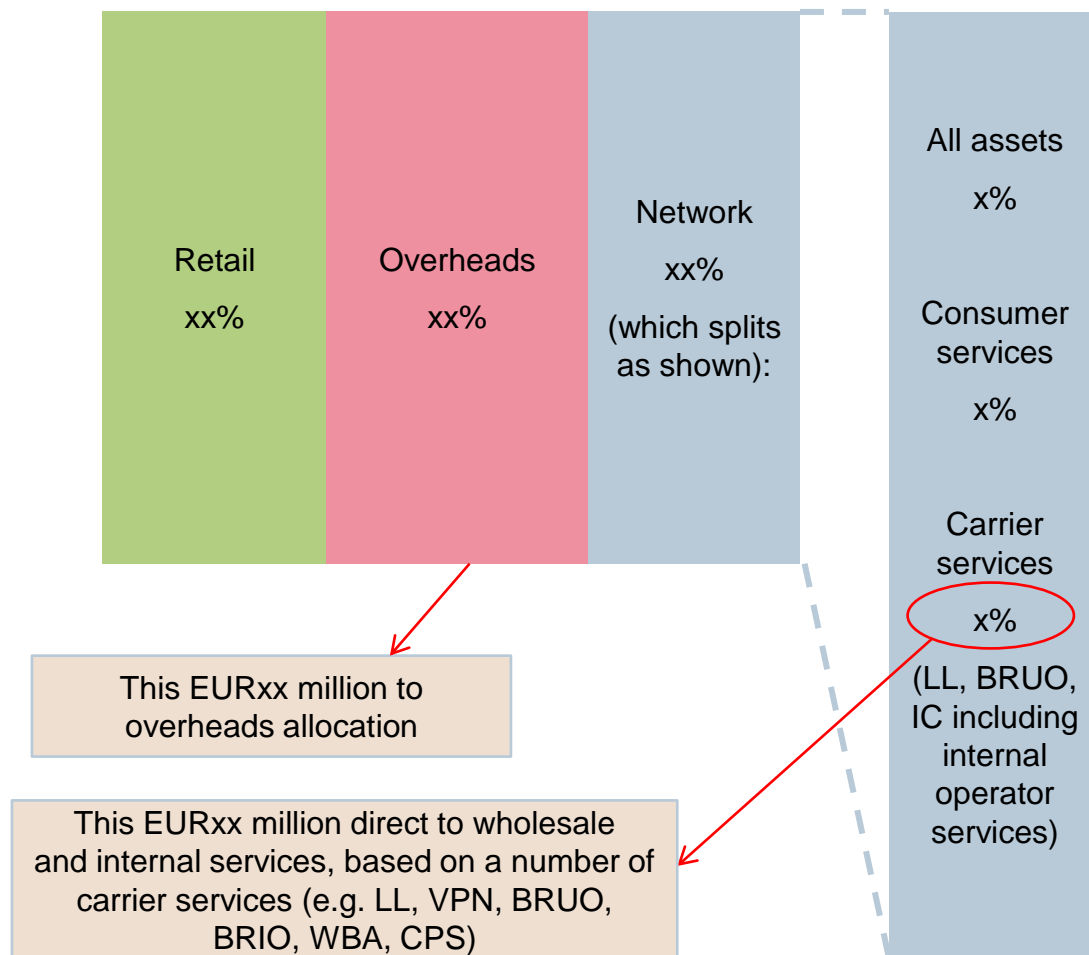
Overheads

Service costing module

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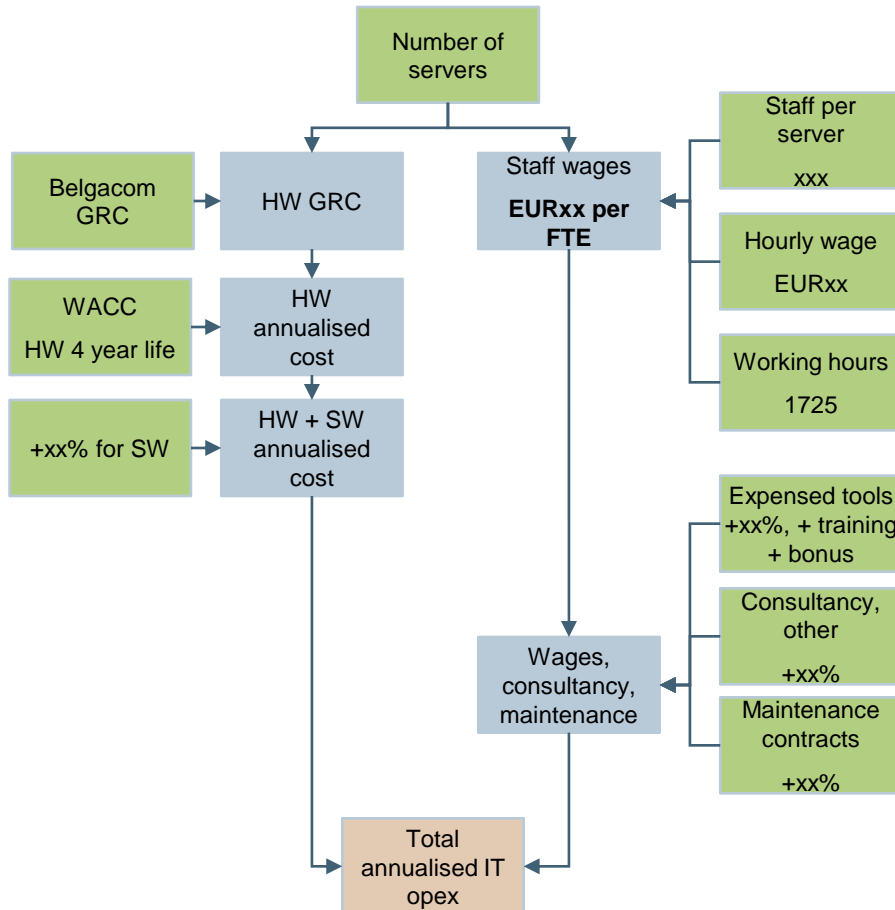
Module 16: IT costs

- For an operator the size of Belgacom, the IT department consists of:
 - around xxx servers (e.g. mix of mainframe, Windows, Linux)
 - xxx IT support staff, excluding developers (admin, monitoring, operations and maintenance, planning, management)
- Annualised costs of the IT department are around EURxxx million
- This covers:
 - all server hardware (four-year assets)
 - development software (annualised cost)
 - IT support staff direct costs
 - EURxx wages per hour (EURxx 000 salary)
 - plus expensed tools/vehicles
 - consultancy and maintenance contracts
- IT functions have been split according to Belgacom's activities
- The overall allocation of IT costs is shown opposite



IT build-up and allocation key

Assumptions to build up the annualised cost



Analysys Mason's assumptions to allocate the functional costs

	Network carrier services	Network consumer services	Network assets	Total retail	Total overheads
Billing	5%	45%		50%	
Business Intelligence					100%
Customer Relationship Management				100%	
End User Computing					100%
Enterprise Resource Planner					100%
Fulfillment BRIO	100%				
Fulfillment MassMarket		50%		50%	
Fulfillment ProfessionalMarket		50%		50%	
Inventories			100%		
Office Automation					100%
Payphone					100%
ServiceAssurance Backbone	100%				
ServiceAssurance MassMarket		50%		50%	
ServiceAssurance ProfessionalMarket		50%		50%	
Workforce Management			100%		

Calculation of IT mark-ups

- Based on the total IT service annualised costs (around EURxxx million) and the allocation keys, a proportion of IT costs are calculated to be relevant for:
 - all network assets
 - network consumer services (e.g. retail voice and broadband)
 - network carrier services (e.g. leased lines, BRUO, internal services)
- We have used Belgacom's regulatory accounts to estimate the total annualised cost applying to the service delivery engine (network and IT). From this, we have calculated the percentage mark-up to network costs:
 - for all network assets: +x% applicable to all network services
 - for consumer services: +x% applicable only to consumer services (i.e. x% in total)
 - for carrier services: +x% applicable to wholesale and other carrier services (i.e. x% in total)

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Module 17: overheads and additional staff costs

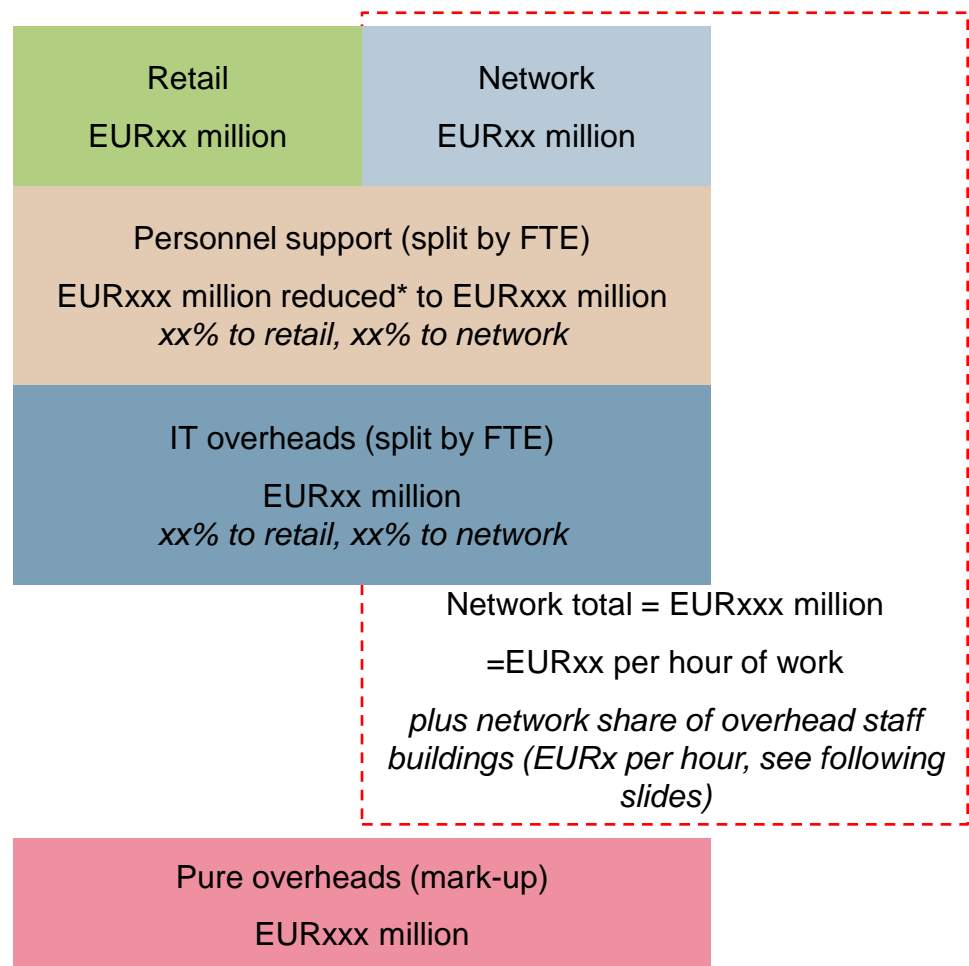
- Hourly staff costs for IT and network functions have been identified:
 - EURxx per hour for IT staff
 - EURxx per hour for network engineers
- Belgacom also incurs the following costs:
 - wage benefits: pension, bonus, training, medicals
 - +xx% (comprising xx% pension back service (excluded in BU), xx% collective bonus and xx% training/medical costs)
 - the pension back service is currently excluded
 - expensed tools and vehicles
 - we estimate that this mark-up is different for the types of network activities (xx% on average)
 - +xx% within the network department for utility work (this includes vehicle-related tools)
 - +x% within the network department for 'desk-based' work
 - office space rental
 - separate space-based calculation

Comparison of Belgacom's hourly costs

- Statbel's Quadrennial survey on the cost of labour (2008) indicates an annual hourly cost of labour of:
 - EUR31 for civil engineering
 - EUR44 for computer programming, etc.
 - EUR53 for telecoms
- The first two of these appear comparable to the bottom-up IT and network inputs for Belgacom

Overheads cost structure: opex plus share of IT in 2009

- Belgacom's 'overheads' department consists of:
 - xxxx staff
 - EURxxx million wages*
 - EURxx million of training/medical costs, collective bonus and overheads department expensed tools/vehicles
 - approximately EURxxx million of other opex
 - we have excluded EURxx million of building costs, leaving EURxxx million of other opex such as consulting, utilities and consumables
- Functions include:
 - communication, corporate relations, corporate sponsor/events, finance, HQ, HR, public affairs, legal, secretary general, strategy, catering, internal management, real estate management, logistics and procurement, facilities, fleet
- These functions have been allocated to network and retail activities, as well as pure overheads
- A share of service-delivery IT also relates to overheads
- The level of hourly cost reflects the high level of support that Belgacom employees enjoy (e.g. catering, HR, IT, management)



Source: Analysys Mason analysis of Belgacom data

* Costs associated with Human Resources have been multiplied by an efficiency factor of xxx

Overheads cost structure: rent per square metre

- In addition to the overheads opex, there is:
 - EURxx million of building costs (rent, taxes, other)
 - EURxx million of annualised FIX+FITTINGS investments
 - EURxxx million of annualised building investments
 - EURxx million estimated to cover owned buildings (e.g. including Heverlee and Schaerbeek of at least xxx 000 square metres)
 - around EURxx million of improvements
 - plus around EURxx million for energy/aircon, etc. in various technical buildings
- These costs appear to cover the entire building estate of Belgacom
- Within these buildings sit the overheads, IT, network and retail personnel, plus network equipment, catering, etc.
- A total space per full-time employee (FTE) of around xx–xx square metre means that total employees occupy xxx 000 square metres:
 - of which xx square metres is for office space per person
- Typical office space allocations range from:
 - 12.5 square metres for personal space only
 - to 25 square metres for rentable space per employee
- Parking allocations of around xx–xx square metres reflect around one space per employee
- Based on more efficient space allocations, and less than one parking space per employee, it appears reasonable to reduce space per FTE from xx square metres to a total of 27.5 square metres:
 - with an annual rent of EURxx per square metres plus 7.5% property taxes

Overheads and buildings: improvements and power/aircon

- Fixtures, fittings and building improvements add EURxx million on around EURxx million of rent:
 - +xxx% mark-up per square metre to all space
- We have estimated that other building costs (e.g. electricity) are higher within technical buildings than office accommodation:
 - EURxx million of other building costs split into EURxx million technical and EURxx million office
- Power/aircon annualised costs add around EURxx million on technical space rent (which is about xx% of the total space):
 - +xxx% mark-up per square metre to technical space
- Resulting costs per square metre:
 - EURxxx per square metre for fitted out, powered and supported office space
 - EURxxx per square metre for technical space including all power/aircon equipment and consumption
- Office space is converted into an hourly cost per FTE and added into the hourly manpower costs (HMC) for network and overhead activities

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The service costing module contains the main scenario and model controls ...

1 Universal control inputs

Nominal cost of capital input.wacc.201 Source: IBPT

2 Market model control parameters (module 0)

Wholesale linear IPTV deployment scenario Linear IPTV deployment scenario selected
Linear IPTV deployment scenarios

3 Core network control parameters (module 1, 2, 3, 4, 6)

Start year: input.start.year

Full cost recovery by year: input.final.year

Last year of capital investment input.final.capex.year

Traffic for pure LRIC calculation scenario.costing.methodology

Number of POIs Number.of.POIs

	Mean	standard deviation	Year A	Value A	Saturation
Share of SIP interconnect	2015	5	2010	0%	50.0%

Quality of service (QoS) inputs
Kbps provisioned for IP voice traffic QoS.IP.voice

4 Access network control parameters (module 5, 7)

Copper network deployment

Type of deployment profile input.copper.profile

Start date input.copper.start

End date input.copper.completion

Years of rollout

Rollout per year (if linear)

Final year of copper access input.copper.final

Copper network removal

Start year input.copper.removal

Final year

Duration

Annual shut-down

Cost of capital for depreciation in the past years of the access network
Date that commercial WACC is applicable date.commerci Note: in theory when investment comes from capital markets a

Select discounting option for the early years discounting.option

Year when economic depreciation starts year.economic.depreciation

Year when SNA costs start to be included year.SNA

... as well as the macro to run the model *without* and *with* wholesale voice termination volumes

- In order to run the macro, it is essential to 'enable macros' within Microsoft Excel
- The macro runs the model *without* then *with* termination volumes, and stores the intermediate results in the *pureLRIC* sheet

6 Macro buttons to run model

Run pure LRIC and LRAIC+

- The service costing module applies the carrier-services IT and overheads mark-up to various unit costs

The cost of the end-to-end wholesale services are built up from the various calculated cost components

BROBA, LRAIC+

ADSL/ADSL2+/ ReADSL with Belgacom-voice

Weights	Services needed	Model it comes from (core or access)	
100%	LLU shared pair	Access	per line per month
100%	ROP Splitter	Access	
	Spare		
100%	xDSL subscribers		
	Spare		
	Spare		
WEIGHTED TOTAL			

ADSL/ADSL2+/ ReADSL without voice

Weights	Services needed	Model it comes from (core or access)	
100%	LLU raw copper	Access	per line per month
	Spare		
	Spare		
100%	xDSL subscribers		
	Spare		
	Spare		
WEIGHTED TOTAL			

WBA VDSL2

WBA VDSL2 without voice

Weights	Services needed	Model it comes from (core or access)	
100%	SLU raw copper	Access	per line per month
89%	VDSL rental (passive part) on ROP	Access	per line per month
17%	VDSL rental (passive part) on LEX/LDC	Access	per line per month
100%	xDSL subscribers		
	Spare		
	Spare		
WEIGHTED TOTAL			

BRUO, LRAIC+

Raw Copper, from LEX

Services needed	Model it comes from (core or access)	
LLU raw copper	Access	per line per month

Raw Copper, from SC

Services needed	Model it comes from (core or access)	
SLU raw copper	Access	per line per month

Shared pair

Services needed	Model it comes from (core or access)	
100% LLU shared pair	Access	per line per month
100% ROP Splitter	Access	per line per month

Raw Copper Plus (also called Shared Pair wov)

Services needed	Model it comes from (core or access)	
LLU raw copper	Access	per line per month

BRIO, pure LRIC

by IT mark-up Average for all areas, average of ss7-SIP migration per minute

BRIO, LRAIC+

Local

The local BRIO service will not be offered in NGN, as there will no local switching

Services needed	Model it comes from (core or access)	
NGN Regional incoming calls	Core	per minute
NGN Incoming ss7 leg	Core	per minute
NGN Incoming SIP leg	Core	per minute

Intra Access Area

Services needed	Model it comes from (core or access)	
NGN Regional incoming calls	Core	per minute
NGN Incoming ss7 leg	Core	per minute
NGN Incoming SIP leg	Core	per minute

Extra Access Area

Services needed	Model it comes from (core or access)	
NGN National incoming calls	Core	per minute
NGN Incoming ss7 leg	Core	per minute
NGN Incoming SIP leg	Core	per minute

BRIO port per 2Mbit/s system, per year

Services needed	Model it comes from (core or access)	
NGN ss7 interconnection ports	Core	per port per year

SNA

Monthly forward-looking cost per line for new connection (Type 1) SNAs

Weights	Services needed	Model it comes from (core or access)	
100%	SNAs for new households	Access	per line per month

Monthly forward-looking cost per xDSL line for Type 2/3 SNAs for old lines for VDSL

Weights	Services needed	Model it comes from (core or access)	
100%	New SNAs for remaining active xDSL connections	Access	per line per month

No mark-ups in formula

No mark-ups in formula

Ethernet transport for xDSL per Mbps per month

Weights	Services needed	Model it comes from (core or access)	
	xDSL retail + resale (contended, direct)	Core	per Mbps per month
	xDSL retail + resale (contended, indirect)	Core	per Mbps per month
	xDSL bitstream (contended, direct)	Core	per Mbps per month
	xDSL bitstream (contended, indirect)	Core	per Mbps per month
	Transport fee (P=0)		
	Transport fee (P=1)		
	Transport fee (P=3)		
	Transport fee (P=5)		

Ethernet transport for xDSL per line per month - average subscriber usage

Weights	Services needed	Model it comes from (core or access)	
	xDSL retail + resale (contended, direct)	Core	per line per month
	xDSL retail + resale (contended, indirect)	Core	per line per month
	xDSL bitstream (contended, direct)	Core	per line per month
	xDSL bitstream (contended, indirect)	Core	per line per month

Ethernet transport for xDSL per line per month - reference usage

80 kbps

Weights	Services needed	Model it comes from (core or access)	
20%	xDSL retail + resale (contended, direct)	Core	per line per month
80%	xDSL retail + resale (contended, indirect)	Core	per line per month
	xDSL bitstream (contended, direct)	Core	per line per month
	xDSL bitstream (contended, indirect)	Core	per line per month

Ethernet transport for VPN

Weights	Services needed	Model it comes from (core or access)	
	Data services (local VPN, contended)	Core	per Mbps per year
	Data services (regional VPN, contended)	Core	per Mbps per year
	Data services (national VPN, contended)	Core	per Mbps per year

Ethernet transport for VoD IPTV

Weights	Services needed	Model it comes from (core or access)	
	VoD retail (direct, contended)	Core	per Mbps per year
	VoD retail (indirect, contended)	Core	per Mbps per year
	VoD wholesale (direct, contended)	Core	per Mbps per year
	VoD wholesale (indirect, contended)	Core	per Mbps per year

Ethernet transport for linear TV

Weights	Services needed	Model it comes from (core or access)	
	linear TV broadcast (distribution to DSLAM)	Core	per Mbps per year
	linear TV broadcast (distribution to Ethernet sw)	Core	per Mbps per year
	linear TV broadcast (provisioning to SN)	Core	per Mbps per year

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Glossary [1/4]

- ADM: Add-drop multiplexer
- ADSL: Asymmetric Digital Subscriber Line
- AGG-AGW: Access gateway aggregator
- AGW: Access Gateway
- AN: Access Node
- ATM: Asynchronous transfer mode
- BAP: Broadband access platforms
- BH: Busy hour
- BHCA: Busy hour call attempt
- BIPT: Belgian Institute for Call and Telecom
- BRAS: Broadband remote access server
- BRIO: Belgacon Reference Interconnect Offer
- BROBA: Belgacon Reference Offer for Bitstream Access
- BRUO: Belgacon Reference Unbundling Offer
- BU: Bottom-up
- CAPM: Capital asset pricing model
- CCA: Current cost accounting
- CPE: Customer premise equipment
- CPS: Carrier Pre Select
- CS: Call Server
- CSN: Central Service Node
- DB: Distribution box
- DCF: Discounted Cash Flow
- DLC: Digital loop carrier
- DNS: Domain name system
- DSL: Digital subscriber line
- DSLAM: Digital subscriber line access multiplexer
- DTT: Digital terrestrial Television
- DTV: Digital TV
- DWDM: Dense wave division multiplexing
- E/IP-VPN: Ethernet or IP VPN
- E1: 2 Megabit per second
- EC: European Commission
- EPMU: Equi-proportionate markup

Glossary [2/4]

- FAC: Fully-allocated cost
- FAR: Fixed asset register
- FTE: Full time equivalent
- FTTC: Fibre-to-the-cabinet
- FTTH: Fibre-to-the-home
- FTTN: Fibre-to-the-node
- FTTO: Fibre-to-the-office
- GE: Gigabit Ethernet
- GPON: Gigabit passive optical network
- HD: High definition
- HDD: Hard Disk Drive
- HMC: Hourly manpower cost
- IGE: International gateway
- IP: Internet protocol
- IP BAP: IP Broadband Access Platform
- IPTV: Internet protocol television
- ISDN: Integrated services digital network
- ISDN-2: ISDN Basic Rate Interface
- ISDN-30: ISDN Primary Rate Interface
- ISLA: Improved Service Level Agreement
- ISP: Internet Service Provider
- IT: Information technology
- LAN: Local Area Network
- LDC: Local Distribution Cabinets
- LEX: Local Exchange
- LEX-AGW: AGW located in the LEX
- LL: Leased Line
- LLU: Local loop unbundling
- LN: Local node
- LRAIC: Long-run average incremental cost
- LRIC: Long-run incremental cost
- LS: Local switch
- MDF: Main distribution frame
- MEA: Modern equivalent asset
- MeLT: Metallic line testing

Glossary [3/4]

- MeLTf: Remote function for metallic line testing
- MGW: Media Gateway
- MSAN: Multi-service access node
- NGA: Next-generation access
- NGN: Next-generation network
- NGN DLC: NGN Digital loop carrier
- NMS: Network management system
- NOK: Norwegian krone
- NPT: Norwegian Post and Telecommunication Authority
- NTP: Network termination point
- ODF: Optical distribution frame
- OH: Overhead
- OLO: Other licenced operator
- PDH: Plesiochronous digital hierarchy
- Pol: Point of interconnect
- PON: Passive optical network
- PR: Peering router
- PSTN: Public switched telephone network
- PSU: Power supply unit
- PTP: Point-to-point
- R99: Release-99
- RADIUS: Remote authentication dial-in user service
- ROP: Remote optical platform
- ROP-AGW: AGW located in the ROP
- RSS: Remote switching stage
- RSU: Remote switching unit
- SBC: Session Border Controllers
- SB-REM: Shelf based Remote DSLAM
- SC: Street cabinet
- SD: Standard definition TV channel
- SDH: Synchronous digital hierarchy
- SDSL: Symmetric digital subscriber line
- SIP: Session initiation protocol
- SLA: Service level agreement
- SLU: Sub-loop unbundling
- SMP: Significant market power

Glossary [4/4]

- SN: Service Node
- SNA: Small network adaptation
- SR: Service router
- SS7: Signalling system 7
- STB: Set top box
- TD: Top-down
- TDM: Time division multiplexing
- TGW: Transit media gateway; trunk gateway
- TSP: Travelling Salesman Problem
- VDSL: Very high-rate Digital Subscriber Line
- VoB: Voice-over-broadband
- VoD: Video-on-demand
- VoIP: Voice over internet protocol
- VPN: Virtual private network
- WACC: Weighted average cost of capital
- xDSL: Generic term for DSL

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