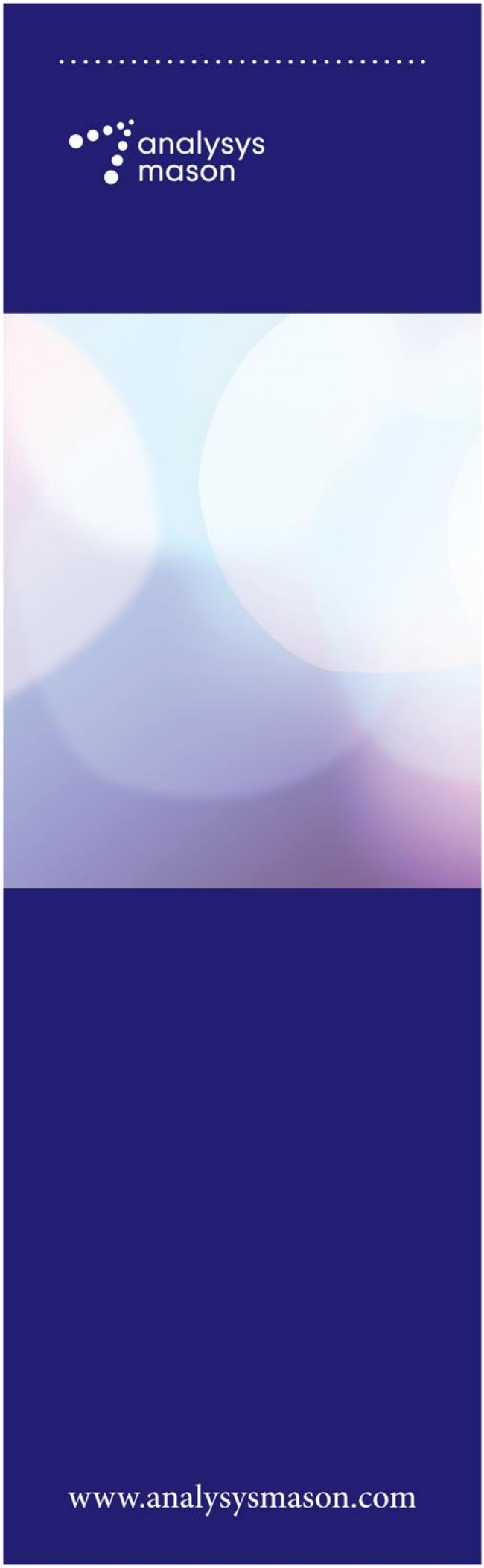

Report for ANACOM

Update of the fixed LRIC model: proposal of changes – PUBLIC VERSION

5 July 2018

Ref: 2010987-273

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Annex C List of acronyms

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1 Update and revision of the fixed termination cost model

This document describes the main aspects that we propose to update in the fixed termination cost model that we have developed on behalf of ANACOM, to reflect the evolutions of the Portuguese fixed market since the last update in 2014. Those evolutions include changes in macro-economic parameters, modelled services, network traffic, cost inputs or updated technical characteristics of the network elements. Additionally, the main conceptual aspects, definitions and parameters of the model have been reviewed and assessed, including updated data collection and demand forecast.

The last version of the model is considered in this document as the "2014 model" and the update of the model is considered as the "2018 model". This document also makes reference to the last update (2017) of the BULRIC mobile model: "MTR model"

Analysys Mason prepared a data request that was sent by ANACOM to the Portuguese operators, and received data responses from MEO, NOS, NOWO, Vodafone, ONI, IP Telecom, Orange Business Services and Colt. This data is being used to populate and calibrate the model.

In general terms, the charts and tables in this document present a comparison between the forecasts in the 2014 model and in the 2018 model.

We have ensured consistency with the recently updated MTR model in 2017 in terms of forecasts and assumptions, namely for macro-economic data (population and inflation) and mobile connections and traffic.

Additionally, the process in place for the development of the BU-LRIC model included a consultation, which gave industry participants the opportunity to contribute. This document has been updated to include the model updates implemented to take into account the comments and data provided by the operators in the public consultation.

This is the public version of the document and therefore confidential inputs were removed and replaced by the mark [✂].

1.1 Update of macro-economic input parameters

We propose to update the macro-economic input parameters in order for the model to reflect the most up to date macroeconomic data.

It should be noted that the macro-economic data for years 2014 to 2017 in the 2014 model were assumptions or forecasts. Hence, we propose to use in the 2018 model the updated figures both for future years but also retrospectively for years 2014 to 2017.

Similarly, we propose to update also 2008-2013 historical figures if they have been revised in order to make sure that the model is run with the most reliable sources of information on the Portuguese market that are available at the moment of the update.

We propose that the forecast values in this section to be the same as for the MTR mobile model as there is no significant new macro-economic data since we performed the analysis for the 2017 mobile model update.

National population

We propose to update the national population data and forecasts based on the latest data from third-party sources (namely Euromonitor, EIU and Analysys Mason Research), in line with MTR model and with the 2014 model.

Proposed Update 1:

- Update national population based on the latest data from third-party sources

Figure 1.1 shows that the updated figures for national population are slightly lower than the previous forecast used in the 2014 model:

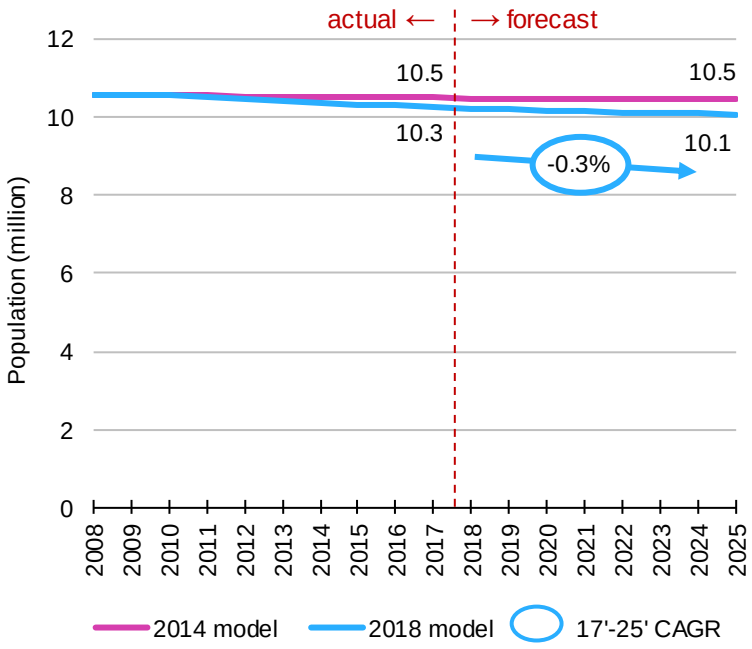


Figure 1.1: Update national population [Source: Analysys Mason, 2018]

The forecast considers data from third-party sources and we propose to use the average of the population values. The proposed update in line with the MTR model.

Figure 1.2: Comparison for population proposed in the 2018 model and used in the 2014 model [Source: Analysys Mason, 2017]

Population	2016	2017	2018	2019	2020	2021	2022
2018 model	10,430,670	10,394,604	10,358,943	10,328,260	10,292,144	10,260,779	10,224,385
2014 model	10,506,316	10,498,841	10,491,848	10,485,306	10,479,186	10,473,460	10,468,104
% change	-0.72%	-0.99%	-1.27%	-1.50%	-1.78%	-2.03%	-2.33%

Households

We propose to update the number of households based on updated forecast data from third-party sources (namely Euromonitor and Analysys Mason Research), in line with the 2014 FTR model. Data suggests that the 2014 model forecast should be adjusted slightly downwards:

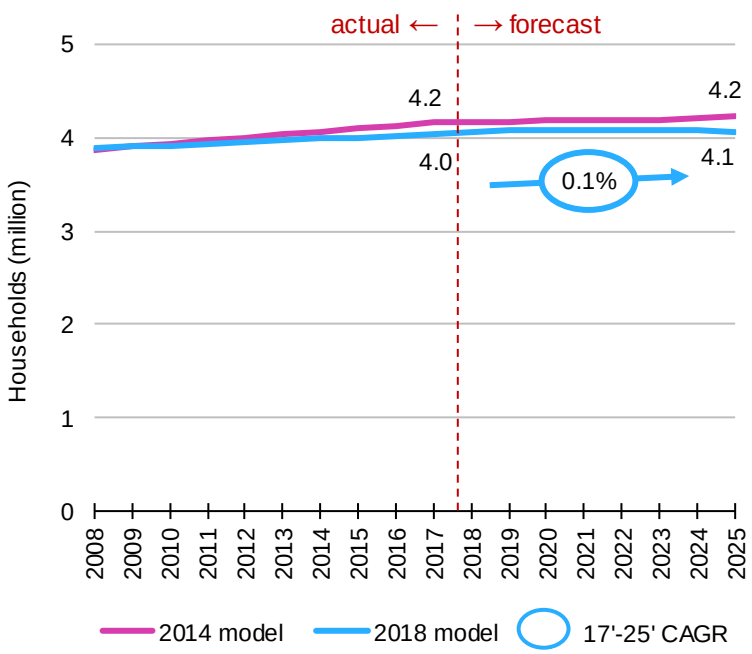


Figure 1.3: Update national households [Source: Analysys Mason, 2018]

Figure 1.4: Comparison for households proposed in the 2018 model and used in the 2014 model [Source: Analysys Mason, 2017]

Population	2016	2017	2018	2019	2020	2021	2022
2018 model	4,024,472	4,043,267	4,058,601	4,072,376	4,078,713	4,077,533	4,076,650
2014 model	4,126,000	4,157,000	4,164,373	4,171,270	4,177,722	4,183,758	4,189,405
% change	-2.46%	-2.74%	-2.54%	-2.37%	-2.37%	-2.37%	-2.37%

Proposed Update 2:

- Update number of households based on updated forecast data from third-party sources

Inflation

We propose to update inflation on the basis of third-party sources. To be consistent with the 2014 model methodology and the MTR model data, we propose to use data from Euromonitor, assuming constant 2% inflation after 2029, in line with the inflation target of the ECB.

Proposed Update 3:

- Update inflation from third-party sources and assume constant 2% inflation after 2029

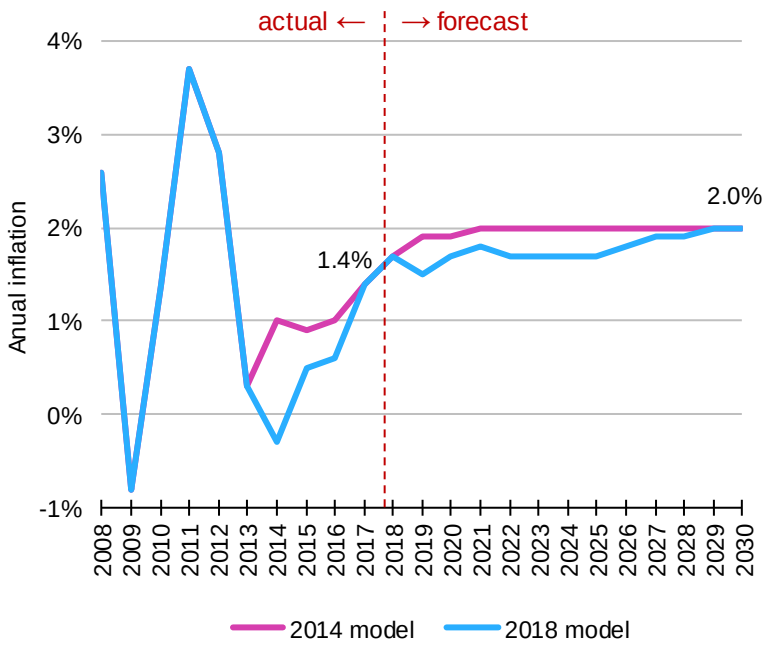


Figure 1.5: Update annual inflation [Source: Analysys Mason, 2018]

1.2 Update of network deployment and market share

1.2.1 Access

There has been a significant increase in the deployment of FTTH and cable networks. Therefore, geotyping needs to be reviewed.

Geotyping

Geotypes are used in the model to determine the addressable market share of the modelled operator and are defined based on market competition in each concelho.

We propose to update the geotyping for Portuguese concelhos based on most recent data on operator presence to consider the network deployment and change in market competition since 2014.

Proposed Update 4:

- Update the geotyping of the 308 concelhos in Portugal to reflect current market competition

Figure 1.6: Distribution by geotype of the 308 Concelhos [Source: Analysys Mason, 2018]

Type	2018 model	2014 model
Geotype 1 – Competitive market (3 fixed operators are present)	188	23
Geotype 2 – Cable operators are present	48	129
Geotype 3 – Cable operators are not present	42	126
Geotype 4 – Islands	30	30
Total Concelhos	**308**	**308**

1.2.2 Switching

[✂]

Figure 1.7: Evolution of the number of nodes in [✂]'s network and in the FTR model [Source: Analysys Mason, 2018]

Node type	[✂] 2014	Model 2014	[✂] 2018	Model 2018
Access Nodes (MDF)	[✂]	1669	[✂]	1669
Agg L1 (Local switch)	[✂]	166	[✂]	166
Agg L2 (Regional switch)	[✂]	25	[✂]	25
Core (National/international switch	[✂]	5	[✂]	5

[✂].

Proposed Update 5:

- Keep the number and coordinates of the modelled nodes as they were in the 2014 model

1.2.3 Interconnection

Evolution of the number of PoI

[✂]

Transition from TDM to IP interconnection

In 2014 model interconnection is expected to transit from TDM to IP between years 2014 and 2019. Following ANACOM's indications, we propose to update this period as IP interconnection is expected to happen from January 2018 to December 2019.

Proposed Update 6:

- To set TDM – IP interconnection transition between 2018 and 2019

1.3 Update of the modelled services

The definition of the range of services to be considered in the model is directly related to how the model in question will determine the incremental cost of providing the call termination service.

Based on the responses provided in the data requests, we have not identified a need to update the two lists of services (list of commercial services and list of network services).

We note that the latest market data from ANACOM lists a new type of broadband connection (Acessos LTE em local fixo). However, the modelled operator is supposed to only offer copper-based or fibre-based access lines and therefore LTE-based access lines are not included here.

Therefore, Analysys Mason proposes that the two lists of services of the model to remain the following:

Figure 1.8: List of commercial services modelled [Source: Analysys Mason, 2018]

Services modelled
Local on-net calls (retail)
National on-net calls (retail)
Non-geographic on-net calls (retail)
Outgoing calls to mobile (retail)
Outgoing calls to other fixed operators (retail)
Outgoing calls to international numbers (retail)
Incoming calls to non-geographic numbers
Other outgoing calls (retail)
Local incoming calls (wholesale)
Simple tandem incoming calls (wholesale)
Double tandem incoming calls (wholesale)
International incoming calls (wholesale)
Other incoming calls (wholesale)
Local outgoing calls (wholesale)
Simple tandem outgoing calls (wholesale)
Double tandem outgoing calls (wholesale)
Other outgoing calls (wholesale)

Services modelled
Local outgoing calls to non-geographic numbers (wholesale)
Simple tandem outgoing calls to non-geographic numbers (wholesale)
Double tandem outgoing calls to non-geographic numbers (wholesale)
Local transit calls (wholesale)
Simple transit calls (wholesale)
Double transit calls (wholesale)
National to International or International to National transit calls (wholesale)
International transit calls (wholesale)
Other transit calls (wholesale)
Dial-up Internet
Broadband (direct access)
Bitstream (indirect access)
Leased lines
TV (IPTV)
TV (VoD)
OTT subscribers

Figure 1.9: List of network services modelled [Source: Analysys Mason, 2018]

Services modelled
Voice services
Regional on-net calls (retail)
National intra-node on-net calls (retail)
National multi-node on-net calls (retail)
Non-geographical on-net calls (retail)
National intra-node outgoing calls (retail)
National multi-node outgoing calls (retail)
National intra-node incoming calls (wholesale)
National multi-node incoming calls (wholesale)
Incoming calls to non-geographical numbers
National intra-node outgoing calls (wholesale)
National multi-node outgoing calls (wholesale)
National intra-node outgoing calls to non-geographic numbers (wholesale)
National multi-node outgoing calls to non-geographic numbers (wholesale)
National intra-node transit calls (wholesale)
National multi-node transit calls (wholesale)
Data services
National intra-node IP/E-VPN circuits
National multi-node IP/E-VPN circuits
Broadband (direct access subscribers)
Broadband (indirect access subscribers)
TV and OTT services
TV - Access
TV - L1 Aggregation
TV (linear broadcast) - L2 Aggregation
TV (VoD)

Services modelled
Voice services
OTT services
Other services
Subscriber lines
Interconnection services

1.4 Network traffic and loading parameters

The traffic volume of modelled services is particularly important in the development of the model, influencing the design of the modelled network and consequently the unit costs of services. Thus, we propose to update the previous assumptions in the model, particularly the evolution of traffic.

1.4.1 Connections

We propose to update the market module in the "Demand" worksheet. For consistency reasons, we have continued to use the same sources as in the previous model, that is:

- ANACOM for actual data
- Analysys Mason Research and third-party analyst data to inform our forecasts.

ANACOM's latest data available corresponds to 3rd quarter 2017. Regarding connections, we have considered data from 3Q as year end.

Fixed voice, fixed broadband and TV connections

ANACOM data shows that the evolution of the number of total fixed voice connections is considerably higher than the one forecasted in 2014 model. This could be explained by the increase of multiple-play bundles in Portugal. We propose to revise upwards the forecast for fixed voice connections considering a small growth and stabilization for the next years.

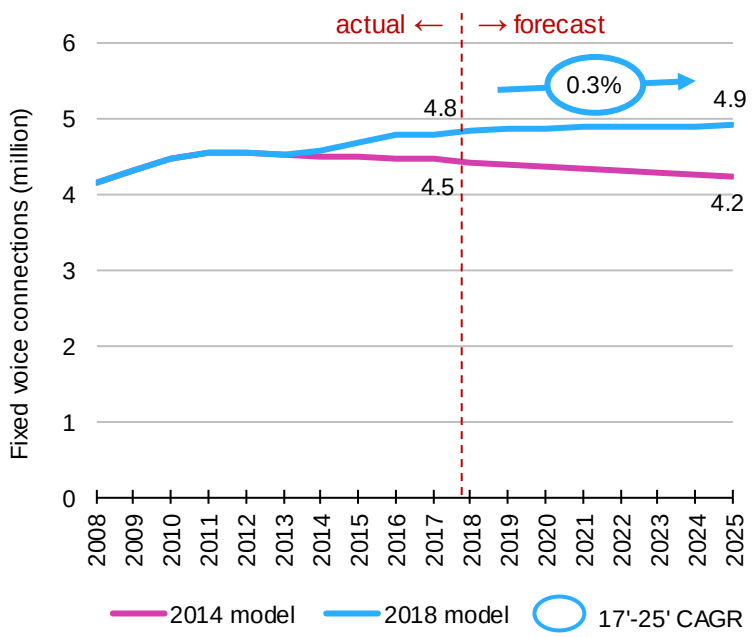


Figure 1.10: Fixed voice connections [Source: Analysys Mason, 2018]

Similarly, historical data suggest that fixed broadband connections should be revised upwards as the number of connections in 2018 is significantly higher than was forecasted in the 2014 model (includes LTE at a fixed location):

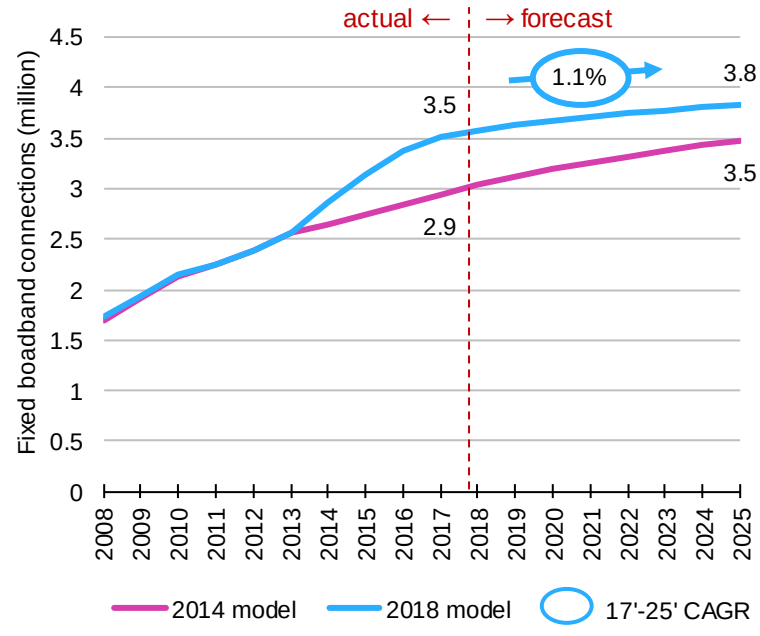


Figure 1.11: Fixed broadband connections [Source: Analysys Mason, 2018]

Additionally, Fixed TV connections are also higher than what was forecast in the 2014 model and should be revised upwards consequently (fixed TV connections includes cable, DTH, FTTH and xDSL+FWA connections):

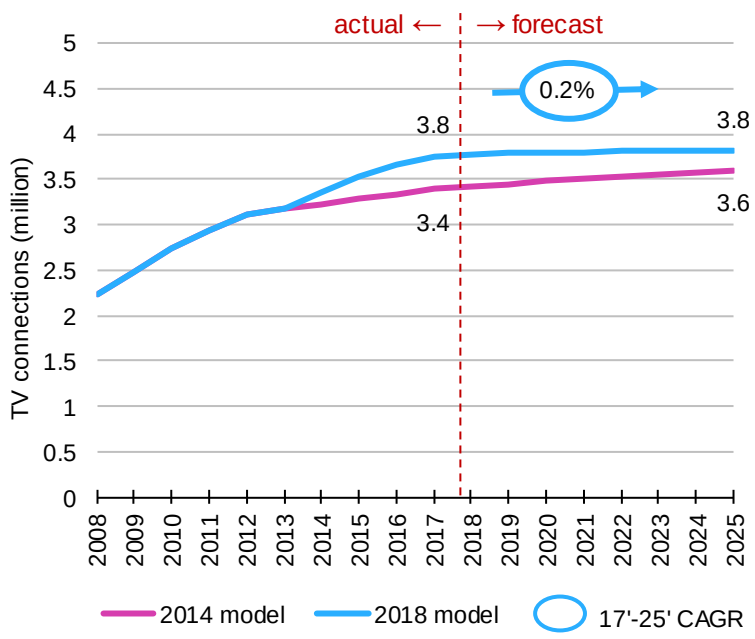


Figure 1.12: Fixed IPTV connections [Source: Analysys Mason, 2018]

Proposed Update 7:

- Update historical figures based on latest ANACOM data
- Revise upwards the forecast of fixed voice, fixed broadband and fixed IPTV connections based on recent trends and third-party forecasts

Mobile segment

We have ensured that the forecast of mobile connections is consistent with the forecast made in the MTR model. For the mobile segment, the FTR model uses ANACOM's MTR model data.

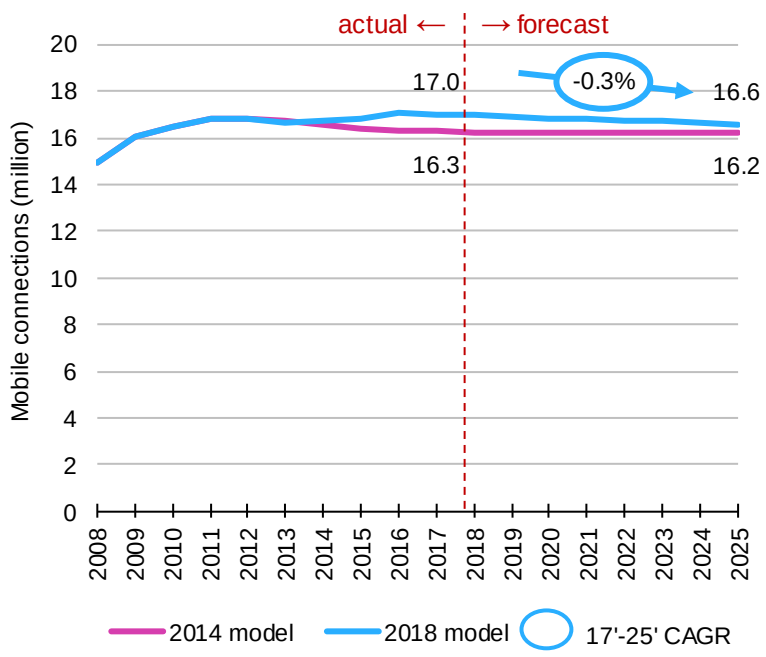


Figure 1.13: Mobile connections [Source: Analysys Mason, 2018]

Proposed Update 8:

- Update historical figures based on ANACOM data
- Revise upwards the forecast of mobile connections based on recent trends and third-party forecasts, in line with the MTR model

1.4.2 Traffic

We propose to update the market module in the "Demand" worksheet. For consistency reasons, we have continued to use the same sources as in the previous model, that is:

- ANACOM for actual data
- Analysys Mason Research and third-party analyst data to inform our forecasts.

ANACOM latest data available corresponds to the 3rd quarter of 2017. To have year-end data on traffic, we have estimated values for the 4th quarter based on usage trends from the other three quarters of the year.

Fixed originated traffic

Data shows that fixed originated traffic has suffered a strong decline over the last few years, most likely due to the increase of MoU of mobile. We propose to take a conservative approach and maintain fixed originated traffic in our forecast.

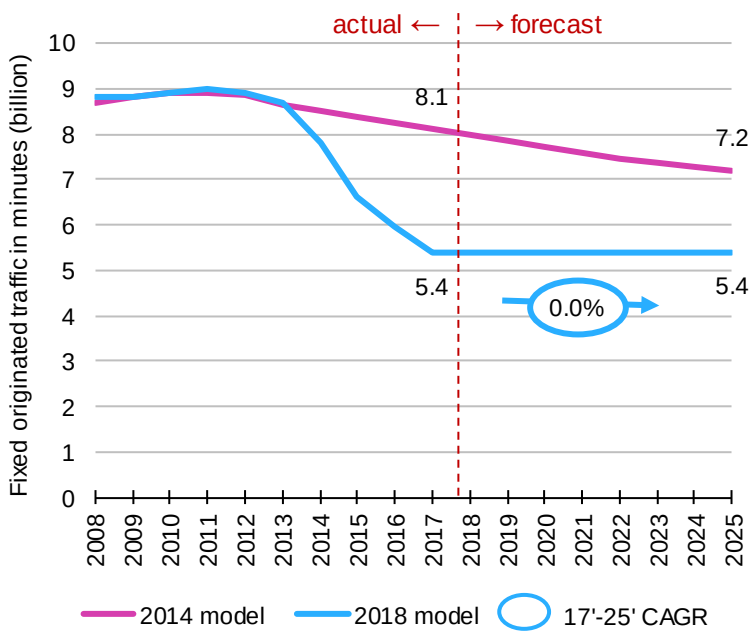


Figure 1.14: Fixed originated traffic [Source: Analysys Mason, 2018]

In its response to the public consultation, [✂] stated that given the historical trend and the expected substitution of the service by other adjacent market services, a negative decline should be considered

We considered the submission as well as examples from other Western European markets and concluded that a larger decrease in traffic per fixed user than initially assumed was reasonable. As a consequence, the forecast of total fixed originated traffic decreases slightly.

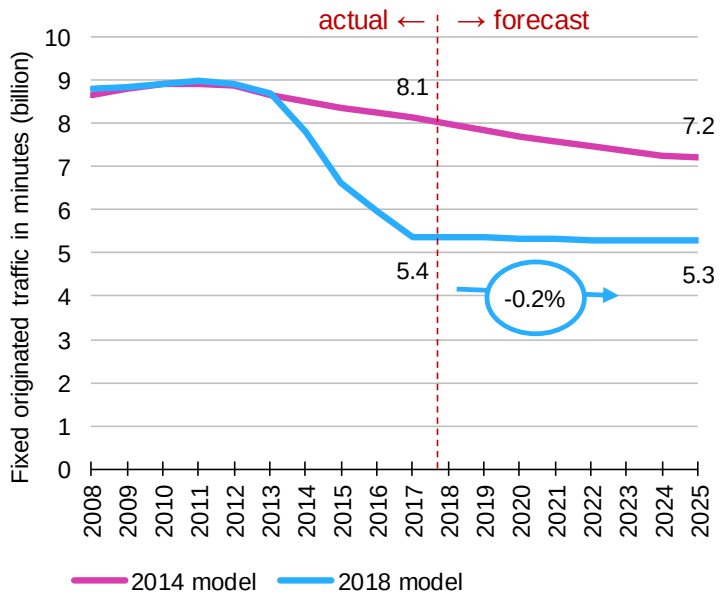


Figure 1.15: Updated Fixed originated traffic [Source: Analysys Mason, 2018]

Fixed broadband traffic

The total fixed broadband traffic (GB) has increased even higher than what was forecast in the 2014 model, and data suggest that this strong growth trend is likely to continue in the future:

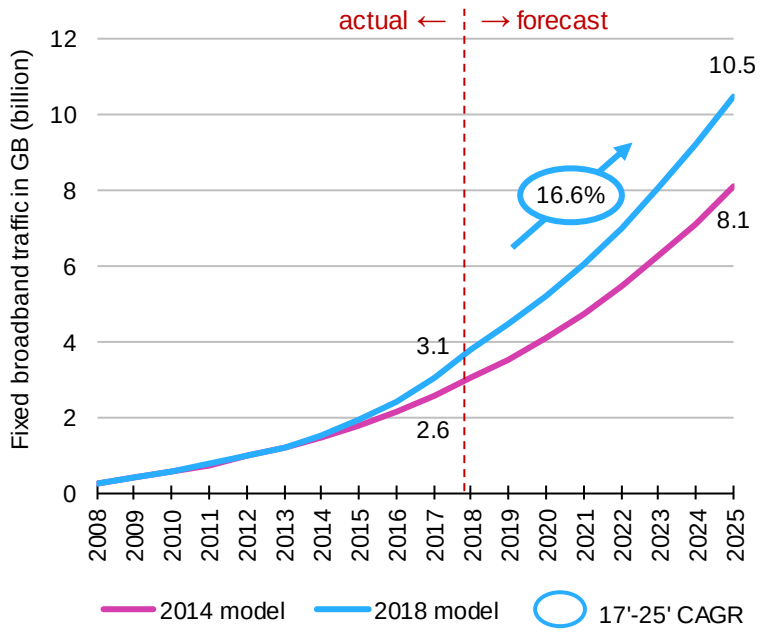


Figure 1.16: Fixed broadband traffic [Source: Analysys Mason, 2018]

We propose to forecast the fixed broadband traffic using the same methodology as in 2014 model, that is:

- defining a breakdown between standard and high-speed broadband subscribers
- calculating the average traffic per broadband connection (GB) splitting between standard and high-speed user
- forecasting the traffic per type of broadband connections aggregating both to calculate blended traffic per connection
- obtain total traffic forecast as blended traffic per connection and number of broadband connections

Proposed Update 9:

- Update historical figures based on ANACOM data
- Revise downwards the forecast for fixed voice traffic
- Revise upwards the forecast for fixed broadband traffic

Mobile segment

We have ensured that forecast of mobile traffic is consistent with the forecast made in the MTR model.

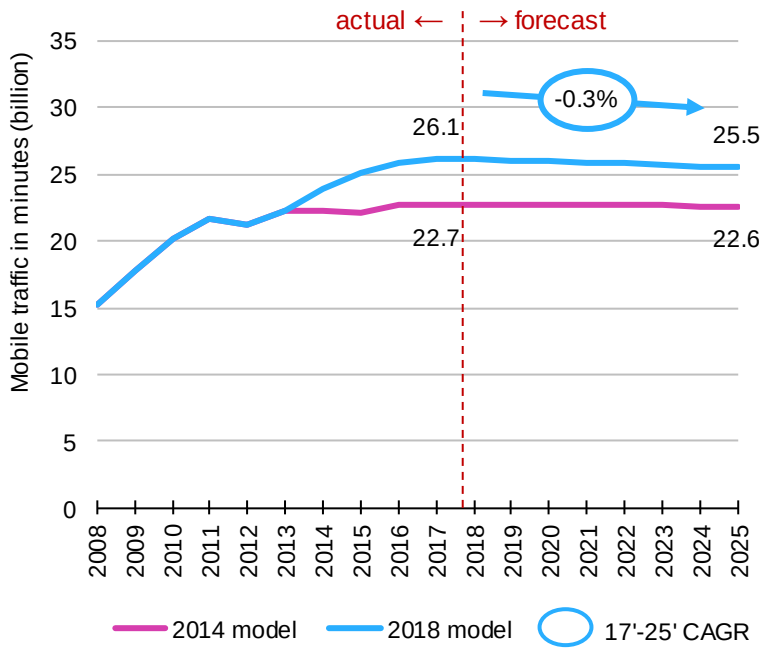


Figure 1.17: Mobile traffic [Source: Analysys Mason, 2018]

Proposed Update 10:

- Update historical figures based on ANACOM data
- Revise upwards the forecast of mobile traffic based on recent trends and third-party forecasts, in line with the MTR model

Business data connectivity

We propose to update the number leased lines with the latest data from ANACOM and forecast leased lines traffic based on average speed per line.

Figure 1.18: Leased lines parameters used in the model as inputs [Source: Analysys Mason, 2018]

Leased lines breakdown	2018 model	2014 model
Number of "Circuitos alugados"	3155	2863
Low-speed circuits (#)	1335	4157
High-speed circuits (#)	1030	605
Average speed per leased line (Mbits/s)	96,96	15.97

Proposed Update 11:

- Update the number of leased lines based on 2017 data and update the forecast for leased lines traffic accordingly

1.4.3 Demand scenarios

The 2014 model allows the user to select from 3 different demand scenarios: base case, aggressive and conservative[1]. We propose to update the base case scenario, in line with the update for connections and traffic described earlier:

Figure 1.19: Proposed changed in market trends for base case scenario [Source: Analysys Mason, 2018]

Id	Serie	Base case	
		2018 model CAGR (17-25)	2014 model (CAGR 12-25)
1	Fixed voice penetration	0.2%	-0.9%
2	Fixed voice traffic per user	-0.25%	-1.0%
3	Fixed broadband penetration	1.0%	2.5%
4	Fixed broadband traffic per standard user	14.0%	13.0%
5	Leased line traffic per line	5.0%	1.0%
6	VoD share of concurrent users	[✂]	[✂]

1.4.4 Traffic and call profiles

We have included the values of network loading parameters using data provided by operators. We propose to use the values provided in the 2018 data request to ensure the model is updated with the latest parameters of the network.

Figure 1.20: Busy-hour loading parameters proposed for the hypothetical operator in the 2018 model [Source: Analysys Mason based on operator data, 2017]

	Voice		Data	
Model	**2018**	**2014**	**2018**	**2014**
% traffic in the busy days	[✂]	[✂]	[✂]	[✂]
% traffic in the peak hour	[✂]	[✂]	[✂]	[✂]

Figure 1.21: Average call duration proposed for the hypothetical operator in the 2018 model, minutes [Source: Analysys Mason based on operator data, 2018]

Voice services	2018 model	2014 model
On-net calls	6.9	5.0
Non-geographical on-net calls	3.7	3.0
Outgoing calls to mobile	1.8	1.9

[1] With the aggressive and conservative scenarios derived from the base case.

Outgoing calls to other fixed operators (retail)	3.1	3.5
Outgoing calls to international numbers (retail)	6.5	4.4
Incoming calls to non-geographical numbers	3.7	3.0
Local, single-transit and double-transit incoming calls	4.3	3.8
International incoming calls	6.5	4.4
Outgoing calls (wholesale)	4.3	3.8
Outgoing calls to non-geographical numbers (wholesale)	3.7	3.0
Local, single-transit and double-transit calls	4.3	3.8
International transit calls	6.5	4.4

Figure 1.22: Call attempts per successful call proposed for the hypothetical operator in the 2017 model [Source: Analysys Mason based on operator data, 2018]

Voice services	2018 model	2014 model
All calls	[✂]	[✂]

We note that [✂] and [✂] indicate in the data request significantly lower values for the call attempts per successful call ([✂] and [✂]) which might indicate that data-points provided only refer to unsuccessful calls due to network issues.

Proposed Update 12:

- Update the traffic profile parameters based on the data request

1.4.5 Other model network parameters

We reviewed and compared the network parameters between operators' responses and the model and we propose to update when differences are found in order to correctly represent the network state of operators in Portugal.

Call servers

Call servers in 2014 model were modelled in each core node (5 call servers in total). Following data request from operators, we propose to reduce the number of call servers to 2 as most of Portuguese operators are reporting between 2 and 3 call servers.

Following the public consultation, a third call server was suggested by [✂] to be used for production testing. We agree that having a third call server for tests is reasonable, therefore we propose to include one additional call server to the number calculated by the algorithm. This additional server is not dimensioned based on traffic as it is only used for production tests.

Other network parameters

Other network parameters that we propose to change include the following:

Figure 1.23: Utilization input parameters [Source: Analysys Mason, 2017]

Parameter	Model 2018	[✂] 2017	Model 2014	[✂] 2014	Comment
BRAS utilisation	[✂]	[✂]	[✂]	[✂]	[✂]
RADIUS capacity	[✂]	[✂]	[✂]	[✂]	[✂]
SDH calculation	[✂]	[✂]	[✂]	[✂]	[✂]
Distance between regenerators	[✂]	[✂]	[✂]	[✂]	[✂]
SBC utilisation	[✂]	[✂]	[✂]	[✂]	[✂]
TGW capacity	[✂]	[✂]	[✂]	[✂]	[✂]
TGW utilisation	[✂]	[✂]	[✂]	[✂]	[✂]

Proposed Update 13:

- Reduce the number of modelled call servers to 2, adding a third one for production testing purposes
- Update network profile parameters based on the data request

1.5 Update of unit cost inputs

Technological developments might have had an impact in unit costs and therefore they need to be reviewed.

Cost trends

The results in the updated model will be shown in real 2017 value, therefore the unit costs will be updated accordingly.

Additionally, we propose to maintain the cost trends from the 2014 model. This is as result of a updated benchmark of European FTR models that were also taken into consideration when the 2014 model was developed. (see **Error! Reference source not found.** for more details).

Figure 1.24: Proposed changed in equipment capital expenditure trends (maintain cost trends)- Pre-consultation [Source: Analysys Mason, 2018]

Equipment	Capex trends (real)	
	2018 model	2014 model
Port cards	-8.0%	-8.0%
Chassis	-5.0%	-5.0%
Active transmission equipment	-5.0%	-5.0%
Passive transmission equipment	-1.0%	-1.0%
Service platforms	-5.0%	-5.0%
BSS_OSS	-4.0%	-4.0%
Sites	2.0%	2.0%
Trench and civil works	2.0%	2.0%
TV platform	-5.0%	-5.0%

In its response to the public consultation, [✂] mentioned that the cost trend for Port Cards should be -5%.

Pursuant to this comment, we have made an international benchmark of capex trends of line cards.

Figure 1.25: Benchmark of capex cost trends of line cards [Source: Analysys Mason, 2018]

Country	Cost trend
[✂]	[✂]
[✂]	[✂]
[✂]	[✂]
[✂]	[✂]
[✂]	[✂]

Based on the benchmark above, and the comment made by [✂], we propose to revise the cost trend to -5%.

Figure 1.26: Proposed changes in equipment capital expenditure trends (maintain cost trends)- Post-consultation – Post consultation [Source: Analysys Mason, 2018]

Equipment	Capex trends (real)	
	2018 model	2014 model
Port cards	-5.0%	-8.0%
Chassis	-5.0%	-5.0%
Active transmission equipment	-5.0%	-5.0%
Passive transmission equipment	-1.0%	-1.0%
Service platforms	-5.0%	-5.0%
BSS_OSS	-4.0%	-4.0%
Sites	2.0%	2.0%

Equipment	Capex trends (real)	
	2018 model	2014 model
Trench and civil works	2.0%	2.0%
TV platform	-5.0%	-5.0%

Proposed Update 14:

- Update the model to real 2017 terms and maintain the cost trends from 2014 model (with the exception of Port Cards), as there is no evidence that cost trends have changed, based on European FTR models benchmark

Capex and opex costs

Responses to the data request from Portuguese operators on unit capex and opex is both limited and too aggregated, and it is not sufficient to populate the model.

We have updated an international benchmark on unit capex and opex based on European FTR cost models. Based on the benchmark, we propose to update the capex and opex unit costs based on the cost trends of the model (and applying inflation rate 2012-2017). This approach is in line with other FTR models from the European Economic Area (see **Error! Reference source not found.** for more details) as there is no indication that the unit cost of opex and capex has deviated from the expected cost trend of the 2014 model.

Figure 1.27: Proposed updates for unit costs for the modelled operator [Source: Analysys Mason, 2018]

Asset	2018 model (2017 real)		2014 model (2012 real)	
	CAPEX	OPEX	CAPEX	OPEX
Access nodes: Site acquisition, preparation and maintenance	[✂]	[✂]	[✂]	[✂]
Access: DSLAM rack/processor	[✂]	[✂]	[✂]	[✂]
Access: DSLAM core-facing ports - 1GE ports	[✂]	[✂]	[✂]	[✂]
Access: DSLAM core-facing ports - 10GE ports	[✂]	[✂]	[✂]	[✂]
Access: OLT rack/processor	[✂]	[✂]	[✂]	[✂]
Access: OLT core-facing ports - 1GE ports	[✂]	[✂]	[✂]	[✂]
Access: OLT core-facing ports - 10GE ports	[✂]	[✂]	[✂]	[✂]
Aggregation L1: Site acquisition, preparation and maintenance	[✂]	[✂]	[✂]	[✂]
Aggregation L1: Switch - chassis	[✂]	[✂]	[✂]	[✂]
Aggregation L1: Switch - 1GE ports card 48 port	[✂]	[✂]	[✂]	[✂]

Asset	2018 model (2017 real)		2014 model (2012 real)	
	CAPEX	OPEX	CAPEX	OPEX
Aggregation L1: Switch - 10GE ports card 12 port	[✂]	[✂]	[✂]	[✂]
Aggregation L2: Site acquisition, preparation and maintenance	[✂]	[✂]	[✂]	[✂]
Aggregation L2: Switch - chassis	[✂]	[✂]	[✂]	[✂]
Aggregation L2: Switch - 1GE ports card 48 port	[✂]	[✂]	[✂]	[✂]
Aggregation L2: Switch - 10GE ports card 12 port	[✂]	[✂]	[✂]	[✂]
Aggregation L2: Edge router - chassis	[✂]	[✂]	[✂]	[✂]
Aggregation L2: Edge router - 1GE ports card 20 port	[✂]	[✂]	[✂]	[✂]
Aggregation L2: Edge router - 10GE ports card 2 port	[✂]	[✂]	[✂]	[✂]
Aggregation L2: SBC - chassis	[✂]	[✂]	[✂]	[✂]
Aggregation L2: SBC - 1GE ports card 2 port	[✂]	[✂]	[✂]	[✂]
Core: Site acquisition, preparation and maintenance	[✂]	[✂]	[✂]	[✂]
Core: core router - chassis	[✂]	[✂]	[✂]	[✂]
Core: core router - 10GE ports card 4 port	[✂]	[✂]	[✂]	[✂]
Core: SBC (Interconnection) - chassis	[✂]	[✂]	[✂]	[✂]
Core: SBC (Interconnection) - 1GE ports card 2 port	[✂]	[✂]	[✂]	[✂]
Core: Interconnect trunk gateways	[✂]	[✂]	[✂]	[✂]
Core: Interconnect trunk gateway E1 ports	[✂]	[✂]	[✂]	[✂]
Core: Core switch - chassis	[✂]	[✂]	[✂]	[✂]
Core: Core switch - 1GE ports card 48 port	[✂]	[✂]	[✂]	[✂]
Core: Core switch - 10GE ports card 12 port	[✂]	[✂]	[✂]	[✂]
Core: Call server/soft-switch	[✂]	[✂]	[✂]	[✂]
Core: DNS	[✂]	[✂]	[✂]	[✂]
Core: RADIUS	[✂]	[✂]	[✂]	[✂]
Core: BRAS	[✂]	[✂]	[✂]	[✂]
Core: HSS	[✂]	[✂]	[✂]	[✂]
Access transmission - fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Access transmission - buried duct (km)	[✂]	[✂]	[✂]	[✂]
Access transmission - aerial duct (km)	[✂]	[✂]	[✂]	[✂]
Access transmission - submarine fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Access transmission - leased dark fibre	[✂]	[✂]	[✂]	[✂]
Access transmission - Ethernet leased lines	[✂]	[✂]	[✂]	[✂]
Access transmission - OADMs	[✂]	[✂]	[✂]	[✂]
Access transmission - Agg TERMs	[✂]	[✂]	[✂]	[✂]
Access transmission - 1GE Transponders	[✂]	[✂]	[✂]	[✂]

Asset	2018 model (2017 real)		2014 model (2012 real)	
	CAPEX	OPEX	CAPEX	OPEX
Access transmission - 10GE Transponders	[✂]	[✂]	[✂]	[✂]
Access transmission - DWDM amplifiers	[✂]	[✂]	[✂]	[✂]
Access transmission - STM-4	[✂]	[✂]	[✂]	[✂]
Access transmission - STM-16	[✂]	[✂]	[✂]	[✂]
Access transmission - STM-64	[✂]	[✂]	[✂]	[✂]
Access transmission - SDH regenerators	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - buried duct (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - aerial duct (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - submarine fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - leased dark fibre	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - Ethernet leased lines	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - OADMs	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - Agg TERMs	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - 1GE Transponders	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - 10GE Transponders	[✂]	[✂]	[✂]	[✂]
Aggregation L1 transmission - DWDM amplifiers	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - buried duct (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - aerial duct (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - submarine fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - leased dark fibre	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - Ethernet leased lines	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - OADMs	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - Agg TERMs	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - 1GE Transponders	[✂]	[✂]	[✂]	[✂]
Aggregation L2 transmission - 10GE Transponders	[✂]	[✂]	[✂]	[✂]

Asset	2018 model (2017 real)		2014 model (2012 real)	
	CAPEX	OPEX	CAPEX	OPEX
Aggregation L2 transmission - DWDM amplifiers	[✂]	[✂]	[✂]	[✂]
Core transmission - fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Core transmission - buried duct (km)	[✂]	[✂]	[✂]	[✂]
Core transmission - aerial duct (km)	[✂]	[✂]	[✂]	[✂]
Core transmission - submarine fibre cables (km)	[✂]	[✂]	[✂]	[✂]
Core transmission - leased dark fibre	[✂]	[✂]	[✂]	[✂]
Core transmission - Ethernet leased lines	[✂]	[✂]	[✂]	[✂]
Core transmission - OADMs/TERMs	[✂]	[✂]	[✂]	[✂]
Core transmission - 10GE Transponders	[✂]	[✂]	[✂]	[✂]
Core transmission - DWDM signal amplifier	[✂]	[✂]	[✂]	[✂]
Core: VMS	[✂]	[✂]	[✂]	[✂]
Core: IN platform	[✂]	[✂]	[✂]	[✂]
Core: Wholesale billing system	[✂]	[✂]	[✂]	[✂]
Core: Clock and synchronisation equipment	[✂]	[✂]	[✂]	[✂]
Core: Network management system	[✂]	[✂]	[✂]	[✂]
Linear TV platform	[✂]	[✂]	[✂]	[✂]
VoD platform	[✂]	[✂]	[✂]	[✂]
Interconnection team	[✂]	[✂]	[✂]	[✂]

Proposed Update 15:

- Update capex and opex costs based on cost and cost trend from the 2014 model, in line with other FTR model updates from the European Economic Area

1.6 WACC and regulatory fees

WACC

We propose to update the WACC with the latest value of cost of capital defined by ANACOM for MEO, in line with methodology of the 2014 model.

Real pre-tax WACC used in the model was calculated using ANACOM nominal pre-tax for 2017[2] (9.0651%) and inflation from Euromonitor for 2017 (1.4%).

[2] Determinaçao da taxa de custo de capital da MEO – Serviços de Comunicaçoes e Multimédia, S.A. https://www.anacom.pt/streaming/RelatorioWACC16maio2017..pdf?contentId=1413506&field=ATTACHED_FILE

Therefore, we propose to decrease the WACC of the model to 7.56% (from 9.33% in the 2014 model).

Proposed Update 16:

- Update the WACC of the model based on the latest calculations by ANACOM for MEO and inflation from Euromonitor

Regulatory fees

We propose to adopt the same methodology followed in the 2014 model, which is in line with ANACOM's calculation of the regulatory fees charged to the major telecoms operators (by revenue).

Tier-2 operators (with revenue higher than EUR1.5 million) pay a variable regulatory fee T_2, which is a percentage of their revenue; i.e. $T_2 = t_2 \times R_2$, where t_2 is the fee rate (expressed as a percentage of revenue) and R_2 is the relevant revenue, which excludes VAT, sales of terminals (equipment), transactions between entities of the same group and revenue from the universal service. t_2 is calculated by ANACOM and is worth 0.6213% for 2015, 0.6884% for 2016 and 0.7195% for 2017.[3]

In light of the actual values, we propose to update the long-term value of regulatory fees to 0.7% for t_2 (from 0.6% in the 2014 model), in line with the MTR model.

Therefore, the fixed termination cost calculated by the new model is marked up by t_2 to also take into account the regulatory fees, i.e. $Termination\ cost_{with\ regulatory\ fees} = Termination\ cost \times (1 + t_2)$.

Proposed Update 17:

- Update the historical regulatory fee rate and update the long-term fee rate based on recent values

1.7 Additional considerations in 2018 model update

Since the last update of the model, some datasets and information reporting by ANACOM have changed.

We have taken the following precautions so that the structure of the model remains fully functional and is consistent with the way the different sources are reported:

[3] Calculation of fees due for exercise of the activity of supplier of electronic communications networks and services, in respect of 2017

https://www.anacom.pt/render.jsp?contentId=1423445

► *The categorization for minutes from public posts has changed in ANACOM datasets*

In the 2014 model, datasets from ANACOM for fixed voice traffic reported traffic from public payphones “postos publicos” in a different section, while now it is included in national fixed-fixed traffic and international outgoing traffic. We have adapted the datasets in the model to reflect this new reporting methodology. We note that it is not clear where calls from “postos publicos” to mobile is being reported.

► *New broadband connection type: LTE at a fixed location*

Broadband datasets from ANACOM now include this new type of connection. This new access type is now included among "others" in the market model, though it does not feed into the rest of the fixed model as the modelled operator is assumed to only have copper-based and fibre-based access connections.

► *Number of HHs passed*

During the consultation, [✂] has made a comment regarding the number of HHs passed in the model.

Following its comment, we have reviewed and updated the number of HHs passed in the model (a change that does not have impact in final model results)

Figure 1.28: Comparison of HHs passed: pre-consultation model vs. proposed model [Source: Analysys Mason, 2018]

HHs passed	2017	2018	2019	2020	2025
Pre-consultation	4,188,334	4,185,445	4,182,670	4,180,009	4,205,888
Proposed	4,188,334	4,932,078	5,024,458	5,110,239	5,406,532

Annex A List of input data updated from ANACOM and third-party sources

The figure below describes the data that was updated in the 2018 model and the different sources that were consulted. The sources are consistent with the 2014 FTR model. Additionally, for some macro-economic data (like population and inflation) and data for the mobile segment, 2017 MTR model figures were used.

Figure 1.29: List of sources and macroeconomic / market metrics that were used for updating the model [Source: Analysys Mason, 2018]

Source	Metrics
ANACOM	Fixed telephone service (3Q 2017)[4] Mobile services (3Q 2017)[5] Internet access service (3Q 2017)[6] Subscription television signal distribution service (3Q 2017)[7] High speed network and services (3Q 2017)[8] OTT services (2017)[9] WACC for MEO (2017)[10] Leased lines
National Statistical Institute of Portugal (INE) [11]	National population
Analysys Mason Research[12]	Population Households Voice connections and penetration Handset subscribers, mobile connections and penetration IPTV subscribers OTT subscribers
Euromonitor[13]	Population (forecast to 2030) Households (forecast to 2030) Inflation (forecast to 2030)

[4] https://www.anacom.pt/render.jsp?contentId=1424068

[5] https://www.anacom.pt/render.jsp?contentId=1423864

[6] https://www.anacom.pt/render.jsp?contentId=1423754

[7] https://www.anacom.pt/render.jsp?contentId=1423904

[8] https://www.anacom.pt/render.jsp?contentId=1423218

[9] https://www.anacom.pt/render.jsp?contentId=1426043

[10] https://www.anacom.pt/streaming/RelatorioWACC16maio2017..pdf?contentId=1413506&field=ATTACHED_FIL

[11] http://www.ine.pt

[12] http://www.analysysmason.com/services/Research/DataHub/

[13] http://go.euromonitor.com/passport.html

Source	Metrics
European commission	Bitstream subscribers[14]
European Audiovisual Observatory	Market share of the TV channels

[14] https://ec.europa.eu/digital-single-market/en/news/broadband-access-eu-data-january-2016

Annex B Geotypes for 308 Concelhos based on operator presence (high-speed connections)

Geotypes in the FTR model determine the achievable market share that the modelled operator may reach in each concelho. We propose to maintain 2014 model geotypes definitions, updating concelho geotype characterization according to actual market competition.

We would like to notice that 2014 model for geotype 1 was referring to "Lisbon, Porto and Setúbal peninsula". This was not an actual definition for geotype 1, but rather a consequence of geotype 1 characterization as a 3-player market. As such, geotype 1 scope in 2018 model is not restricted to Lisbon, Porto and Setúbal peninsula only, but all concelhos where 3 or more fixed operators can be found.

The proposed changed in concelho geotyping is shown in the figures below (for mainland Portugal, as the 30 remaining island concelhos stay in geotype 4).

Figure 1.30: Geotypes in mainland Portugal-2014 model [Source: Analysys Mason, 2018]

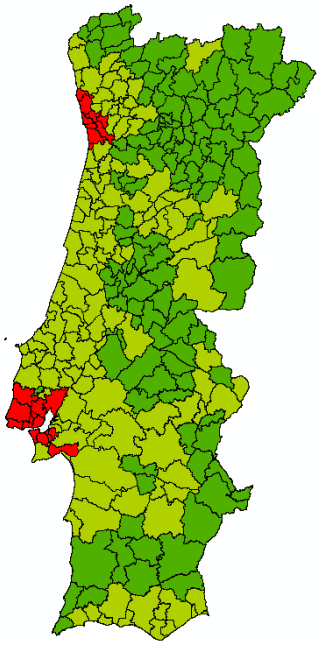
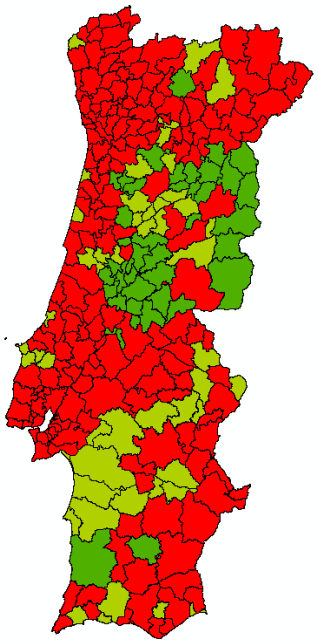


Figure 1.31: Geotypes in mainland Portugal-2018 model [Source: Analysys Mason, 2018]



Annex C List of acronyms

ADM	Add-drop multiplexer
AS	Application server
BAP	Bandwidth allocation protocol
BHCA	Busy-hour call attempt
BRAS	Broadband remote access server
BU-LRIC	Bottom-up long-run incremental cost
CAGR	Compound annual growth rate
CDR	Call detail record
CS	Call server
CWDM	Coarse wavelength division multiplexing
DNS	Domain name server
DSLAM	Digital subscriber line access multiplexer
DTH	Direct to home
DWDM	Dense wavelength division multiplexing
EC	European Commission
EPMU	Equi-proportionate mark-up
FTE	Full-time equivalent
FTTH	Fibre to the home
GPON	Gigabit passive optical network
HSS	Home subscriber server
I&C	Installation and commissioning
ANACOM	Autoridade Nacional de Comunicações
IP	Internet protocol
IPTV	Internet protocol television
LRAIC	Long-run average incremental cost
MEA	Modern equivalent asset
MPLS	Multi-protocol label switching
NGA	Next-generation access
NGN	Next-generation network
NMS	Network management system
OADM	Optical add-drop multiplexer
OEO	Optical electrical optical
OLT	Optical line terminal
OTT	Over the top
PTP	Point to point
PV	Present value
RADIUS	Remote authentication dial-in user
SBC	Session border controller
SDH	Synchronous digital hierarchy
TDM	Time division multiplexing
TERM	Terminal multiplexor
TWG	Trunking gateway
VAS	Value-added service
VMS	Voice main server
VoD	Video on demand
VoIP	Voice over Internet protocol
VPN	Virtual private network
WACC	Weighted average cost of capital
WBS	Wholesale billing system
WDM	Wavelength division multiplexing