AXON

Excellence in Business

Cost of Providing Roaming Wholesale Services – CNECT/2022/OP/0065

User manual

Axon Partners Group

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Contents

1.   Introduction

The European Commission (hereinafter "EC") commissioned Axon Partners Group Consulting S.L.U. (hereinafter "Axon Consulting" or "Axon") for the study "*Cost of Providing Roaming Wholesale Services – CNECT/2022/OP/0065*" ('the Project').

As described during Workshop 1 held on 21 June 2023, the EC deemed relevant to develop a new cost study to understand the costs of providing mobile services in EU/EEA countries. This initiative was necessitated by the new roaming regulation ('the Regulation')[1], which requires comprehensive review reports in the years 2025 and 2029. With such objective in mind, the EC/Axon team has updated the Bottom-Up Long Run Incremental Cost (hereinafter 'BULRIC') model previously elaborated by the EC/Axon during the project SMART 2017/0091[2], which calculates the costs of providing mobile services in the EU/EEA countries. The updated model aligns with the current market conditions and adheres to the regulatory framework established by the Regulation, ensuring that the EC's approach is both current and compliant for the forthcoming review periods.

This report describes how to use the costing model ('the model') for mobile networks commissioned by the EC and is split in the following sections:

▶ **General overview of the model,** which describes the structure of the costing model.

▶ **Getting started**, which outlines the main considerations and specifications to run the model.

▶ **Understanding the control panel**, describes the Control Panel of the model, which is the main user interface where the main options and scenarios are selected. Additionally, this worksheet contains a 'RUN' button to execute the model.

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[1] Regulation (EU) 2022/612 of the European Parliament and of the Council of 6 April 2022 on roaming on public mobile communications networks within the Union.

[2] The complete list of public materials developed as part of such project is available in the following link: https://digital-strategy.ec.europa.eu/en/library/finalisation-mobile-cost-model-roaming-and-delegated-act-single-eu-wide-mobile-voice-call

2. General overview of the model

The model file is comprised of worksheets grouped in the following blocks or calculation steps:

▶ Support and control worksheets

▶ Step 0: Parameters

▶ Step 1: Main inputs

▶ Step 2: Advanced inputs

▶ Step 3: Drivers and Routing Factors mappings

▶ Step 4: Relationships between services, drivers and resources

▶ Step 5: Unit costs and drivers consolidation

▶ Step 6: Network dimensioning

▶ Step 7: Costing and allocation

▶ Step 8: LRIC and common costs calculation

▶ Step 9: Outputs (Network perspective)

▶ Step 10: Outputs (Regulatory policy perspective)

The model has been developed based on a linear architecture to improve the execution performance and to reproduce the calculation flow logic. The exhibit below shows the model calculation flow.
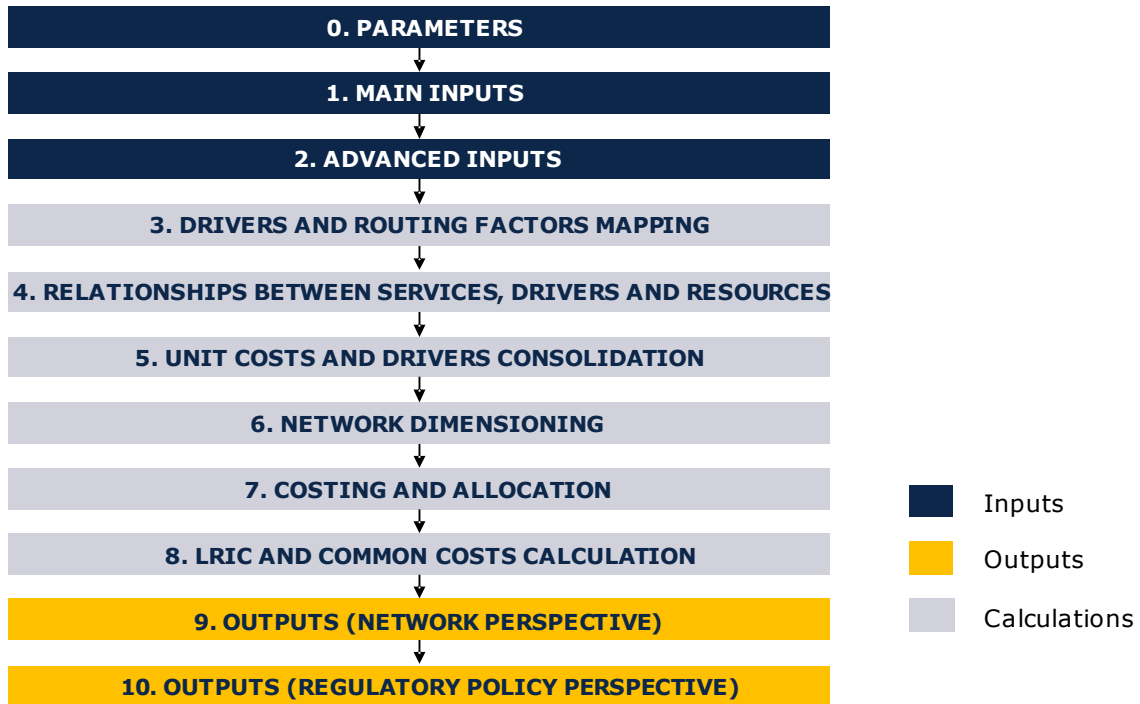
Exhibit 2.1: Calculation flow of the model [Source: Axon Consulting]

The block "Support and Control Worksheets" has not been represented in the previous exhibit for clarity purposes.

The worksheets of the model have been labelled according to the following structure (not applicable to the "Support and Control Worksheets" block):

▶ Step number and ordinal: It is composed of the number of the step (i.e. 0, 1, 2…) and the order of the worksheet in alphabetical format (i.e. A, B …)

▶ Type of worksheet indicators:

- *PAR*: Definition of parameters

- *INP*: Input worksheet

- *MAT*: Matrix obtaining the relationship between two dimensions

- *MAP*: Mapping between two dimensions

- *CALC*: Other Calculations

- *OUT*: Results worksheet

▶ Name of the worksheet

As an example, the worksheet '1B INP DEMAND' is the second (B) worksheet of the Step 1. It represents an input (INP) related with the demand (DEMAND).

2.1. Relationship between the model calculation flow and its worksheets

This section describes the calculation blocks of the model, including a detailed description of the worksheets contained in each block. Note that sub-section 2.1.1 does not strictly describe a block of the calculation flow, but it describes the support and control worksheets used within the model.

2.1.1 Support and control worksheets

In the model there are six (6) worksheets that provide general information, supporting the calculation process and checking that the execution has been completed successfully.

Worksheet name	Description
COVER	▶ This worksheet is the cover page of the model. It allows the user to run the model and have access to the main controls of the model (Worksheets "CONTENTS", "MAP"). ▶ It provides a graphical overview of the results for the service selected.
CONTENTS	▶ Provides high-level information about the model (i.e. version, status and contacts). ▶ Provides a list and brief descriptions of the model's worksheets.
CHANGE LOG	▶ This worksheet includes the list of changes implemented in the model when compared with the version that was submitted to the first consultation round. ▶ The list has been customised for each country, especially in terms of the inputs, as different adjustments/updates have been performed in each country.
MAP	▶ Map that presents the relationships between worksheet blocks and the calculation flow of the model. ▶ Colours have no meaning and have been selected to ease the identification of the blocks throughout the model.
COLOUR CODE	▶ It contains the colour code used throughout the model.

Worksheet name	Description
CHECKS	▶ Multiple checks are included in this worksheet to ensure that the model is working properly. ▶ Each check presents a quick link that allows the user to directly move to the worksheet where the issue has been identified.

Exhibit 2.2: Support and Control Worksheets. [Source: Axon Consulting]

2.1.2 Step 0: Parameters

The five (5) worksheets concerning the parameterisations taken into consideration in the model are defined in the table below:

Worksheet name	Description
0A PAR SERVICES	▶ This worksheet includes the list of services for which it will calculate costs. There are two categories of services used in the model, as listed below: • *External Services*: In order to present the services' results in a manner that is useful to the EC and that is respectful with the technological neutrality of the network, the external services have been created. The main objective of the external services is to provide the EC with a unique cost reference per service (e.g. a single cost for mobile voice termination). These external services will be used in the model's interaction with the user. • *Internal Services*: Internal services constitute a disaggregation of external services by technology. The model will consider these services internally to perform a more accurate dimensioning of the network and better allocate its costs. ▶ The demand traffic, obtained from stakeholders, is entered in the model at external service level (Worksheet-"1B INP DEMAND"), and it is mapped to internal services in block 4 (Worksheet - "4A MAT EXT.SERV 2 INT.SERV").

Worksheet name	Description

0B PAR DRIVERS	▶ Drivers are network entities used to dimension the network in terms of Erlangs, Channels, etc. The rationale of the dimensioning drivers is to express traffic and demand (at service level) in a way that facilitates the dimensioning of the network resources.
	
	▶ The explicit recognition of a dimensioning "Driver" in the model aims at simplifying and maximising the transparency of the network dimensioning process. Dimensioning drivers represent, among others, the following elements:
	
	   • Erlangs
	
	   • Mbps for packet switching carriers 2G / 3G / 4G / 5G
	
	   • Mbps for transmission through the core network
	
	   • Total number of subscribers for the dimensioning of HLR
	
	▶ The mapping between services and drivers is presented in the block 4 of the model, more specifically in worksheet "4B MAT SERV2DRIV".

0C PAR OTHER PARAMETERS	▶ This worksheet includes other parameters employed across the model. These include, but are not limited to, the parameterisation of increments, time, technologies, currency, spectrum, annualization methods, countries etc.

0D PAR RESOURCES	▶ This worksheet includes the network resources (e.g. sites, core platforms, etc.) used in the cost model.
	
	▶ The main aspects of the resource parameterisation are listed below:
	
	   • *Category*: Main classification of the resource (e.g. site, core, etc.).
	
	   • *Name*: Complete name of the resource
	
	   • *Short Name*: Shorter version of the name for abbreviation purposes throughout the model
	
	   • *Unit*: Unit in which the resource is measured
	
	   • *Resources Group for Cost Allocation*: Resource category that will be considered for the allocation of costs to services through the Routing Factors matrix.
	
	   • *Access / Core*: it indicates if the resource belongs to the Access Network (geotype dependant) or the Core Network (non-geotype dependant)

Worksheet name	Description
	▶ The dimensioning of the resources is performed in block 6 of the model.
0E PAR TX TECH	▶ This worksheet includes the definition and characterization of the technologies used for transmission (Leased Lines, Microwaves, Optic Fibre).
	▶ This information is relevant in the dimensioning algorithms of the transmission network (backhaul and backbone), as it includes the relationships between transmission configurations and the associated network elements required to provide such configuration, in terms of technology, capacity and distance.

Exhibit 2.3: Parameters worksheets. [Source: Axon Consulting]

2.1.3 Step 1: Main inputs

The main inputs are those which need to be regularly updated to better represent the characteristics of the operator modelled at any specific moment in time. A total of ten (10) worksheets have been introduced in this calculation block, which are defined below:

Worksheet name	Description
1A INP MARKET SHARE	▶ The size of the reference operator (% of market share) is defined in this worksheet. The market share of the reference operator is defined as 1/N, with N being the number of MNOs in the market, subject to a minimum efficient scale of 20% of the market.
1B INP DEMAND	▶ The overall demand (subscribers and traffic) generated in each EU/EEA country is introduced in this worksheet. This represents the total market demand and is afterwards adjusted according to the market share of the reference operator.
	▶ The demand is introduced in a technology-neutral manner in this worksheet, for each of the external services defined in worksheet "0A PAR SERVICES".
	▶ The demand of the three scenarios defined in section 4 is included in this sheet.
1C INP NW STATISTICS	▶ The call and data statistics registered in the operator's network are introduced in this worksheet.

Worksheet name	Description
1D INP COVERAGE	▶ The percentage of population covered in each geotype under each mobile access technologies (by year) is input in this worksheet. This information is introduced for each EU/EEA country. ▶ The coverage information is used to dimension the access networks in block 6 of the Model.
1E INP SPECTRUM	▶ The spectrum available per band, technology and year is defined in this worksheet for each EU/EEA country. This information is used to dimension the access networks in block 6 of the model. ▶ Note that the spectrum information included below is representative of the reference operator and not the total market.
1F INP UNITARY COSTS	▶ Unitary costs (both CapEx and OpEx) are defined in this worksheet for each resource asset introduced in sheet "0D PAR RESOURCES". The cost values are represented in Euros for the year 2022. OPEX values represent an average of EEA countries and are adjusted based on Purchasing Power Parity (PPP) factors, as presented in worksheet "1G INP COST ADJ FACTORS". ▶ The CapEx trends are also entered in this worksheet (in nominal terms). These trends are used to estimate the costs of the equipment for each of the years considered in the model (calculations performed in block 5 of the model).
1G INP COUNTRY ECO PAR	▶ The parameters used to properly represent OpEx per country and to project it throughout the timeframe considered in the model are introduced in this worksheet. In particular: • Inflation rate is used to estimate historical and forecast values of OpEx for the network resources in block 5. • PPP factor is used to adjust EEA average OpEx figures to the realities of each country, based on the weight of salaries.
1H INP COST OVERHEADS	▶ The G&A overhead considered in the model is defined in this worksheet as a percentage of the Gross Book Value (GBV). ▶ This percentage is used to estimate G&A costs in block 9 of the Model.

Worksheet name	Description
1I INP TECHNOLOGY DIS	▶ This worksheet introduces the technological (2G, 3G, 4G and 5G) disaggregation of traffic per service category (Subscribers, Data, Voice, etc.) over the years, in each EU/EEA country. ▶ These percentages are used to allocate the demand of external services to internal services in block 4 of the model. ▶ Additionally, this worksheet also includes the disaggregation of data traffic and customers per type of service, by differentiating between i) traditional data services provided to end-customers and ii) M2M / IoT data services. Finally, the number of Roamer Days for each country is presented.
1J INP ARPU	▶ The Average Revenue Per User (ARPU) is introduced in this worksheet for all EEA countries. This information is introduced in terms of EUR/month/user (without any service-level split). ▶ The ARPU information is used in the annualisation of assets' investments in block 7 when an ARPU-based economic depreciation is selected in the control panel.

Exhibit 2.4: Main inputs worksheets. [Source: Axon Consulting]

2.1.4 Step 2: Advanced inputs

The second type of inputs, named Advanced Inputs, are not expected to be updated regularly by the user, as they refer to information that will generally remain unchanged over a prolonged number of years (e.g. geographical information, busy hour traffic percentage). Ten (10) worksheets have been defined in this step, and they are described in the table below:

Worksheet name	Description
2A INP NW	▶ Network parameters required for the dimensioning of the network (e.g. equipment's capacity, standard indicators, constants) are introduced in this worksheet. ▶ These parameters are used in block 6 of the model during the dimensioning process.

Worksheet name	Description
2B INP GEO	▶ This worksheet contains the information required in order to properly characterise the access network (e.g. area, population, site configurations). ▶ This information is used in block 6 of the model during the dimensioning process. ▶ The geographical characterisation of the country under each of the three thresholds to identify seasonal patterns defined in section 4 is included in this sheet.
2C INP CELL RADIUS	▶ This worksheet contains the cell radius information per country, band and geotype that will be considered in the dimensioning of the access networks.
2D INP DIST POP RURAL	▶ The table in this worksheet defines the distribution of population and area in rural geotypes. ▶ The information is used in the dimensioning process (block 6) of the model.
2E INP BUSY HOUR	▶ The busy hour distribution profile in each EU/EEA country is defined in this worksheet. The outcome generated in this worksheet constitutes the percentage of traffic in the busy hour of a normal day over the traffic carried over one year for the different categories of services. ▶ The information from this worksheet is used in the calculation of drivers in block 5.
2F INP BACKBONE & CORE	▶ The information needed to dimension the core and backbone networks is introduced in this worksheet. ▶ The dimensioning of the core and backbone networks is performed in block 6.
2G INP RESOURCES LIFE	▶ Useful lives for the annualisation of resources costs are introduced in this worksheet and applied in block 7.
2H INP WACC	▶ The nominal pre-tax Weighted Average Cost of Capital (WACC) for each EEA country is defined in this worksheet. ▶ The WACC is used to calculate the economic depreciation of the assets in block 7.

Worksheet name	Description
2I INP ERLANG	▶ The Erlang B table (used for network dimensioning) is reproduced in this worksheet. ▶ It will be used when dimensioning the number of channels.
2J INP SERVICE SPEC COSTS	▶ The wholesale specific costs incurred in the provision of wholesale roaming and voice termination services are introduced in this worksheet.

Exhibit 2.5: Advanced inputs worksheets. [Source: Axon Consulting]

2.1.5 Step 3: Drivers and Routing Factors mappings

The two (2) worksheets contained in this block are used to map the services with the drivers used for dimensioning and to define the routing factors that will be considered in the allocation of costs to services. These worksheets are defined in the table below:

Worksheet name	Description
3A MAP SERV2DRIV	▶ This worksheet defines the relationships between internal services and dimensioning drivers based on the conversion factors and the usage of the drivers by each service. ▶ It should also be noted that a service is generally assigned to more than one driver, as drivers represent traffic in a particular point of the network. For example, voice on-net calls should be contained in the drivers used to dimension the access network as well as the drivers used to dimension the core network. ▶ The relationships introduced in this worksheet, presented in tabular format, are restructured in a matrix format in sheet "4B MAT SERV2DRIV".

Worksheet name	Description
3B MAP ROUTING FACTORS	▶ The cost allocation of resources to services is defined in this worksheet through Routing Factors. The Routing Factors are calculated taking into account network statistics and parameters. ▶ The Routing Factors approach consists in allocating costs to services based on the use they make of each equipment. The Routing Factor is a measure of how many times a resource is used by a specific service in its provision. ▶ The relationships introduced in this worksheet, presented in tabular format, are restructured in a matrix format in sheet "4C MAT RF - SERV".

Exhibit 2.6: Drivers and routing factors mappings worksheets. [Source: Axon Consulting]

2.1.6 Step 4: Relationships between services, drivers and resources

The three (3) worksheets contained in this step are used to calculate the relationship matrixes between external services and internal services, between services and drivers, and between services and resources. These worksheets are described in the table below:

Worksheet name	Description
4A MAT EXT.SERV 2 INT.SERV	▶ This worksheet includes the allocation of external services (end-user services) to internal services (network services), based on the technological disaggregation defined in worksheet "1I INP TECHNOLOGY DIS". ▶ The relationship presented in this worksheet, together with the demand information from block 1, is used to estimate the demand for internal services in block 5.
4B MAT SERV2DRIV	▶ This worksheet re-organises the relationships between services and drivers previously defined in worksheet "3A MAP SERV2DRIV". ▶ This information is used to estimate the volume of dimensioning drivers in block 5.

Worksheet name	Description
4C MAT RF - SERV	▶ This worksheet re-organises the routing factors between resources and services previously defined in worksheet "3B MAP ROUTING FACTORS". ▶ This information is used to allocate resources costs to services in blocks 7 and 8.

Exhibit 2.7: Relationships between services, drivers and resources worksheets [Source: Axon Consulting]

2.1.7 Step 5: Unit costs and drivers consolidation

The six (6) worksheets included in this section are responsible for calculating the unitary costs of the resources for the years considered in the model and consolidate the demand and drivers' information to ease the network dimensioning process. These worksheets are described below:

Worksheet name	Description
5A CALC UNITARY COSTS	▶ This worksheet consolidates the unit costs of the resources (CapEx and OpEx) in the format required by the model for the selected country. • CapEx unitary costs are calculated by taking into consideration the 2022 reference CapEx defined in the inputs section and applying the CapEx trends to it. • OpEx unitary costs are calculated by taking into consideration the 2022 reference OpEx defined in the inputs section and applying the applicable inflation rates to it. At the same time, OpEx figures are adjusted based on the PPP factor to properly represent the realities of each EEA country. ▶ The values obtained are later used to calculate the total costs of the network in block 7.

Worksheet name	Description
5B CALC COST ESTIMATION FOR TX	▶ This worksheet estimates the annualised unit costs of transmission resources which are later used in the dimensioning algorithms to select the optimum transmission technology in block 6. ▶ Both capital and operational costs are considered in this worksheet. CapEx is annualised through the PMT formula (which calculates the applicable CapEx annuity based on a given WACC).
5C CALC DEMAND INT SERV	▶ The demand for internal services is calculated based on the relationship from external to internal services defined in worksheet "4A MAP EXT.SERV 2 INT.SERV". ▶ This information is used to calculate the volume of drivers in worksheet "5F CALC DRIVERS".
5D CALC TRAFFIC PERC BY GEO	▶ This worksheet introduces the percentage of traffic of each access technology that will be handled in each geotype, based on their population and coverage levels. ▶ This information is used in the next worksheet to estimate the demand for each geotype.
5E CALC DEMAND GEOTYPE	▶ The demand for internal services is split per geotype based on the percentages calculated in the previous worksheet "5D CALC TRAFFIC PERC BY GEO". ▶ This information is used in the worksheet "5F CALC DRIVERS" to calculate the demand for dimensioning drivers at geotype level.
5F CALC DRIVERS	▶ The dimensioning drivers' volume per geotype and increment is calculated in this worksheet. The different increments are presented towards the right of the worksheet. ▶ This information is used to dimension the network in block 6.

Exhibit 2.8: Unit costs and drivers consolidation worksheets. [Source: Axon Consulting]

2.1.8 Step 6: Network dimensioning

This block includes eight (8) worksheets responsible for the network dimensioning, including the access, transmission and core sections. The descriptions of each of the worksheets included in this block are presented below:

Worksheet name	Description
6A CALC DIM GSM	▶ The GSM network is dimensioned in this worksheet, calculating the equipment required to support the 2G traffic for each increment and in each geotype. ▶ Calculations are presented for four different increments (when moving towards the right of the sheet) and for all the geotypes defined (when moving towards the bottom of the sheet), in a total of 4 x 6 = 24 steps. Finally, at the lower end, results in terms of KPIs are consolidated. ▶ The dimensioning of the network takes as starting point the drivers obtained in block 5 as well as other inputs extracted from blocks 1 and 2. The results of this worksheet are consolidated in worksheet "6H CALC RES GEO" and then used to calculate the total costs of the network in block 7.
6B CALC DIM UMTS	▶ The UMTS network is dimensioned in this worksheet, calculating the equipment required to support the 2G traffic for each increment and in each geotype. ▶ Calculations are presented for four different increments (when moving towards the right of the sheet) and for all the geotypes defined (when moving towards the bottom of the sheet), in a total of 4 x 6 = 24 steps. Finally, at the lower end, results in terms of KPIs are consolidated. ▶ The dimensioning of the network takes as starting point the drivers obtained in block 5 as well as other inputs extracted from blocks 1 and 2. The results of this worksheet are consolidated in worksheet "6H CALC RES GEO" and then used to calculate the total costs of the network in block 7.

Worksheet name	Description
6C CALC DIM LTE	▶ The LTE network is dimensioned in this worksheet, calculating the equipment required to support the 2G traffic for each increment and in each geotype. ▶ Calculations are presented for four different increments (when moving towards the right of the sheet) and for all the geotypes defined (when moving towards the bottom of the sheet), in a total of 4 x 6 = 24 steps. Finally, at the lower end, results in terms of KPIs are consolidated. ▶ The dimensioning of the network takes as starting point the drivers obtained in block 5 as well as other inputs extracted from blocks 1 and 2. The results of this worksheet are consolidated in worksheet "6H CALC RES GEO" and then used to calculate the total costs of the network in block 7.
6D CALC DIM 5G	▶ The 5G network is dimensioned in this worksheet, calculating the equipment required to support the 5G traffic for each increment and in each geotype. ▶ Calculations are presented for four different increments (when moving towards the right of the sheet) and for all the geotypes defined (when moving towards the bottom of the sheet), in a total of 4 x 6 = 24 steps. Finally, at the lower end, results in terms of KPIs are consolidated. ▶ The dimensioning of the network takes as starting point the drivers obtained in block 5 as well as other inputs extracted from blocks 1 and 2. The results of this worksheet are consolidated in worksheet "6H CALC RES GEO" and then used to calculate the total costs of the network in block 7.

Worksheet name	Description
6E CALC DIM SITES	▶ The access sites are dimensioned in this worksheet. ▶ Calculations are presented for four different increments (when moving towards the right of the sheet) and for all the geotypes defined (when moving towards the bottom of the sheet), in a total of 4 x 6 = 24 steps. Finally, at the lower end, results in terms of KPIs are consolidated. ▶ The dimensioning of the network takes as starting point the drivers obtained in block 5 as well as other inputs extracted from blocks 1 and 2. The results of this worksheet are consolidated in worksheet "6H CALC RES GEO" and then used to calculate the total costs of the network in block 7.
6F CALC DIM BACKHAUL	▶ The backhaul network is dimensioned in this worksheet, calculating the equipment required to support the traffic for each increment and in each geotype. ▶ Calculations are presented for four different increments (when moving towards the right of the sheet) and for all the geotypes defined (when moving towards the bottom of the sheet), in a total of 4 x 6 = 24 steps. Finally, at the lower end, results in terms of KPIs are consolidated. ▶ The dimensioning of the network takes as starting point the drivers obtained in block 5 as well as other inputs extracted from blocks 1 and 2. The results of this worksheet are consolidated in worksheet "6H CALC RES GEO" and then used to calculate the total costs of the network in block 7.

Worksheet name	Description
6G CALC DIM CORE	▶ The backbone and core networks are dimensioned in this worksheet, calculating the equipment required to support the traffic for each increment and in each geotype. ▶ Calculations are presented for four different increments (when moving towards the right of the sheet) and for all the geotypes defined (when moving towards the bottom of the sheet), in a total of 4 x 6 = 24 steps. Finally, at the lower end, results in terms of KPIs are consolidated. ▶ The dimensioning of the network takes as starting point the drivers obtained in block 5 as well as other inputs extracted from blocks 1 and 2. The results of this worksheet are consolidated in worksheet "6H CALC RES GEO" and then used to calculate the total costs of the network in block 7.
6H CALC RES GEO	▶ This worksheet consolidates the resources obtained in all the previous dimensioning worksheets (block 6). ▶ The results of this sheet are subsequently employed for the calculation of the total costs associated to the network in block 7.

Exhibit 2.9: Network dimensioning worksheets. [Source: Axon Consulting]

2.1.9 Step 7: Costing and allocation

This step contains five (5) worksheets related with the costing of resources and their allocation to services. A description of each of these worksheets is provided in the table below:

Worksheet name	Description
7A CALC RES OPEX	▶ The OpEx generated by the resources installed in the network is calculated in this worksheet for each increment. The information for the different increments is presented towards the right of the worksheet. ▶ The calculation takes into account the number of resources calculated in worksheet "6H CALC RES GEO" and their OpEx unitary cost.
7B CALC CAPEX	▶ Resources' CapEx is annualised in this worksheet using the selected economic depreciation method for each increment. The information for the different increments is presented towards the right of the worksheet. ▶ The calculation takes into account the number of resources calculated in worksheet "6H CALC RES GEO" and their CapEx unitary cost.
7C CALC RES COMMON COST	▶ Network common costs are calculated in this worksheet for each geotype based on the information extracted from the previous two worksheets. ▶ Common costs by resource are obtained as the difference between the total cost base obtained under the 'Total Cost' increment (considering all the demand) and the sum of the pure incremental costs (i.e. Total Cost - sum of all other increments). This step is calculated independently for OpEx and CapEx.
7D CALC ADJ DEMAND	▶ The relevant demand of internal services under each increment is presented in this table to ease the cost allocation process to be performed in the coming worksheets.

Worksheet name	Description
7E CALC SERV COST	▶ This worksheet allocates resources' cost (from worksheet "7A CALC RES OPEX" and "7B CALC RES CAPEX") to services through the Routing Factors matrix (extracted from worksheet "4C MAT RF - SERV"). ▶ The methodology employed to allocate resources' costs to services is based on the idea that the cost of a resource has to be imputed to services proportionally to the amount of traffic generated by the service itself, and to a "factor of use", the Routing Factor. ▶ Note that the allocation for the "Total Cost" increment would be equivalent to a FDC methodology.

Exhibit 2.10: Costing and allocation worksheets. [Source: Axon Consulting]

2.1.10 Step 8: LRIC and common costs calculation

This step is responsible for obtaining the incremental and common costs of the services. The two (2) worksheets contained in this step are described below:

Worksheet name	Description
8A CALC SERV INCREMENTAL	▶ Incremental costs of each service are calculated in this worksheet as the sum of the cost associated to each increment, extracted from the previous sheet "7E CALC SERV COST".
8B CALC SERV COMMON NW	▶ This worksheet allocates the network common costs to services through the routing factors matrix.

Exhibit 2.11: LRIC and common costs calculation worksheets. [Source: Axon Consulting]

2.1.11   Step 9: Outputs (Network perspective)

The seven (7) worksheets included in this block are responsible for calculating the costs at service level under a network perspective. The description of each of these worksheets is provided below:

Worksheet name	Description
9A OUT SERV LRIC TOT COST	▶ This worksheet consolidates the total costs per external service, based on the results obtained for the internal services. Costs are disaggregated per cost category and cost type.
9B OUT SERV LRIC UNIT COST	▶ This worksheet consolidates the unitary LRIC+ costs of internal and external services. ▶ Additionally, in the case of data services, it also establishes the differentiation of unitary LRIC+ costs between i) traditional data services provided to end-customers and ii) M2M / IoT data services.
9C OUT RES VOL CONSOL	▶ This worksheet consolidates the resources volumes calculated in each EEA country. These are extracted from worksheet "6H CALC RES GEO".
9D OUT EXT SERV LRIC TOT CONS	▶ This worksheet consolidates the total costs of external services calculated in each EEA country. These are extracted from worksheet "9A OUT SERV LRIC TOT COST".
9E OUT EXT SERV LRIC UNIT CONS	▶ This worksheet consolidates the unitary costs of external services calculated in each EEA country. These are extracted from worksheet "9B OUT SERV LRIC UNIT COST"
9F OUT RES COSTS	▶ This worksheet consolidates the total costs of the resources calculated in each EEA country. These are extracted from worksheets "7A CALC OPEX" and "7B CALC CAPEX"

Worksheet name	Description
9G OUT RESULTS - NW	▶ This worksheet summarises and illustrates the main results obtained in the model when costs are allocated following a purely network-oriented perspective.

Exhibit 2.12: Outputs worksheets – Network perspective. [Source: Axon Consulting]

2.1.12 Step 10: Outputs (Regulatory policy perspective)

On the other hand, the worksheets included in this block show the results obtained at service level under a regulatory policy perspective. The worksheets within this block adapt the cost allocations performed in the network-perspective block in compliance with the prevailing regulation. A description of the five (5) worksheets presented in this block is provided below:

Worksheet name	Description
10A INP REG. POLICY ALLOC RULES	▶ This worksheet defines the main allocation rules to be considered when adopting a regulatory policy-based approach to allocate costs to services.
10B CALC EC REG. POLICY ALLOC	▶ This worksheet rearranges some costs allocations to services based on the outcomes presented in worksheets "9D OUT EXT SERV LRIC TOT CONS" and "9E OUT EXT SERV LRIC UNIT CONS" as well as the rules defined in worksheet "10A INP REG. POLICY ALLOC RULES". The outcomes of this re-arrangement are the unit costs at service level under a regulatory policy perspective for cost allocation.
10C OUT RESULTS - POLICY	▶ This worksheet summarises and illustrates the main results obtained in the model when costs are allocated following a regulatory policy perspective.
10D OUT POLICY IMPACT	▶ This worksheet summarises the impact of the policy decisions and rules defined in this module

Worksheet name	Description
10E OUT IMPACT CHART	▶ This worksheet provides the impact of the policy decisions graphically, comparing it against the base case (network perspective).

Exhibit 2.13: Outputs worksheets – Regulatory policy perspective. [Source: Axon Consulting]

3. Getting started

Computer requirements

The costing model is an Excel file. To run the model, a computer with at least 1 GB of RAM memory and with Microsoft Excel version 2010 (or a newer version) is required. For enhanced performance, it is recommended to run the model on computers with at least 2 GB of RAM Memory.

Opening the model

The execution of the model is based on Macros (embedded programs in Visual Basic). Therefore, they need to be enabled to run the model. If Macros are not enabled when opening the model, the following warning message will appear[3]:
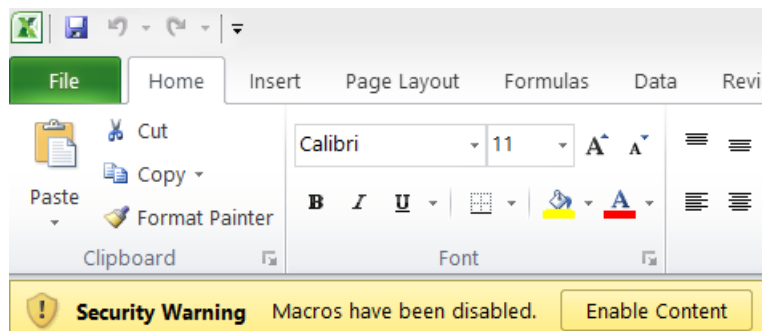
Exhibit 3.1: Warning appearing in Microsoft Excel 2010 when the model is open and Macros are not enabled. [Source: Axon Consulting]

If the warning shown above appears, click the "Enable Content" button to enable Macros and be able to execute the model.

---

[3] If the warning shown in Exhibit 3.1 does not appear, disregard further steps described in this section.

4. Understanding the control panel

The control panel (or COVER) represents the main interface of the model to the user. This worksheet is used to select the model's main available options, configure the execution mode and run the model. The following figure shows a snapshot of the control panel.
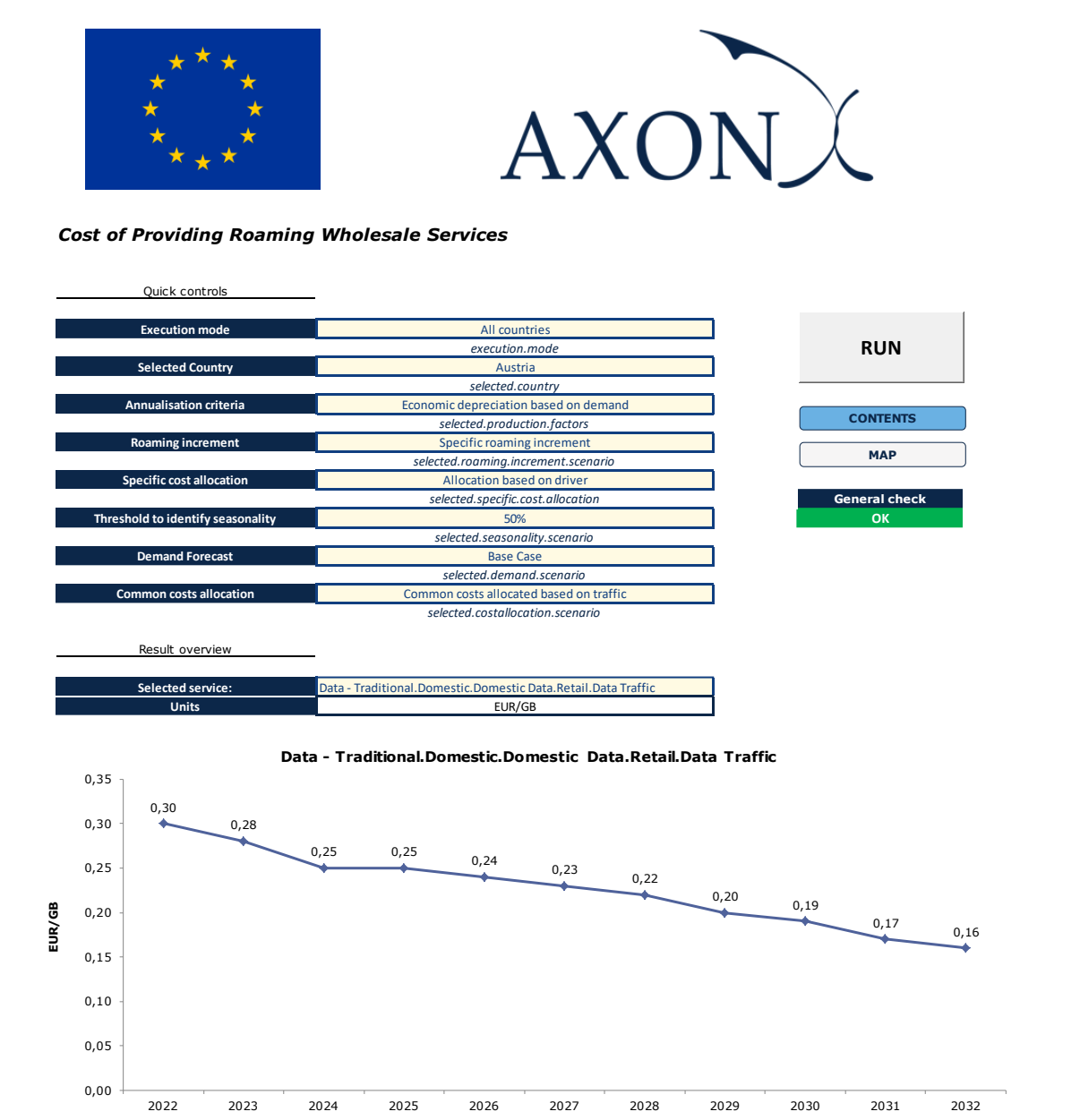

Cost of Providing Roaming Wholesale Services

Quick controls

Execution mode	All countries
	execution.mode
Selected Country	Austria
	selected.country
Annualisation criteria	Economic depreciation based on demand
	selected.production.factors
Roaming increment	Specific roaming increment
	selected.roaming.increment.scenario
Specific cost allocation	Allocation based on driver
	selected.specific.cost.allocation
Threshold to identify seasonality	50%
	selected.seasonality.scenario
Demand Forecast	Base Case
	selected.demand.scenario
Common costs allocation	Common costs allocated based on traffic
	selected.costallocation.scenario

RUN

CONTENTS

MAP

General check
OK

Result overview

| Selected service: | Data - Traditional.Domestic.Domestic Data.Retail.Data Traffic |
| Units | EUR/GB |

Exhibit 4.1: Snapshot of the control panel [Source: Axon Consulting]

Important warning: the model needs to be run in order to see the impact on the results of any change made in the control panel.

The main options available to the user in the "Quick controls" section are described below:

▶ **Execution mode:** This option allows the user to select between the execution modes described below:

- "*Selected country*" mode: The model will be executed for the selected country in the scenarios panel (estimated execution time: 1 minute).

- "*All countries*": The model will be executed for all the EU/EEA countries (estimated execution time: 30 minutes). In this case, each country is executed in order and its results are stored in block 9 worksheets.

▶ **Selected country:** Selection of the country to be executed when the "Selected country" mode is enabled. The user can select any of the EU/EEA countries.

▶ **Annualisation criteria:** The user can choose between two methodologies to calculate the economic depreciation of the assets in the model, namely:

- "*Economic depreciation based on ARPU*": When this criterion is selected, the annualisation of assets is performed based on ARPU.

- "*Economic depreciation based on demand*": When this criterion is selected, the annualisation of assets is performed based on services' demand.

▶ **Roaming increment:** This selection enables the user to choose whether to consider roaming traffic as a separate increment or to consider it together with the domestic traffic. The two scenarios are listed below:

- "*Specific roaming increment*": This scenario considers roaming traffic as a standalone increment. This is, under this scenario, three increments are defined: termination, domestic and roaming.

- "*Joint roaming and domestic increment*": This scenario considers roaming and domestic traffic together in a single increment. This is, under this scenario, two increments are defined: termination and other.

▶ **Specific cost allocation:** This selection enables the user to choose the allocation of the wholesale specific costs that are incurred in the provision of wholesale roaming and voice termination services. The wholesale specific costs are either driven by the total TAPS (Transferred account procedures) or the total GB. The two allocation modes are listed below:

- "*Allocation based on GB*": This mode allocates all the wholesale specific costs based on the equivalent GB.

- "*Allocation based on driver*": This mode allocates the wholesale specific costs based on the same drivers employed to build up the regression curves for wholesale specific costs (i.e. GB for some cost categories and TAPs for some others).

▶ **Threshold to identify seasonality:** This option allows stakeholders to run the model under different thresholds to identify seasonal patterns. The three scenarios defined are listed below:

- *"50%"*: Under this scenario areas are considered as seasonal when the traffic in the peak month (net of structural growth) is above the traffic in the average month by 50%.

- *"30%"*: Under this scenario areas are considered as seasonal when the traffic in the peak month (net of structural growth) is above the traffic in the average month by 30%.

- *"10%"*: Under this scenario areas are considered as seasonal when the traffic in the peak month (net of structural growth) is above the traffic in the average month by 10%.

▶ **Demand forecast:** This selectable allows stakeholders to assess the results produced by the model under different data traffic forecasts. The three alternative scenarios defined are described below:

- *"Conservative"*: The YoY growth rate of domestic data traffic is expected to decrease by 30% a year (e.g. 90%, 63%, 44%, 31%...).

- *"Base Case"*: This is the base-case scenario that was already considered in the first draft model. The YoY growth rate of domestic data traffic is expected to decrease by 20% a year (e.g. 90%, 72%, 58%, 46%...).

- *"Aggressive"*: The YoY growth rate of domestic data traffic is expected to decrease by 10% a year (e.g. 90%, 81%, 73%, 66%...).

▶ **Common costs allocation:** This selectable allows stakeholders to assess the results produced by the model under different scenarios for the allocation of common costs. The two alternative scenarios defined are described below:

- *"Common costs allocated based on traffic"*. This scenario allocates the common costs of data services between traditional services to end-customers and M2M services by taking into account their split of traffic (volumes of GB).

- *"Common costs allocated based on customers"*. This scenario allocates the common costs of data services between traditional services to end-customers and M2M services by taking into account their split of customers.

Important: For further information about the definition of these scenarios, please refer to the methodological approach document.

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