

Report for NPT

Finalisation of NPT's LRIC model of mobile networks (v8F)

22 May 2013 • Ian Streule, Matthew Starling, Alex Slinger, Alex Reichl

Contents

Introduction

Adjustments and corrections to the v8F model

Industry viewpoints not resulting in model changes

Illustration of outputs from the v8F model

Next steps

Context of the project

- Since November 2012, Analysys Mason has assisted the Norwegian Post and Telecommunications Authority in updating the existing LRIC model for mobile networks in Norway (model v7.1)
- The draft model issued in March 2013 (v8D) has now been revised, taking into account the conclusions of Analysys Mason and NPT on the views submitted by industry
 - this has led to the “v8F” model being derived



Today's aims

- Explain the adjustments made to the draft v8D model in response to industry input, and the impact of these changes on the modelled costs
 - Summarise where certain industry viewpoints have not been taken into account, and why
 - Explain the final results of the v8F model and the main reasons for the changes arising
 - Inform the industry group of the next steps in the process
-
- The following slides list the issues that were raised by industry
 - The next section gives more detail on the issues that led to changes in the model, while the following section discusses the remaining issues

Summary of issues considered related to the demand calculations [1/2]

Comment	Operators	Impact on modelling
C.1.1 2G data traffic low relative to international benchmarks	TDC	Revised the low-speed data migration profile
C.1.2 Market calculation structure for generic operator does not fit with that for the real MNOs	Telenor	Restructured the generic operator market calculations
C.1.3 Traffic migration from GSM to UMTS is overly aggressive	Tele2	Retained the v8D model assumption
C.1.4 Migration to LTE is too conservative	Tele2; TeliaSonera	Retained the v8D model assumption

KEY: Led to change to the v8F model

Did not lead to change to the v8F model

Summary of issues considered related to the demand calculations [2/2]

Comment	Operators	Impact on modelling
C.1.5 Traffic share in Tele2's network is too high given the modelled network coverage	Tele2	Retained the v8D model assumption, given other accepted issues
C.1.6 Retail market share too high for Tele2 and Network Norway	Tele2	Retained the v8D model assumption
C.1.7 OTT traffic proportion is too conservative	TeliaSonera	Retained the v8D model assumption
C.1.8 Market share for Mobile Norway in the long run is too low	TeliaSonera	Retained the v8D model assumption

KEY: Led to change to the v8F model

Did not lead to change to the v8F model

Summary of issues considered related to the network calculations [1/2]

Comment	Operators	Impact on modelling
C.2.1 Shutdown of the 2G network should be delayed	TDC; Tele2; Telenor	Retained the v8D model assumption
C.2.2 GSM in-fill cell radius should be updated to reflect the proportion of terminating traffic	TDC; TeliaSonera	Revised GSM in-fill radius multiplier post 2008; included UMTS in-fill radius multiplier
C.2.3 Effects of Norwegian topography and population density should be considered	Telenor	Considered to already be sufficiently reflected in the v8D model
C.2.4 Roll-out period of one year is too short	Telenor	Retained the v8D model assumption

KEY: Led to change to the v8F model

Did not lead to change to the v8F model

Summary of issues considered related to the **network** calculations [2/2]

Comment	Operators	Impact on modelling
C.2.5 Costs of providing voice over LTE should be included in the cost base	Telenor	No VoLTE costs included, but assumption added that 50% of LTE megabytes allocated a share of the 2G/3G site costs
C.2.6 UMTS-only network has a significant impact	Tele2	Retained the v8D model assumption
C.2.7 Number of sites and population coverage should be updated to reflect roll-out	Tele2	Increased number of sites in the Mobile Norway model to match operator's forecast
C.2.8 Coverage of generic operator should be reduced	TeliaSonera	Coverage retained, while deployment period extended

KEY: Led to change to the v8F model

Did not lead to change to the v8F model

Summary of issues considered related to the **costing** calculations

Comment	Operators	Impact on modelling
C.3.1 Economic depreciation method inappropriate	Telenor	Retained the v8D model assumption
C.3.2 Site and ancillary cost trends should be changed	Telenor	Adjusted cost trends in the period 2009–2018
C.3.3 Reflection of actual roaming tariffs in the MTR price cap	Tele2	Roaming tariffs are not included, in principle
C.3.4 Modelled licences should consider the forthcoming auctions	Tele2; TeliaSonera	Retained the v8D model assumption
C.3.5 Cost data provided for Mobile Norway's sites	Tele2	Adjusted base unit site costs for Mobile Norway

KEY: Led to change to the v8F model

Did not lead to change to the v8F model

Introduction

Adjustments and corrections to the v8F model

Industry viewpoints not resulting in model changes

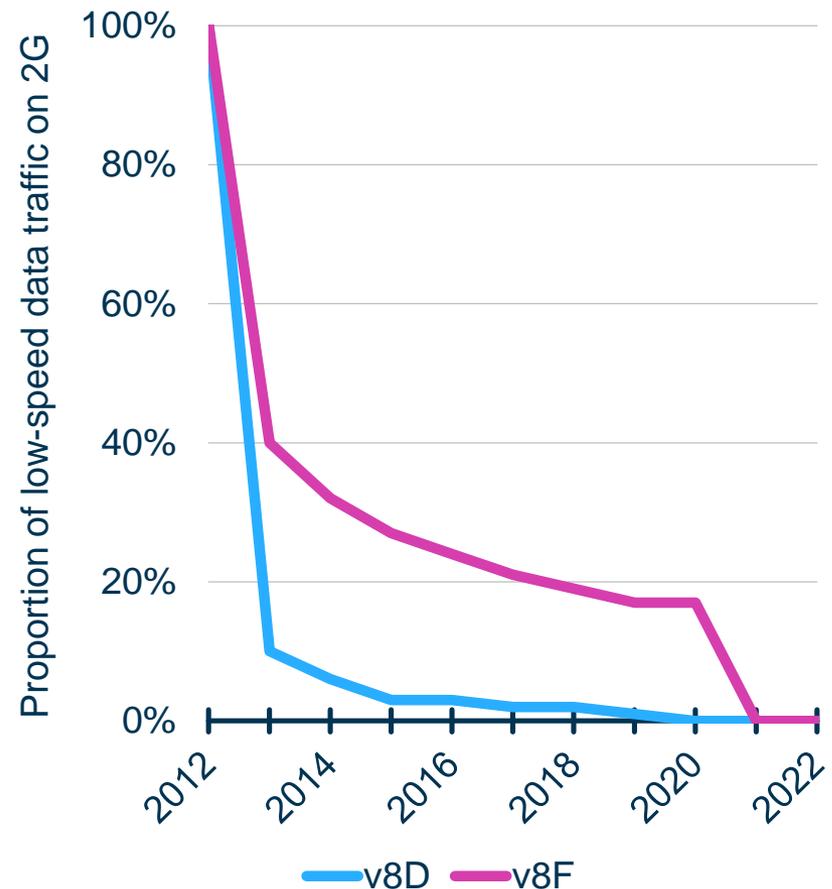
Illustration of outputs from the v8F model

Next steps

C.1.1: The 2009–2012 low-speed data migration profile has been revised, using operator data

- The v8D model contained the correct volume of total low-speed data (i.e. a combination of GPRS/EDGE and R99)
- However, the GPRS/EDGE portion was too low as the migration profile had not been updated from the v7.1 model
- We revised this profile for the MNOs for 2009–2012 using operator data
 - the forecast migration profile was adjusted so that GPRS/EDGE traffic volumes remain stable year-on-year up to 2020

2G low-speed data (generic operator)



C.1.2: Generic operator demand calculations have been restructured to match MNO calculations

- Following operator feedback we have re-ordered the generic operator's demand calculations (on the *D3_M8F* worksheet) to match the flow of the actual operator calculations
- The generic operator's inputs remain derived as functions of actual operator data (as detailed in the v8D model), including forecasted years
- This reordering of calculations leads to rounding occurring at a different stage of the calculations
 - this causes the v8F generic operator market traffic levels to change fractionally from the v8D model

C.2.2: The 2G in-fill radius multiplier was revised and a 3G in-fill radius multiplier added

- The v8D model implicitly assumes that if x% of traffic is removed from the 2G network when termination is excluded, then x% of in-fill sites can be removed from that network
- This is captured by using a multiplier to generate a larger cell radius for in-fill sites, as follows:
$$\text{cell radius multiplier} = \sqrt{\frac{1}{(1 - \% \text{ traffic excluded})}}$$
- The v8D model used:
 - a single constant in-fill cell radius multiplier for 2G cell radii
 - no multiplier for 3G cell radii
- The v8F model uses revised multipliers for the 2G in-fill radius:
 - 1.20 pre-2006; 1.10 post-2008
 - this reflects the change in 2G network voice traffic with the launch of 3G
- We have added a 3G in-fill cell radius multiplier of 1.06 to the v8F model (but have removed cell breathing from 3G in-fill)

C.2.2: These multipliers are derived in a consistent way using the proportion of traffic excluded

- We used the same approach to derive each of the multipliers
 - based on the proportion of voice-equivalent minutes removed by excluding termination
- The updated multipliers lead to fewer 2G sites and slightly more 3G sites being avoided
 - Telenor's suggestion that a larger number of sites are avoided in the absence of termination traffic is therefore not accepted

Derivation of multipliers using equivalent minutes (billions)

Service	2G pre-2006	2G post-2008	3G
Data	1	55	1 302
SMS	0.04	0.07	0.39
Other voice	59	106	578
MT voice	28	39	240
Implied multiplier	1.20	1.10	1.06

Replaces the adjustment for cell breathing for 3G in-fill (though this still occurs in 3G wide area coverage)

C.2.5: A proportion of site costs are assumed to be shared with the LTE traffic using the network

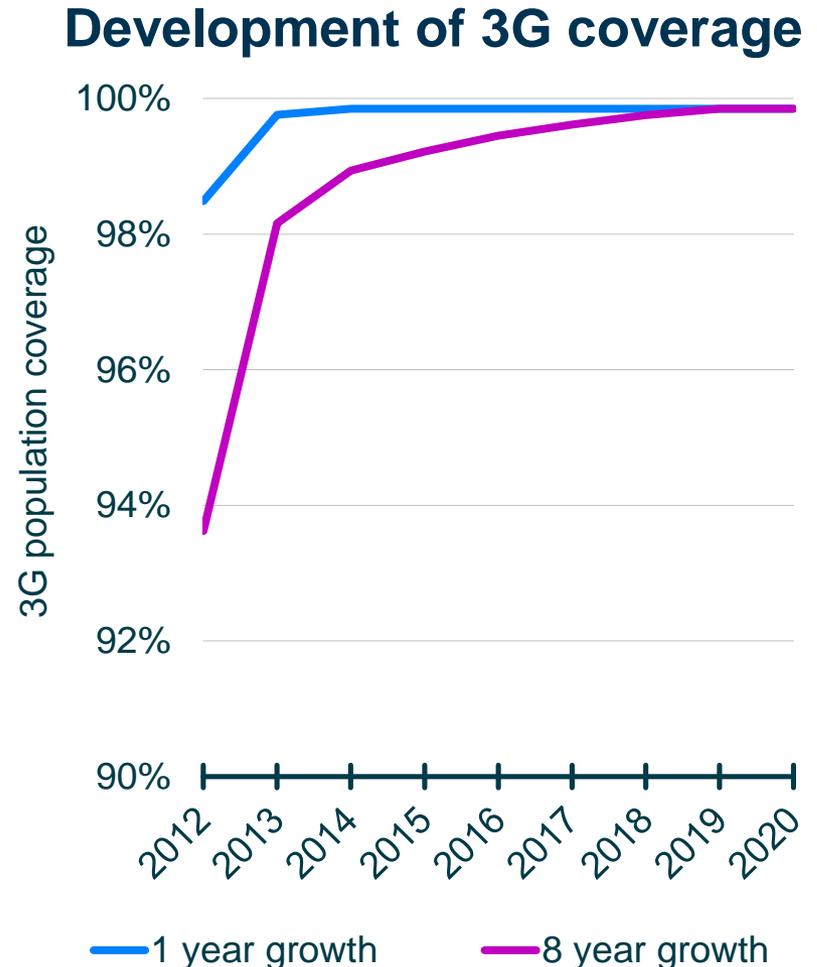
- It is not appropriate for VoLTE costs to be included in 2G/3G voice termination, contrary to Telenor's comments
 - any VoLTE platform costs should be allocated to voice traffic carried by the 4G network
 - 4G voice traffic is a very small proportion of traffic within NPT's period of regulatory interest
- However, it is reasonable to assume that LTE traffic which shares 2G/3G sites should be included in the cost recovery of those assets
- The v8F model includes a 50% factor for 4G megabytes within the cost allocation routing factors for the site assets
- We believe this is a reasonable allocation proportion given:
 - the expected degree to which LTE sites are to be co-located with 2G/3G sites
 - the expected increases in coding rate efficiencies to be obtained from LTE technologies
 - the more efficient LTE is, the smaller the cost that should be allocated to 4G megabytes

C.2.7: Mobile Norway's population coverage was retained at 85%, but the number of sites increased

- Tele2 requested that the Mobile Norway model was updated to reflect its plans for site deployment, and adjusted to 100% population coverage in the long-term
 - on investigation we found that the modelled UMTS2100 coverage needed to be adjusted to deploy a denser 3G network
 - it has been decided, however, to keep long-term population coverage at 85%*
- The Mobile Norway calculation includes the inputs so that it can be run for several different levels of UMTS2100 coverage
 - including 85% and 100%
- The inputs were updated for these two settings so that the actual site targets cited by Tele2 were achieved in each case
 - however, this change does not affect the generic operator

C.2.8: The year in which the generic operator reaches its forecast 3G coverage was revised

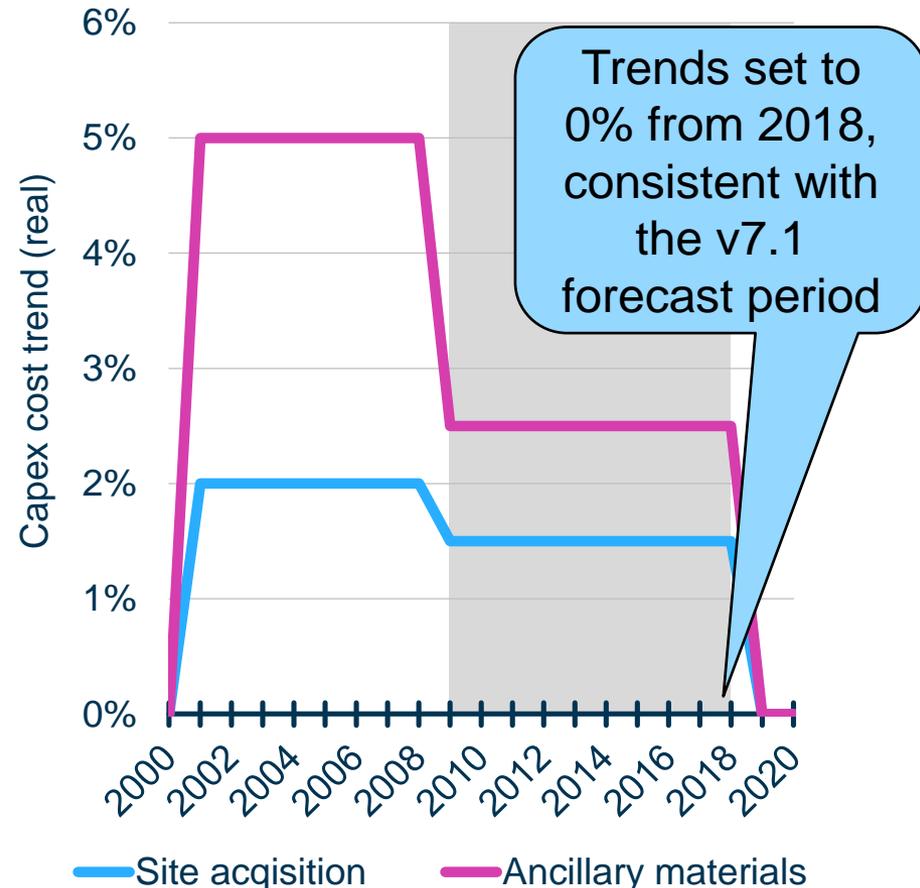
- The time required for the generic operator to reach a forecast 3G coverage area (2100MHz + 900MHz) of 99.9% has been set to 8 years for the v8F model
 - this was previously set to 1 year (for instantaneous scale)
 - this 8-year forecast aligns the 99.9% coverage endpoint with the shutdown of 2G services



C.3.2: Historic cost trends were updated for both site acquisition and ancillary materials

- The 2009–2018 capex cost trends were updated using Statistics Norway data on:
 - the cost index for road construction
 - the cost index for works in offices and commercial buildings
- This is consistent with the sources used in the v7.1 model
- Following this update the reconciliation was reviewed and found to not have significantly altered

Updated cost trends in v8F model



C.3.5: Mobile Norway's cost assumptions were adjusted slightly, given updated data

- Tele2 supplied additional site cost information, which we have used to adjust Mobile Norway's site costs
- Our consideration of the data supplied indicated that certain assets should have their costs adjusted (some upwards and some downwards)
 - accordingly, we have rebalanced Mobile Norway's site costs
- This affects the generic operator, resulting in new site costs as shown

Site costs for **generic operator** in 2013* (NOK nominal)

	v8D model	v8F model
2G-only owned tower site	1 113 000	1 196 000
2G-only 3 rd party site	643 000	637 000
2G/3G owned tower	351 000	311 000
2G/3G 3 rd party site	351 000	311 000
3G-only owned tower site	1 344 000	1 196 000
3G-only 3 rd party site	559 000	614 000

Source: v8D/v8F cost models, Analysys Mason

* This includes the effect of updated cost trends and corrections

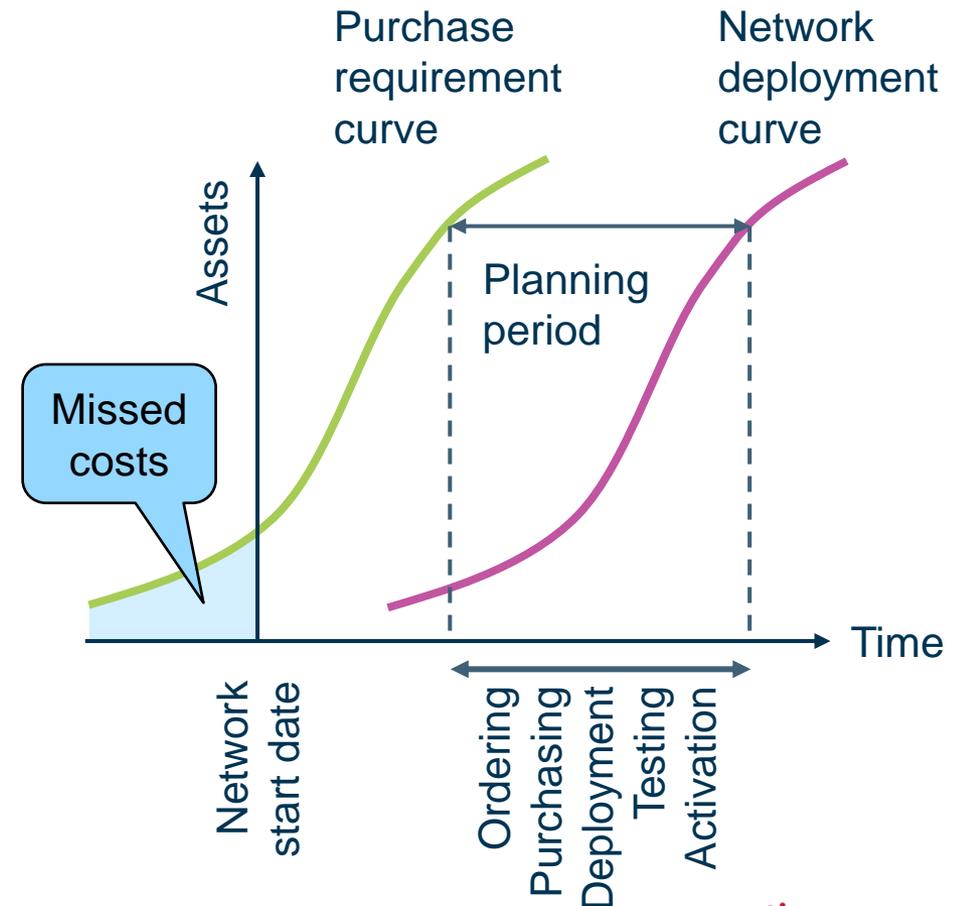
Corrections: We have also made six model corrections following the v8D model release

- While investigating industry comments, several issues with the model were identified and corrected
- The corrections that affected the generic operator results were:
 - A. Expenditure filter adjusted to capture planning period costs
 - B. Migration profile adjusted to give 2G network traffic in 2020
 - C. Unit costs of HSUPA and 3G-only 3rd party ancillary site costs were corrected
- Other corrections that did not affect the generic operator results were made to:
 - D. The calculation of operator LTE upload megabytes
 - E. The treatment of UMTS900 spectrum payments before 2G network shutdown for the Telenor and NetCom calculations
 - F. The presence of 2G spectrum after 2020 (the year of GSM shutdown)

A The expenditure filter was adjusted to include the first planning period

- The v8D model's expenditure filter was incorrectly set so that a portion of the first year's network capex was not captured
 - this only affected Mobile Norway and the generic operator
 - this issue occurred due to planning periods pulling some expenditure forward into a year where the costs were excluded

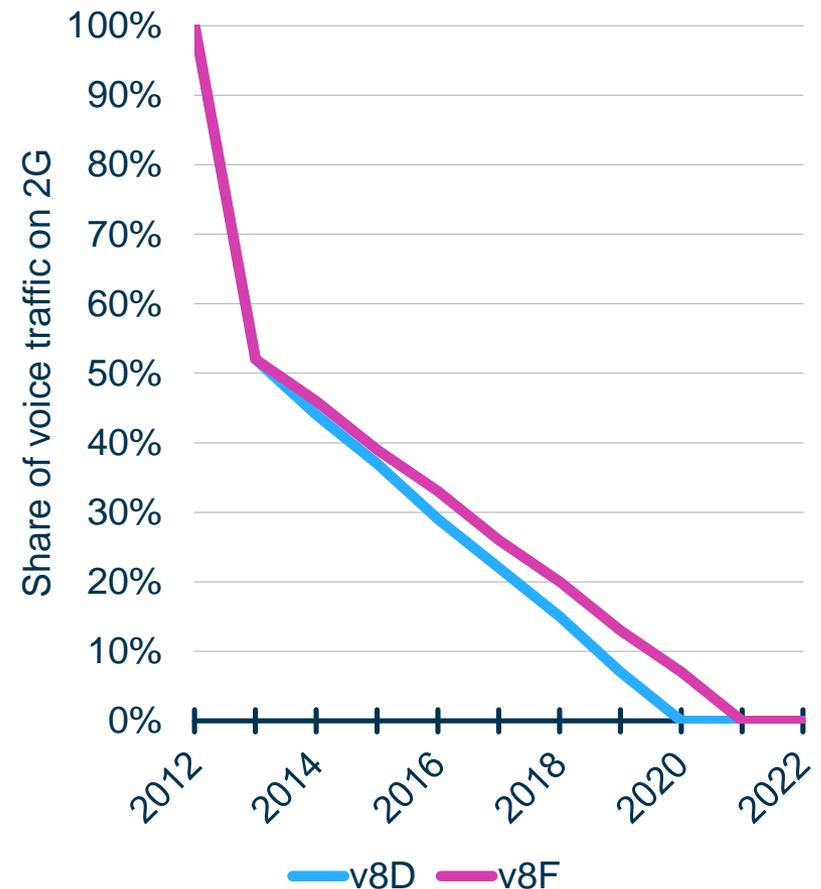
Lead time expenditure profile



B The migration profile was corrected to include traffic on the 2G network in 2020

- Following investigation of TDC's comment (issue C.2.1)* the migration profile was corrected to reach 0% in 2021 rather than 2020
 - this matches the model's opex which continues into 2021
 - this means that the 2G site costs are now utilised for the whole 8-year lifetime of the radio network assets

2G/3G voice migration profiles



* This is discussed in the following section.

Source: v8D/v8F cost models, Analysys Mason

C Two asset costs and **D** the modelled LTE upload data demand were corrected

- The v8D model's costs for '3G-only 3rd party site ancillary / permits' and 'HSUPA upgrade per NodeB' were entered incorrectly
 - the 3rd party site costs were reinstated as in the v7.1 model
 - the HSUPA first upgrade cost was updated
- The v8D model incorrectly set the LTE upload data megabytes to the HSUPA level in the operator demand summary tables
 - however, this had no impact under the v8D model's base settings, as no cost was allocated to LTE megabytes
- This has been adjusted so that LTE data demand flows through the model correctly
 - as discussed previously, in the v8F model LTE megabytes are now allocated some site costs

E + F Two spectrum corrections were made, but neither affected the generic operator results

- The v8D model did not charge UMTS900 periodic spectrum fees until after 2G network shutdown for both the Telenor and NetCom calculations
 - this led to these operators not incurring all 3G spectrum costs
 - the generic operator and Mobile Norway were not affected
- This has been corrected
- While the v8D model showed 2G 900MHz and 1800MHz spectrum in use after the 2G shutdown (as noted by Telenor) no costs were incurred beyond the 2G end date
- For clarity the v8F model has been changed so that no 2G spectrum-related assets appear in any worksheet after 2020
 - this change does not affect any costs incurred

Introduction

Adjustments and corrections to the v8F model

Industry viewpoints not resulting in model changes

Illustration of outputs from the v8F model

Next steps

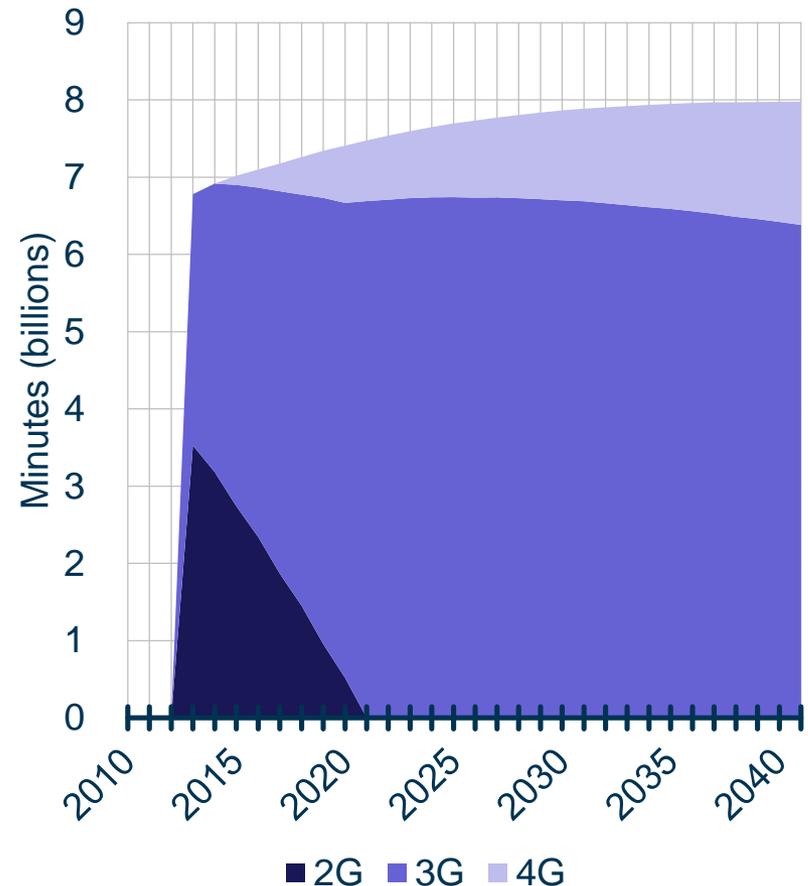
C.1.3: Tele2 believes NPT should be “conservative” and reduce 2G migration

- NPT’s previous cost models assumed rapid migration off 2G, consistent with evidence available at the time
 - Tele2 highlighted there has been a slowdown in migration; however, we consider this is only temporary given the steady trend of average traffic mix
- Having a higher level of traffic on the GSM network has an impact on the LRIC+++ for all services
 - unit costs for 2G services fall while those for 3G services rise
- Tele2’s suggestion means:
 - voice traffic would remain on the higher-cost 2G network for longer
 - 3G unit costs would rise as the network carries less traffic
 - voice termination would not benefit from the steady migration from old (2G) to new (3G) technology
 - 3G benefits from greater economies of scope and scale by carrying more (data) traffic

C.1.3: The v8D model's linear migration is maintained, with no 2G traffic after 2020

- We consider migration to 3G by 2020 is not unreasonable given the migration profiles of the actual operators
 - we believe Mobile Norway can migrate to 3G by 2020, given the size of its 2G network
- There is no obvious reason why the generic operator should use a different migration profile
 - we believe using the average of the actual operator migration profiles is reasonable

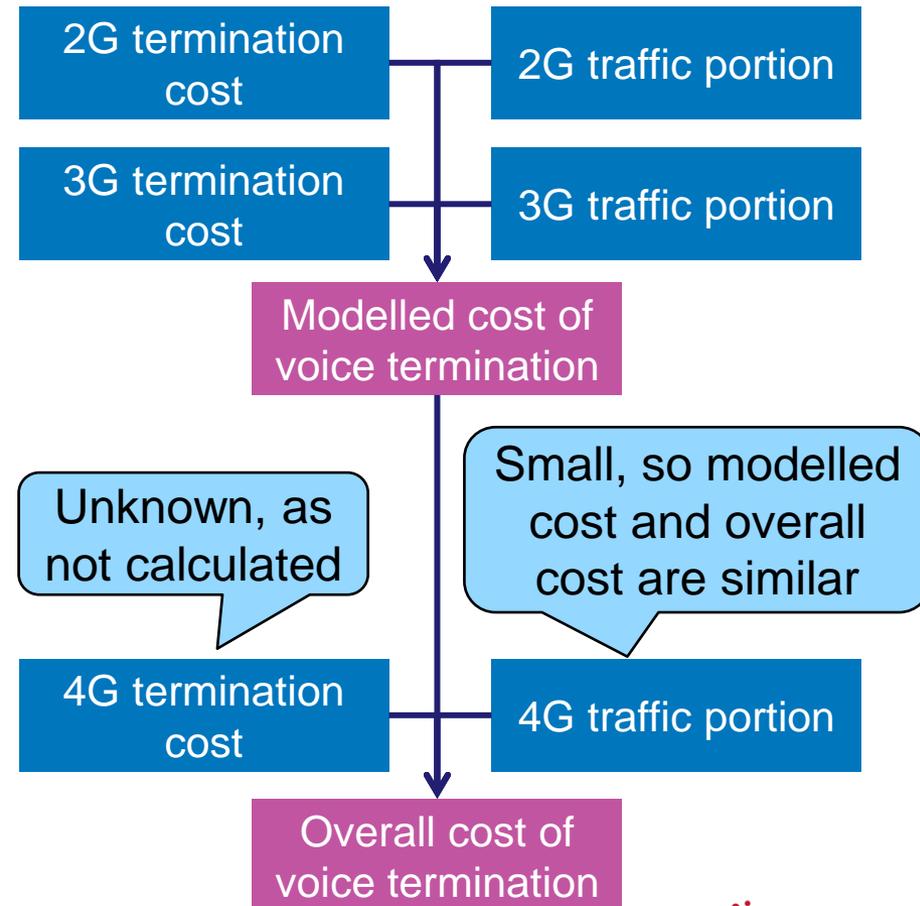
v8F generic operator voice traffic



C.1.4: A higher rate of 4G migration would increase the uncertainty of the total cost...

- TeliaSonera commented that 4G voice migration should begin earlier and progress more aggressively
- In principle, 4G voice should give a lower long-run unit cost of voice, given:
 - greater sharing of costs with higher data traffic
 - use of a single IP air interface as opposed to channelized R99 versus HSPA layers
- The model does not explicitly calculate 4G unit costs

Voice termination costing



C.1.4: ... and so the v8D assumption of a long-term 20% 4G voice migration is retained

- Given uncertainty over 4G voice usage and cost, it is reasonable to maintain the conservative v8D voice migration profiles
 - conservative 4G voice migration reduces the proportion of the cost blend for which there is uncertainty
- Faster migration to 4G would require VoLTE handsets to be widely adopted in the near future
 - we do not currently see evidence that this will occur
- Some operators also claim that 4G voice is challenging to implement, requiring significant systems investment to integrate with circuit-based voice
- We do not consider it appropriate to allow faster migration of voice to 4G if VoLTE costs are high
 - it is inefficient for the MTR payers to support an operator migration to a higher-cost (voice) technology

C.1.5: We continue to assume the same coverage vs. traffic share relationship as the v8D model

- Tele2 does not believe that Mobile Norway's assumed traffic share is appropriate, given the 85% long-term coverage forecast and the number of sites included in the v8D model
- Given our refinement of the Mobile Norway UMTS2100 coverage network,* the updated Mobile Norway network will be better able to carry a traffic proportion corresponding to its population coverage
- Accordingly, following this change to the Mobile Norway UMTS2100 network, we retain the assumption that an operator with x% population coverage carries x% of its own traffic

C.1.6: We continue to assume an equal long-run retail share forecast for all operators

- Tele2 does not believe Mobile Norway will reach 33% *retail* market share in the long-run
 - this retail market share forecast is used to determine the share of traffic carried on Mobile Norway's network
- We note that this principle was established in the v4 model, based on a hypothetical forecast of a balanced three-player market, and was considered plausible by Telenor at the time
- Changing the assumed 33% retail market share would have a significant effect on Mobile Norway's costs, but a very limited affect on the generic operator
 - the generic operator is only impacted due to the rebalancing of market-share weighted average inputs
- Given that the forecast has previously been established and the exact development of the future market is unknown, we consider it reasonable to retain the v8D assumption

C.1.7: Given uncertainty in OTT development, we believe a conservative forecast is sensible

- An increased OTT proportion reduces the amount of traffic that is split between 2G/3G/4G, as follows:

$$\begin{aligned} 3G \text{ voice traffic} &= \text{total voice minutes} \times (1 - \% \text{ OTT}) \\ &\times (1 - 2G \text{ voice migration} - 4G \text{ voice migration}) \end{aligned}$$

- TeliaSonera believes that more than 15% of voice will be carried by OTT in the long-run
 - this decreases the modelled 2G/3G voice traffic, but also reduces network costs, given the lower requirements of carrying OTT voice traffic
- Given current low usage and uncertainty over development of OTT services, we consider a conservative assumption is appropriate
 - we therefore retain the current OTT endpoint in the v8F model

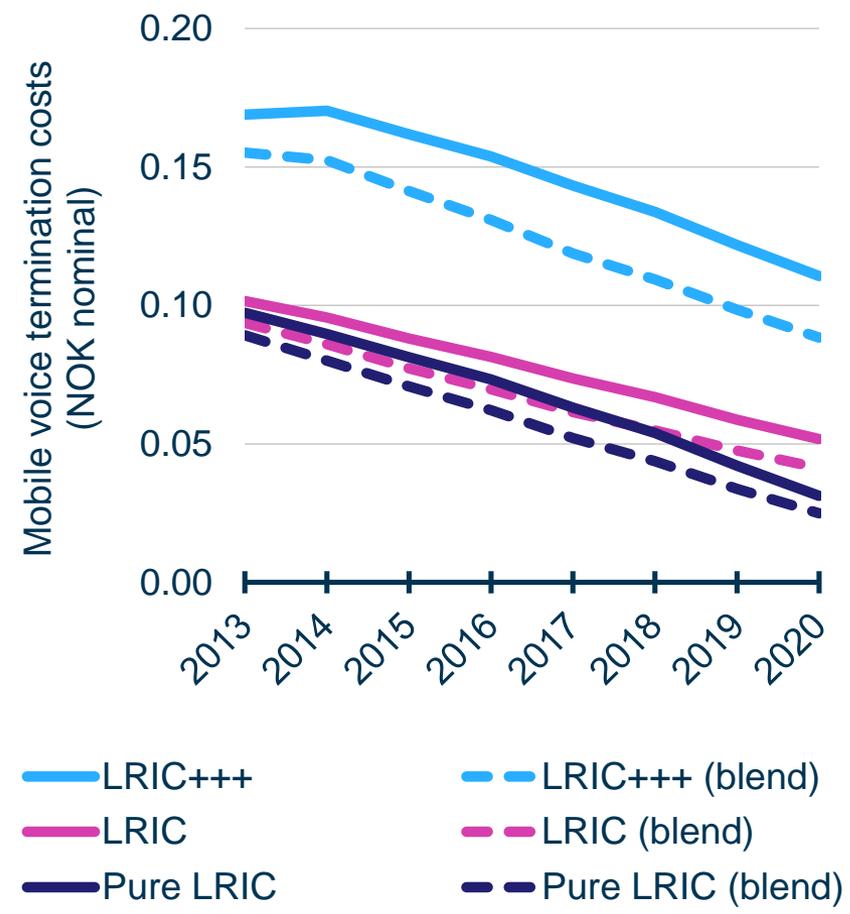
C.1.7: Increases in OTT traffic would lead to higher 2G/3G voice costs, but a lower total cost

- We consider traffic carried via OTT to have zero MTR voice cost on LRIC+++ and pure LRIC basis
 - the relevant cost is paid by the mobile party data bundle
 - this zero MTR OTT proportion can be blended with the 2G/3G results to give lower total costs

2017 cost results (NOK nominal)

	LRIC	Pure LRIC
15% OTT	0.074	0.063
60% OTT	0.077	0.065
60% OTT when blended with zero	0.061	0.052

v8F cost results blended with OTT



C.1.8: We assume that 85% population coverage is achieved by Mobile Norway in the long-term

- The long-term coverage assumption for Mobile Norway is set at 85% for the v8D model
 - this assumption gives a generic operator voice market share of $100\% \div (100\% + 100\% + 85\%) = 35.1\%$
- TeliaSonera's suggests long-term coverage of 75% for Mobile Norway
 - we consider this too low
- Assuming 100% long-term coverage would be inconsistent with NPT's 2012 pricing decision
 - the analysis indicates it is efficient for the third operator to achieve 85–90% coverage rather than duplicate nationwide coverage
- We therefore consider it appropriate to retain the 85% coverage assumption and the resulting generic operator market share

C.2.1: An extension of the 2G network for M2M appears to be inefficient for voice

- Telenor and Tele2 propose that GSM networks will persist for longer than the 2020 shutdown
 - both operators argue that the 2G network is needed past 2020 for M2M terminals
- However, the costs of maintaining a 2G network for M2M are not relevant to the costs of mobile voice termination if voice has migrated away from 2G
 - M2M could be served with a minimal 2G network beyond 2020, and its cost should only be allocated to M2M traffic
- Extension of the lifetime of the 2G network would give results that are higher than those for the base case over the whole period
 - this is due to the requirement for additional asset replacements, and voice remaining longer on a higher-cost (legacy) technology
 - this shows that such changes do not reflect a reasonably efficient solution for the costs of voice traffic

C.2.1: We retain the v8D assumption of 2G shutdown in 2020 and 3G existing in perpetuity

- In previous cost modelling decisions, NPT adopted the position of reflecting a steady migration profile from legacy 2G technology onto 3G technology
 - steady migration is dynamically efficient from the perspective of voice termination traffic costs
- Adopting a longer lifetime for the 2G network results in medium- and long-term termination costs set on the basis of voice traffic remaining on a higher-cost 2G network for longer
- The ESA Recommendation states that “*the model for mobile networks should be based on a combination of 2G and 3G employed in the access part of the network*” ...
 - *not* that both technologies must persist for the entire duration of the model
- This supports the 2G network shutdown approach used in all previous NPT models, and as such we have retained this in the v8F model

C.2.3: Effects of Norwegian topography and population density are already considered

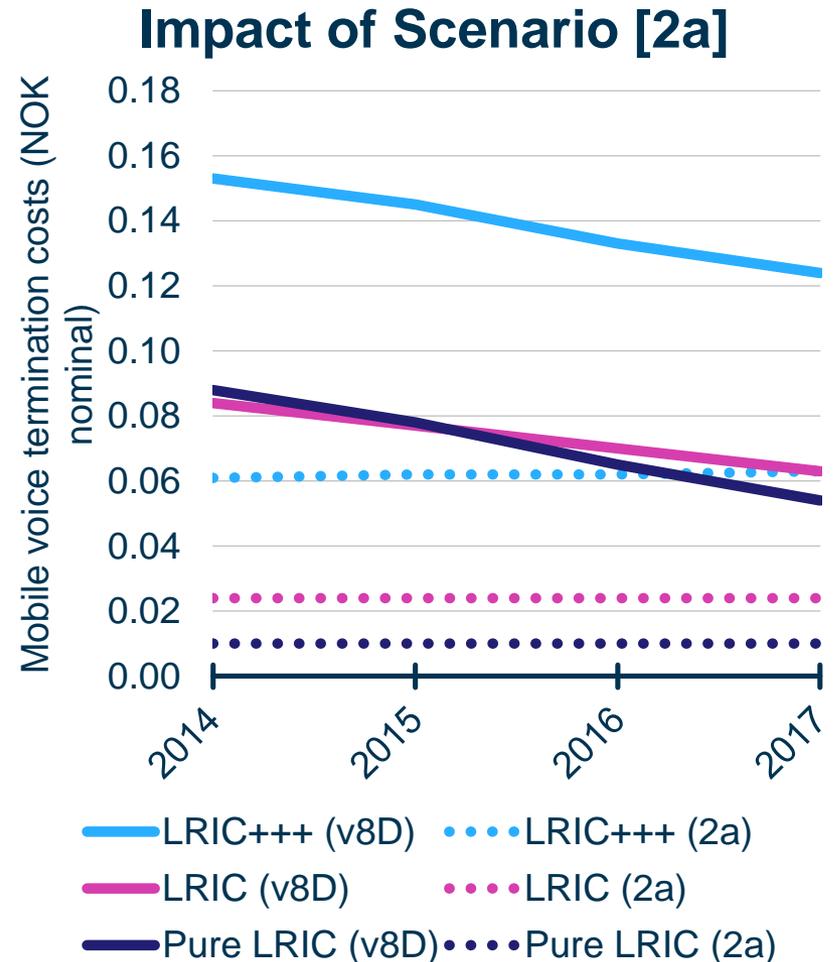
- Telenor states that pure LRIC calculations should consider the effects of the Norwegian topography and population density
 - it recommends these be modelled by removing 5% of coverage area when termination traffic is removed
- However the model already removes in-fill sites when termination is not included, thereby capturing the effect discussed by Telenor
- The amount of in-fill sites removed has been carefully considered, and so Telenor's estimate is rejected
 - this was detailed in the previous section, in the discussion of issue C.2.2
- We do not believe that Telenor's argument applies to wide area coverage
 - the (non-in-fill) coverage area could not be reduced without an impact on the remaining voice and data services

C.2.4: The generic operator continues to be modelled as deploying a network in a single year

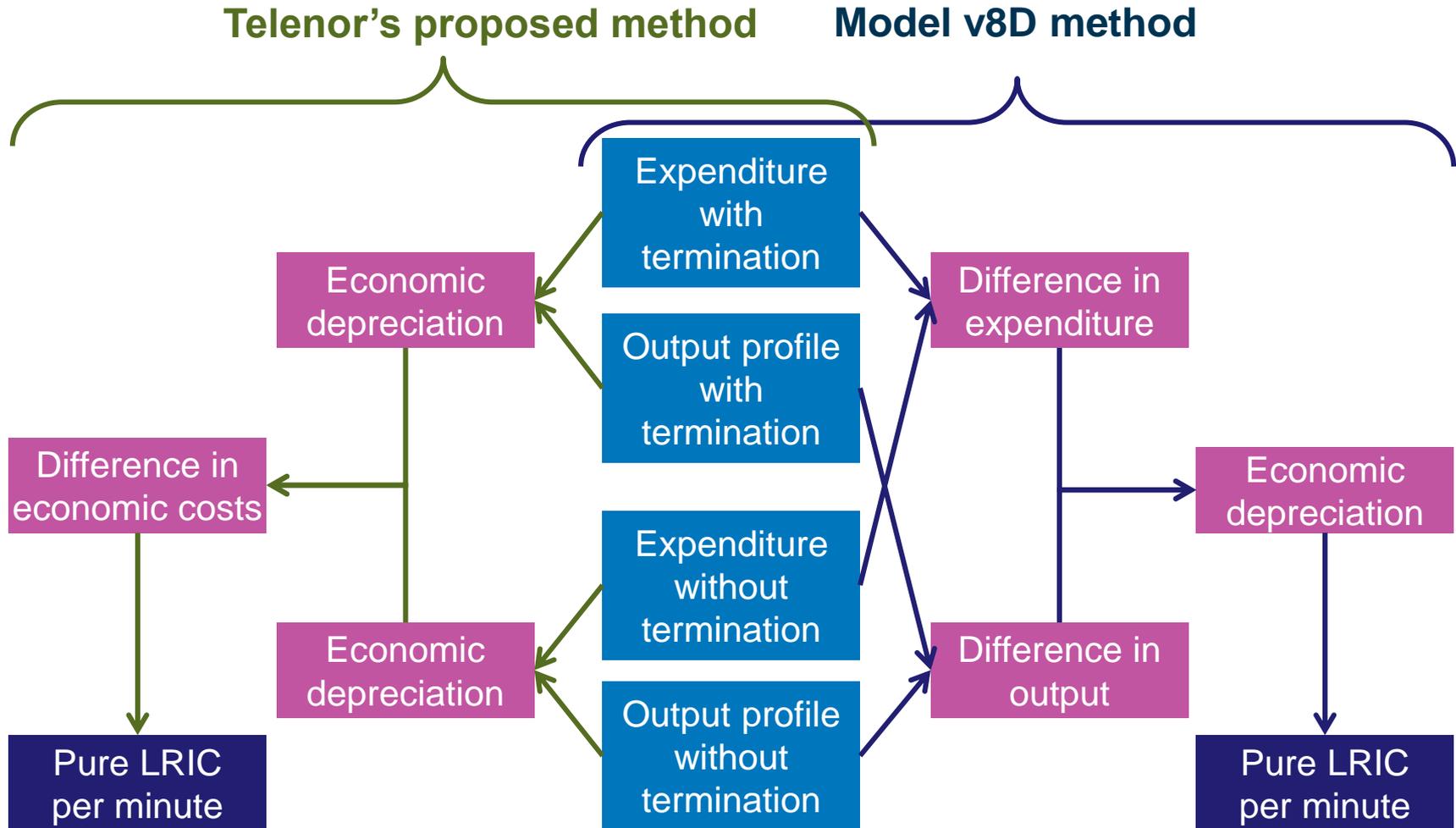
- Telenor does not believe that the assumption that the generic operator will roll out its network in a single year is suitable, given its experience of actual operators
 - the generic operator is assumed to deploy assets in 2012, prior to a 2013 network launch with immediate scale
 - planning periods are included to reflect some purchases and planning of new assets occurring in 2011
- We note that the generic operator's deployment is not expected to match that seen in actual operator's roll-outs
 - e.g. no actual operator has the certainty of immediate scale to an equi-proportional market share
- The generic operator reflects key principles about roll-out and the development of market share
 - we consider the single year 'head start' in deploying the coverage network appropriate

C.2.6: The UMTS-only network scenario [2a] was provided as a sensitivity test

- Tele2 do not consider sensitivity Scenario [2a] (reflecting a perpetual UMTS network with no 2G network) to be realistic
- It should be made clear that this was only provided as a sensitivity test
- Though it can be seen that a 3G-only scenario appears to give rise to statically more efficient costs
 - potentially at the expense of dynamic efficiency, regulatory certainty, and incentives to invest in technologies that may be superseded in the future



C.3.1: Pure LRIC considers the difference in annualised costs with and without termination



KEY: Input Calculation Output

C.3.1: As discussed for the v6 model, the ED of the delta in expenditures is most appropriate

- Calculating the difference in two profiles of annualised costs, *post-economic depreciation*, can result in unexpected time variances in the incremental costs for the Telenor and NetCom calculations
- This is caused by the interactions between the dynamic multi-year model and economic depreciation in the ‘with’ and ‘without’ cases in the calculation
 - subtracting an increment (wholesale termination) that is not a constant proportion of traffic results in a ‘horizontal’ time shift in annualised costs

C.3.3: Reflection of actual roaming tariffs in the MTR price cap is not considered here

- The cost of national roaming traffic is included in the model only in terms of what it costs the network to carry that traffic
 - the price paid by Tele2 to Telenor/TeliaSonera for national roaming traffic is not included in the model
- The further issue of national roaming sits outside the remit of the LRIC model and so is not discussed here
 - NPT is aware of Tele2's comments on the relationship between national roaming and MTRs

C.3.4: We still set renewal periods equal to the duration of the most recently issued licence

- TeliaSonera suggested extending licence durations to 15 years
 - the Ministry is issuing 20-year licences in the 2013/2014 auction
- Historically, fees paid were for licences of a particular duration
 - increasing licence duration would imply licence payments rise to offset this, giving the same costs overall
- Given the above point and uncertainty about future licence values, we have retained the current spectrum fee structure

Licence fee cost adjustment

Example	Value
12-year licence period	100 000
12-year discounted value (at 10% WACC)	7.50
20-year discounted value (at 10% WACC)	9.36
20-year licence period (at 10% WACC)	$(100\ 000 / 7.5 \times 9.36) = 125\ 000$
Over a 60-year period (i.e. 5 × 12 or 3 × 20 year licences) both will give an identical discounted value of 133 000 – but the 20-year licence is less repetitive	

Introduction

Adjustments and corrections to the v8F model

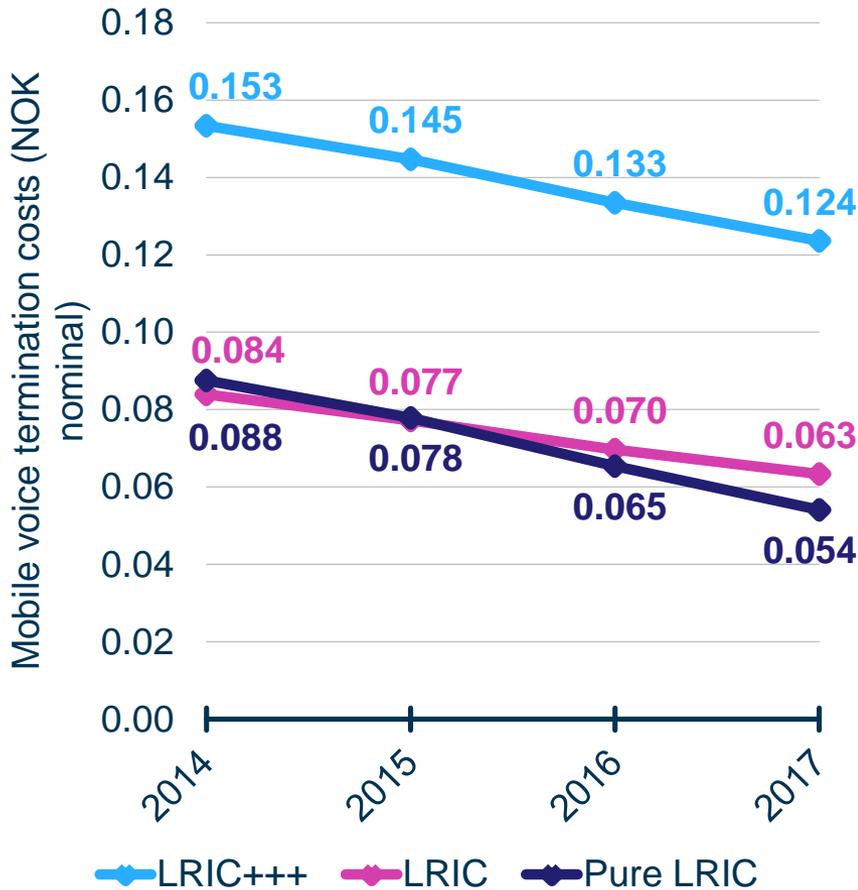
Industry viewpoints not resulting in model changes

Illustration of outputs from the v8F model

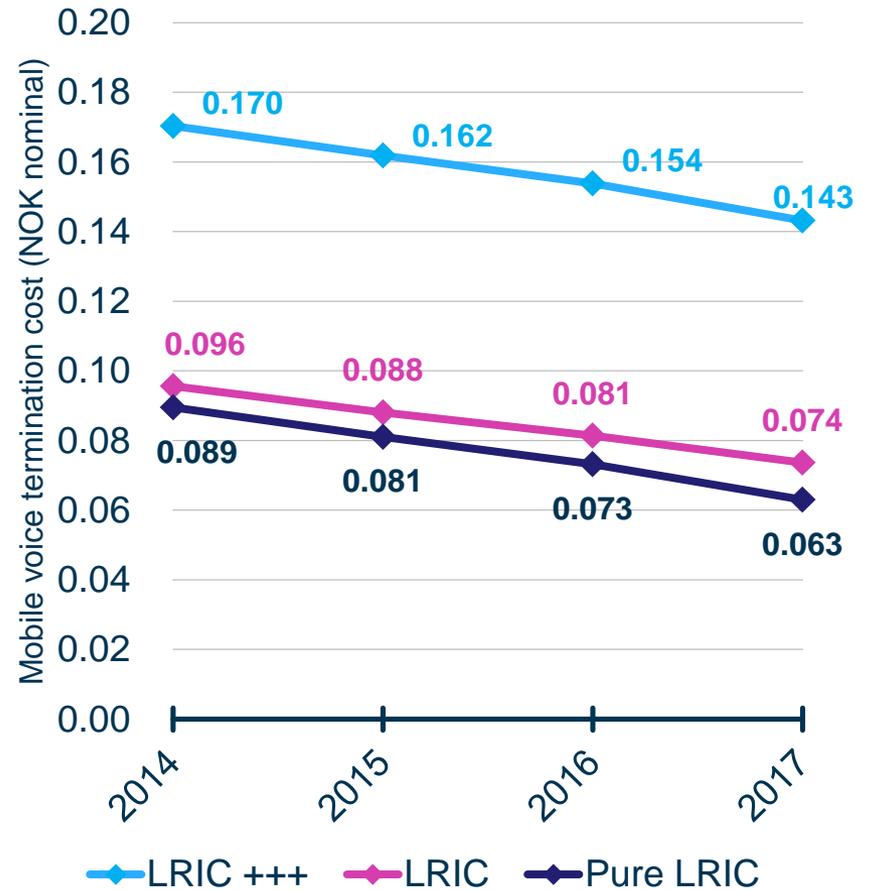
Next steps

The impact of these changes can be seen in the revised outputs for the generic operator

Generic operator: v8D model



Generic operator: v8F model



Introduction

Adjustments and corrections to the v8F model

Industry viewpoints not resulting in model changes

Illustration of outputs from the v8F model

Next steps

Next steps

- Electronic versions of this report slides will be provided
- The materials for the v8F model will be released to industry parties
 - the timetable for their release is yet to be finalised
- Upon release:
 - each mobile network operator will receive its own calculation and the generic operator calculation
 - the generic operator calculation will be released on NPT's website
 - updated model documentation will be published, providing details of:
 - the consultation responses (excluding confidential data)
 - the revisions to the model
- NPT is working on its Draft Decision in Market 7

Main contacts

For NPT

Inger Vollstad

+47 2282 4600

Iric.mobil@npt.no

For Analysys Mason

Ian Streule

+44 845 600 5244

ian.streule@analysysmason.com

Relevant documents

- Documentation related to the NPT v8D model:
<http://www.npt.no/marked/markedsregulering-smp/kostnadsmodeller/lric-mobilnett>
- Documentation related to the NPT v7.1 model:
http://www.npt.no/marked/markedsregulering-smp/kostnadsmodeller/lric-mobilnett/_attachment/1804?_ts=1390fd85d55
- Concept paper related to the NPT v7.1 model:
http://www.npt.no/marked/markedsregulering-smp/kostnadsmodeller/lric-mobilnett/_attachment/1803?_ts=1390fd7ef91
- ESA Recommendation on wholesale termination costing:
<http://www.eftasurv.int/media/internal-market/ESAs-Recommendation-on-termination-rates.pdf>
- EC Recommendation on wholesale termination costing:
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:124:0067:0074:EN:PDF>

Glossary

- **2G**: Second generation of mobile telephony
- **3G**: Third generation of mobile telephony
- **4G**: Fourth generation of mobile telephony
- **EC**: European Commission
- **ED**: Economic depreciation
- **EDGE**: Enhanced Data-rates for Global Evolution
- **ESA**: EFTA Surveillance Authority
- **GPRS**: General packet radio system
- **GSM**: Global System for Mobile Communications
- **HSDPA**: High-speed downlink packet access
- **HSPA**: High-speed packet access
- **HSUPA**: High-speed uplink packet access
- **IP**: Internet Protocol
- **LRIC(+++)**: Long-run incremental cost
- **LTE**: Long-term evolution
- **M2M**: Machine-to-machine
- **MNO**: Mobile network operator
- **MT**: Mobile terminated
- **MTR**: Mobile termination rate
- **NodeB**: 3G equivalent of a base station
- **OTT**: Over-the-top
- **R99**: Release-99
- **SMS**: Short message service
- **UMTS**: Universal Mobile Telecommunications System
- **VoLTE**: Voice over LTE
- **WACC**: Weighted average cost of capital

Contact details

Ian Streule

Partner

ian.streule@analysismason.com

Matthew Starling

Manager

matthew.starling@analysismason.com

Alex Slinger

Consultant

alex.slinger@analysismason.com

Alex Reichl

Associate Consultant

alex.reichl@analysismason.com

Analysys Mason Limited
St Giles Court, 24 Castle Street
Cambridge CB3 0AJ, UK

Tel: +44 (0)845 600 5244

Fax: +44 (0)845 528 0760

www.analysismason.com

Registered in England No. 5177472

Confidentiality notice

- Copyright © 2013. Analysys Mason Limited has produced the information contained herein for the Norwegian Post and Telecommunications Authority ('NPT'). The ownership, use and disclosure of this information are subject to the commercial terms contained in the contract between Analysys Mason and NPT