Presentation on behalf of BIPT

Draft NGN/NGA models

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Ref: 17915-516

analysys mason

The figures presented in this document are provisional, based partly on Analysys Mason and BIPT estimates and partly on Belgacom information. The figures that will be subject to consultation may be different from those presented in this document

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Agenda

- Morning:
  - 0900-1000: Introduction and principles
  - 1100-1200: Overview, break, discussion
  - 1200-1300: Draft results, next steps, consultation
- Afternoon from 1330:
  - BIPT and Analysys Mason will meet with Belgacom to discuss detailed model aspects, input data and to identify any issues prior to industry consultation

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Introduction

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Objectives of today's meeting

- Provide update on project status
- Present modelling principles applied for the draft model
- Provide an overview of the draft model for consultation
  - market and operator service demand – incumbent scale
  - reference model design – the "next generation network"
  - service costing approach
- Discuss next steps

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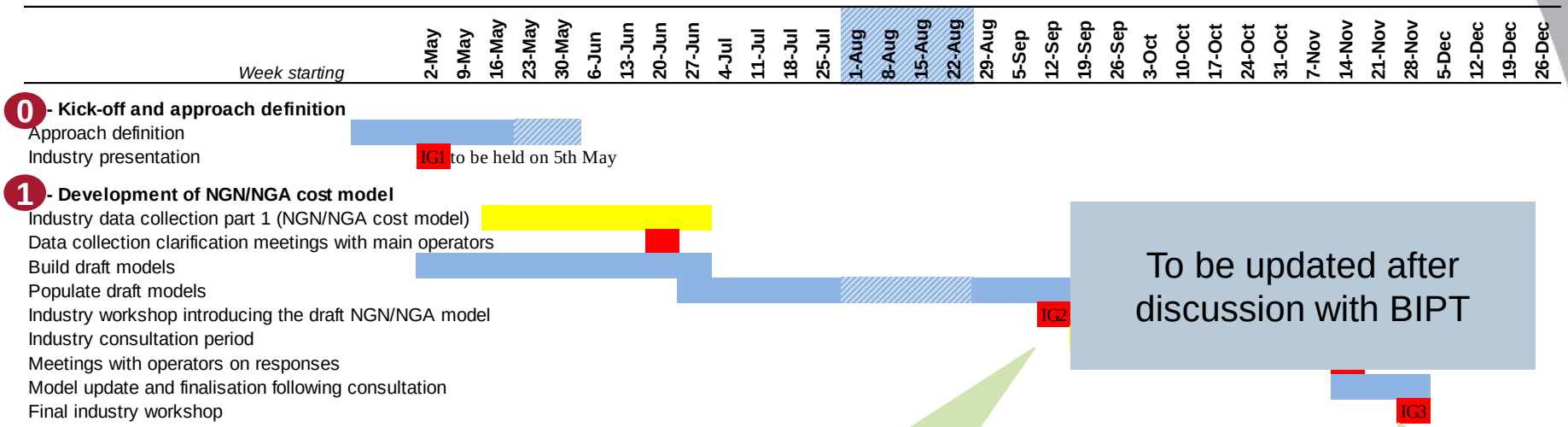
Project scope

- Develop a **bottom-up** cost model of a fixed **next-generation core and access network** to calculate the unit costs of the services provided, then:
  - develop **business plans** of generic ISPs to **ensure the economic viability** of wholesale tariffs
  - determine appropriate tariffs for regulated fixed wholesale services (BRUO, BRIO, BROBA, etc.)
- This meeting is to discuss the first of these points, not business planning and price setting
- We would like to thank the operators who have responded to the data collection, particularly Belgacom who has provided BIPT with extensive information from its access, core, financial and overhead departments
- Further industry interaction remains:
  - a public consultation on the model methodology, the model results and wholesale prices
  - post-consultation bilateral meetings with operators

Project timetable



To be updated after discussion with BIPT

Industry workshop to present the draft NGA+NGN model, followed by 6 to 8 weeks of public consultation on the methodology and model results

The consultation will be followed by bilateral clarification meetings and a final industry workshop to present the model update

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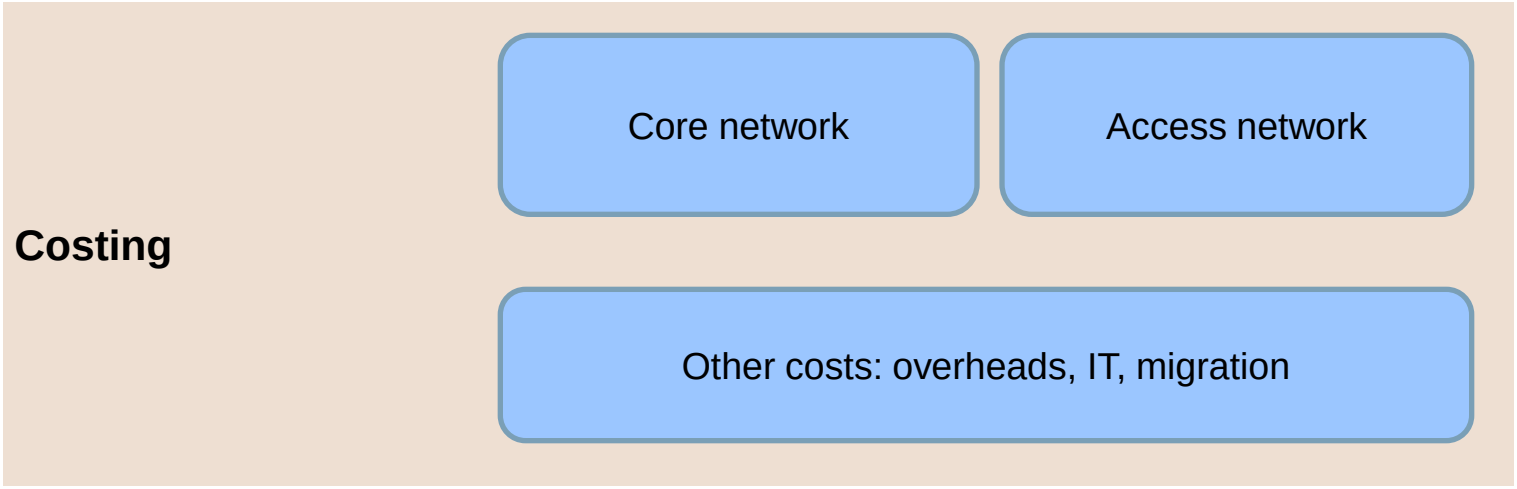
Costing principles cover three areas

- We have separated the costing process into three main areas
  - these areas are intended to cover the entire cost base necessary to deploy and maintain the modelled fixed network, and supply a wide range of services which are the same or similar to those offered by Belgacom



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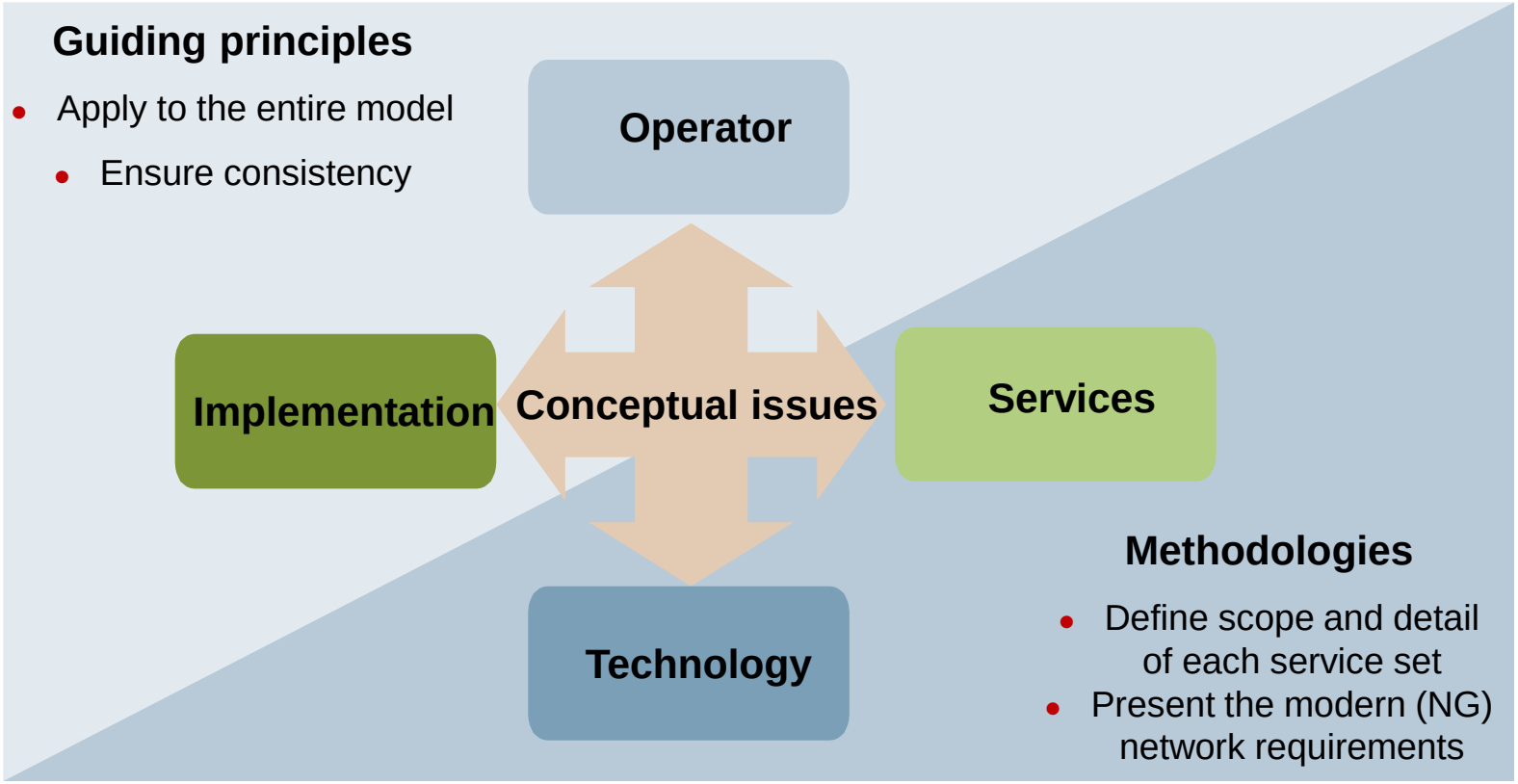
Four main conceptual principles are applied in the costing model



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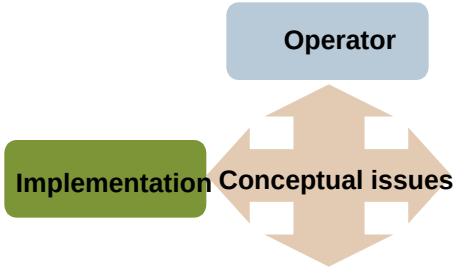
Guiding principles apply to the entire model and ensure consistency of treatment and overall costs



- **Operator**:
  - **type** – actual, average, hypothetical (existing or new entrant)
  - **footprint** – national or sub-national, shared or standalone, age of build
  - **scale –** share of market (possibly by service layer)
- **Implementation**:
  - **model –** bottom-up and/or top-down
  - **increments to be costed** – small ('pure'), large average traffic, access increment(s)
  - **depreciation** – annualisation over time and gross/
    net book values, time period of calculation
  - **weighted average cost of capital (WACC)** – average, or possibly by service layer
  - **mark-up mechanism** – treatment of common costs

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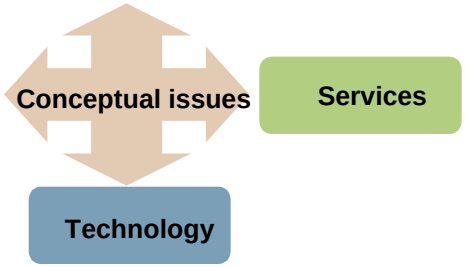
Methodological issues apply to each module of the network and service costing calculation



- **Technology**:
  - choice of (next-generation) **technology**
  - network **architecture**
  - network **nodes**
  - **other rules**, specific to some modules – level of efficiency in costs, staff activity costs, migration effects, etc.
- **Services**:
  - **service set**
  - traffic/service **volumes**
  - **scope** – (sub-)national or regionalised

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Recap: Choice of the operator [1/2]

Issue	*Approach*
Type of operator	**Existing efficient operator** • In order to satisfy the requirement for costing LLU/BROBA, **an operator 'based on' Belgacom** is applied; **should not be less efficient than Belgacom**, departures from Belgacom can be envisaged provided there are relevant efficiency justifications • We model the operator as an efficient **existing network operator**, starting with an **existing passive network** with a **fibre-to-the-cabinet (FTTC) roll-out** profile based on Belgacom from a date to be determined. Active electronics are deployed according to today's standards. Choice of voice over Internet Protocol (VoIP) technology and location of access gateways/MSAN/aggregation/mini-MDF influences the use of copper and fibre in the feeder network • **Scorched-node is** applied to Belgacom's topology; **5+5 IP peering and I/C nodes** are applied (1+1 I/C node sensitivity) • Modern **all-IP NGN** is applied; **VoIP and Ethernet transport and WDM will be applied**, rather than legacy TDM or PDH/SDH transmission

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Choice of the operator [2/2]

Issue	*Approach*
Footprint	**A national network operator will be modelled** • The degree of **sharing in the network** will be a relevant issue to consider • **Sharing between Belgacom's fixed and mobile** network is relevant (according to the layer in which sharing occurs)
Scale (market share)	**'Real' Belgacom scale is the draft approach** • A declining share of the market may be relevant (though overall volumes of many services will be increasing) • Wholesale and retail scale needs to be modelled

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Implementation issues [1/2]

Issue	*Approach*
Model	**Bottom-up modelling is required by the scope of work** • Validation with top-down information and regulatory accounts improves robustness of the result and engagement with Belgacom; other operators may contribute to the validation • Validation involves **adjustments to incumbent opex (e.g. for NGN and NGA technologies)** as well as **IT/HMC/OH opex consistency checks** (e.g. fixed–mobile, opex changes over time)
Increments	**The cost of different increments of service/demand are calculated** • **The pure long-run incremental cost (LRIC) of FTR** is applied (required by EC Recommendation) • **Long-run average incremental cost (LRAIC) of all traffic** in the core network is applied • **Separate cost of access**, identifying each of the cost components for feeder, cabinets, last-drop, SNA, CPE, etc. • **Co-location and service migration** as separate services • **IT/HMC/OH costs added as mark-up** where relevant

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Implementation issues [2/2]

Issue	*Approach*
Depreciation **See the following slides for our adopted approach**	**Various possible options** • Various methods are all possible options (including combinations in different parts of the network): for example: depreciated current cost for existing passive infrastructure, economic depreciation (or tilted annuity proxy) for next-generation electronics, gross replacement cost with very long lifetime • Network could be divided into various parts for valuation and depreciation – e.g. trench, duct, fibre, copper, street cabinets/access nodes, transmission electronics, technical buildings • There are important associated depreciation decisions to take: asset valuation method, asset lifetime (cost recovery period) and lifecycle modelling
WACC	**Determined by BIPT** • **9.61% nominal from 2011 onwards; we also define a 3.5% 'WACC' applying to pre-liberalisation access network investments**
Mark-up mechanism	**Flexible: EPMU or a 'pro-rata' allocation** • Allocation of **technical buildings, overheads, etc., as a mark-up to network costs, using a pro-rata allocation** such as footprint space per network element

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The depreciation calculation relies upon a *full time series* model

- In order to fully calculate the adopted depreciation method, it is necessary to model the full time series applying to the relevant fixed network assets
- A full time series model displays demand, capital investments, operating expenditures, network output and cost recovery over a "long" period of time
  - "long" depends on which group of assets…
- Terminal values may or may not be included (depending on whether they are material or required in principle)
  - we have not applied any terminal value in this case because we model a long time period (terminal value would be small) and for some assets (e.g. copper) it has no further value
- Periodic asset replacement occurs (for some assets)

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The depreciation principle is consistent across the model but has some implications

1. Forward-looking cost recovery should be based on economic depreciation

2. Historic cost recovery applies before there are replicable assets deployed during competitive times

- Economic depreciation is applied to recovery of all of the asset value in **the core** and ***some* of the asset value in the access network**
- The NG **core** network and **FTTC layer** is valued on a full (replacement) cost basis because it was deployed in a competitive environment – economic depreciation applies across all time (from 2005 when next-generation technologies were available)
- The legacy copper access network is recovered using HCA principles in the early period (e.g. to 2000), remaining un-recovered costs are then recovered using economic depreciation (e.g. after 2007)

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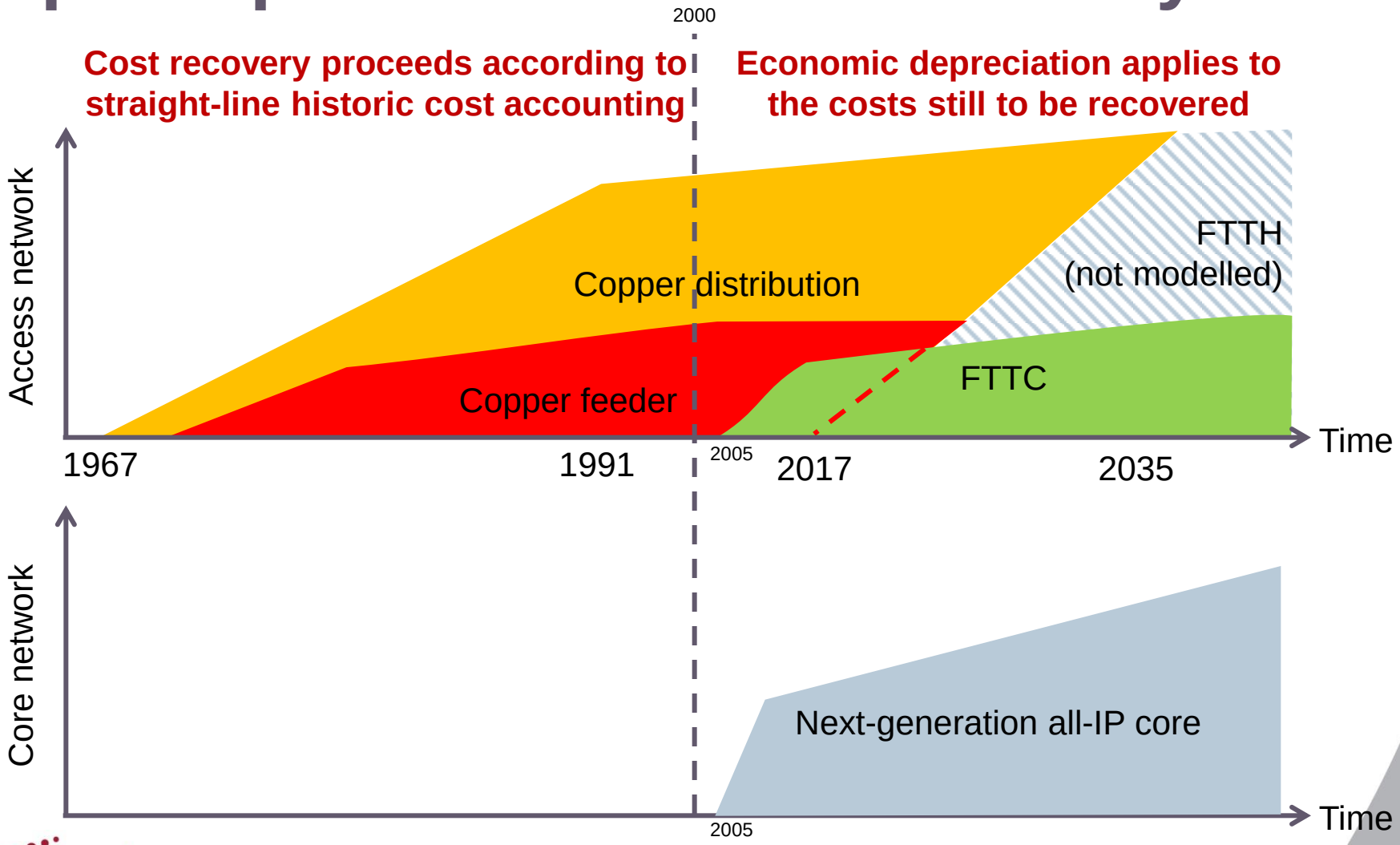
Illustration of the depreciation principle in access and core layers



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

- The fixed LRIC model reflects an NGN/NGA operator with the scale of Belgacom
- The legacy voice, broadband and transmission platforms are not modelled
  - the corresponding services are replaced by NGN/NGA equivalents
- In the next-generation network, voice is carried on Ethernet/IP networks, using DWDM transmission
  - all services share the converged transmission resources
- FTTC deployments place active equipment (initially xDSL and later voice TDM-VoIP gateways) at the street cabinet

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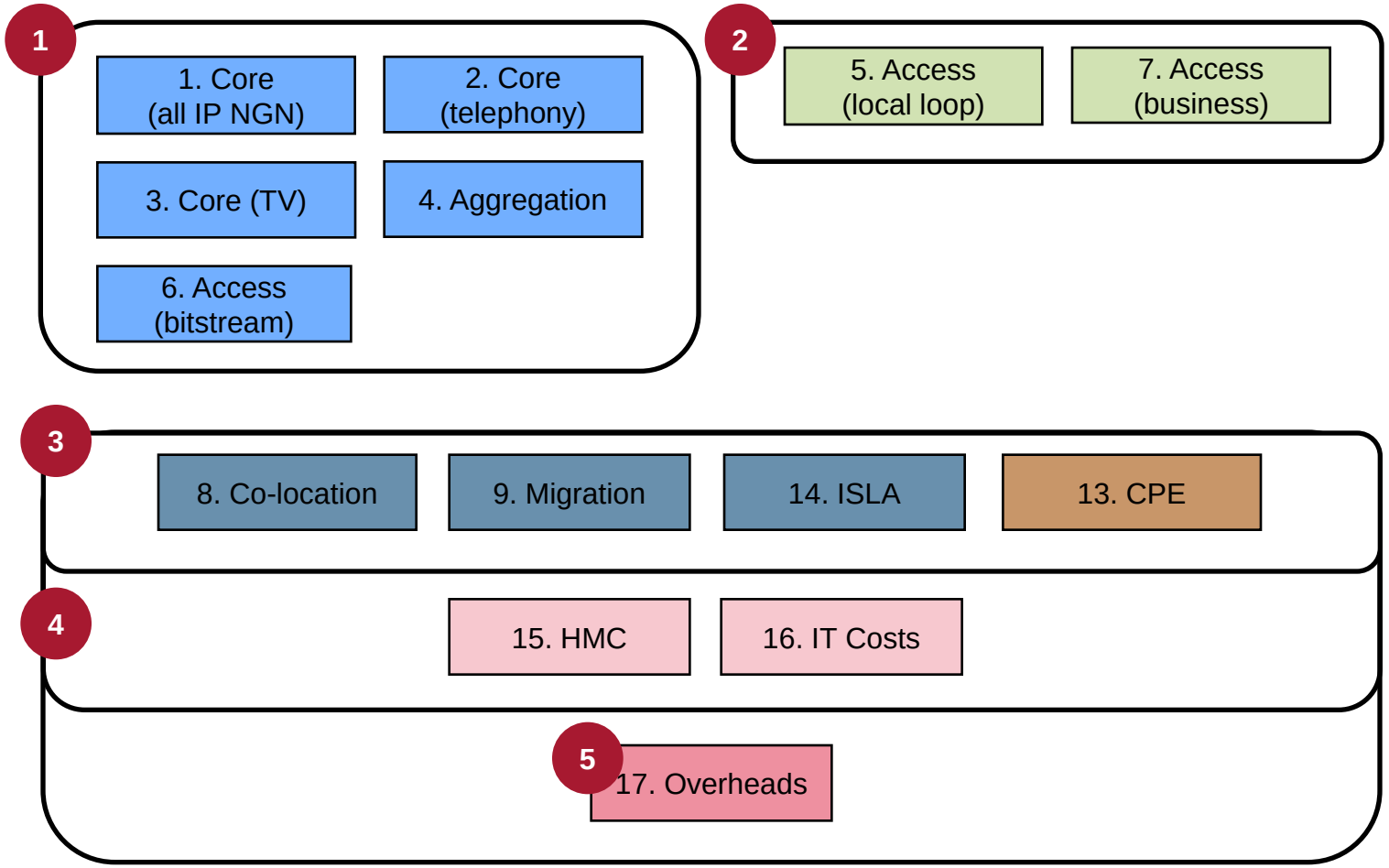
It covers a large number of activity and service modules



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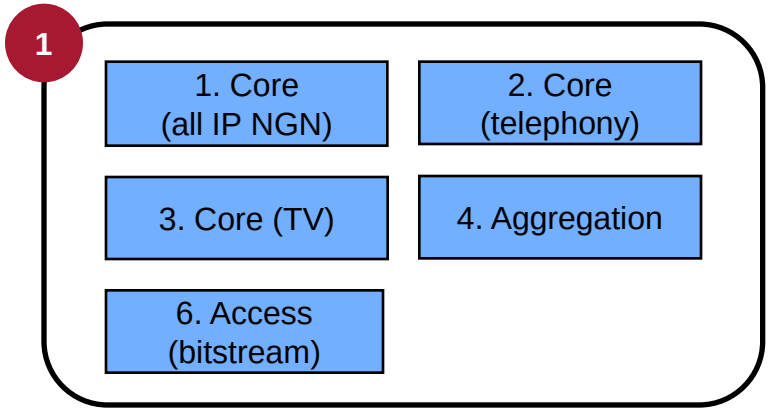
It covers a large number of activity and service modules, 1. Core



- Ethernet aggregation, IP core transport and service layer voice are modelled together
- These costs cover the trench, fibre and platform costs of the core network, along with active street equipment in the remote optical platforms (ROPs)

- We model an operator with the following:
  - an Ethernet aggregation network
  - an IP core network
  - a mix of ROP-based and LEX-based IP DSLAMs
  - a mix of ROP-based and LEX-based TDM-IP AGWs
  - a national DWDM transmission network

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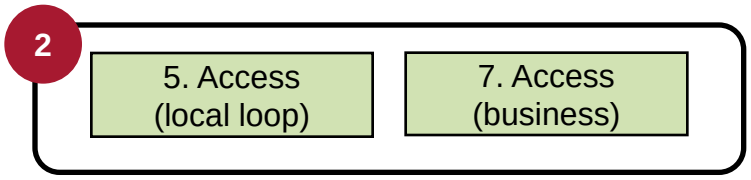
It covers a large number of activity and service modules, 2. Access



- Passive infrastructure from the LEX MDF / ODF is modelled together
- This covers the trench, duct and cables for copper loops, copper and fibre feeders, passive street equipment (cabinets, ROPs), plus PSTN/xDSL signal splitters, ROP power and cooling, MDF/ODF, tie cables, etc.

- We model an operator with:
  - a legacy national footprint of buried copper distribution cables
  - a legacy national copper feeders and street cabinets
  - FTTC roll-out of feeder duct+fibre, and active street equipment (ROPs)
    - starting in 2005; we assume it reaches 100% of cabinets in 2015
  - Fibre to the business overlay (retail, wholesale, mobile, internal, etc.)

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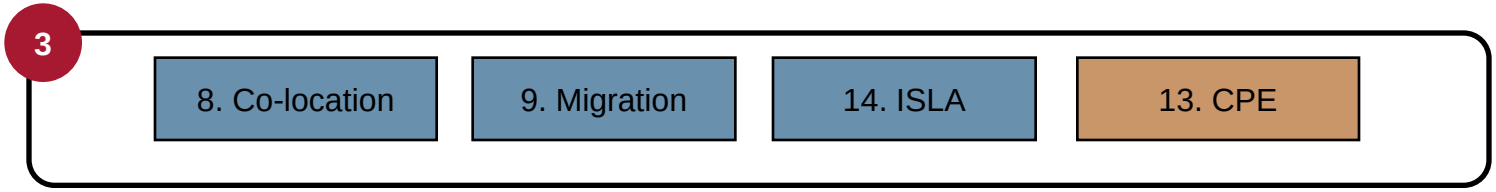
It covers a large number of activity and service modules, 3. Ancillary



- The common modules are the most diverse calculations within the model
- Equipment and hourly manpower for:
  - ***co-location services*** within the (Belgacom) technical buildings
  - ***migration*** of wholesale customers from legacy to new services, including necessary ***small network adaptations*** within the copper distribution network
  - ***(enhanced) service level agreements*** which ensure the staffing and management of network services to wholesale (and retail) customers
  - ***CPE***, which covers the hardware plus any installation activities for end-customer premise equipment

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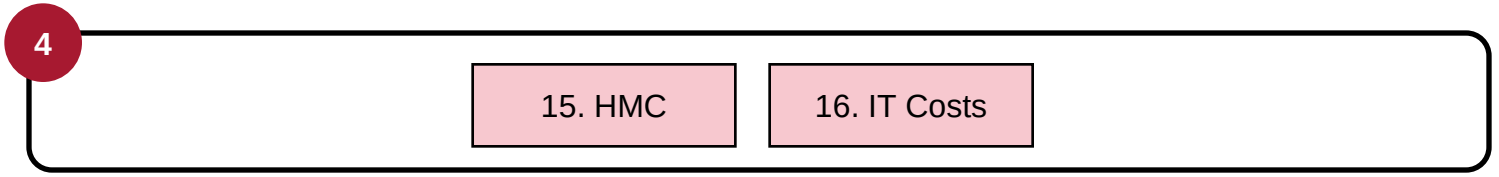
It covers a large number of activity and service modules, 4. Common



- All the core, access and ancillary services require (hourly) network manpower in order to deploy, operate and maintain the passive and active network equipment
- We calculate an efficient ***Hourly Manpower Cost*** for network engineers and the wholesale department
  - including all relevant cost components and allowances such as absence, training, breaks, expensed tools and equipment, leveraged third party sub-contract costs
- We have examined the large ***IT system components*** of Belgacom. We estimate an efficient allocation of hardware, software, support and staff costs to different retail, network and overhead functional activities

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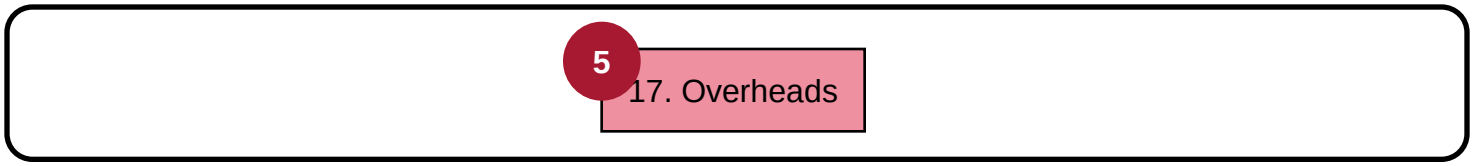
It covers a large number of activity and service modules, 5. Overheads



- The network (and un-modelled retail) activities of the modelled operator are supported by business overhead activities
  - top-level management, human resources, finance, administration, catering, facilities support, office space, fixtures, fleet, head office, etc.
- We have analysed Belgacom's categorised **overheads** costs. We have also estimated an efficient allocation of overhead costs to the supported network and retail activities
  - we have calculated this overhead as a mark-up on network HMC
  - i.e. every hour of engineer must be supported by EUR *n* of overheads
- The cost of technical buildings is also estimated per square meter as a technical overhead for all indoor network floor space costs
- We also include a general overhead % mark-up to all costs

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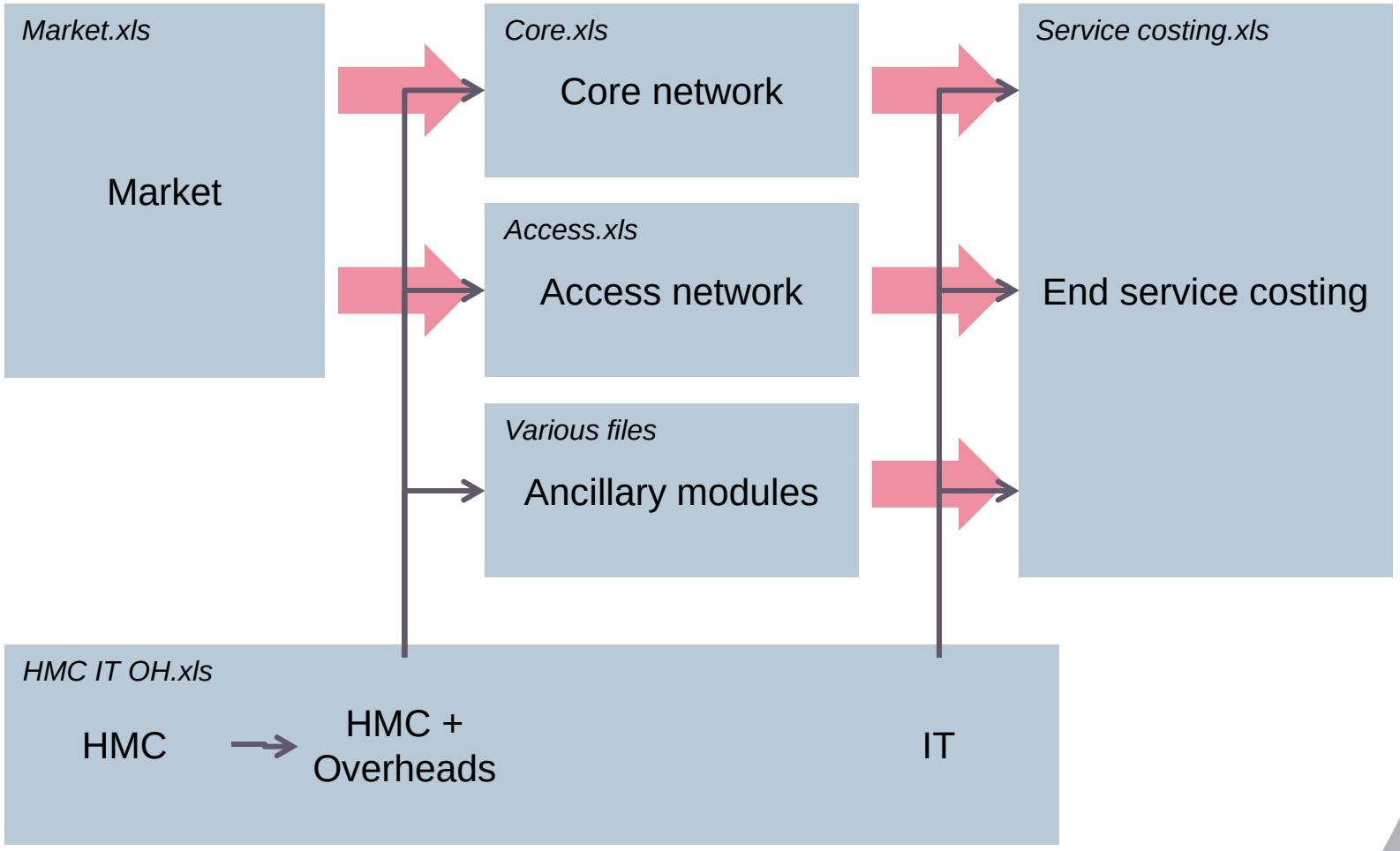
The fixed LRIC model has a modular structure



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Model overview

Market module

Core network design module

Access network design modules

Ancillary / Common / Overhead modules

Service costing module

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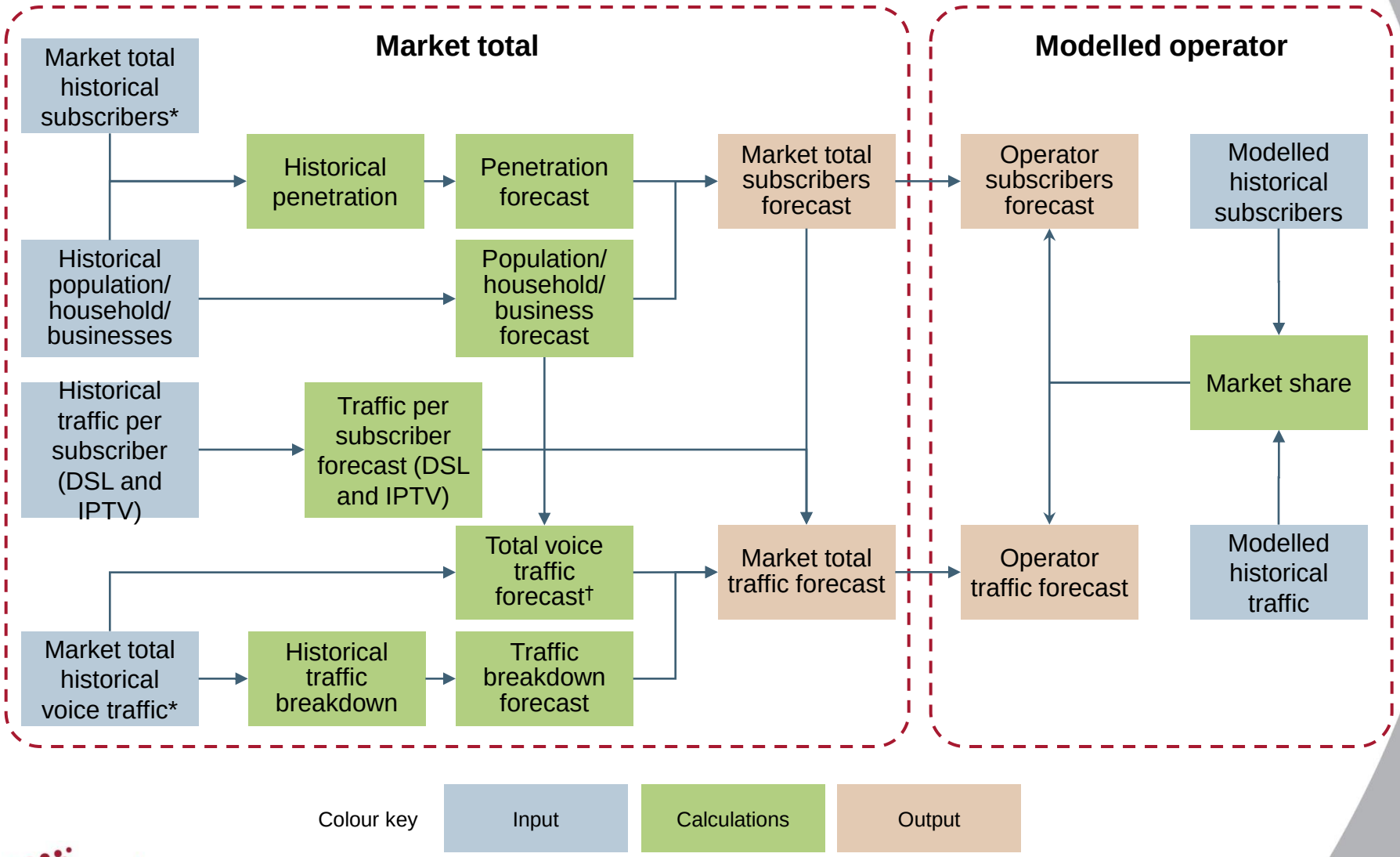
Outline of the market module



(*) Includes some data, at the total market level, from the mobile LRIC model

(†) Total voice traffic means fixed and mobile, towards all recipients/destinations

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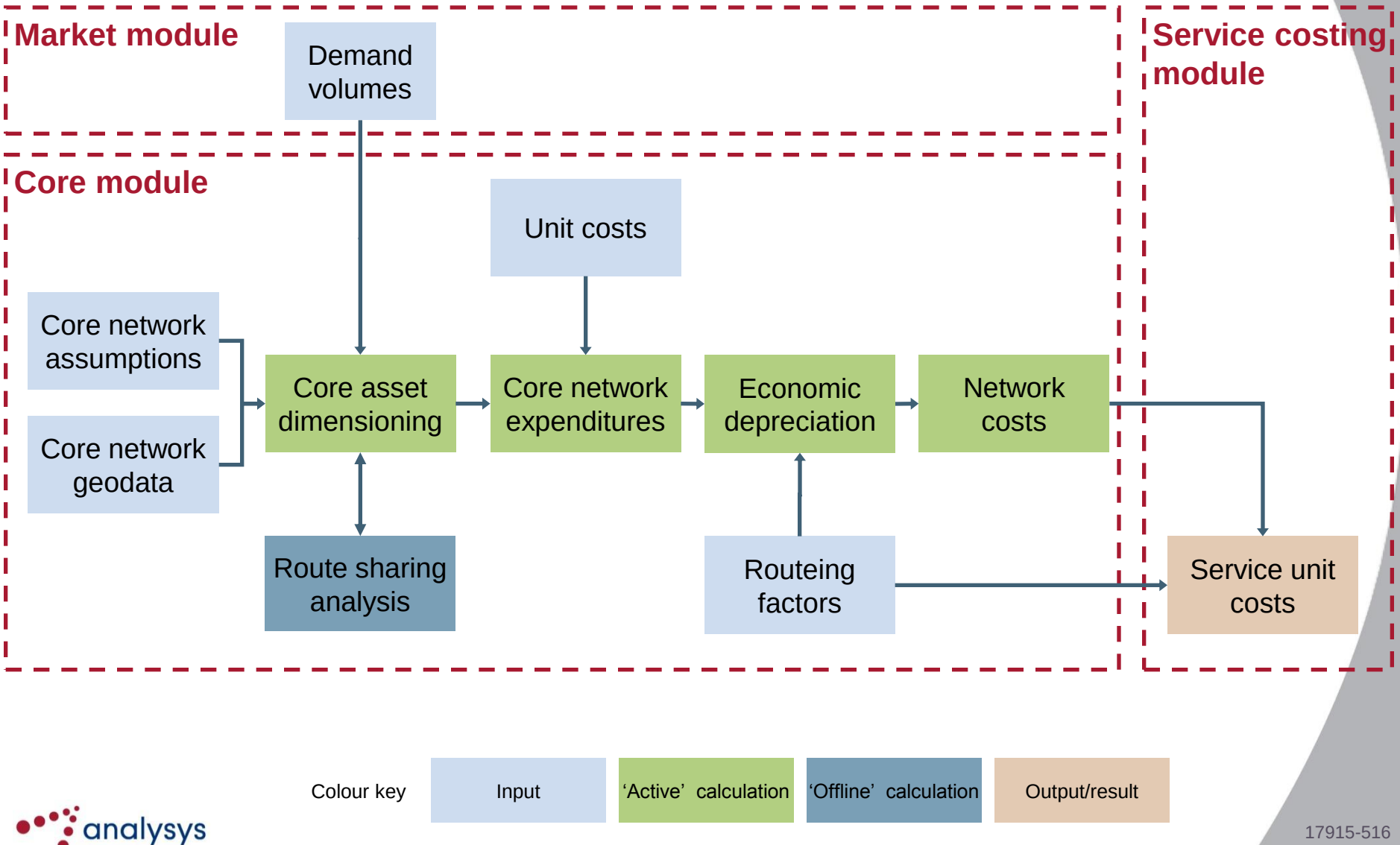
Outline of the core module



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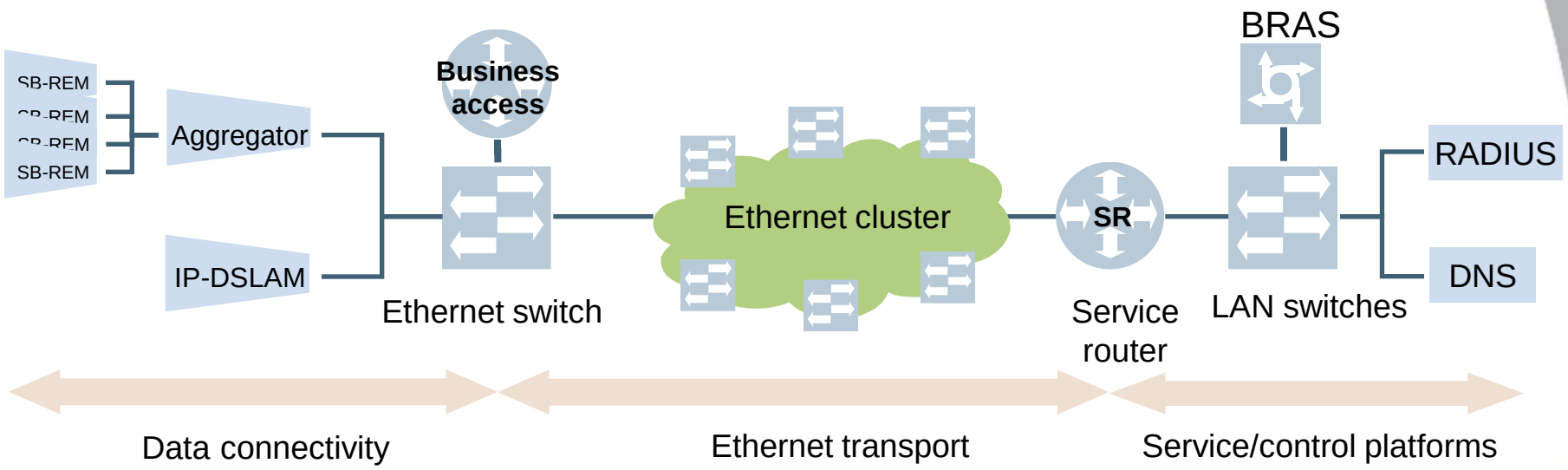
IP core network design

High-level IP core network architecture diagram



- A mix of disaggregated/monolithic IP DSLAMs is deployed respectively in the Street Cabinets (ROP) / in the LEX/LDC
  - DSLAMs deployed use IP network, under MEA principles
- Ethernet switches are deployed in the LEX and connect the DSLAMs to the core network
  - equipment loading is driven port connectivity and traffic volume requirements

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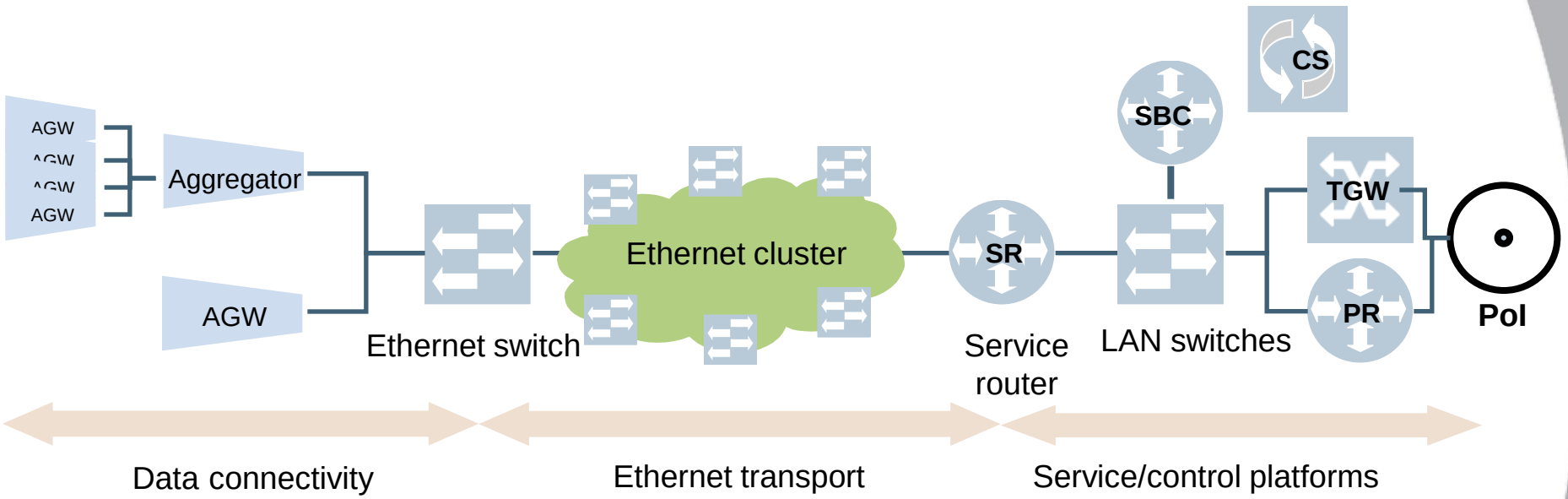
NGN voice services design

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	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

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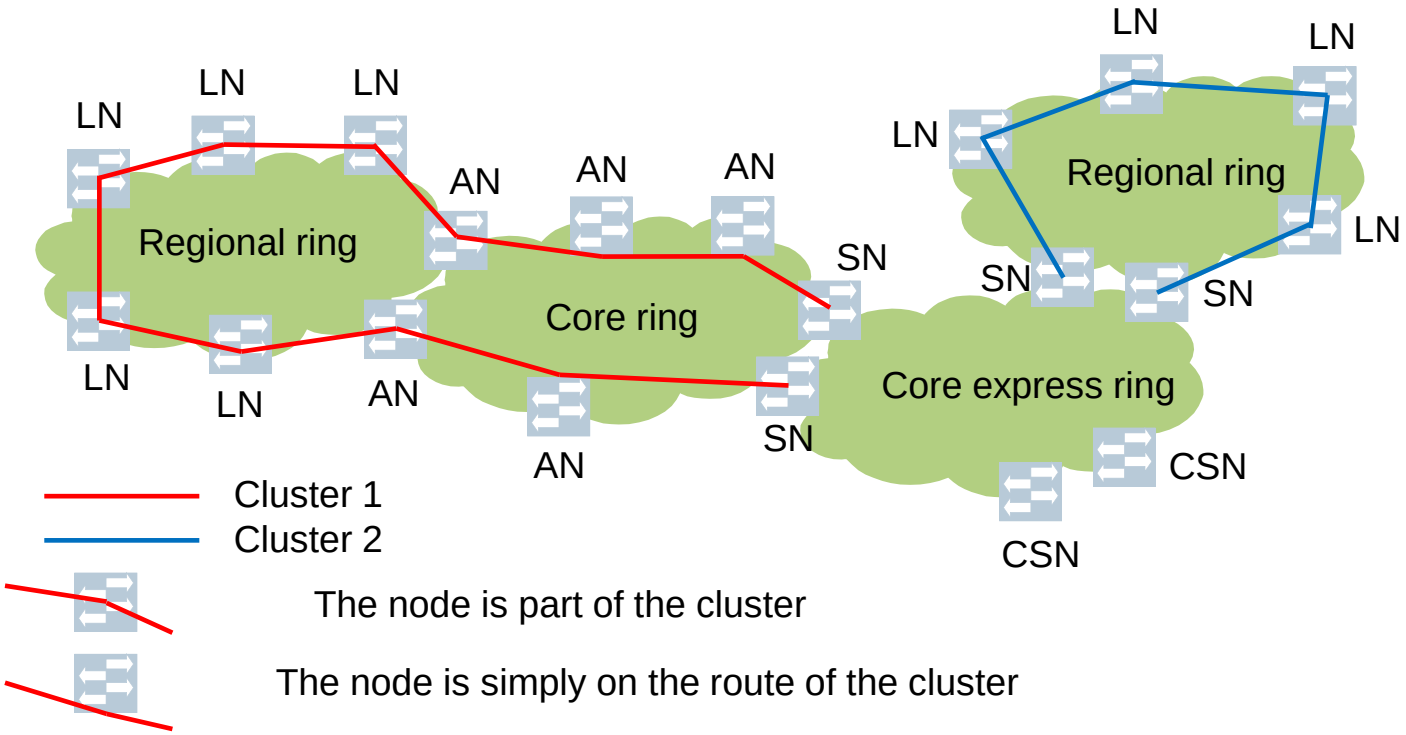
Fibre rings



- Local nodes (LN): LEX which only contain an Ethernet switch
- Aggregation nodes (AN): LEX which contain an Ethernet switch, are located on a core ring and aggregate the traffic of several LNs
- Service nodes and central service nodes (SN/CSN): LEX which contain an Ethernet switch and a service router and are located on a core express ring

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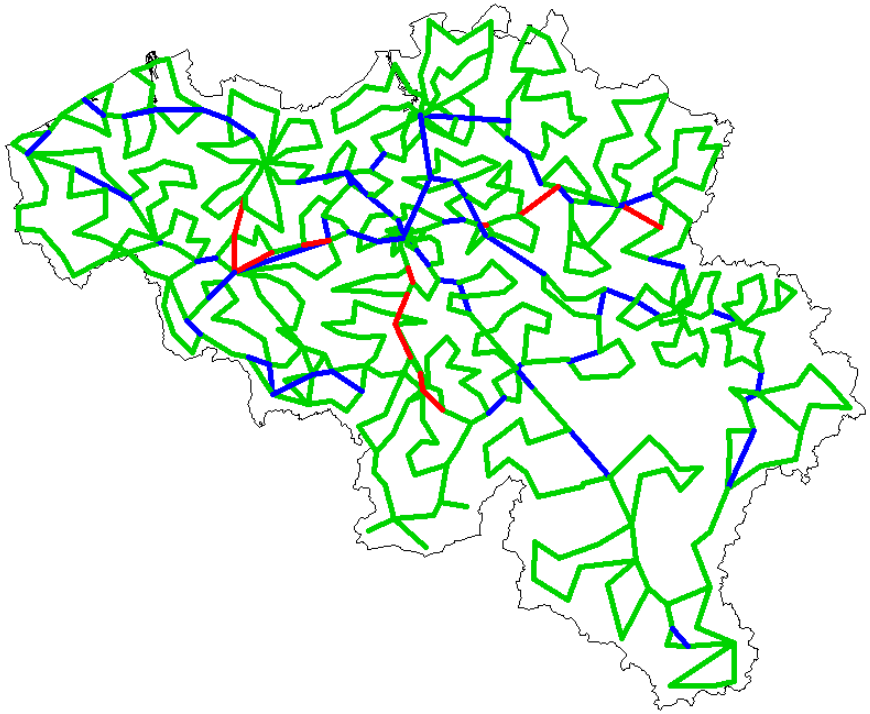
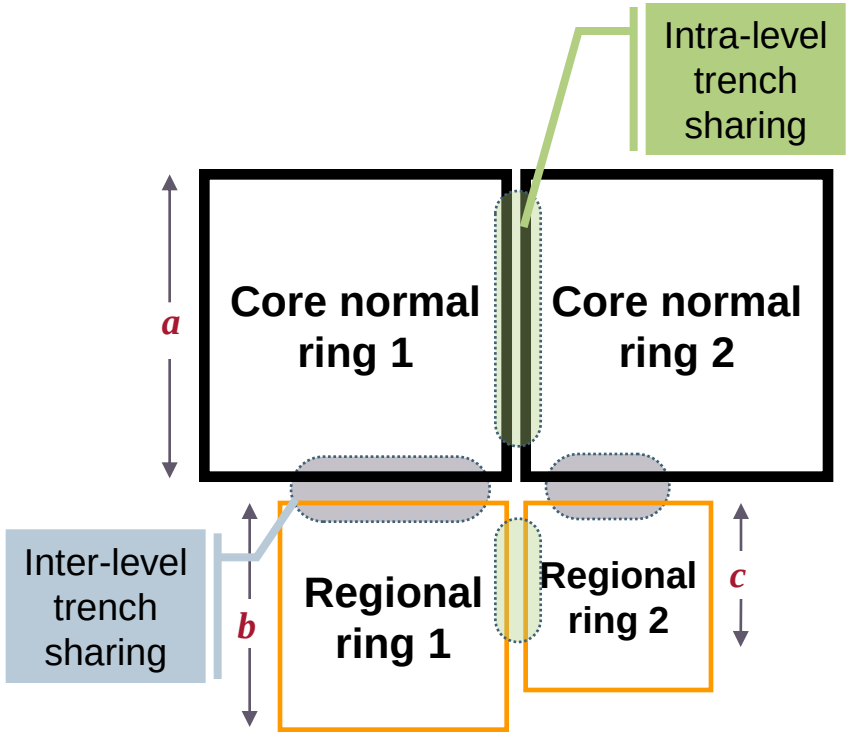
All trenched routes are then taken and analysed to identify the overlap of routes …



Regional Core normal Core express

Source: Analysys Mason



Source: Analysys Mason geo-analysis

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… to estimate the sharing of trench routes achievable in the core

Network layer	*Physical rings*	*Links*	*Dedicated cable (km)*	*Incremental trench (km)*	*Fibre regenerators**
Regional	62	611	4,453	4,453	0
Core Normal	7	137	1,200	605	0
Core Express	2	50	688	80	3
TOTAL	**71**	**798**	**6,340**	**5, 138**	**3**

Source: Analysys Mason estimates

Statistics from these calculations are then used in the model to calculate the costs related to the transport network routes

Source: Analysys Mason geo-analysis

(*) Assumes distance thresholds of 80km

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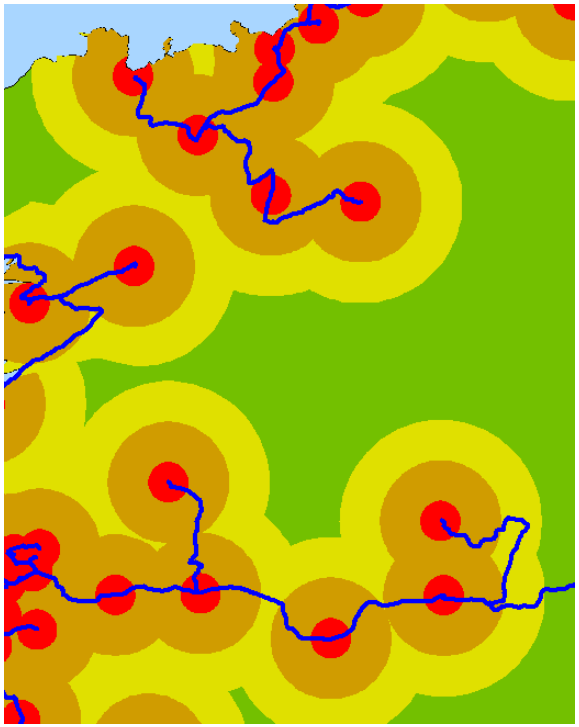
We have also estimated potential route sharing with the access network

Illustration of potential route sharing with the access network



- We have calculated the length of core routes within various distances of the access nodes
  - 0km, 0.5km, 1km, 1.5km, 2km
  - we assume that a 2km sharing from the LEX is efficient
- These parts of the core routes are assumed to share the trenches dug for the access network
  - the cost of these trenches is shared between the access and the core cost modules

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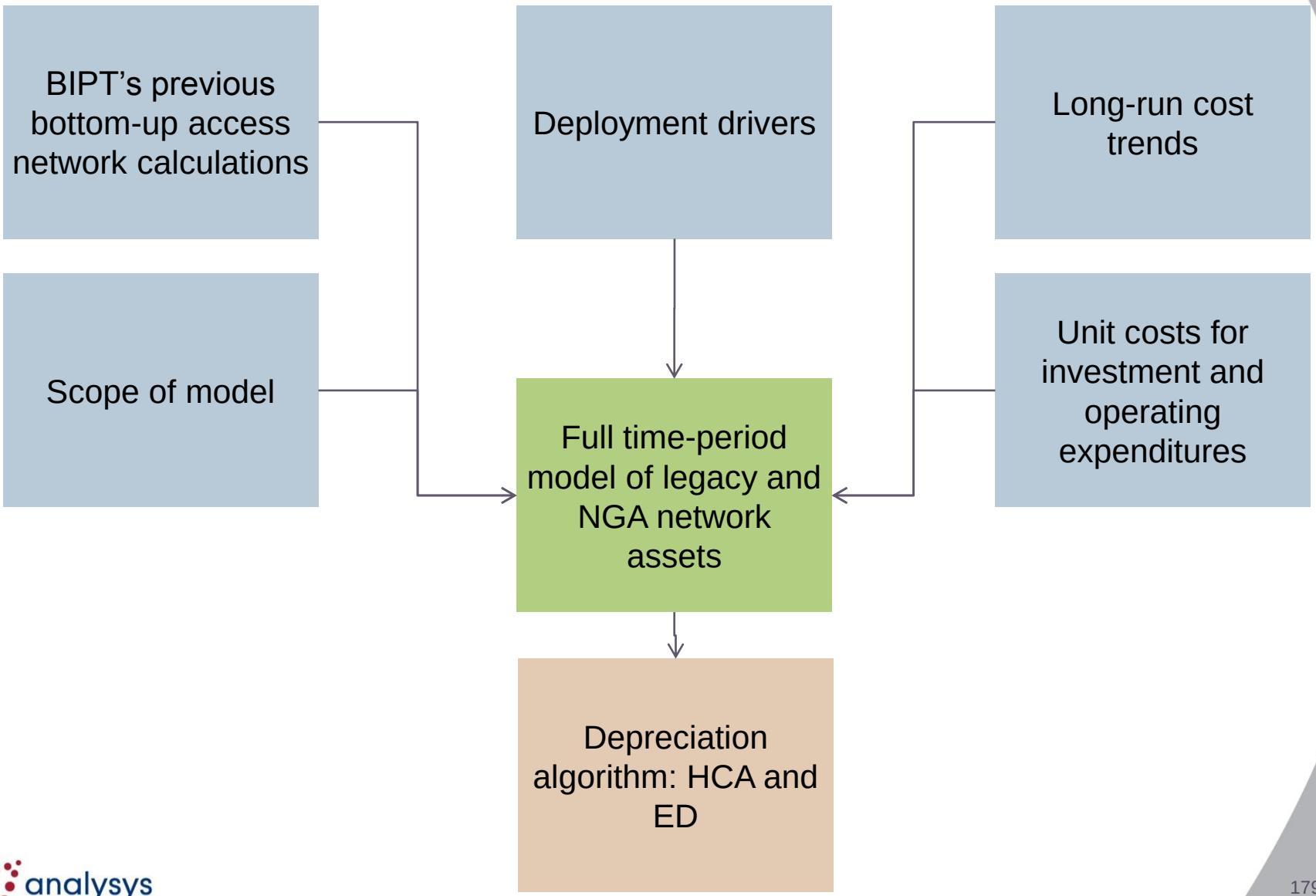
Access network design



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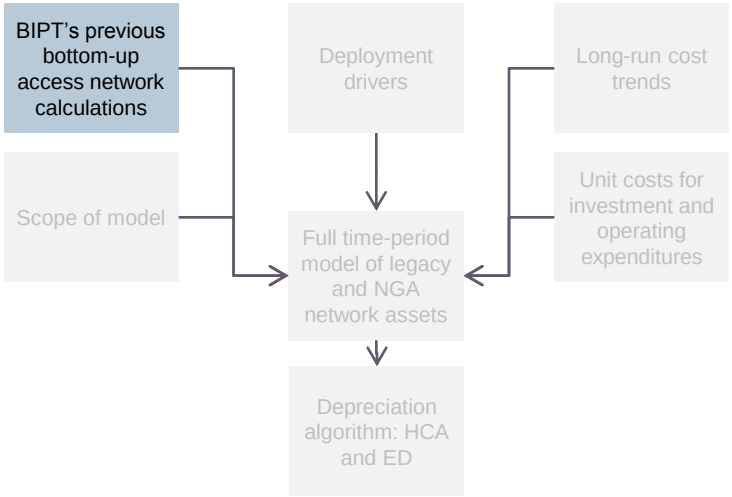

BIPT's previous bottom-up calculations

- BIPT developed a detailed bottom-up design algorithm in 2007
  - copper and feeder trench, cable, and splice assets using geo-modelling
  - "efficient" in comparison to Belgacom's actual copper access inventory
  - has been updated since 2007 with asset price indexes, volumes, WACC, VDSL, etc.
- This provides a number of inputs to our bottom-up calculation
  - efficient deployment of trench and cable km
  - efficient number of cable splices
  - starting costs for installation and equipment

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BIPT's previous bottom-up access network calculations

Deployment drivers

Long-run cost trends

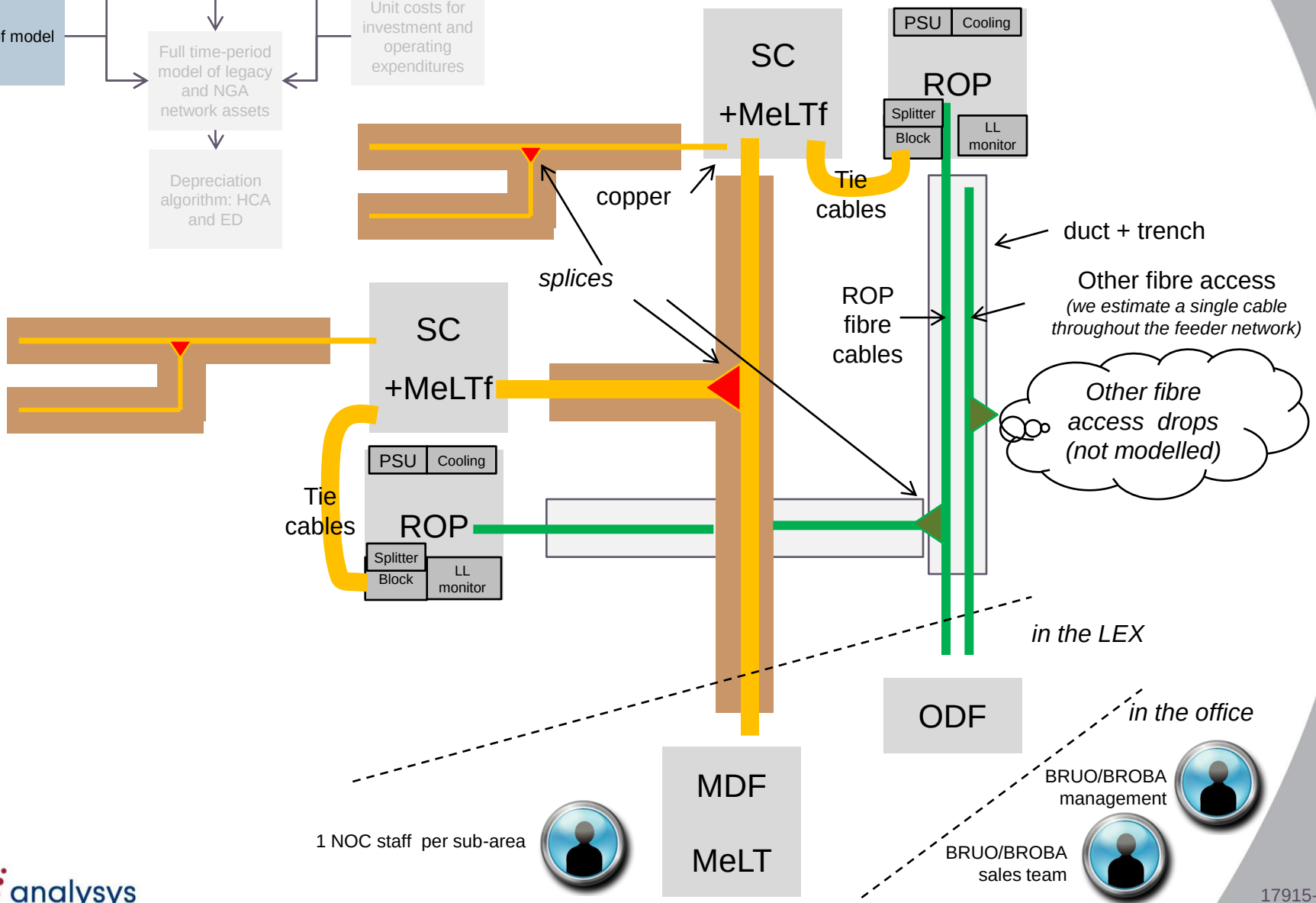
Scope of model

Unit costs for investment and operating expenditures

Full time-period model of legacy and NGA network assets

Depreciation algorithm: HCA and ED

Scope of model



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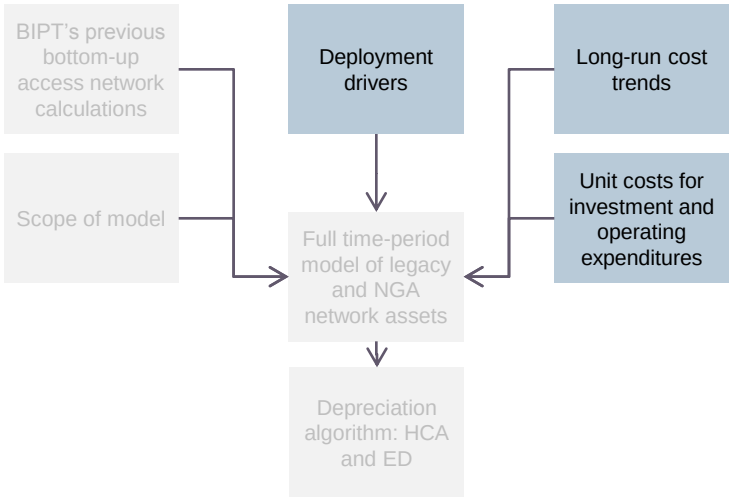
Other inputs



- Deployment drivers are used to grow the network over time
  - households
  - SCs and ROPs
  - FTTO and other fibre links
- We use long-run cost trends over the full time period
  - generally +/- 1% to 2% within inflation over a long period of time
- Short-run cost trend in copper is applied to investment but not economic cost recovery
- Capital expenditures per item:
  - installation
    - some trench is 'free' – paid for by house-builders
  - materials
- Operating expenditure per item:
  - maintenance hours and replacement/spares
  - power consumption and cooling

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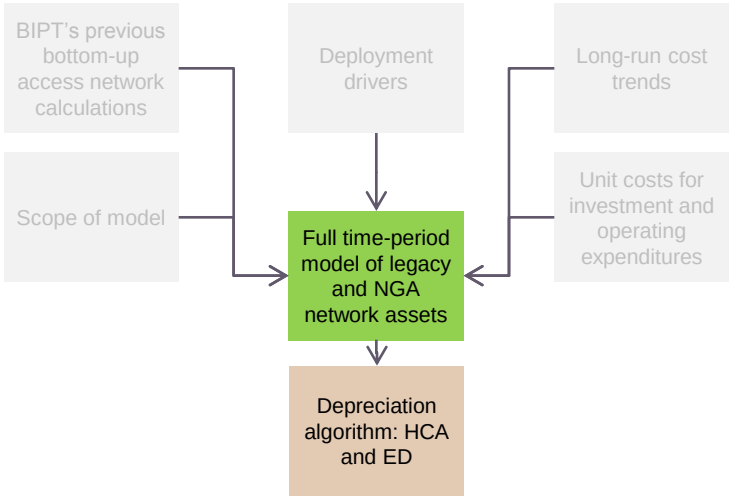
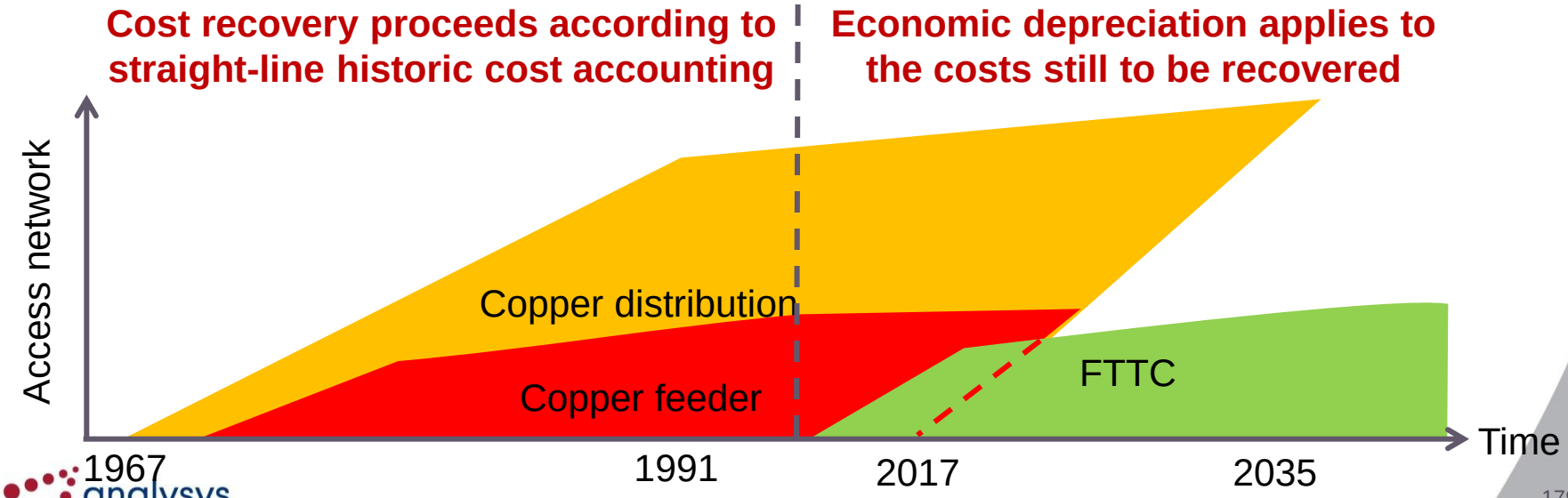


Calculations and annualised cost outputs

- Use deployment drivers and bottom-up inputs to calculate network extent
- Use unit costs and cost trends to calculate expenditures over time
- Apply HCA depreciation, then economic depreciation to the residual costs



DISCLAIMER: For industry information only, provisional based on Analysys Mason draft modelling

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Model overview

Market module

Core network design module

Access network design modules

Ancillary / Common / Overhead modules

Service costing module

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Colocation [1]

- The BIPT has a series of detailed colocation models
  - three **activity models** for upfront and recurring administrative costs
  - one **asset model** for upfront and recurring power costs
  - one composite **floorspace model** taking into account real estate management costs (e.g. rent, tax), facility management (e.g. security equipment) and costs directly related to colocation services (e.g. cost of National Wholesale department)

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Colocation [2]

- We have updated these models with:
  - new hourly manpower charge
  - new IT and overheads mark-ups for indirect allocations
  - updated building related costs
  - updated power related inputs (energy consumption, power equipment costs, power equipment footprint, cooling consumption, costs of maintenance)
- This produces a new set of colocation unit costs

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Migration – SNA [1]

- 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
  - 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 on average 7.5% of 'pre-2005' copper loops when they are upgraded for VDSL connectivity
  - e.g. moving to direct pair in same/different cable

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Migration – SNA [2]

- 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**

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Migration – one-time fees

- The BIPT has a detailed activity-by-activity model for the costs of one-time wholesale events
- We have updated this model with:
  - new hourly manpower charge
  - travel time cost
  - equipment cost trends
  - adjustments to overheads and indirect allocations
- This produces a new set of one-time fee unit costs

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ISLA

- We have modelled the operational costs of Improved Service Level Agreements (ISLA). Those correspond to the additional labour costs of having 24/7 activities compared ‘best efforts’ activities.
- An annual cost per line is calculated by estimating the average cost per trouble ticket and the proportion of access lines that have a trouble ticket per year (whether basic SLA or ISLA):
  - multiplying both numbers by each other gives an average ISLA servicing cost per year 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 average cost per line reflects the difference in the proportion of access lines that have a trouble ticket per year

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Customer premise equipment (CPE)

CPE	*2011 unit cost (EUR)*	*Price trend estimates*
ADSL2+ modem	**5**	Has reached cost floor
VDSL2 modem	**40**	Will decline towards 5-10 EUR 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 2-3 years
IPTV decoder (HD+DTV plus HDD)	**100**	Is today's high-end model, rapid cost declines in the next 2-3 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

Source: Analysys Mason estimates

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HMC (initial costs set in 2009)

- Annual salary of a network engineer divided by employed hours equals
  - **EUR[30-36]***
- For wholesale department staff, cost per hour is
  - **EUR[30-53]****
- This is the ‘raw’ hourly manpower cost
- **We assume a 10%** allowance for absence, training and breaks (where relevant)

** source: Statbel 2008, civil engineers, etc.*
*** source: Statbel 2008, admin, telecoms, etc.*

- Various mark-ups must be made to this raw hourly cost
  - see overheads section
- Indexed annually by **inflation**
- Additional outsourced labour and maintenance costs for some areas of the cost model:
  - **EURxx** per hour for own passive network activities
  - **EURxx** per hour for active equipment
  - **EURxx** per hour for civil works and digging

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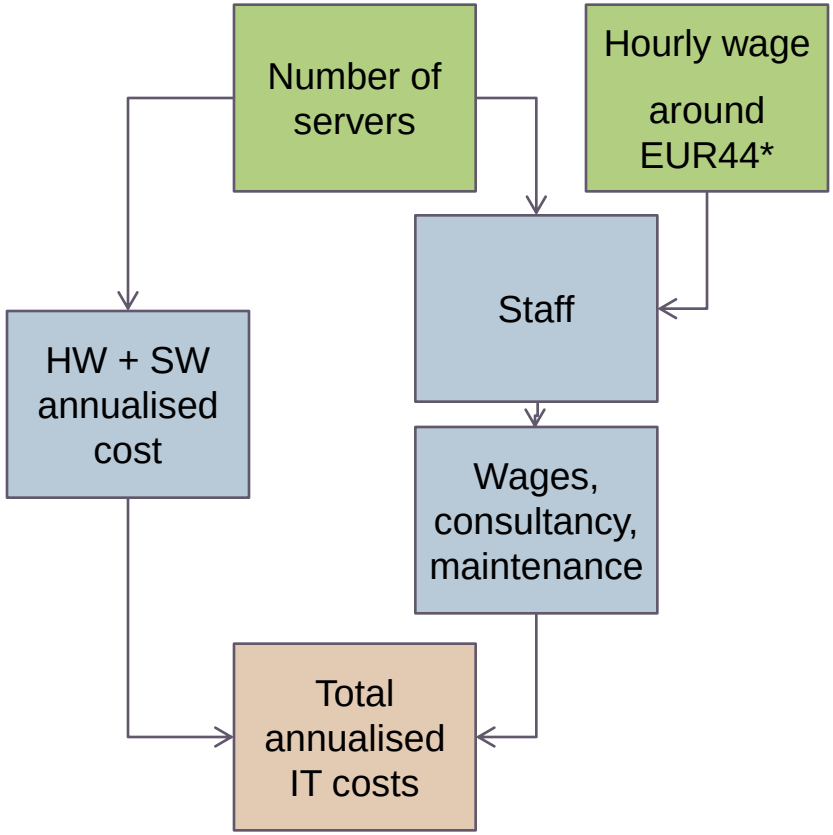
IT costs (initial costs set in 2009)

- IT costs consist of a sequence of cost elements



** source: Statbel 2008 survey on the cost of labour, Computer programming and IT*

- We have used Belgacom's functional IT classification and server pool to estimate a split of IT costs by:
  - retail (excluded)
  - network (included)
    - infrastructure
    - consumer services
    - carrier services
  - overheads (marked-up, see next section)
- The included categories are then allocated to services

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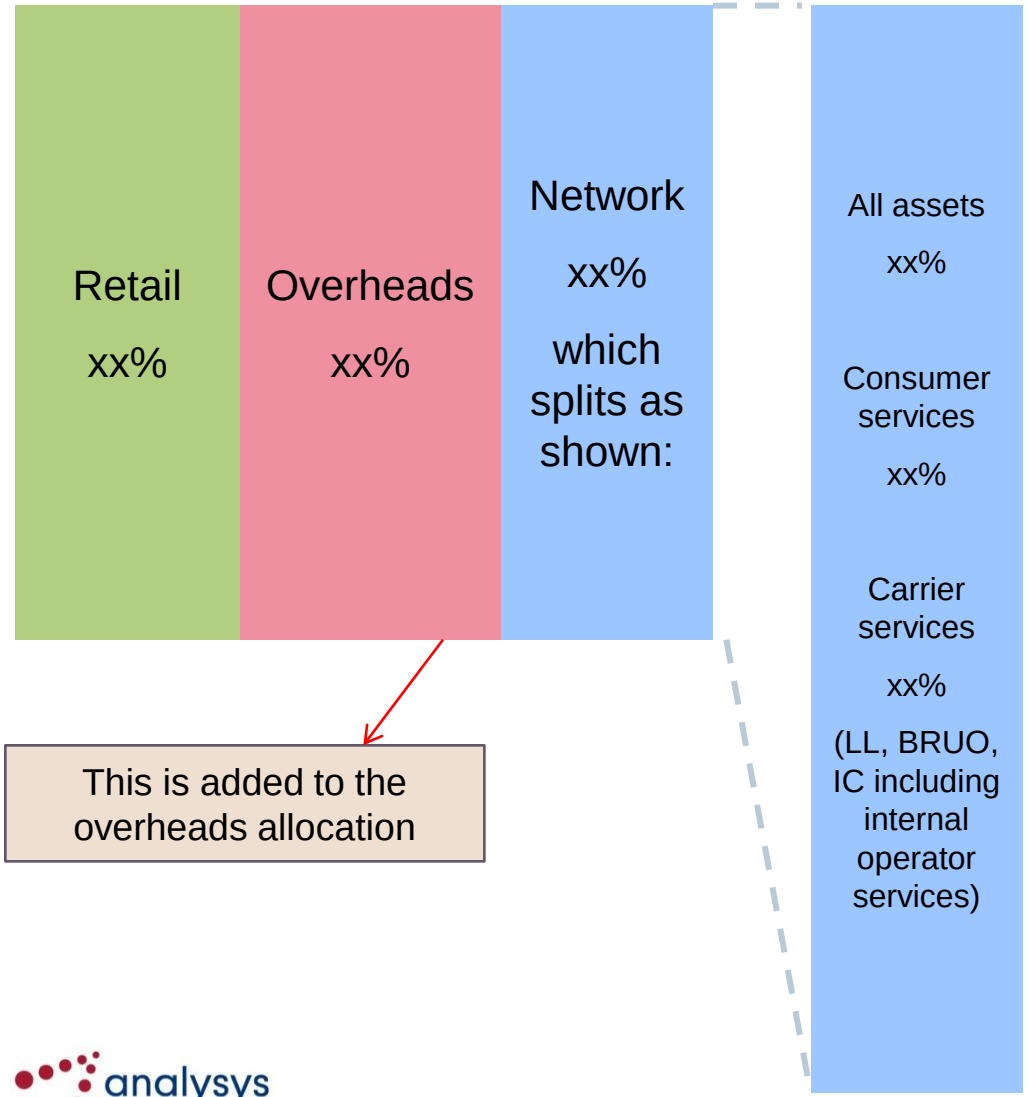
IT costs (initial costs set in 2009)



- By estimating the annualised costs of IT, we obtain three mark-ups:
  - **+a%** to all network services
  - **+b%** to consumer services (i.e. a+b% in total)
  - **+c%** to wholesale and other carrier services (i.e. a+c% in total)
- Previously BIPT used a 6% mark-up based on a third party survey on IT costs, cross-checked with Belgacom budgets

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Overheads (initial costs set in 2009)

- To the hourly manpower costs we add the following:
  - **around 1.2% for training and medicals***
  - **x% collective bonus**
  - **xx% expensed tools and vehicles for 'utility' work**
  - **x% expensed tools and vehicles for 'desk-based' work**
  - office accommodation (see next slide)

** source: Statbel 2008 survey on the cost of labour, training costs in the telecoms sector*

- We have investigated efficient overheads activity costs and estimated a split by:
  - directly related to retail
  - directly related to network
  - overheads related to the FTE of the business
  - to this we add the classified overheads IT costs
- The network share of these overhead costs totals **EURxx** per hour of network manpower
- We also identify remaining fixed network 'common' overheads for the final mark-up **(<5%)**

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Offices / buildings (in 2009)

- Office space for the average FTE is estimated using the following bottom-up inputs
  - **20m^2** total space per FTE
  - **7.5m^2** parking space per FTE
  - annual rent around **EUR[50] per m^2**
    - source: CBRE Richard Ellis, Q4 2009*
    - **plus 7.5% property taxes**
- We estimate two additions to this "empty" space cost
  - **+EUR[<100] per m^2** for office fixtures, electricity, security, etc.
  - **+EUR[<400] per m^2** for power, backup, aircon, and the fit out of technical building space
- Total office space costs per hour of work is **EUR[2-3]**

** http://www.investinbrussels.com/en/index.cfm/about-brussels/business-environment/competitive-real-estate/*

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Model overview

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Service costing module

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The service costing module contains the *controls* and *results*

Market.xls

Market

Core.xls

Core network

Access.xls

Access network

Various files

Ancillary modules

Service costing.xls

Control Panel

End service costing

Results calculation

HMC IT OH.xls

HMC → HMC + Overheads

IT

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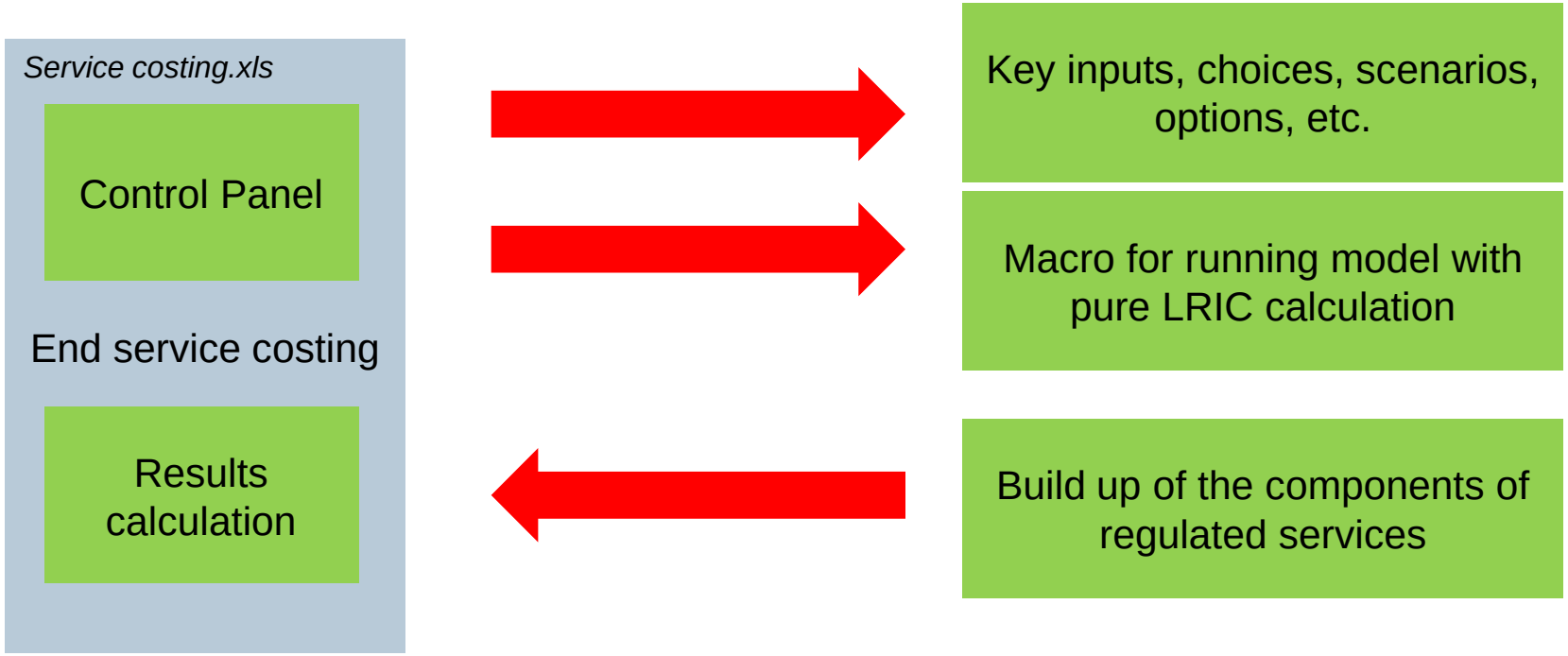
The service costing module contains the *controls* and *results*



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The service costing module contains the *controls* and *results*

Key inputs, choices, scenarios, options, etc.

- WACC
- Start/end dates
- Copper deployment profiles
- Depreciation and discounting choices
- SNA options

Macro for running model with pure LRIC calculation

- Macro runs model 'without wholesale termination' and records the capex and opex requirements
- Model runs model 'with wholesale termination' and records the capex and opex requirements
- Difference between these two is calculated as the pure LRIC per minute

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The service costing module contains the *controls* and *results*

Build up of the components of regulated services

- Pure LRIC of termination
- LRAIC+ of termination
- BRUO LEX/SC
- Shared pair / wo voice
- BROBA w/wo voice
- WBA VDSL2
- SNA Type 1
- SNA Type 2/3
- Other services

- Some end services need multiple components to be added together (in proportion if necessary). For example:
  - LRAIC+ of termination = minute of conveyance plus ss7 or SIP interconnection
  - WBA VDSL2 =
    - SLU of raw copper
    - rental of passive VDSL part (to SC and direct loops to LEX)
    - bitstream services (direct and indirect via core transmission)

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Draft results

Next steps / issues for consultation

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Draft results

- We plan to issue draft results at the time of the consultation only
  - we have a complete and working model which we are discussing with BIPT
  - we are still analysing the draft results and refining the way in which the results are presented
  - we do not wish to inform industry parties of our preliminary results until these are our final draft results for consultation

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Next steps / Consultation

- Analysys Mason will finalise the draft model in discussion with BIPT
- We must discuss and agree with BIPT, and with Belgacom, the scope of the bottom-up models which can be released to the industry for consultation (e.g. we have to remove confidential data, etc.)
  - we will produce a description of the methodology (EN, FR, NL), along with a description of the released models
- Estimated consultation start: before November
- Estimated consultation end: before 2012

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