ERHVERVSSTYRELSEN

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Consultation note regarding first draft of the LRAIC fixed model Paper

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DBA started the consultation on the second version of the draft LRAIC fixed model the 20th of March 2014. By the end of the consultation period, the 23th of April 2014, DBA had received consultation responses from Telenor, Telia, Concepy and TDC. DBA has after the end of the consultation period held meetings with Telenor, Telia, Concepy and TDC. DBA has furthermore asked TDC, Telia and Telenor follow up questions and received new information and has organised a conference call with Global Connect.

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General comments

Incentives for investments

TDC emphasize how important it is that the LRAIC based prices for TDC's wholesale products give positive incentives for investments in NGA. With the present draft of the LRAIC model this objectives is not fulfilled at all – on the contrary.

If prices should be based on the cost calculations in the second draft of the model, the wholesale prices for TDC's major wholesale products will be reduced by 30% - 60%. That would have a huge impact not only on TDC's own incentives for investments, but also – via the so-called "Business Migration Effect"[1] – on all other operators using the copper, coax, fibre and mobile platforms.
Good incentives for investments require:

- Stable retail and wholesale prices for broadband – e.g. EU has recommended a band of 8 – 10 € per month for raw copper.
- A price level both on the wholesale market and on the retail market that makes it possible to obtain a reasonable payback on investments in NGA in a long term perspective.

TDC notes that DBA should be aware that with the price level in the second draft, the price of raw coppers is far below the price band and below other comparable countries in Western Europe.

There need not be any contradiction between the objectives of supporting competition in the sector and positive incentives for investments. That can be solved by monitoring a reasonable margin between retail and wholesale prices. That is what is recommended from EU in the recommendation from September 2013 about "Non-discrimination obligations and costing methodologies".

Given that the model is not final and therefore the price levels are not finale, it is DBA's view that it is premature to discuss issues related to pricing at this stage.

DBA believes that it is important that the LRAIC model follows the technical and economical principles set out in the Commission's recommendations. To DBA's understanding, the Commission's main

[1] See "Commission Staff working Document – Impact Assessment
Accompanying the document
"Commission Recommendation on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment." From EU Commission 11.9.2013. page 59."

objective with the Recommendation on costing and non-discrimination is to ensure stable prices as this will promote investments.

DBA does, however, not see the price band of 8-10 € as binding but rather the Commission's anticipation for the price level if the Recommendation is followed – it is a Recommendation. In this relation, DBA notes that national circumstances can give rise to prices above or below this band.

DBA would also like to remind TDC that DBA is one of the first countries in the European Union to build a LRAIC model for the fixed network following the issuing of the costing and non-discrimination Recommendation. Comparisons with prices in countries that does not yet follow the Recommendation is in DBA's view not of much use.

Use of risk premium

TDC is aware that DBA is still considering the risk premium to be decided in the pricing phase. However, DBA states initially that TDC faces a lower risk, since the current customer base (on copper) can be migrated to the NGA network. In TDC opinion this perception should as a consequence lead to a specific risk premium on the copper network or use of short lifetime for copper assets.

In general TDC does not find DBA argument valid; since incumbents all over Europe potentially can use this migration opportunity in the future, hence eliminating use of risk premiums in general. TDC doubts that this was the thoughts behind the Commission's Recommendation.

In the previous model a risk premium of 2,3% was in practice incorporated via conservative customer estimates. TDC requests DBA to sustain this level in the draft model on the top of the WACC calculation

As stated in a previous consultation note related to the draft model, DBA believes that it is premature to discuss the issue of the risk premium at this stage in the project.

Based on the comments from the industry, DBA will, however initiate the pricing process as a part of the upcoming consultation round. On this basis, DBA will ask for general inputs related to pricing as part of the next consultation round.

Lifetime of copper and fibre

TDC finds that DBA should focus on the economic lifetime of cables and not the physical. Jess Ibsen's statement is clearly meant on the physical lifetime for cables and not the economical. In TDC's point of view, DBA should investigate how long time copper will be able to support the bandwidth demand and to what degree the demand is migrated to other operators and mobile services. Given TDC's high investments in upgrading the copper network, TDC expects to catch up with the demand for a decade or two, but have no indication of copper as bandwidth technology in year 2049 as assumed by DBA.

DBA should further be aware that technical lifetimes are not used elsewhere in Europe.

TDC requests DBA to re-implement a 20 years economic lifetime for copper cables.

Even though the fibre seems to be the 'future' technology, the long term technical and economical lifetime is uncertain. This is reflected in other LRAIC models, where the fibre cable lifetimes are between 10 and 25 years.

TDC requests DBA to re-implement 20 years lifetime for fibre cables.

Even if a long lifetime is used for the copper on the NTP-PDP part of the network, TDC finds that a shorter lifetime must be assumed for the copper net laid out between the PDP and CO. If this part of the network copper based production is moved to fibre, then remote DSLAMS are established. Hence an average economic lifetime of 35 years cannot be expected even if the technical lifetime supports this.

Given the rollout of remote DSLAMs in the coming years, TDC requests DBA to reduce the lifetime for assets between PDP and CO to 15 years.

First of all, DBA would like to clarify that DBA is in fact considering economical lifetimes in the model. DBA has based the estimate of the technical lifetime on the information from Jess Ibsen.

Copper
For copper, DBA finds the economic lifetime shorter than the technical lifetime, as it is likely that customers switch to a competing technology before the technical lifetime of the cable is reached.

However, DBA finds the economical lifetime significant longer that the lifetime previously used (as also explained in the consultation note to the first draft). Further, the Commission has recognized that the technological developments on the copper platform can give rise to changed lifetimes. In this respect, DBA would like to draw TDC's attention to the recital 41 of the Commission's costing and non-discrimination Recommendation where it is stated:

"... When setting the economic lifetime of the assets in a modelled FttC network NRAs should take into account the expected technological and

network developments of the different network components"

TDC requests DBA to investigate for how long copper will be able to support the bandwidth demand. This would imply that the lifetime of copper cables should be reduced as we approach the date where copper no longer can meet the bandwidth demands. This would result in increasing copper prices and DBA doubts that this is in line with the Commission's Recommendation.

DBA would like to remind TDC that fibre is found to be MEA and that the modelling of CATV network and copper network should be seen as a way of converting the fibre price to a price for the actual demanded technology. This is a theoretical exercise which can be difficult to relate exactly to reality. In this context, DBA does not expect an efficient operator to build a copper network today and therefore it can be difficult to discuss lifetimes of copper actives in a purely forward looking perspective. All in all, DBA finds that the correct approach in this respect is to evaluate the economical lifetime of copper cables, assuming that copper will be able to meet the bandwidth demand continuously – as has been seen in real life so far.

DBA partly agrees with TDC in relation to the argument regarding a shorter lifetime for copper cables from primary distribution point (PDP) to central office (CO). When remote DSLAMs are installed, the lifetime of the copper from PDP to CO will be shorter than the lifetime for the copper from the NTP to the PDP.

However, the deployment of e.g. pair bonding will increase the lifetime for the full loop. In general, it is the view of DBA that the lifetime of copper cables of 20 years used in Denmark in the past has been quite conservative.

DBA agrees that it might be relevant to use different lifetimes for the two different parts of the network. However, as DBA has seen no actual data justifying different lifetimes and DBA has no basis for evaluating this properly, DBA finds it most appropriate to use a common lifetime for both sections of 35 years. Hence, the lifetime of the copper cables is kept at 35 years.

Fibre
For fibre, DBA has set the economical lifetime at the same level as the technical lifetime. DBA believes that the speeds delivered over the fibre network will be capable of supplying the demanded speed for several years to come and DBA does not see any competing fixed line technology under development. Furthermore, DBA does not believe that overlapping fibre networks will be deployed to a great extent. This is supported by the actual fibre deployments in Denmark to date. Thereby, the economical lifetime of fibre infrastructure will neither be reduced due to deployment of alternative fibre infrastructure.

On this basis, DBA expects the economical lifetime to be approximately equal to the technical lifetime. Based on discussions with the industry and other experts, DBA has seen no indications that 35 years is an overestimation of the technical lifetime of fibre cables.

In general, it should be noted that DBA has historically modelled TDC's three platforms individually with the actual demand on each platform. This approach gives rise to lower economical lifetimes compared to the approach recommended by the Commission. When modelling three platforms simultaneously, as it has historically been done, churn between the platforms will reduce the economical lifetime of the cables. This is not the case when modelling the platforms one at the time. Therefore, DBA believes that increased lifetimes is a natural result of complying with the Commission's Recommendation.

In conclusion, DBA finds that the approach is in line with the Commission's Recommendation and reflects valid lifetimes of the cables.

100% demand Footprint
<u>TDC</u> states that according to DBA, the approach of modelling one network instead of three is in line with the Commission's Recommendation. TDC does not agree. The Recommendation describes the modelling of a combined copper/fibre network in order to avoid increasing copper unit price when copper over the years are migrated to fibre. The Recommendations does not perceive CATV as a part of this migration process and TDC expects to keep the CATV network and to continue the investment in the network making it to a NGA network. Migration of CATV to fibre with resulting higher unit prices are therefore not a risk in the future.

TDC thereby requests DBA to exclude the CATV from the modelling in the copper and fibre scenario.

In recital 39 of the Recommendation it is stated that:

*"Active copper lines are decreasing due to customers migrating to cable, fibre and/or mobile networks. Modelling a **single efficient NGA network for copper and NGA access products** neutralises the inflationary volume effect that arises when modelling a copper network, where fixed network costs are distributed over a decreasing number of active copper lines. It allows for progressively transferring the traffic volume from copper to **NGA** with deployment of and switching to NGA. Only traffic volume from moving to other infrastructures (for example cable, mobile), **which are not included in the cost model**, will entail a rise in unit costs" (highlights by DBA)*

DBA believes that it is clear from the costing and non-discrimination Recommendation, that the CATV customers should be part of the single efficient network. Contrary to many European countries, the incumbent in Denmark owns the largest CATV operator, and access to the network is regulated.

As customers migrate from TDC's copper network to TDC's CATV network, copper prices will increase, unless the CATV customers are included in the customer base for the single efficient network. Therefore, DBA believes that the used method is in line with the Commission Recommendation.

Method for estimating footprint

TDC states that in the draft model, DBA uses a common subscriber base for copper, fibre and CATV of 2,7 million subscribers. TDC cannot see how this figure has occurred and how customers with multiple accesses to technologies (e.g. copper + CATV) are handled. From TDC's point of view, the 'Overlap correction factor' - used to calculate the 2,7 million customers - is derived from a customer base of geographical distinct connection of app. 1,5 mill but is applied on a customer base of 2 mill connections[2].

TDC requests DBA to describe the perception of the national network with common demand of the platforms.

If it is assumed that each customer should have just one connection (in the copper and fibre scenario) no matter if he is using copper, fibre or coax or a combination today TDC finds that the national footprint gives less than 2,2 mill. subscribers, see table 1 below.

Table 1. Subscribers use of access technology

Access type, active subscribers*	**# addresses**
Copper only	XX
CATV only (incl. fibre based CATV)	XX
Fibre only	XX
Copper&CATV	XX
Copper&Fibre	XX
Fibre&CATV	XX
Copper&CATV&Fibre	XX
Total	XX

*) The subscriber may have more than one connection of the specified technology(ies)

[2] See Model documentation page 19 and Access model, sheet 'Parameters' cell I54 respectively.

Given the approach is to connect customers with one connection of the chose technology in the scenario and given the so far inclusion of CATV in the scenario, TDC requests DBA to alter the customer base from 2,7 to 2,2 million customers in the copper and national fibre scenario.

According to the model reference paper, the access network modelled aims at handling the aggregated demand of all existing access platforms (Copper, Fibre and CATV). Criterion BU 22 states

"The LRAIC model should assume that each access network technology supports 100% of TDC's local fixed network demand in terms of active subscriptions (i.e. 100% of the "copper + cable TV + fibre" demand)".

In Denmark, active subscribers can have a unique connection of one given technology (copper only, fibre only or CATV only customers) or a combination of the different available access technologies (copper & CATV, copper & fibre, fibre & CATV or copper & CATV &fibre). Some active customers also have multiple copper connections (e.g. one for broadband and one to connect a fax). To DBA's understanding, the number of active customers having multiple CATV or multiple fibre connections is very limited. As a consequence, a preliminary step of the access network modelling is to derive the demand for the LRAIC model network from this real life demand.

The LRAIC model contains three different technological scenarios, respectively copper, CATV and fibre. For each scenario, the modelled active lines are a mix of all of the three technological platforms. For instance, when running the copper scenario, both active copper, CATV and fibre lines are included. When defining the total number of active lines, DBA believes the following principles are appropriate:

1) All active lines corresponding to the modelled technological scenario are included.

2) Active lines <u>not</u> corresponding to the modelled technological scenario are only included if the specific end-user does not have one (or more) active lines corresponding to the modelled technological scenario.

For the copper scenario, these principles imply that all active copper lines are included whether end-users have one or more active copper lines. In addition, active CATV and fibre lines are included for end-users that do not have an active copper line.

In relation to the first point, DBA believes that this is in line with the way the cost of the copper local loop (e.g. local loop unbundling) is currently being priced, where the unit cost is based on the total number of active lines (i.e. a customer having two active copper lines in the same building would pay for two local loops). This makes sense from a cost causation point of view and this is a fundamental principle in the LRAIC regulation all over Europe.

The method proposed by TDC is equivalent to assuming that the cost driver is the customer address, meaning that a customer having two active copper lines would pay for only one copper access. DBA does not consider this a possible solution as it is not in line with the local loop pricing already in use in Denmark and in other European countries.

In relation to the second point DBA believes that this is a conservative approach. Consider the example of a customer having both an active copper line and an active CATV line. This could be counted as two active connections in the context of a unique access platform. This would lead to more active lines in total (+ XX compared with the current level), that is to say a higher level of economies of scale and lower per lines costs.

In order to simplify the calculation, TDC will be required to provide the number of CATV customers using no other technology (as provided for the answer of the 2nd round of the consultation, see above) for the annual update. Table 1 is an extract of the Excel part of the LRAIC access network cost model.

The CATV only customers will be modelled as single copper pair customers (XX customers in the table provided by TDC above) and the same approach is used for fibre only customers.

The demand for the national copper will be calculated as (Number of <u>active copper pairs</u> + Number of active fibre customers + Number of CATV customers using no other technologies) = 2,856,146.

The demand for national fibre will be calculated as (Number of <u>active copper customers</u> + Number of active fibre customers + Number of CATV customers using no other technologies) = 2,755,669. That is, active copper customers are considered instead of active copper pairs.

The demand for CATV will be calculated as in the previous version of the model: (Number of active CATV customers * (1+ “Mark up to take into account active copper customers in the CATV scenario”)) = = 1,355,015. The mark up has been derived to match the active premises in the CATV coverage.

The demand for the DONG scenario is the actual telecom penetration in the DONG coverage area. The telecom penetration has been calculated to 86% on the 112,334 premises passed, that is to say 93,353 customers.

This calculation has been implemented in the Excel part of the LRAIC access network cost model spreadsheet “Parameters” part 2: “Active lines”.

Table 1 - Active copper subscribers 2013

Active lines of TDC copper network calculation	
Active copper primary pairs (customers)	**1 997 196**
Active local loops (first pair)	**1 996 911**
Active sub-loops (first pair)	**285**
Active copper local loop second pairs (ISDN + Pair bound-ing)	**100 477**
Active copper subloop second pairs	**-**
PSTN lines	1 001 717
Broadband without PSTN	466 443
BSA withtout PSTN	154 207
Second pairs for broadband without PSTN (Dual pair bonding)	-
Second pairs for BSA without PSTN (Dual pair bonding)	-
ISDN2	94 232
ISDN30	6 245
Copper leased lines	14 742
Raw copper	259 325
Second pairs for raw copper (Dual pair bonding)	-
Subloop customers	285
Second pairs for subloop customers (Dual pair bonding)	-

Source: DBA

CATV Modelling in copper scenario

TDC states, that in the national footprint in the copper scenario only TDC's amount of current or planned remote DSLAM locations are used. The remaining part of the country and the 2,7 mill. customers are according to the model expected to use full raw copper to produce services.

In the copper scenario 1,1 mill. CATV customers are included. Each of these requires tv signals (multiple TV-streams and up to 100 Mbit/s broadband) and thereby high bandwidth, which are not provided by full loops and TDC's current amount of remote DSLAMs.TDC finds that all CATV customers have to be connected via remote DSLAMs as a minimum to ensure proper bandwidth. Even with this approach it is doubtful, if the network can fulfil the demand.

DBA should be aware that according to Criterion 21

> "*the modeled network as a minimum should be capable of providing comparable quality of service as currently available on the SMP operator's network, and be able to provide functionality comparable to that of the existing products and services.*"

TDC requests DBA to incorporate use of remote DSLAMs for CATV-customers. Consequently the CATV customers should be excluded from the use of the PDP-CO copper network.

In the MEA final paper, DBA decided that the MEA for copper and CATV was Fibre to the Home (FTTH) and that adjustments based on costs (and thus requiring the modelling of a copper network and of a CATV network) were needed to reflect the lower performances of copper and CATV compared to FTTH. This is in line with the then published European Commission Recommendation which states:

"When determining the access prices of services that are entirely based on copper, NRAs should adjust the cost calculated for the modeled NGA network to reflect the different features of wholesale access services that are based entirely on copper. For this purpose, the NRAs should estimate the cost difference between an access product based on for example FttC/FttH and an access product based entirely on copper by replacing the optical elements with efficiently priced copper elements, where appropriate, in the NGA engineering model."

If DBA where to incorporate remote DSLAMs for CATV customers, then this would not enable DBA to calculate the costs of a network with technical performances and with a footprint of TDC's current network. In absence of a CATV network, customers would need to connect to the copper network but would have lower capabilities of the modelled network. This is exactly the goal of the adjustments based on costs.

Also, by following the current approach, DBA is consistent with Criterion BU 21 of the Model Reference Paper, since the modelled copper network includes existing DSLAMs (remote and located at the CO) which means it provides comparable QoS (or higher) as currently available on TDC's copper network.

CATV modelling
TDC finds that the CATV modelling in the access model better reflects the network than it did in the first draft.
However, with regard to the modelling of CATV in the core model TDC sees no progress in terms of making the model reflecting the real CATV network. The draft model still uses the Busy Hours (BH) cost of xDSL customers to calculate the end used price. TDC finds that specific fibres should be modelled from the CO-sites to the 30 MPEG sites. Furthermore, DBA should be aware that a specific CATV multicast service is included in the model demand in order to feed the MPEG stations with TV signals.

TDC again requests DBA to remodel the 'core'-part of the CATV.

As discussed during the 25th of April 2014 meeting, the core network cost model has been updated following the comments received during the previous round of consultation by using BH cost of CATV customers instead of BH cost of xDSL customers in order to compute the coax BSA price. This change can be observed in the pricing sheet in cell G52.

TDC's understanding was in the first place that CATV customers were considered as connected to the closest CO and not to the closest MPEG station. However, DBA can confirm that all CATV customers are connected to the closest MPEG station. This has been carried out in 2 steps:

- First, by connecting all customers to the closest CO

- And second, by connecting this CO to the relevant MPEG station.

These calculations are carried out in the access network cost model. The link between the CO and the MPEG station is included in the category PDP.

The LRAIC model therefore deploys a fibre between the FTTN node and the MPEG station.

Therefore DBA does not believe that any change is needed. DBA will contact TDC to clarify if TDC still believes that changes of the model are needed.

Furthermore – it is TDC's understanding that the model also will be used for TV pricing. TDC would like to understand how this is covered in the model.

Regarding the passive part of the CATV network, the allocation of the costs has been performed in two parts:

- The costs of the dedicated part (localized in the private property) have been equally split between TV and broadband as the dimensioning is not capacity driven. For broadband, costs are split equally between upstream and downstream.

- The costs of the shared coax part (between the edge of the private property to the Fibre to the Node (FTTN) node, excluding the FTTN node) have been split based on the frequency bandwidth allocated to each services as the dimensioning is driven by the capacity needed.

-The costs from the FTTN node to the MPEG station (costs of installing the FTTN node and the fibre between the FTTN and the MPEG station) are also allocated based on frequency bandwidth used by the different services.

-Regarding the active part of the CATV network (core network), the costs allocation has been carried out according to the following rules:

- The cost of the shared assets between the CATV network and other networks is allocated based on capacity;

- The cost of the dedicated CATV assets is allocated either to specific services or based on capacity.

The answer regarding the comment on the pricing of TV channels and cost allocation of dedicated CATV assets is pending data from TDC.

Cost recovery
TDC finds in the model no adaption of TDC's general comments regarding cost recovery in the model.

TDC finds a cost check is required in the model to ensure that all costs are covered exactly once in the model. The total yearly cost of depreciated capex, opex and overhead cost should equals the inputted volumes in 'Historical input' multiplied by the calculated unit prices in the result sheets. In this way it is ensured that all costs are covered by services – regulated as well as unregulated.

In TDC's opinion, the draft model does not ensure cost recovery – among other things because of missing routing factor calculations in the access model. DBA is requested to ensure cost recovery.

As discussed during the 25th of April 2014 meeting with TDC, DBA disagrees with TDC. DBA is of the view that the new cost allocation mechanism for the access network ensures cost recovery.

The Excel part of the LRAIC access network cost model has however been updated by including cross-checks showing that the prices ensures cost recovery. See line 63 of "Cost allocation" spreadsheet and line 40 of "Cost allocation CATV" spreadsheet.

Overhead costs
It is Telia's and Telenor's experience that the level of overhead in the existing model is too high. In today's telecommunication industry, 17 percent is far from a best practice level. Telia and Telenor find it important to reach a more realistic level of overhead in the new model.

Indications that the level of overhead should be much lower for an efficient operator include the Swedish LRAIC model, and experience from Telia's and Telenor's common network company – TT Netværket.

The Swedish LRAIC model (Consolidation model 10.1) operates with an overhead mark up at less than 4% of the total yearly costs, while the existing Danish model operates with 17% mark up as fraction of the total yearly costs. On top of the common overhead mark up – the existing Danish model also operates with additional interconnection specific overhead mark up.

TT Netværket which is a joint venture established by Telia and Telenor, is a pure network company, producing wholesale services (Radio Access Network) to Telia and Telenor. Even though the produced wholesale products are mobile services, Telia and Telenor believe that the company can be used as benchmark. Some of the arguments for using TT Netværket as benchmark are:

- It is a pure wholesale company. I.e. there is no discussion about whether the overhead costs shall be allocated to wholesale or retail services.

- It is newly established by two experienced and cost-conscious companies, i.e. it is realistic to assume that the company is efficient.

- The company operates in the telecom business area. There are differences between broadband and mobile network operators, but when it comes to overhead the difference should not be significant.

The overhead in TT Netværket in 2013 was 2.3% if measured as a fraction of OPEX plus depreciations, and 4.1% if measured as a fraction of OPEX. This can be seen from Appendix 1.

The second model draft that was released in March has a total OPEX of DKK 409 million, and the level of depreciated CAPEX is DKK 1.928 billion in the copper scenario. As shown in the table below, the benchmarks from the Swedish LRAIC model and from TT Netværket, indicates that overhead in the Danish LRAIC model should be somewhere in between DKK 17 and 85 million a year, the average of which is DKK 52 million.

Source	Mark up to…	Mark-up	Overhead estimate (mDKK)
Swedish LRAIC	OPEX+Dep. CAPEX	3,64%	85
TT-Netværket	OPEX	4,15%	17
TT-Netværket	OPEX+Dep. CAPEX	2,35%	55

DBA would like to point out that it is not the level of the mark-up that is important when assessing the level of overhead costs but the actual value of the overhead costs. The mark-up value depends on the actual value of the overhead but also on the total yearly cost of the network as the mark-up is computed as follows:

Mark-up for overhead = Overhead yearly costs / Network total yearly costs

The overhead costs account for 90 mDKK in the draft model which is in line with the Swedish overhead costs provided by Telia and Telenor.

TT Netværket experiences lower overhead costs than TDC as it is a smaller company with a scope of mobile activities which are hard to compare with a fixed line company.

Therefore, DBA disagrees with Telia and Telenor that the overhead costs are too high and above what is experienced elsewhere.

On this basis, DBA does not believe that any changes are needed.

Network management systems
Telia and Telenor state that the model includes a network management system (NMS). Telia and Telenor would like DBA to further elaborate on the functionality and costs related to the NMS. The NMS is not explained in the model or in the documentation. What exactly is the functionality of the NMS, and how does it differ from the support systems which are also included in the Non-network cost sheet? The yearly costs of the NMS are entered in the model and the source refers to “new data”. Telia and Telenor would like DBA to explain how those huge NMS costs (290 mDKK) have been calculated.

TDC finds that the costs of NMS/It-platforms are not derived correctly from TDC’s submission. The depreciation and maintenance cost used in the model are the total IT-cost allocated to net elements in TDC’s submission. However, only a part of these costs are LRAIC relevant. TDC has in the submission stated for each net element, whether the elements is LRAIC-relevant or not.

On contrary, DBA has not included costs for ‘Columbus- netdel’ and ‘TOT’ which are allocated directly to services. These are marked with orange background in the data submitted by TDC.

TDC requests DBA to update the use of IT-cost for the NMS-markup calculation.

TDC states also that the NMS cost base is split between copper, fibre, CATV, core and Colo services in ‘Non-network costs’ cell L10:P10.

TDC finds no documentation of e.g. allocation of 30% of copper and fibre respectively.

Further, TDC does not find that the fixed allocation make sense in the scenarios, where one technology is built to serve all customers. E.g. why is 30% of the NMS cost allocated to fibre access in a full copper scenario? DBA should note that the reduction in IT-cost are minimal if e.g. fibre customers are served in the copper scenario or vice versa since the existing IT-systems used for the copper platform are reused for the fibre platform. Larger cost reductions can therefore not be expected in a one-network approach.

Furthermore, the IT-cost should be scaled to a network with 2.7 mill. subscribers.

TDC requests DBA to

- Document the allocations percentages.
- Make the allocation dynamic in order to reflect the chosen scenario (like for the Corporate Overhead mark-up calculation).
- Scale the IT-cost in order to reflect the larger (copper or PTP) or smaller (e.g. DONG) network modelled.

TDC furthermore anticipates the inclusion of CATV-cost submitted by TDC.

DBA notes, that the model includes four types of non-network costs:

- The overhead costs

- The IC specific and commercial costs;

- The network management systems (the NMS);

- The compensation received due to third party damage (this is in fact an income).

The overhead costs include all the cost (staff and material) related to the non-network teams. Typical costs that are included are the pay costs of the CEO, the CFO, the COO, the CTO, the finance team, the regulatory team, the legal team, the HR team etc. It would also include the headquarters of the company.

The IC specific and commercial costs include all the costs related to selling wholesale products. This includes the cost of the wholesale billing platforms but also the pay cost of the wholesale team.

The compensation received due to third party damage is an income perceived by TDC. Typical damage is a cable cut.

The network management systems include all the cost related to IT platforms or IT systems needed to design, plan, operate and maintain the network. There are around 100 IT platforms, each having a specific functionality such as:

- System administrating a fault;

- System allowing wholesale customers to report a fault;

- System used for the access network inventory;

- System to manage the workforce

- Reporting system

It should be noted that all the 290 mDKK quoted by Telia and Telenor are not relevant to the LRAIC cost models. Only those needed to plan, design, build, operate and maintain a network are accounted for. In the draft model sent for the 2nd round of consultation, depending on the scenario selected, only a share is allocated to the access and the core cost models:

- Copper scenario: 57% was not taken into account, 30% was allocated to the copper local loop and 13% was allocated to core network services;

- Fibre scenario: 57% was not taken into account, 30% was allocated to the fibre local loop and 13% was allocated to core network services;

- CATV scenario: 87% was not taken into account and 13% is allocated to the core network services.

However, following additional submissions and comments from TDC and from other operators regarding the level of costs that should be taken into account and regarding the allocation keys, changes have been made:

- TDC has submitted relevant additional IT platforms costs related to NMS that they forgot to send during the data collection phase. This increases the NMS costs from 290 mDKK to 360 mDKK.

- The NMS costs were including only OPEX and depreciated CAPEX although the working cost of capital should also be taken into account. Including the working cost of capital increases the NMS costs from 360 mDKK to 380 mDKK.

- The NMS costs include some pay costs. DBA would like to point out that the hourly wages used by TDC in its regulatory accounts are much higher than the bottom-up hourly wages. This is due to the fact that the wages used by TDC do not include only the direct salaries but also IT, overhead and department costs. DBA is therefore of the view that using the hourly regulatory wages would lead to a double counting of the overhead costs and that the pay costs included in the NMS costs should be adjusted to reflect the bottom-up hourly wages. Based on the hourly wage difference between TDC's regulatory and the bottom-up cost models, DBA has scaled down the pay cost part of the Opex of the NMS costs by 44%. DBA has no information regarding the share of the pay cost in the Opex of the NMS costs. DBA has therefore assumed that this share is the same as for the IC specific costs, i.e. that pay costs represent 80% of the Opex related to the NMS costs. Adjusting the wages in the NMS decreases the NMS costs from 380 mDKK to 345 mDKK.

The NMS costs relevant to the CATV is pending data from TDC.

- The allocation keys that were used in the draft model sent for the 2nd round of consultation were based on the allocation keys of the previous LRAIC cost model. However, these allocation keys are not in line with TDC's NMS costs. DBA has therefore decided to update these allocation keys. The new allocation keys are based on the analysis of TDC's regulatory accounts thanks to the following methodology:

- The cost of the NMS is split asset by asset. This split has been carried out using TDC's regulatory accounts allocation keys.

- DBA has assessed for each asset of TDC's regulatory account whether it is relevant to the LRAIC cost models or not. E.g. the assets "IT for mobile platform", "Other data CPE" or "ADSL_Installation_Modem" are not relevant to the LRAIC cost models. If it is relevant to the LRAIC cost models, then DBA has assessed whether it is part of the core network or part of the access network. If it is part of the core network, DBA has then assessed whether it is part of the IP core network or not.

- Having carried these assessments, DBA has included in the model solely the NMS costs allocated to the assets that are relevant to the LRAIC cost models and part of the access network or part of the IP core network (as the core network being modelled is a full IP core network).

Based on this analysis 194 out of the 345 mDKK is relevant for the LRAIC cost model.

DBA would like to point out that the 194 mDKK NMS costs are relevant to the copper access platform. As TDC does not have a national fibre network, DBA believes that it is a good approximation to use the same amount of NMS costs for the fibre platform.

The spreadsheet “Non-network costs” ((see cells H10 to J14) and the section 9.6 of the documentation have been updated by including these additional costs.

This approach leads to use the following allocation keys:

- For the copper scenario: 43% of the total NMS costs are not taken into account, 57% are allocated to all LRAIC relevant services (access, core and colocation services).

- For the fibre scenario: 43% of the total NMS costs are not taken into account, 57% are allocated to all LRAIC relevant services (access, core and colocation services).

The NMS costs allocation relevant to the CATV is pending data from TDC.

The spreadsheet “Non-network costs” ((see cells M10 to U14) and the section 9.6 of the documentation have been updated by including these new allocation keys.

The model has been updated by including all the NMS costs and by setting the allocation keys based on TDC’s regulatory accounts.

Finally, DBA would therefore like to point out that the allocation keys have been made dynamic so that they reflect the selected scenario.

The model has been updated (spreadsheet “Non-network costs”) by setting dynamic allocation keys reflecting the selected scenario.

IC specific costs

Telia and Telenor highlights that DBA on page 16 of the consultation note states that:

> *It is DBA’s preliminary view that the cost of such a platform is unlikely to be significantly more costly than the platform dedicated to external customers (as TDC can be seen as one more customer). Such a platform is indeed a fixed cost.*

Telia and Telenor would like to underline that the cost of TDC’s existing external wholesale IT and support platform does not reflect the costs of an efficient operator.

TDC’s Columbine system (and related systems) is a patchwork of solutions built over time on top of TDC’s internal Columbus system which is technically outdated (but difficult and expensive to replace). Therefore the historic costs of building the current Columbine system far surpasses what an efficient operator would spend on a modern IT and support platform built from scratch and with the functional ability to serve both internal and external customers. Telia and Telenor would like DBA to keep this in mind when going through any documentation from TDC on the historic costs for their wholesale platform.

DBA would first like to point out that IC specific costs include the cost of the wholesale billing platforms but also the cost of the wholesale team.

TDC has submitted 183 mDKK of yearly cost (OPEX, depreciated CAPEX and cost of capital) related to interconnection. Out of these 182 mDKK, only 20% are due to the wholesale billing platforms. The rest is due to the wholesale team.

Although DBA has stated that its preliminary view was that the wholesale platform was unlikely to be more expensive than the billing platform, DBA has identified a number of cost drivers making the wholesale platform (i.e. the IT system + the wholesale team) more expensive:

- Change in the number of wholesale customers: limited IT systems costs but impacts the wholesale team;

- Implementation of a new wholesale product: costly for the IT systems and for the wholesale team.

- Change in the products bought by a wholesale customer: not costly in terms of IT systems but impacts the wholesale team;

- General traffic increase: leads to continuous upgrades of the network and therefore upgrades of the IT costs;

- Number of points of interconnection: having multiple POIs does not increase the IT costs, however leads to higher wholesale team costs.

It should also be noted that the costs of the actual billing system is shared whenever possible between the retail and the wholesale customers in order to generate economies of scale.

As for the NMS costs, the allocation of the IC specific costs has been carried out based on TDC’s regulatory accounts. The assessment of the relevance of the assets in TDC’s regulatory accounts is the exact same assessment than the one carried out to determine the level of NMS costs that should be taken into account in the LRAIC cost models. It leads to use the following allocation keys:

- For the copper scenario: 15% of the total IC costs are not taken into account, 18% are allocated to copper access services, 31.5% to voice services, 21.5% to broadband services and 14% to leased lines services.

- For the fibre scenario: 15% of the total IC costs are not taken into account, 18% are allocated to fibre access services, 31.5% to voice services, 21.5% to broadband services and 14% to leased lines services.

- For the CATV scenario: 15% of the total IC costs are not taken into account, 6% are allocated to copper access services, 6% to fibre access services and 6% to CATV access services, 31.5% to voice services, 21.5% to broadband services and 14% to leased lines services.

Also, TDC has submitted new data showing that the yearly cost of a new billing platform is more expensive than the yearly cost incurred due to the current system.

Furthermore, DBA would like to point out that the cost of the billing platform is allocated across both internal and external customers.

Finally, DBA would like to point out that the hourly wages used by TDC in its regulatory accounts are much higher than the bottom-up hourly wages. This is due to the fact that the wages used by TDC do not include only the direct salaries but also IT, overhead and department costs. DBA is therefore of the view that using the hourly regulatory wages would lead to a double counting of the overhead costs and that the pay costs included in the IC specific costs should be adjusted to reflect the bottom-up hourly wages.

Based on the hourly wage difference between TDC's regulatory and the bottom-up cost models, DBA has scaled down the pay cost part, i.e. 80%, of the Opex of the IC specific costs by 44%.

This adjustment has led to decrease the IC specific costs from 183 mDKK to 137 mDKK.

The spreadsheet "Non-network costs" on line 34 has been updated to reflect these changes.

Specific comments on Core model

MSAN costs
TDC has noted that several changes have been conducted regarding the MSAN costing. TDC disagree on several points, and finds that argumentation in the hearing note for carrying these changes in general are weak and other parties viewpoints has been followed on undocumented grounds.

Below TDC has detailed the points which should be revisited:

MDF cables:

DBA has changed the cost of MDF cable (asset 31 and asset 23) to 800 DKK. TDC finds the price too low as this price must refer to a cable of a short length. Different cable lengths are used on different sites and TDC suggests a price of XX DKK for the MSAN (weighted average on lengths from 20 meters to 75 meters on actual demand in 2013) and XX DKK for the MSAN REMOTE (10 meters). TDC has attached documentation on the weighted average as well as the cost of different cables lengths (Appendix 2, *MDF cable.xls*).

<u>Man hours for installing DSLAM's:</u>
DBA has updated the model by using 20 man hours of technician for installation of the 'MSAN – xDSL – REMOTE' and the 'MSAN – xDSL'. But the 'MSAN – xDSL' has the capacity for 16 cards whereas the 'MSAN – xDSL – REMOTE' has the capacity for 4 cards and cabling is the main part of the installation time. TDC agrees that the installation time has been lowered the resent years due to implementation of DSLAMs without splitters, but 20 hours are highly underestimated. TDC has done new extracts from its Worksforce management system based on production with a high fraction of none-splitter-based DSLAMs (see Appendix 3 - *Installation time fully cabled 7302 DSLAMs 2013*) Hence the 'MSAN – xDSL' technician time for a fully cabled DSLAM should be updated to 50 man hours.

<u>Number of cards per Subrack:</u>
The number of cards per subrack has been increased to 17 instead of 16 (18 slots for cards except 1 that is reserved for providing POI0 access to alternative operators). But both slot 17 and slot 18 has to be reserved for providing POI0 access as the MSANs software functionality allows only either POI0 or LT cards (extension slots) in slot 17/18.
Hence the number of cards per subrack should be changed back to 16.

DBA has reviewed TDC submission on the cost of MDF cables. DBA has used alternative operators' unit costs as they are lower for the exact same asset (same length, same number of pairs). However, in order to compute the average unit cost, DBA has used TDC's demand per type of cable.

The unit costs of the MDF cables have therefore been update to 1200 DKK for the MSAN and 500 DKK for the remote MSAN.

This update has been carried out in the spreadsheet "Network assets and costs" for respectively asset 31 and asset 23.

As regards the installation time of the MSAN, DBA agrees with TDC that the cabling is the main part of the installation.

According to the inputs provided in the file "TDC - Data regarding copper" submitted in June, TDC needs the same time as other operators to connect 10 pairs (including time to carry out all the other operations needed to install the MSANs).

It is therefore expected that the cabling part of a fully loaded MSAN with:

- 16 cards would 23 hours.

- 4 cards would require 6 hours.

The installation time of the MSAN has therefore been updated to 6 hours for asset 22, to 12 hours for asset 157, to 0 hour for asset29 and to 23 hours for asset 30.

This update has been carried out in the spreadsheet "Network assets and costs".

Having reviewed the vendor documentation, DBA agrees with TDC that 2 slots are not used for line cards as they are both reserved for POI0 access. This is also in line with international best practices.

DBA has therefore decreased the number of cards per subrack (asset 2) from 17 to 16.

This update has been carried out in the spreadsheet "Network assets and costs".

MSAN - Resilience issues
TDC appreciate that the MSAN resilience norm has been implemented. TDC has the comment that the model must also ensure that the number of 20p interface cards are sufficient to implement the norm. A number of sites are missing a 20p GE card to fulfill the norm.

On DBA's invitation:

> *DBA welcomes the industry views on the appropriate level of resiliency that should be taken into account*

TDC will like to mention that there are other ways to implement the norm than what has been modelled in the current model: At many sites (both edge sites and aggregation sites) this leads to use of multiple aggregation switches. Stacking of smaller boxes is not an efficient network design. Another possibility is to use boxes with more capacity and the appropriate level of redundancy, thereby reducing the number of smaller boxes and the complexity in handling and interconnecting these.

At edge sites, customers and MSANs can be connected directly at a MX960 edge router. Resilience for MSAN customers can be ensured by using multiple MPCs/interface cards in the MX960 routers. The same principle can be used at larger aggregation sites, where a single MX960 can substitute multiple aggregation switches. TDC is migrating towards the latter approach.

DBA agrees that some interface cards are missing in the actual model. The implementation of the SPOF norm not only requires a computation of the relevant number of aggregation routers but also to fully interconnect these additional routers.

DBA has therefore updated the model in order to include all relevant links and interface cards.

The update has been carried out in the spreadsheet “Traffic driven assets” by explicitly computing the number of links needed in order to link all aggregation sites (lines 201 and 202) and to interconnect aggregation rings and edge sites (lines 203 and 204).

As regards the alternative approach proposed by TDC to implement the norm, DBA shares TDC’s view that replacing multiple small boxes by single bigger boxes enabling the same level of redundancy is representative of a more efficient network design. Implementing multiple boxes would imply that a less manageable network is modelled and that interconnection is more complicated. It would also require more floor space in TDC’s premises along with higher power and AC requirements.

DBA also notes that this design rule currently reflects TDC’s actual roll-out.

All the relevant interface cards have been included. The network design has been updated in the model with bigger boxes replacing multiple small boxes.

The “Traffic driven assets” spreadsheet has therefore been updated in order to offer the possibility to choose to roll-out in the aggregation sites 2 different configurations:

- An aggregation switch which is based on the same assets previously rolled-out in the aggregation sites (therefore no change);

- An edge router which is based on the assets previously rolled-out in the edge sites.

The choice between the two configurations is made on line 207 in this spreadsheet. The aggregation switch configuration is rolled-out if at least one the following two rules is verified:

- The number of MSAN or leased line customers connected at one aggregation site is smaller or equal to 20;

- The number of 10G leased line customers connected at a single aggregation site is smaller or equal to 2.

Based on the chosen configuration, either an aggregation switch is rolled-out, which dimensioning is carried out between the line 209 and 218, or an edge router is rolled-out, which dimensioning is carried out between the line 220 and 232.

MSAN – spare part management

TDC is surprised that the spare part management cost has been removed from the model. Even though that TDC through warranties with equipment vendors gets repairs, this doesn't cover the full lifetime of the assets. TDC warranty is typically XX months and lifetime is 60 months, therefore spare parts are still needed in the model.

The number of cards that should serve as spare are argued to be 5-10. This is by far the number held by TDC. At least 20 cards pr type are held to replacement in case of breakdown. Taking the high number of ports in the model at least 100 cards should be needed to cope with failures, geography taken into account.

TDC requests DBA to re-implement the current percentage on spare part management.

DBA has updated the number of spare cards needed during the first consultation following a comment from an alternative operator stating that the card unit cost was already including a warranty.

Given that the typical length of the warranty is much lower than the asset life of the line cards, DBA agrees with TDC that spare cards are needed in order to cope with card failure and maintain a level of quality of service.

However, given the level of faults observed by Concepy on line cards, i.e. 1 fault per 1500 line cards per month and that 2 months are required to repair a line card, DBA's view is that number of spare cards should be 2/1500 = 0.13%

DBA has updated the model by including 0.13% spare cards.

The column N of the spreadsheet “Network assets and costs” has been updated.

This update leads to an inclusion of more than 80 spare line cards in the core network cost model. This is a bit less than the figure provided by TDC regarding the number of line cards that should be included.

MSAN dimensioning for POI0 access

Telia and Telenor state that on page 28 of the consultation note DBA mentions that 1 card of each MSAN sub-rack has been reserved for POI0 access from alternative operators

Given that the historical demand for POI0 access has been negligible if not zero, it appears to be a very radical procedure to reserve 1 card-slot up front on every single sub-rack to prepare for a future event which might or might not materialize.

Telia’s and Telenor’s conjecture is that TDC does not follow such an internal dimensioning process in practice but rather deploy a wait and see strategy where POI0 capacity is made available if and only if needed at a specific site following a formal AO request.

DBA is asked to reconsider whether the preliminary dimensioning strategy is indeed superior to the “wait and see” approach most likely observed in practice.

DBA agrees with Telia and Telenor that the “wait and see” approach is more cost efficient than to reserve 1 slot per sub-rack for POI0 access that may not materialize (2 slots are in fact needed for POI0 access as stated in comment “Number of cards per Subrack”).

However, an alternative operator asking for POI0 access to a sub-rack with 17 or 18 line cards installed (MSANs have a 18 line cards capacity with each 48 ports) would force TDC to disconnect up to 96 of its own customers (Max number of customers to be disconnected = 48 ports * 2 cards = 96). This would not be consistent with the level of service to be delivered to customers.

DBA, therefore, disagrees with Telia and Telenor and has adjusted the number of slots per subrack (asset 30) to 16 in the spreadsheet “Network assets and costs”.

As stated in the answer to the comment “Number of cards per Subrack”, this is consistent with international best practices.

The spreadsheet “Network assets and costs” on line 66 has been updated by setting the dimensioning driver of asset 30 to 16.

Subracks and MSAN dimensioning rules
Telia and Telenor note that the consultation note deals with TDC’s dimensioning argument on page 28. TDC claimed in their hearing response that only one sub rack (MSAN) can be fitted into a rack. As a result of TDC’s argument the model’s dimensioning rule was changed so that one rack can hold only one MSAN.

Telia and Telenor do not agree with TDC. Telia uses the same type of MSAN as TDC, and the racks allow for two MSANs per rack. The Alcatal-Lucent PowerPoint presentation in Appendix 3 shows on page 11, that the rack supports two 7302 MSANs if the card has integrated splitter. It is possible that TDC uses cards without integrated splitter, and then the rack only leaves room for one MSAN. However, in the LRAIC model, the question about splitters is irrelevant because the Model reference paper concludes that VoIP is MEA. I.e. PSTN is not modelled. The dimensioning rule in the LRAIC model should be changed back to two, as in the first draft model, so that each rack supports two MSAN.

DBA agrees with Telia and Telenor that, given the fact that no splitter is needed, the rack should able to hold two subracks.

The capacity of the rack (asset 29) has been updated from 1 to 2 in the spreadsheet “Network assets and costs”.

DSLAM/MSAN asset life
Telia and Telenor state that on 11 March 2014, Telenor submitted a spread sheet documenting asset life of currently installed DSLAM equipment in Telenor DKs network. The current average lifetime was calculated to be approx. 7.3 years. Telenor has no plans to replace or supplement the current DSLAM asset stock. Consequently, the average DSLAM asset life will increase further moving forward.

In the draft model the asset life for MSANs are set at 5 years. DBA is requested to increase the average lifetime for MSAN equipment to at least 8 years.

Given the supporting documentation provided by the industry, DBA agrees with Telia and Telenor that the asset life of the MSANs has been underestimated.

The asset life of the different MSAN components (asset 16 to asset 37) has been increased from 5 years to 8 years.

Remote DSLAM –modelling
It is not totally clear to TDC how the cabinets are included in the model. Hence TDC would like DBA to confirm that:

- Asset 52 (Site preparation) is the cabinet.
- Asset 47 (Power supply unit) is the power supply for the cabinet.
- Asset 51 (Security system) is the lightning safety equipment.

If the above is confirmed, then the price for the power supply unit is too low and installation time for the cabinet is missing.

DBA should note that only one MSAN (and that is only a small one!) can fit into the cabinet. Hence one cabinet must be included in the model for every remote MSAN. The same applies to the lightning safety equipment and power supply. Also a backdoor setup is needed for every remote MSAN. Further, if 4 cards are installed; a heat exchanger must be applied to every remote MSAN.

TDC requests DBA to alter the model accordingly.

DBA can confirm that the description proposed by TDC regarding asset 47, asset 51 and asset 52 is correct. To further clarify, asset 52 is the physical shelter that contains the MDF. The cost includes the shelter itself but also the site preparation (like the grounding).

The installation time needed for the MDF itself located inside the physical shelter is part of the unit cost of the assets 1 to 4. However, the model was missing the installation time for the physical shelter.

The model has been updated to include the installation time for the physical shelter.

This update has been carried out by including 23.4 hours of technician work for installation for the asset 52 in the spreadsheet "Network assets and costs".

The cost of power supply has been updated during the first consultation round according to TDC's submission. **The new inputs submitted by TDC are not documented, therefore DBA disagrees with TDC that the cost of power should be increased.**

DBA agrees with TDC that only one MSAN can fit in each cabinet. Therefore, DBA has updated the model in order to take into account this dimensioning rule. **Therefore, each remote MSAN is rolled-out in a cabinet with a complete setup (power, backup, backdoor system, safety system, physical shelter…).**

This update has been done line 121 of the spreadsheet “Lines driven assets”

DBA also agrees that the use of 4 cards triggers the installation of a heat exchanger in each cabinet.

The model has been updated by installing a cabinet for every remote MSAN and by installing a heat exchanger each time at least 4 cards are needed in each remote MSAN.

This update has been done line 123 of the spreadsheet “Lines driven assets”

Active equipment
Concepy still believes that 5 year lifetime for active equipment without incorporating a scrap value is highly misleading compared to practical industry experience. This should be easy to check and verify.

Regarding Concepy’s comments in the first hearing answer: Furthermore, unit CAPEX is a sum of different elements including hardware, installation, manpower, power and cooling cost with different lifetimes. Some of these elements will not recur when replacing with newer equipment.

Concepy believes that the major part of the 7.018 DKK technician cost for the installation of the MSAN is due to the installation of the copper trunks from the MDF and the local “telco cable” that is connected to the MSAN (via LSA connectors). This installation cost will obviously not have to recur when replacing the MSAN. The replacement of the MSAN is a very simple operation with a resulting low cost.

Furthermore, the MDF cables, LSA connectors and the passive rack in the MSAN section are not active equipment elements and will as such have an increased lifetime. 15-20 years would be much more accurate than the current 5 years in the model. Regarding the passive rack, it is our understanding that it can hold two MSAN’s, and not one as in the current model.

The cost for installing an XDSL card is high in a total network build scenario. We would expect that it takes no more than one hour to install all linecards in a MSAN once a technician has arrived on-site and the cabinet is mounted, which would be case in the total network build scenario.

The model only uses 4 slot ISAM shelves at remote sites. By modeling only the 4 slot ISAM chassis (7360?) and not the 8 slot ISAM chassis (7330?) the total number of ISAM needed for the remote sites is 489 units higher than in an effective setup. Concepy believes that a mixed set up of MSAN’s with different densities is by far the most cost efficient implementation, as can be seen in every real life installation across a variety of fixed line telecom operators. We would also like to point out that a density of 384 ports per chassis is a very frequent real-world scenario in TDC's plans for vectoring deployment, which can easily be checked and confirmed. Also, we are concerned that the density of the chassis used in the model is based on GPON suitable products and not the most efficient XDSL platforms.

DBA does not believe that the scrap value of active equipment is of any significant value. If scrap value is to be modelled, cost of removing the assets, storage and selling would also need to be included in the model. DBA believes that this would increase the complexity of the model without increasing precision.

In addition, DBA would like to point out that, based on supporting contribution from Telia and Telenor, DBA has updated the MSAN asset lifetime to 8 years instead of the current 5 years. This is furthermore consistent with comment made by Concepy during the first round of consultation.

The other assets, even if they are passive assets, have the same asset life as the MSAN as they are not reusable when the MSAN is changed due to several reasons:

- When the access equipment is changed, the modularity changes.
- When the access equipment is changed, the plugs and sockets may change if the vendor changes
- When access equipment is changed, it is often placed in racks located at another position in the CO.
- A large part of the cabling cost is man work which is anyway incurred due to the renewal of plugs, sockets, labelling etc.

It should be noted that power and cooling assets have a longer asset life than the MSAN. Therefore, these assets will not be changed when the MSAN is renewed.

In the current version of the model, a cabinet includes up to 4 line cards, leading to an installation time of 15 minutes per card based on Concepy's submission. This value seems low given the inputs of all other operators and is supported by no documentation. DBA will therefore not update the line card installation based on this submission.

DBA agrees with Concepy that it is more efficient to use two different types of MSAN, one supporting up to 4 cards and one supporting up to 8 cards.

DBA has updated the cost model by including a new MSAN supporting up to 8 cards instead of using solely a MSAN supporting up to 4 cards.

Asset 157 in the spreadsheet “Network assets and costs” is a new asset introduced to reflect that the model is now using either 4 card remote MSANs (asset 22) or 8 card remote MSANs (asset 157). The selection between these 2 assets is done on line 85 and 86 in the spreadsheet “Lines driven assets”. The selection is based on the number of cards needed:

- If the number of cards is bigger than 4 then, the 8 card remote MSAN is installed.

- If the number of cards is smaller or equal to 4, then the 4 card remote MSAN is installed.

MDF/Street cabinet I

Telia and Telenor state that they raised a question in the first model consultation regarding MDF and street cabinet. DBA addresses this issue in the consultation note page 17, but it seems like Telia and Telenor’s concern was misunderstood. What Telia and Telenor were trying to explain in the hearing response was that when the price for the street cabinet is between 14.000 to 56.000 DKK it could indicate that the asset covered more than just a MDF and a cabinet. DBA’s answer sort of confirms that asset 1-4 is nothing more than the MDF and a cabinet, but without addressing the price level.

Clearly, a MDF/street cabinet should in this case conform better with the prices set for distribution points in the access model.

The assets 1 to 4 are street cabinets containing a MDF with cable side and line side.

DBA agrees with Telia and Telenor that these assets are equivalent to the PDP assets (assets 37 to 44) of the access model. The cost levels should therefore be similar.

DBA has updated the costs of the assets 1 to 4 in the spreadsheet “Network assets and costs” by using the costs of the PDP in the access model.

MDF/Street cabinet II

Telia and Telenor would like DBA to confirm that the street cabinets (asset 1-4) are the relative small cabinets intended for remote MSAN. It is Telia’s and Telenor’s understanding that a street cabinet with a capacity for 200 ports (asset 1) measures something like 60x60x25cm (WxHxD), and that it can be placed in the street in front of buildings, or in the boundary between the pavement and the parcel. The model assumes that asset 1 (the smallest street cabinet) requires 80 Rack units (RU), which corresponds to 3 square meters with the used model assumptions about number of RU per rack, and the assumption about the required space for one rack.

Telia and Telenor believe that the used space requirements for asset 1-4 are too high. The space requirement assumption for street cabinets should either be corrected or deleted. Telia and Telenor suggest that the space requirement for street cabinet is deleted in the model. The space requirement for street cabinet is only used to calculate the yearly OPEX related to space, i.e. rental fees. But the street cabinet is not placed within a central office building or in a technical house, so it makes no sense to multiply the needed space for street cabinet with the yearly rental cost of a building, as it is done in the draft model (Core, Network Costing, AQ26).

Assets 1 to 4 are cabinets containing a small MDF with cable side and line side.

DBA agrees with Telia and Telenor that no rental fees is paid for the street cabinets. As the space is used solely for the computation of the rental cost, the space is not needed in the model and should be removed.

DBA has updated the model by removing the space (column Y) of assets 1 to 4 in the spreadsheet "Network assets and costs".

MDF space requirement

Telia and Telenor state that the incumbent can chose either to place the MDF in a separate rack, or in a rack together with the DSLAM. When AO's install DSLAMs at TDC's co-locations, an extra set of MDF is needed, because AO's do not have access to the central office's MDF where the copper pairs from customers are terminated – only TDC technicians are allowed to patch the copper pairs where they terminate in the building. The raw copper pairs used by AO's will therefore pass two MDF – TDC's MDF, and AO's MDF. AO's MDF is sometimes referred to as LSA blocks, and they are usually placed in the rack above the DSLAM. It is not necessary for TDC to use this second set of MDF, as TDC is able to patch the cables directly in the central office MDF.

Appendix 4 shows a picture of the MDF. One MDF holds 150 pairs, and has a height of 13.25 cm corresponding to 3 RU. That means a 300 pair MDF fits in 6 RU. In contrast, a 250 pair MDF takes up 80 RU in the model. Clearly, MDF's take up too much space in the model.

It is important to stress that the pairs used by TDC only have to pass one MDF as mentioned above. The Core model is based on an assumption that MDF's and DSLAM's are placed in separate racks. The model calculates the needed rack space for MDF (asset 1-9), and then for DSLAMs (asset 22 and 30). When MDFs and DSLAMs are placed in separate racks it leaves rooms for two DSLAMs per rack as written in paragraph “Subracks and MSAN dimensioning rules”.

DBA would first like to state that the size of the assets 1 to 15 is given by the number of customers and not by the number of pairs or fibres. E.g.: asset 5 which is “MDF – 250 ports” can connect up to 250 copper lines and not 250 copper pairs. In order to clarify this, the name of assets 1 to 15 will be renamed. E.g.: asset 5 will be named “MDF – 250 subscribers”.

Each copper subscriber needs 3 copper pairs (2 on the passive part and 1 towards the active equipment). A rack can hold up to 2000 pairs and is made of 45 RU with a utilization rate of 70% for the MDF and ODF given that the lower part is never used and the upper part is used to store over length.

Therefore, the number of RU needed for 250 customers is:

250 * 3 / (2000*70%)*45 = 25 RU

Same reasoning applies to all MDFs and to ODFs, knowing that:

- 3 fibres are needed per customers;
- There is room for 16 patch shelves per rack, each patch shelf having 96 fibre connectors.

The model has been updated by changing the space needed for all MDFs and ODFs (asset 5 to asset 15 in the spreadsheet “Network assets and costs”, column Y).

SDSL cards

TDC has submitted data on SDSL card in the Appendix 4, *SDSL.pdf*. The information supports DBA’s conclusion of setting the card capacity to 24. See Section 4 in the above mentioned file.

On p. 28 of the consultation note DBA invites the industry to comment about capacity of SDSL cards.

Telia and Telenor can confirm that one SDSL card has 24 ports.

DBA will maintain the SDSL card capacity to 24.

Therefore, DBA does not believe that any changes are needed.

DSL line card usage

Telia and Telenor state that when calculating the blended cost for DSL line cards, the model is utilizing information on the number of sites where VDSL is offered.

In this context DBA should be aware that many sites both offer ADSL and VDSL, i.e. it is not correct to assume full deployment of VDSL from a given site just because the site is VDSL enabled. That needs to be taken into account to prevent cost inflation in the model.

DBA agrees with Telia and Telenor that the model should compute a weighted average based on the actual number of ADSL and VDSL cards instead of the number of sites offering ADSL and VDSL.

The model has been updated by basing the blended cost of the xDSL card on the number of ADSL and VDSL cards instead of the number of sites offering ADSL and VDSL.

The asset cost of asset 25 and asset 33 in the spreadsheet "Network assets and costs" has been updated by computing a weighted average cost based on the number of VDSL card and the number of ADSL cards.

Line card utilization

Concepy would like to refer to our first hearing answer regarding this subject:

The utilisation rate for MSAN/DSLAM line cards seems to be too restrictive. Taking into consideration that xDSL is a mature technology with zero to negative growth, the sum of line cards added and regained across the total installed base of DSLAM cabinets will be close to zero. This means that the last line card in any MSAN/DSLAM will have an average utilisation rate of 50%, irrespective of whether any specific card experiences net addition or loss of active ports. In the current model assumes a maximum of 50% utilisation on the last card resulting in (48+24)/2 free ports or 25% average utilisation on the last card.

The model for deploying line cards therefore results in very low utilisation rates, especially on remote sites with fewer total active lines. We find this level too low in an environment where TDC will be the only provider allowed to produce VDSL on subloops and the expected variation in the number of active ports is very small.

Concepy recommends that a correct model will not have a minimum of free ports.

DBA agrees with Concepy that the rules applied in the model of having 50% utilisation rate on the last line card rolled-out is too restrictive given the threshold effects:

E.g.: In a street cabinet with 25 customers, the number of line cards needed would be 2 given the 50% utilisation rate on the last line card rolled-out leading to a spare capacity of 71 ports, i.e. 74% spare capacity.

However, as stated in the previous consultation note, a negative market growth at the national level does not prevent a positive local growth. This is why a reasonable level of spare capacity should be taken into account. DBA is of the view that a 50% spare capacity on the last line card of the MSAN when the MSAN is at full capacity would be reasonable. There would be free ports only if all cards are installed in the MSAN. In any MSAN, the maximum number of free ports would therefore be 24.

The model has been updated by setting a 50% utilization rate on the last line card of the MSAN when the MSAN is at full capacity instead of setting a 50% utilization rate on the last line card installed.

The computation of the number of xDSL cards needed located in lines 89 and 96 in the spreadsheet “Lines driven assets” has therefore been updated.

VDSL / ADSL line card cost
TDC highlights that DBA has stated that the xDSL card cost in the model will be updated to reflect the weighted average cost between ADSL and VDSL. But no change has been made. TDC suggests that the price should be XX DDK (based on the number of customers on each technology). The price should be updated each year as the mix between ADSL and VDSL change.

TDC requests DBA to change the prices.

DBA has updated the core network cost model following the first round of consultation so that the xDSL card cost is the result of the weighted average cost between an ADSL card and a VDSL card. The unit costs of these cards are located in the sheet “Dashboard”.

The weights for computing the average cost were the number of sites offering ADSL and VDSL. Following the comments “VDSL line card usage” made by Telia and Telenor, the weights have been updated by using the number of ADSL and VDSL cards.

The number of ADSL and VDSL cards is part of the TDC’s data submitted during the yearly update. As this data is still missing, the number of sites offering VDSL has been set to 0. However, it will be updated as soon as the data is available.

Therefore, DBA does not believe that any changes are needed.

Vectoring
TDC states that vectoring has not been implemented correctly in the model. Asset 26 is a line card (a VDSL card which can facilitate vectoring) whereas asset 27 and asset 28 is processor cards needed to compute the vectoring. Hence both a processor card (either asset 27 or asset 28) and a number of line cards (asset 26) should be placed in the MSAN. Note also that the naming of asset 28 is wrong and should be changed from *Vectoring card (large)* to *Vectoring processor card (large)*. If more than 4 vectoring line cards (asset 26) is needed, a *Vectoring processor card (large)* has to be used, and if 4 or less vectoring line cards is needed, than a *Vectoring processor card (Small)* has to be used.

Hence the formula in cell H264 on sheet *Network costing* is wrong and should be changed from

> *=HVIS(H259*'Network assets and costs'!$L$57<='Network assets and costs'!$L$58;'Network assets and costs'!J58;HVIS(H259*'Network assets and costs'!$L$57<='Network assets and costs'!$L$59;'Network assets and costs'!$J$59;'Network assets and costs'!$J$60))*
>
> To
>
> *=HVIS(H259*'Network assets and costs'!$L$57<='Network assets and costs'!$L$59;'Network assets and costs'!$J$59;'Network assets and costs'!$J$60).*

Note that a maximum of 8 vectoring line cards can be placed in a MSAN.

Installation time for vectoring line cards and installation time and planning time for vectoring processor cards is missing. Updates to implement in the model are:
Installation time 1,24 hours for

- Asset 26 (Vectoring card)
- Asset 35 (Vectoring card)
- Installation time 2 hours and planning time 1 hour for
- Asset 27 (Vectoring processor card (small))
- Asset 28 (Vectoring processor card (large))
- Asset 36 (Vectoring processor card (small))
- Asset 37 (Vectoring processor card (large))

Note that all VDSL cards in the MSAN has to be vectoring cards as regular VDSL card (e.g. the xDSL card in the model) and vectoring cards cannot coexist in the MSAN.

TDC requests DBA to alter the modelling of vectoring.

Telia and Telenor states that it seems that the number of vectoring cards should be inputted manually in cells S71:S73 and cells S81:S83 in sheet “Network costing”. At the same time, elsewhere in sheet “Network costing”, the incremental costs of vectoring are calculated. Here it is calculated that currently four vectoring line cards are needed per vectorised site. In sheet “Data selected” it is inputted how many sites are offering vectoring. There seems to be a lack of coordination in the model regarding the number of vectoring line cards needed.

Telia and Telenor encourage DBA to streamline this, so that the number of vectoring cards are not inputted manually but instead based on the number of vectorised sites and the models calculation of number of vectoring cards per vectorised site.

In addition to this, Telia and Telenor find the prices of the three pieces of vectoring equipment in the model too high. In confidential Appendix 5, Telia has provided prices for vectoring line cards and the two kinds of vectoring processor cards. Telia and Telenor request DBA to correct these prices in the model.

Finally, the year “2020” entered in cell I972 in sheet “Data selected” seems confusing.

DBA agrees with TDC that the naming of asset 28 and asset 37 was not appropriate. DBA has therefore updated the naming according to TDC’s proposal.

DBA also agrees with TDC that given the capacity of the small vectoring processor card (192 ports), a maximum number of 4 vectoring cards can be installed. If 5 or more vectoring cards are needed, then the large vectoring processor card should be installed.

Given the use of the vectoring card described by TDC, DBA agrees with TDC’s correction proposal regarding the formula located in cell H264 in the spreadsheet “Network costing”. DBA has therefore updated the model accordingly.

DBA also agrees that a maximum of 8 vectoring line cards can be installed in each MSAN.

DBA agrees with TDC that the model should include installation time for vectoring line cards and installation and planning time for vectoring processor cards.

The model has been updated by implementing the correction proposed by TDC and by including installation and planning time for the relevant assets.

In the spreadsheet “Network costing” on line 246, the model computes the average incremental cost of vectorizing a site. This is computed as follow:

- In order to vectorize a site, the model has to remove the xDSL cards and to replace them by vectoring cards and by a vectoring processor card;

- In average, 3 xDSL cards are needed. Their capacity is 48 ports;

- To replace the 3xDSL cards, 3 vectoring cards would be needed as they have the same port capacity, i.e. 48 ports.

- Given that 3 vectoring cards would be needed, only a small vectoring processor card is needed;

- The average incremental cost of vectorizing a site is therefore the cost of the 3 vectoring cards plus the cost of the small vectoring processor card minus the cost of the 3 xDSL cards.

The total cost of the network therefore needs to be increased by the average incremental cost of vectorizing a site multiplied by the number of vectorized sites. The number of vectorized sites is an input part of the yearly update. This is why it appears in the sheet “Data selected” but also in the sheet “Historical inputs”.

Given the data submitted by Telia and Telenor, DBA agrees on the cost of the different vectoring cards (assets 26, 27, 28, 35, 36 and 37).

The cell I972 in the spreadsheet “Data selected” has been corrected so that it reflects the modelling year.

The model documentation has been updated to describe further this approach. The unit costs of the assets 26, 27, 28, 35, 36 and 37 have been updated in the spreadsheet “Network assets and costs”.

Installation time on GPON assets
TDC states that the installation time on GPON assets are missing. Updates in the model should be:

- Asset 16 (Rack) 14.9 hours.
- Asset 17 (Card) 0.97 hours.

TDC requests DBA to include installation time on these assets.

Furthermore it should be noted that if vectoring is introduced on a remote DSLAM a Heat exchanger is installed as default no matter the number of active line cards, due the high degree of CPU load on the vectoring processor card.

TDC requests DBA to update the vectoring calculations.

DBA agrees with TDC that the model should include installation time for the GPON assets.

DBA has updated the model in order to include:

- 14.9 technician-hour for the installation of asset 16

- 0.97 technician-hour for the installation of asset 17

The installation times of asset 16 and asset 17 have been included in the core network cost model in the spreadsheet "Network assets and costs".

DBA agrees with TDC that a heat exchanger should be installed in all cabinets offering vectoring services.

The model has been updated to include a heat exchanger in all vectorized cabinets.

The incremental cost of vectoring located in the spreadsheet "Network costing" starting line 249 has been updated by including the cost of having one heat exchanger in all vectorized cabinet.

NON blocking norm – Redundancy
TDC states that DBA argues that model capture both Non-blocking issues and resilience issue by introducing a modelled "redundant router" on core and distribution sites. But the way the model introduce these routers they would not have any effect in the network since there are not model-wise connected to the network.

It is necessary to include the routers in the Traffic driven assets calculation, as fully integrated with the needed link, Interfaces and SFP's and not only as an excel formula that add one standalone router without any connections. The redundant routers on TDCs site are all internally connected.

TDC requests DBA to fully integrate the redundancy routers in the assets modelling by ensuring connections to these routers both internally between routers and towards other network layers.

DBA agrees with TDC that the redundant routers should be fully integrated in the network. This can be achieved by adding the relevant links, interfaces and SFPs as suggested by TDC.

The model has been updated by ensuring the full connection of the redundant routers.

The computation of the number of links between edge and distribution sites and between distribution and core sites located in the spreadsheet “Traffic driven assets” has been updated to include all relevant links to fully connect the redundant routers.

Core router cost level

TDC is surprised to see that DBA has implemented a dramatic decrease in the cost level of Core routers. Having checked the current prices of available core routers from different industry vendors, it is clear that the price for core equipment introduced by Telia is far from any Core router costs known to TDC. TDC assumes that this might be a router with another functionality sceme than a core router. It could also be the case that it is a price of a base chassis without any concentrator cards, power supplies redundant routing engines etc.

If it is solely due to bargaining power, it is still wrong to incorporate the low cost level, since it then would be based on an operator with scale of operation that is far larger than TDC’s. The LRAIC model should reflect an efficient operator scalable on par with a Danish national incumbent that is regulated.

TDC requests DBA to reconsider the cost level of core routers.

After the first round of consultation, DBA has updated the core router costs to reflect the core network technology being modelled: The modelled network is using “clever” switches at the aggregation and at the edge levels that offer more functionalities than the switches that have been modelled in the previous LRAIC-model.

Following this approach, the core routers modelled are less “clever” than in the previous model as they only require transporting large volumes of traffic. As they have lower functionalities than in the previous model, the costs have been updated according to market prices for this type of routers.

This approach is part of the IP/MPLS network design being modelled.

Therefore, DBA does not believe that any changes are needed.

Choice of asset type – distribution sites:
TDC states that the choice of distribution router should be 8 x router 1 for Core sites, and 16 x router 2. Router 2's 10G card does not have 20 ports (it is the 1G card that holds 20 port). The correct number of 10 G ports is 4. Furthermore the asset price does not follow the price for distribution router sent to DBA.

TDC requests DBA to alter the model to reflect the correct number of 10 G ports, and also the correct cost level of the different assets.

As described in the previous comment, the IP/MPLS design, which uses a different type of core router than the one selected in the previous LRAIC-model, has been implemented. This router is less "clever" and is therefore cheaper.

This router also offers the possibility to use up to 10G line cards, each having up to 20 ports.

Therefore, DBA does not believe that any changes are needed.

SFP modelling
TDC acknowledge that DBA has introduced differentiated cost for 1 and 10 G SFP's, but find that the cost level of the two types still are considerable below the cost level experienced by TDC, (and as submitted to DBA).

Furthermore TDC finds that model lacks in SFP modelling since DBA assume that build-in ports also is fully equipped with SFP's; this is not the case - see bundle information in the submitted information regarding aggregation routers.

Finally DBA has stated that the SFP for PON/PTP is already included in the cost of the card. But TDC would like to emphasize the fact that a SFP for uplink between MSAN and aggregation equipment is still needed besides the SFPs for the card. Otherwise no traffic from the MSAN can reach the aggregation layer.

TDC requests DBA to correct the cost level of the different SFP's and to ensure that every fibre based port in any switch, router, or DSLAM uplink are configured with a SFP and that costs for such assets is captured.

DBA has used the prices of the SFP as submitted by TDC

DBA agrees with TDC that the built-in ports need to be fully equipped with SFP.

DBA also agrees with TDC that SFPs are needed for the uplink between the PON and PTP MSAN and the aggregation switch.

The model has been updated by equipping the built-in ports with SFP, by using SFP for the uplinks between the GPON and PTP MSAN and the aggregation switch.

The model has been updated by adding two assets in the spreadsheet "Network assets and costs":

- Asset 158: SFP for the MSAN PON
- Asset 159: SFP for the MSAN PTP

The spreadsheet "Lines driven assets" has been updated in order to include the modelling of these two assets.

SFP modules

Telia and Telenor state that the model uses several different SFP modules. Telia only use two different types of SFP, one for MSAN and another one for aggregation, distribution, core and edge. The SFP for aggregation, distribution, core and edge is used in two different capacities – 1G and 10G. Based on Telia's experience, it is sufficient just to use three different SFP assets in the model:

1. SFP MSAN (Corresponding to asset 24 and 32)
2. SFP 1G (Corresponding to asset 60 and 74)
3. SFP 10G (Corresponding to asset 59, 73, 86 and 98)

Telia is offered these three assets at lower prices than is used in the model. Due to confidentiality the Telia prices are documented in confidential Appendix 2 which will be sent separately by Telia. Telia and Telenor requests DBA to adjust the model so that it matches Telia's practice and prices.

The model includes the same three types of SFP as suggested by Telia and Telenor. However, these assets are duplicated in order to ease the modelling.

The prices suggested by Telia and Telenor do not seem to reflect original parts. Choosing original parts is the efficient choice in order to reach the relevant level of quality as:

- Some maintenance data are only available if original optic is used;
- Warranties and support agreements depends on the use of original hardware;
- In the Long run price strategy it is optimal to use original optics.

Therefore, DBA does not believe that any changes are needed.

Interconnection between network layers

TDC is not convinced that the model is complete and complies with the model documentation. To clarify this, please consider a figure of the aggregation and edge equipment at the edge site “ab” (please see Appendix 5, file *site ab.pptx*). The figure reflects the setup using the numbers from the excel model and the structures as TDC understand from the documentation.

This leads to the following questions and associated missing items:

- 10 aggregation switches are modelled in ab. TDC understand that they are connected in a ring structure as described in the model documentation.
- Traffic calculation in the model shows that 2x10G ports are needed for traffic from aggregation towards edge. TDC believes that the ring capacity is also 2x10G in order to cope with a single failure in the ring.
- The 10 aggregation switches in ab can be put in a local ring in ab or can be part of MM2-107-108 where ab belongs to. The local ring option is assumed in the figure. TDC requests DBA to clarify which option that is implemented in the model.
- It is not clear from the excel model at which edge router the second aggregation-to-edge connection terminates. This can be either at the second edge router in ab or at a distant edge router in the same region, i.e. site sr, aars, hb or hds. If MM2-107-108 is used, sr will be the second edge router. But, no ports are calculated for termination at second edge routers in the region, so in the figure TDC assumes that the aggregation ring is terminated at the second edge router in ab. TDC requests DBA to clarify where the second uplink is terminated.
- According to the excel model, the number of edge routers at a site is determined solely based on the need for interface cards/slots. Based on TDC comments under the heading “Choice of asset type – edge layer”, a MX960 is able to handle more interface cards than used in the excel model. However, the need for two edge terminations for a local aggregation ring as in ab calls for a second edge router (regardless of card/slots capacity). TDC requests DBA to implement the relevant second router at a number of edge sites.
- It can be noted that all 4 backbone 10G ports are used at all aggregation switches, so the 4p (four Build-in ports) model is required here (cf. to discussion under the heading “Choice of asset type – aggregation layer”). I.e. if just one aggregation node has the need for the 4p version, all other sites in that ring must be equipped with the 4p version. That is the network structure as a whole must be taken into account, and not just traffic demand from a single site.

- Beside the local aggregation ring, 4 other aggregation rings have a termination in ab. These aggregation rings are (edge site terminations mentioned in brackets) MM2-107-101(ab, aars), MM2-107-108(ab, sr), MM2-107-109(ab, sr) and MM2-107-110(ab, aars). Termination of these aggregation rings are not calculated in the model, but clearly stated in sec. 7.1.1 of the model documentation ("Each aggregation ring has two parent nodes that are collocated with two edge routers").
  According to TDC norm, max. 4 aggregation rings must be terminated at a single Q-MPC. In the figure, the ring terminations are distributed at both routers. It is assumed that 10G is enough for the ring capacity (based on line 89 in sheet "traffic driven assets". TDC requests DBA to implement modelling of sufficient Q-MPC/IF-cards on the edge sites, to handle termination of all agg.-rings.
- TDC asks for a conversion of the ring capacity to nx10G equivalents to make it clear, for the model user what capacity the model assume in the different rings. This goes for both agg-rings as well as edge rings. It would increase the transparency, and the opportunity for model validation.
- TDC has made the general observation that many ports for uplink from aggregation ring to edge router are missing. As an example, MM2-201-109 has no connection to an edge router at all in the model. This also explains why TDC has many, many more uplinks in the actual network than the 230 x GE and 109 x 10G uplinks in the model.
- According to the model documentation, all edge routers are located in an edge layer structure. It is not clear where capacity in edge layer structure is calculated (row 113 in sheet "traffic driven assets"?), but in the drawing 2x10G is assumed for capacity in MM3-107-1 edge layer structure. Again, TDC asks for a conversion of the edge layer capacity to nx10G equivalents to make this clear.
- 8x10G ports are needed from edge towards distribution layer. These are added in the drawing.
- To implement the norm with maximum 1536 customers affected by a single point of failure, both sufficient aggregation switches as well as 20p cards are needed. There are sites where a 20p cards are lacking (cf. example with site "abs" below.

TDC has made a comparison of the model calculation and what should have been in inventory of sites ab and abs, please refer to Appendix 6, file *ab, abs example.xlsx.*

TDC requests DBA to take into account the above issues when updating the model.

Note, that there are other ways of implementing the requirements including the resiliency requirements. Please refer to the discussion under the heading “Resilience issues – MSAN”.

DBA agrees with TDC that the modelling of the interconnection between the aggregation and the edge layers is not consistent with all the rules provided by TDC.

The aggregation switches are connected in a ring structure as described in the model documentation.

In most cases, the model includes only one uplink between the aggregation rings and the edge although two uplinks are required.

As stated in the comment “MSAN - Resilience issues”, DBA agrees that when too many boxes are installed in a ring, a larger box should be used.

DBA agrees that if in a given ring an aggregation switch needs 4 built-in ports then all other aggregation switches of the aggregation ring should use the 4 built-in port model. As stated in the next comment “Choice of assets – aggregation layer”, the model will include solely the aggregation switch model with 4 built-in ports as it makes to the model more simple and transparent.

Given criterion 39 of the MRP “The LRAIC model needs to demonstrate that the optimised network provides services at a level of quality and functionality, which as a minimum meets the level that the SMP operator offers today to interconnect operators and end-users.”, DBA agrees that a maximum of 4 aggregations rings can be terminated at a MPC.

DBA has updated the model in order to show the aggregation and the edge rings capacity requirements.

DBA agrees that the number of line cards should also be impacted by the SPOF norm.

The model has been updated in order to include all the changes required by TDC so that the model is compliant with the MRP and with TDC’s design rules.

The spreadsheet “Network dimensioning rules” has been updated by including the data regarding the aggregation switch bundles and the edge router bundles.

The spreadsheet “Traffic driven assets” has been updated in order to show the aggregation rings traffic and the edge rings traffic (from lines

153 to 186). The spreadsheet has also been updated to include the relevant engineering rules.

Choice of assets – aggregation layer:
TDC states that DBA claims that introduction of 4-build-in port- only version of the aggregation router would lead to over dimensioning.
TDC would like to state, that beside the difference in number of built-in backbone ports, the model with 4 built-in 10G backbone ports also has redundant routing engine. The vendor has no bundle with redundant routing engine and 2 built-in backbone 10G ports. TDC has chosen to implement redundant routing engine to eliminate this single point of failure and therefore has selected the version with 4 built-in backbone ports. Furthermore, this introduces simplifications with respect to both modelling, handling of license keys, spare parts and upgrade in backbone capacity.

TDC suggests using only the version with 4 built-in backbone ports.

DBA agrees with TDC that the choice of a single type of aggregation switch would simplify the modelling. Furthermore, the choice of the model with 4 built-in ports would eliminate the single point of failure.

The model has been updated by using only the asset with 4 built-in ports.

The asset 55 in the spreadsheet “Network assets and costs” has been removed from the modelling.

Drivers for active equipment volumes other than MSAN’s
As Telia and Telenor interpret the model, the total number of aggregation switches in the network is to a great extent driven by the design criterion of no more than 1.536 customers per unit of active equipment.

For one thing, Telia and Telenor would like to question the rationale behind this criterion. At the price levels indicated in the model, it hard, if at all possible, to believe that this equipment will be likely to hold a significant “single point of failure” risk.

If the “single point of failure” criterion for 1.536 customers is considered a key building block in the design guidelines, Telia and Telenor would definitely expect that an efficient network would use much more cost efficient equipment. In an xDSL scenario, 1.536 customers is equivalent to the capacity of two ISAM 7302 units. Two such units could easily be aggregated using equipment at significantly lower costs than stated in the model.

As a general concern, it is Telia and Telenor’s impression that leased line customers are a significant factor to drive the amount of equipment units and the number of ports in these. This could lead to the effect that leased lines drive significant cost factors, but only pay a disproportionate part of these, seeing as the cost is allocated according to bandwidth usage. In addition, the leased line products and the demand for redundancy and resiliency will drive the need for much more expensive equipment than would be necessary to support xDSL products.

The SPOF norm is part of TDC's design rules in order to reach a given level of quality of service. According to criterion 39 of the MRP "*The LRAIC model needs to demonstrate that the optimised network provides services at a level of quality and functionality, which as a minimum meets the level that the SMP operator offers today to interconnect operators and end-users.*". The cost models have to offer a similar level of quality. The implementation of the SPOF norm is therefore required.

Each leased line uses only one port. DBA would like thus to point out that the additional costs due to the leased lines are mostly the result of the additional traffic in the network and not the result of the additional ports needed.

As the cost allocation is based on capacity, the leased lines will bear entirely the additional cost they are creating.

Therefore, DBA does not believe that any changes are needed.

Choice of assets – edge layer:
TDC appreciates that DBA will update the model to use router 1 (asset 70, XX) as the standard choice for all edge sites. TDC has identified a number of issues regarding the modelling with router 1 (cf. also to MX960 equipment information provided earlier by TDC):

- Router 1 (XX) has no built-in ports like MX104 and also no built-in MPCs. So backbone ports used to connect to other edge routers within the edge structure have to be modeled beside the ports needed to connect to different network layers.
- A MPC can hold two interface cards. A MPC must be considered as a single point of failure. XX can hold 11 MPCs.
- TDC uses the principle that backbone connections towards other routers in the same layer use different cards and port concentrators. Therefore, minimum of two backbone MPCs and two 4p 10G interface cards are needed in every edge router in order to avoid single point of failures for backbone connections to the same layer.
- The most cost efficient is to start using the XX bundle (TDC assume that this bundle is used in the current model already). This bundle includes 2 x MPC port concentrators (for backbone interfaces) and 2x4p 10G interface cards. Note, that only 2 SR XFPs (SFP 10G) are included in the bundle.

- When more backbone interfaces than available in the start bundle is needed, a new MPC (Item MX-MPC2E-3D-R-B) must be added together with appropriate interface cards and SFPs.
- For customer facing interfaces (i.e. direct customers access or interfaces towards aggregation switches/rings), MPCs with queuing features are needed (MX-MPC2E-3D-Q-R-B) together with appropriate interface cards and SFPs.

With reference to the model documentation sec. 7.3.3.2;, this should be change to reflect, that MPCs must be modeled beside SFP, Card and Rack.

Furthermore it is said that

> "*The dimensioning of routers (edge, distribution and core) is very similar to the dimensioning of the aggregation switches. The only difference is that the number of ports required is based solely on traffic".*

TDC does not agree to the last sentence, since cards and SFPs must be reserved for termination of aggregation rings.

TDC requests DBA to alter the model and the associated model documentation to take into account the above mentioned issues.

DBA agrees with TDC that since the selected edge router has changed, its modelling should be updated. The model should include MPCs, no built-in ports and the appropriate number of SFPs.

The model and the documentation have been updated to reflect the new edge router modelling.

The spreadsheet "Network assets and costs" has been updated by including asset 155 and asset 156.

The spreadsheet "Network dimensioning rules" has been updated by including the data regarding the edge router rack bundle.

The spreadsheet "Traffic driven assets" has been updated by updating the modelling rules of the edge router.

Network dimensioning – LL
TDC has noticed that DBA agrees to the dimensioning rules proposed by TDC and will update the modelling of the capacity link between the aggregation switches and the edge routers.

TDC has noticed that the model per edge site ensures that if 10G customers are present at the edge site then the capacity between aggregation ring and edge router will be at least 10G. However, in order to fulfil the dimensioning rule, TDC sees two more points to be implemented:

1. In case of 10G customer at aggregation sites, the capacity between aggregation ring and edge router must also be at least 10G.
2. The two (uplink) connection from an aggregation ring to two edge routers must have symmetrical capacity in order to cope with a single point of failure at any of the uplinks. This is currently not the case which is shown by the following example:
   Aggregation site "vks" in MM2-201-108 has a 10G customer. The two edge sites for MM2-201-108 are site "få" and site "svg". At site "få" 5xGE uplinks are calculated in the model. This should be at least a 10G uplink according to the dimensioning rule. Furthermore, MM2-201-108 has no uplinks at site "svg" according to the model. Here, minimum a 10G uplink is also needed.

TDC requests DBA to fully implement the dimensioning rule.

DBA agrees with TDC that when a 10G customer is connected at an aggregation site, a 10G uplink is needed between the aggregation ring and the two edge parent nodes.

The model has been updated so that both uplinks from an aggregation ring to its two edge parent nodes are 10G uplinks when there is a 10G customer on the ring.

The spreadsheet "Traffic driven assets" has been updated by including the engineering rule (line 162).

Network dimensioning – # of agg ports
<u>TDC</u> argues that with the change of router for asset 70 (to XX) this issue raised by TDC must be reconsidered:

As discussed under the heading "Choice of asset type – edge layer", the new asset 70 have no built-in ports which can be used for termination of aggregation rings. This means that the model must take into account MPCs, interface cards and SFPs to terminate the aggregation rings. Refer to more detailed information provided under the headings "Interconnect between network layers" and "Choice of asset type – edge layer".

TDC requests DBA to include termination of aggregation rings in the model.

DBA agrees with TDC that with the new router selected for the edge sites, the modelling of edge sites needs to be reconsidered. The new edge routers have indeed no built-in ports and require MPCs and SFPs.

The modelling of the edge router has been updated.

The spreadsheet “Network assets and costs” has been updated by including asset 155 and asset 156.

The spreadsheet “Network dimensioning rules” has been updated by including the data regarding the edge router rack bundle.

The spreadsheet “Traffic driven assets” has been updated by updating the modelling rules of the edge router.

Submarine cables
TDC recognizes that the submarine links has been implemented in the model. However, TDC would like to question the quantity

DBA has modelled 286 km submarine links which seems very low. To two links to Bornholm alone exceeds this amount. TDC data indicates a level of 854 km, split between 210 km ground trench and 644 km submarine trench. Please check already submitted data from February 28, 2014.

The length of the submarine links included in the core network cost model reflects a calculation of straight line links without taking into account factors that would increase the length needed. These factors would typically be natural obstacles, redundancies and exact position of the landing stations. Therefore, DBA agrees with TDC that the length of the submarine cables should be increased from 286km to 644km.

The model has been updated by increasing the length of the submarine links.

DBA will send a question to TDC regarding if submarine links are shared with other operators.

Working capital
TDC recognises that the working capital correction is sustained in the model. TDC finds the calculations undocumented and are adding complexity to the model without major effect. TDC therefore requests DBA to remove the calculations.

As explained in the Model Reference Paper (Criterion BU 34) *“Like for working capital generated by CAPEX, which should be taken into account through depreciation formulas, the cost of working capital related to network OPEX should be included in the LRAIC model if significant”*. It is important to keep in mind that there are two types of working capital:

- working capital related to CAPEX (included in the depreciation formula)
- working capital related to OPEX (included at the bottom of the spreadsheet “Non network & IC costs”).

The working capital related to OPEX is due to a possible delay (positive or negative) between the time when revenues are perceived and the time when costs are incurred. The cash flow resulting from this delay generates interests (perceived or to be paid).

However, in light of the criterion BU 34 and of the fact that the cost of working capital related to OPEX is negligible (-0.02% of total OPEX), it is proposed to remove this calculation from the model.

The model has been updated by removing the cost of working capital related to OPEX.

The spreadsheet “Dashboard” has been updated by removing the parameters related to OPEX working capital.

The spreadsheet “Non network & IC costs” has been updated by removing the computation of the mark-up for OPEX.

The spreadsheets “Capacity based” and “Shapley-Shubik” have been updated by removing the mark-up for OPEX.

Traffic services
TDC has on March 7th submitted a document suggesting changes in the traffic services in order for the model to better reflect the routing of traffic. TDC sees no implementation of these suggestions or no commenting on the document.

TDC requests DBA to include the suggested changes to traffic services.

DBA agrees with TDC that the data provided by TDC on March 7th and April 23rd makes it possible to reconcile the traffic modelled in the core network cost model with the figures provided by TDC during the data collection phase.

Therefore, DBA agrees to update the contention of the “IP via LL service” to 0.05% as it is a legacy service almost not used anymore and to change the way the recalibration factor is working: there is a 9.3% gap between TDC’s figures and the traffic modelled reflecting for a part the international traffic that does not enter the network and that is not measured and for the other part some issues with the traffic measured. The traffic recalibration will therefore be applied to all services instead of only the leased lines services and will represent only half of the gap observed in order to take into account the international traffic.

The model has been updated to update the contention ratio of the “IP via LL” service and the amount and the scope of the traffic recalibration option.

The file “2012-55-DB-DBA-Fixed LRAIC-Leased Lines” has been updated by setting the “IP via LL” contention ratio to 0.05%.

The spreadsheet “Leased Lines” of the core network cost model has been updated with the new figures.

An additional parameter has been added to the spreadsheet “Dashboard” in order to take into account only 50% of the traffic difference.

The traffic recalibration calculations have been updated in the spreadsheet “BH Traffic”.

Traffic forecast
TDC notes that in core model ‘Network dimensioning rules’ table 2, the allowance for growth should be inputted.

TDC requests DBA to specify the growth period to consider and to update the growth percentages based on the last year’s development in traffic.

The model offers the possibility to take into account traffic growth in the model so that future demand is taken into account.

However, as no data has been submitted by the industry regarding the level of allowance that should be included, it has been set to 0%. This value is furthermore in line with the previous version of the model.

Based on previous meetings with TDC, DBA is of the view that TDC does not upgrade capacity unless the capacity level is reached.

Therefore DBA does not believe that any changes are needed.

Voice routing table
Telia and Telenor state that the routing table for voice services seems inconsistent in places and should be corrected to improve transparency.

For the following services the routing should be identical up till (but not including) the core layer (ignoring differences in specific calling patterns/traffic distributions):

- Voice - International - Incoming
- Voice - International – Outgoing
- Voice - Incoming fixed off-net - Local interconnection

- Voice - Incoming fixed off-net - National interconnection
- Voice - Outgoing off-net
- Voice - Incoming Mobile to fixed

An incoming local interconnection call will by definition be delivered at the correct core node/PSTN gateway by the interconnect partner and be routed directly to the end user through the different layers.

It is not clear why two separate international GW are needed instead of utilizing the same "PSTN" gateways as are used for national interconnect. Telia and Telenor view this as an historical leftover. Ignoring this inefficiency, with two gateways and four core node locations, an incoming international call has a 50% chance of being delivered at the correct core node and a 50% chance of having to use intra core transmission and doubling the use of core node equipment. These probabilities assume that international carriers/IC partners are present at both gateways. If this is not the case, the probabilities should be chanced towards a 25%/75% ("success/failure") ratio. Apart from these core layer differences the routing should be identical with that of an incoming local interconnect call. Clearly, it is most reasonable to assume that an outgoing international call is routed along the same path as an incoming international call.

For incoming national interconnection, traffic may be delivered by the IC partner at any of the four core nodes, i.e. ceteris paribus there is a 25% chance of hitting the right core node and 75% chance of having to use intra core transmission and doubling up on the use of core node equipment. Otherwise, the call should be routed the same way as a local interconnect call. As with international calls there is no reason to expect differences between the routing of an outgoing off net call and incoming (off net) calls.

For incoming mobile to fixed it is assumed that these calls are delivered at a separate PLMN gateway instead of at the same (PSTN) gateway as is being used for local interconnect calls. If a call originates in Telenor's or Telia's mobile network to be terminated in TDC's fixed network this means that the call is using the PSTN gateway whereas if the call originates in TDC's mobile network it is routed via a separate PLMN gateway which does therefore not contribute to cost recovery. Telia and Telenor does not believe such a separation reflects an efficient network build or operation. Ignoring this inefficiency – with a PLMN server placed at each of the four core node locations the call should be routed exactly the same way as a local interconnect call.

The routing matrix is mainly based on the routing matrix from the former model. However, the network topology has been updated. DBA would like to remind that the IMS platforms are now located at the core level instead of the distribution level. The IN servers and the different gateways are also located at the core level.

It is therefore DBA's view that the routing matrix is consistent with the new network topology. This has impact on the use of the core routers, the intra-core links and the IMS platforms.

It is furthermore important to maintain the consistency of the routing factors between all services. This impacts the use of the edge routers, the distribution routers, the edge to distribution links and the distribution to core links.

The routing factors of the following voice services have therefore been updated:

- IN
- International incoming
- International outgoing
- Incoming fixed off-net – local interconnection
- Incoming fixed off-net – national interconnection
- Transit - National interconnection
- Outgoing off-net
- Incoming Mobile to fixed

The "Voice – International – Incoming" and "Voice – International – Outgoing" services have the same routing factors.

The routing factors of the voice services have been updated in the spreadsheet "Routing table".

Mobile network traffic
Telia and Telenor highlight that DBA has stated in the consultation note that mobile traffic is included in the leased line traffic in the model.

Telia and Telenor believe that this should also be reflected in the routing table for leased line traffic. In particular, mobile voice and data traffic will also utilize the same IMS platform as fixed traffic and the entries for node equipment and transmission paths in the routing table seem very favourable towards the leased line traffic. The entries do not seem to integrate backhauling from mobile sites to the core on a comparable level with backhauling from CO's despite the fact that backhauling from mobile sites will also pass through the CO's on its path to the core.

The IMS platform is used for VoIP services provided mainly over the fixed network. PSTN, mobile and international voice services interconnect to the IMS via MGW's or SIP interconnection but do not use it.

There is, however, a business voice service which is using the IMS. The number of customers using this service is very limited and the service would bear less than 0.5% of the IMS cost. Given the complexity of adding this service and the very limited impact, DBA disagrees with Telia and Telenor that this service should be included.

Therefore, DBA does not believe that any changes are needed.

Traffic routing

Telia and Telenor are still convinced that the modelled core network is not efficient. As put forward by Telia in the autumn 2013, it is Telia's conviction that it should not be necessary to route all Layer 2 traffic in the core through Edge routers. In a mail from 25 September 2013 to DBA Telia stated that:

> - Expensive router interfaces is used for transporting L2 traffic.
>
> If you simply replace the L2 switches of today, with MPLS enabled switches (L2,5) you would solve the technical issue with transparency and VLANs. But you would aggravate the financial issue, by making the former L2 switch ports more expensive (now L2,5 MPLS ports) and keeping the L3 interfaces for L2 traffic in aggregation and core. So Telia and Telenor do not recommend such a solution.

Furthermore, in a mail from 11 October 2013 to DBA Telia stated that:

> Telia still see a need to underline that an optimal network has edge routers on the edge of the network, and not within the MPLS aggregation network. A wholesale customer like Telia will only buy L2 services like POI0-3, BSA, VULA, eVPN from TDC, and we would not require any Edge router functionality. If the edge routers are connected at the edge of the network, this will be clear in the price model, and Telia will not have to pay for the L3 edge functionality like special processor cards. If the Edge routers are placed in the aggregation network and used for MPLS traffic transport, the model has to keep in mind that the added cost for the edge routers should not be part of the L2 product price.
>
> Furthermore a network where Edge routers are used for MPLS traffic transport will require more edge routers, since the number of edges will be determined by how many interconnects between rings are

> needed in the network. In an optimal designed network, like the one supposed by Telia, the number of edge routers should be determined by the number of customers and the amount of traffic you have on a service.

The current network design seems to result in unnecessary high costs for Edge equipment as it leads to an unwarranted need for a high number of Edge routers. Instead, Telia argued in 2013, it should be possible for AO's to access the broadband traffic (afvande) directly at the switches in the aggregation ring, and that Edge routers should be reserved for the types of traffic that actually needs to run through the routers.

Looking at the routing table Telia and Telenor are under the impression that AO's buying broadband products from TDC are still forced to finance Edge routers that should not be necessary for these broadband products. For layer 3 VULA/BSA for instance, there is a routing factor of 1,0 for "Edge node equipment" and a routing factor of 2,0 for "Tx Path: aggregation to Edge"

Welcome ##

This sheet contains the routing matrix: one is an aggregated routing matrix one is the detailed routing matrix

1 Detailed routing matrix for assets dimensioned based on traffic

Routing matrix	Service category	Aggregation node eq	Edge node equipmen	Distribution node equ	Core node equipment	Tx path: aggregation	Tx path: aggregation	Tx path: edge ring	Tx path: edge to Distr	Tx path: distribution	Tx path: intra Core	IMS platform	Intelligent network	PSTN GW	PLMN GW	International GW
Broadband																
Broadband - Internal VULA/BSA	Broadband	1,0	2,0	2,0	1,5	1,0	2,0	1,0	2,0	2,0	0,5	-	-	-	-	-
Broadband - External VULA/BSA - Cabinet	Bitstream	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broadband - External VULA/BSA - Layer 2	Bitstream	1,0	-	-	-	-	1,0	-	-	-	-	-	-	-	-	-
Broadband - External VULA/BSA - Layer 3	Bitstream	1,0	1,0	-	-	1,0	2,0	-	-	-	-	-	-	-	-	-
Broadband - Ethernet Transport - National	Bitstream	-	1,0	2,0	2,0	-	1,0	2,0	2,0	2,0	1,0	-	-	-	-	-

Telia and Telenor believe that this design leads to costs at a non-efficient level for AO's utilising TDC's network services. This effect is amplified now when the cost of Edge routers (assets 70/71) seems to increase compared to the first consultation round, cf. the consultation notes page 23-24.

Telia and Telenor encourage DBA to ensure a more efficient network design in the model and/or change the routing factors in order to reflect an efficient network design where external products are not burdened by costs to unnecessary Edge Layer equipment and sites. If needed, Telia and Telenor will be happy to facilitate a meeting between DBA and a relevant network equipment vendor to further clarify this issue.

DBA agrees with Telia and Telenor that, given the network design being modelled, the service "Broadband - External VULA/BSA - Layer 3" does not need to use the edge router nor the transmission link between the aggregation and the edge link.

The routing factor of the service "Broadband - External VULA/BSA - Layer 3" has therefore been updated by setting the routing factor of the edge node equipment and of the transmission path from the aggregation to Edge to 0.

In order to reflect this update, the names of the external broadband services have been updated to:

- Broadband - External VULA/BSA - POI0
- Broadband - External VULA/BSA – POI1
- Broadband - External VULA/BSA – POI2

The routing matrix and the documentation have been updated.

Trench length in core network

TDC notes that length of trenches falls dramatically in the core network from 10t km to 6,5t km. TDC requests DBA to confirm that this decrease is correct.

As noted by TDC, the total length of trenches between the first and the second draft has been kept constant. The decrease of trenches allocated to the core is a result of the review of the method used to allocate trenches to the different levels. As shown in the table below, this reviewed allocation mainly led to more trenches being allocated to the SDP part and less trenches being allocated to the Core and BTO parts of the network.

Therefore, DBA does not believe that any changes are needed.

Table 2- Trenches allocation evolution

Trenches inventory	V1	V2
	Km	Km
Total	**141,492**	**141,492**
InBuilding	-	-
Private	26,157	26,157
Aggregation	16,558	18,620
SDP	64,256	73,505
PDP	12,891	9,002
Core	10,191	6,465
BTO	11,439	7,742

Source: DBA

Corporate overhead mark-up
TDC recognises the use of the Corporate Overhead mark-up. The cost for corporate overhead is allocated to Copper/Fibre or CATV depending of the chosen scenario and to Voice and data. However, the 33% of cost specified for Voice in sheet 'Non-network costs', cell T21 is not allocated to Voice services.

DBA is requested to update the formulas to allocate the specified voice overhead cost properly.

DBA agrees with TDC that the 33% of the corporate overhead located in cell T21 of the sheet "Non-network costs" have not been allocated to voice services.

However, the allocation of the corporate overhead mark-up has been reviewed in order to:

- Reflect TDC's regulatory account.
- Make it consistent with the approach followed for the allocation of the NMS costs.

DBA has therefore used the following approach:

- The cost of the overhead is split asset by asset. This split has been carried out using TDC's regulatory accounts allocation keys.

- DBA has assessed for each asset of TDC's regulatory account whether it is relevant to the LRAIC cost models or not. If it is relevant to the LRAIC cost models, then DBA has assessed whether it is part of the core network or part of the access network. If it is part of the core network, DBA has then assessed whether it is part of the IP core network or not. This whole assessment is exactly the same as the one carried out for the NMS.

- Having carried these assessments, DBA has included in the model solely the overhead costs allocated to the assets that are relevant to the LRAIC cost models and part of the access network or part of the IP core network (as the core network being modelled is a full IP core network).

- This approach leads to use the following allocation keys:

  - For the copper scenario and the fibre scenario: 35.2% of the total NMS costs are not taken into account, 64.8% are allocated to all LRAIC relevant services (access, core and colocation services).

The corporate overhead mark-up value and allocation relevant to the CATV is pending data from TDC.

The spreadsheet “Non-network costs” (line 24) has been updated by including these new allocation keys.

The model has been updated by changing the overhead mark-up allocation keys between the different services so that all the overhead cost is allocated and so that the allocation keys are in line with TDC’s regulatory accounts.

The spreadsheets “Non-network costs” and “Non network mark-up” have been updated.

Mark-ups for pure LRIC calculation
<u>TDC</u> cannot identify any mark-ups for the pure LRIC calculation.

TDC requests DBA to include mark-ups for termination like in the current model.

The mark-ups relative to the pure LRIC calculation have been implemented in the core network cost model. However, as DBA was still investigating the relevant level of cost that should be included, the mark-ups have been left to 0%.

DBA has consulted the relevant parties and assesses that 30% should be included based on the submissions of TDC and the submissions of the alternative operators. This assessment is based on the analysis carried out in answer to the comment “IC specific cost” of this consultation note.

The model has been updated by including a 30% mark-up for the LRIC calculation.

The spreadsheet “Non-network costs” has been updated in order to include the relevant IC costs leading to a 30% mark-up.

Wholesale mark-up
TDC states that according to DBA, page 16 in the consultation note, DBA’s preliminary view is that there are no cost differences in providing operators with TDC’s wholesale services than providing the services to the retail divisions. TDC does not understand this statement. By providing services to the operators, TDC has to handle agreements, tracking traffic etc. for billing purposes and handle the billing itself. These are cost/activities that are not required when serving retail divisions.

In DBA’s coming analyses of the wholesale mark-up, TDC requests DBA to focus on systems that are required to offer services to other operators.

As stated in the comment “IC specific costs”, DBA’s preliminary view has changed as a result of further investigations. Please see this section for more details.

OPEX for core network
TDC states that according to DBA, page 12 in the consultation note, the OPEX level in the core-model equals the cost for TDC’s IP-network.

TDC does not find that OPEX level is corresponding to the OPEX in TDC’s IP-network/platform. Furthermore is TDC’s IP-network not of the same size as the IP-network in the core model, where all traffic is routed via IP. TDC has separate platforms for SDH leased lines and have some of the xDSL-customers produces on an ATM-platform. The aggregation network is based on Ethernet whereby this platform should be included when comparing the costs.

From the TD-cost data submitted to DBA, TDC has made the table below showing the discrepancies.

Table 2. Core OPEX comparison.

Core Opex, mDKK/Year	**LRAIC, 2. draft, ex. IT/NMS and Corporate overhead**	**TDC TD, LRAIC relevant, ex. IT/NMS and Corporate overhead**
SDH		XX
DXX		XX
SWITCH	14	XX
FIBER, Transport	14	

		XX
ATM		XX
IP	52	XX
DSL_ATM		XX
DSL_Ethernet	86	XX
ETHERNET	18	XX
Coax	8	XX
Total	**190**	**XX**

The exact mapping between TDC's platforms and the LRAIC categories is for discussion. However, TDC finds no match of the IP cost in the LRAIC-model.

The yearly OPEX of XX mDKK is TDC's cost of providing the core services that are modelled in the LRAIC model. TDC acknowledge that some cost reduction appears if it is assumed that all services can be provided by an IP-network and that telephony service is simulated, but a XX% reduction in cost are not realistic.

DBA should further be in mind that the core OPEX level is far below other LRAIC modelled networks, see Appendix 1, sec. 3.3.1.

DBA is requested to revise the core OPEX and describe how the mapping from TDC's OPEX is done.

With respect to the OPEX calculation, it is DBA's view that there are 5 different possible approaches:

1. The top-down approach:

This approach is not relevant because a single core network platform is being modelled whereas TDC has several platforms (SDH, ATM, PSTN, etc.) in its actual core network;

2. The full bottom-up approach:

This is the approach currently implemented. It is based on the engineering rules provided by the industry (TDC and the alternative operators).

The industry is welcome to provide any cost and engineering rule missing.

3. The approach based on TDC's IP network OPEX:

This approach is being used as a cross-check to assess whether the bottom-up approach is computing a relevant level of OPEX.

4. The studies based approach:

This approach is based on studies carried out by vendors to show the level of savings that could be achieved by migrating to a full IP core network. This approach is not used as vendors have incentive to show unrealistic level of savings.

5. The approach based on an analysis of what would be TDC's OPEX when the migration towards the full-IP network will be achieved:

As a starting point, this approach would use TDC's IP network OPEX as shown in its regulatory accounts. These OPEX would then be adjusted based on the analysis of the different cost drivers.

The third approach is the preferred approach since it best reflects the costs in Denmark and the costs of a new network. It can be potentially complemented by the fifth approach.

In relation to the third approach, DBA would first like to point out that some costs are accounted as OPEX by TDC whereas they are computed as CAPEX in the network cost model. Installation and planning costs are accounted as CAPEX, although they are pay costs, because they are one-off costs.

In order to implement the third approach, DBA has analysed TDC's regulatory accounts. The following approach has been followed:

- The Opex are split asset by asset. This split has been carried out using TDC's regulatory accounts allocation keys.

- DBA has assessed for each asset of TDC's regulatory account whether it is relevant to the LRAIC cost models or not. E.g. the assets "IT for mobile platform", "Other data CPE" or "ADSL_Installation_Modem" are not relevant to the LRAIC cost models. If it is relevant to the LRAIC cost models, then DBA has assessed whether it is part of the core network or not. If it is part of the core network, DBA has then assessed whether it is part of the IP core network or not.

- Having carried these assessments, DBA has split the Opex obtained in five new categories.

- DBA has then matched the values obtained in the model with the five values derived from TDC's regulatory accounts:

- Operation and maintenance:

This category is included in the model.It is computed bottom-up based on mark-ups of the former model, on mark-ups provided by the industry during the data collection and the consultations and on annual costs provided by the industry. DBA is therefore of the view that the Opex of this category reflect the costs incurred by an efficient operator. No adjustment is therefore needed;

- Housing rental:

This category is included in the model. It is computed bottom-up based on engineering rules provided by the industry. It is normal that the value computed in the model does not match with TDC's Opex as new assets are using less space than the old ones. Therefore building an entirely new network would save space as compared to the space required in TDC's network. No adjustment is therefore needed;

- Power and cooling:

This category is included in the model. It is computed bottom-up based on engineering rules provided by the industry. The power usage and the cooling requirement in the model are those of new assets whereas it is not the case in TDC's network. No adjustment is therefore needed;

- Support/overhead:

This category is not included in the model. No engineering rules allowing performing a bottom-up calculation has been provided by the industry regarding this category. DBA has furthermore not been able to verify the cost levels based on the information provided by TDC. Therefore, DBA would like TDC to supply additional information regarding the support/overhead category ;

- Design and planning (non-capitalized):

This category is not included in the model. No engineering rules allowing performing a bottom-up calculation has been provided by the industry regarding this category. DBA has furthermore not been able to verify the cost levels based on the information provided by TDC. Therefore, DBA would like TDC to supply additional information regarding the design and planning category.DBA has also received from TDC a new additional submission assessing the level of OPEX of a full-IP core network. This assessment has been done according to the following approach:

- The OPEX of each legacy platform has been split by asset using TDC's regulatory accounts.
- For each asset, TDC has assessed whether it is relevant to a full-IP core network. If the asset is not relevant, then the share of OPEX borne by this asset is discarded. Otherwise it is split between the following three categories:
  - Remaining net costs
  - Power/house rental
  - Remaining overhead
- TDC has furthermore identified a number of activities that generate OPEX that should be included. E.g.: "Customer handling", "Economic/strategy and analysis" or "Leaders and managers allocated by new deployments (non capitalized)".
- TDC has assessed that the level of OPEX that should be taken into account for a full-IP network is XX m DKK.

DBA has reviewed this analysis submitted by TDC and has several comments on it:

- The power/house rental OPEX are computed bottom-up in the LRAIC cost model. These account for XX mDKK in TDC's analysis. They should however be discarded from the analysis.
- The remaining overhead are part of the overhead costs already taken into account in the model. These account for XX mDKK in TDC's analysis. They should however also be discarded from the analysis.
- DBA has identified that the OPEX of 8 IT platforms are already taken into account in the NMS costs and should therefore not be double counted. These OPEX account for XX mDKK and should be discarded from the analysis.
- A number of activities generating OPEX identified by TDC are already taken into account in the LRAIC cost models. E.g.: "Maintenance/fault correction – Onsite" is already part of the modelling. Out of the XX mDKK accounted by TDC, only XX mDKK have not been taken into account in the LRAIC cost models.
- TDC is therefore stating that there is XX mDKK OPEX that have not been taken into account in the LRAIC cost models: 25% due to activities not included in the LRAIC cost models and 75% due to OPEX of the legacy platforms that do not disappear when migrating to a full-IP network.

- The OPEX of the legacy platforms that do not disappear when migrating to a full-IP network are due to customer handling and network surveillance. DBA agrees that these two activities will continue to exist with a full-IP network. However, DBA disagrees that the OPEX of a full-IP network would stay at the same level. There are indeed economies of scale that should be taken into account. E.g.: network surveillance would continue, however there would be only one platform to monitor as compared to the 7 platforms that TDC has to monitor currently. It is expected that the network surveillance of a full-IP network may cost more than the network surveillance of a network with a smaller size such as the ATM network but it cannot be as expensive as to monitor 7 different platforms.

DBA is thus of the view that TDC did not provide sufficient supporting documentation allowing DBA to take these OPEX into account. In order to allow DBA to take these OPEX into account, TDC should provide very detailed cost drivers of the OPEX related to customer handling and network surveillance. TDC should provide also more details regarding the figures: the OPEX should be split into different categories such as pay costs, opex related to some IT platforms. For each of the categories, TDC should provide a description of the costs included.

DBA is therefore of the view that the level of OPEX computed in the model is consistent with the level of OPEX that an operator would occur when rolling-out a full IP/MPLS core network.

Therefore, DBA does not believe that any changes are needed following this comment.

OPEX level of the current/previous model to use in the draft model
TDC finds the current OPEX level low - not only low compared to TDC's submissions but also to the level in the previous model.

According to the OPEX level in the previous model, DBA does not find this necessarily relevant, see page 11. TDC would like DBA to explain why this OPEX level (with successive productivity adjustment) is not relevant – at least as a point of origin. In TDC's mind, DBA is modelling the same network structure as in the previous model – as well for Core as for Access. Even though the modelling approach differs and the model is re-implemented in Excel, the OPEX reflecting the efficient SMP should not change because of these technical modelling differences.

TDC therefore requests DBA to substantiate the rejection of the OPEX level that is so far used.

The approach followed in the previous model is based on the functional area analysis. This approach does not seem relevant for a full IP core network where the maintenance is more and more carried out remotely and the supplier support is increasing.

Furthermore, the core network modelled in the previous network was not a full IP core network. The previous model included several platforms. It is therefore expected that the OPEX in the new model will be lower than the OPEX in the former model.

The starting point of a bottom-up model should be the engineering rules and costs provided by the industry. The OPEX included in the model are based on these engineering rules and costs.

The model includes non-network OPEX. These are included in the non-network costs. The value of those is based on TDC's regulatory accounts as they cannot be modelled bottom-up (because they are non-network costs).

Therefore, DBA does not believe that any changes are needed following this comment.

Power production investment and cooling production investment
Telia and Telenor state that as described on p. 15 in the consultation note, DBA has removed the costs related to "power production investment" and "cooling investment" in order to avoid excess cost coverage. The columns for "power production investment" and "cooling investment" should, however, be removed completely to simplify the model, as they are no longer needed.

DBA agrees with Telia and Telenor that power production investment and cooling production investment could be removed in order to improve the model transparency. However, DBA prefers to keep these cost categories in case any other party would like to further comment them.

Therefore, DBA does not believe that any changes are needed.

Power
Concepy argues that the power supply units in the model are set to life-time of 15 years. We believe that 25 years is a more accurate estimated lifetime for this asset category. The maintenance mark up at 13% should be reduced to an absolute minimum, seeing as these types of installations rarely need maintenance. We have a similar concern regarding the level of the power production maintenance on active equipment.

Without any supporting documentation from Concepy, DBA is of the view that the asset life of the power supply unit should be left unchanged from what has been provided by TDC.

Therefore, DBA does not believe that any changes are needed.

DBA would like to have input from the industry on the lifetime of power supply units.

Fees for "other services"
Telia and Telenor support that several new one-off fees have been added to the model as this greatly increases cost transparency.

On the other hand, the transparency regarding the resources needed to undertake the different tasks for the individual services is indeed very limited. Since the first LRAIC model was published in 2002 very few attempts (if any) has been made from DBA's side to actually gather and publish coherent cost documentation underlying the pricing of most of these service fees. This is a great deficiency in the model which needs to be corrected.

This deficiency does not stem from the fact that this information is not available. TDC knows the facts both from internal time registrations/studies and from the procurement contracts used when TDC outsources these activities partially or completely to subcontractors. The mere fact that TDC decides not to share this information with DBA is a very strong indicator that the resource requirements assumed by DBA are set at a too high level. The development of in particular the broadband markets from immature to mature and satiated is another strong indicator that underlying costs when e.g. setting up new connection should have changed dramatically.

In the past growth periods new installations (e.g. NTP) was often needed when setting up new customers and individual line testing and line switching had relevance. Today, new installation of e.g. a BSA customer most often does involve nothing more than a simple administrative procedure if shifting from one broadband service provider to another or if the premise in question has had BSA delivered in the past.

This structural market change has, however, not been reflected in the model. It is still assumed that on average an unassisted BSA new installation requires 5 minutes of administration, 24 minutes installation time for a technician and 25 minutes of transportation for the very same technician. For the resolution of this specific issue, introduction of various new reduced charges for shift of operator or production platform for lines that are known to be active might help. More generally, Telia and Telenor strongly recommends that DBA takes the necessary steps towards TDC to secure fair and transparent pricing. One radical and efficient cure would be to set all charges for "other services" at zero until TDC "voluntarily" decides to submit relevant cost documentation.

DBA believes that this approach is very transparent as it is possible for the alternative operators to see the time consumption for each of the activities. DBA does not find it proportionate to disaggregate the different activities further as this would require significant work.

The alternative operators have had the possibility to comments on the time consumption in relation to fees during model revisions.

DBA has asked Telia/Telenor to specify all the fees which they do not believe are correctly set.

DBA has received this information the 5th of May 2014 from Telia and Telenor and has furthermore received new information from TDC regarding fees. DBA will assess this new information in parallel with the third consultation round. It is likely that DBA will invite the parties to meetings regarding the calculation of fees. Below follows some more specific comments on the current modelling of "other services".

Multicast services
Telia and Telenor find that a need for an academic to spend almost three full-time weeks (6,000 minutes = 100 hours) to specify parameters for a multicast wholesale customer seems very high (cell W158 in sheet "Colo and other services"). Also, three technician weeks *and* three academic weeks for implementation of the multicast customer seems overrated (cells R159 and X159 in sheet "Colo and other services"). Telia and Telenor believe that these tasks could be performed with fewer resources.

DBA agrees that it is likely that the resources needed in reality are lower than what is currently specified in the model.

As there are no wholesale customers buying multicast from TDC today, it is difficult to assess the resources needed.

In case an operator wants to buy multicast from TDC, DBA will mediate between the parties and assess the work needed for the specific wholesale agreement.

Therefore the time consumption has been set to zero and the fee is not priced.

Unjustified request for fault repair for PSTN and Leased lines
Telia and Telenor states that besides the newly modeled fees, Telia and Telenor also find it relevant to include a new fee for unjustified request for fault repair or "unproductive fault handling" *for PSTN lines and 2Mbps leased lines* in the model. Today, TDC's fee for unproductive fault handling on PSTN lines and 2Mbps leased lines is almost double

(674 DKK) of TDC's fee for unproductive fault handling on LLU or BSA lines (376 DKK), which is not justified, because it is the same copper bearer line. Adding unproductive fault handling on PSTN lines and 2Mbps leased lines to the LRAIC model and thereby setting the fee at the same level as for unproductive fault handling on LLU or BSA lines would solve this problem. Alternatively, TDC should be obliged to charge the LRAIC-regulated fee for all types of unproductive fault handling.

DBA agrees with Telia/Telenor and does not see any reason for "unproductive fault handling" for PSTN lines and 2Mbps leased lines should be significant higher that for LLU or BSA lines.

On this basis, DBA has set the fees for "unproductive fault handling" for PSTN lines and 2Mbps leased lines at the same level as for LLU and BSA.

Therefore the time consumption has been set to zero and the fee is not priced.

Updating of weights

Telia and Telenor states that regarding time spent by administrative, technical and academic personnel on different services, it seems that the weights used in the existing model have not been carried over to the revised model. For instance, the 20 minutes transport time to the end user spent by the technician in a BSA "New Installation – engineer assisted" in the existing model is weighted by 50 pct.:

			Weight	Administrative staff	Technician	Academic staff	[empty]	[empty]
8,2 New Installation- Ingineer assisted								
Processing of order	Man-minutes		80%	6,1	0,0	-	-	-
Physical coupling in Exchange	Man-minutes		100%	0,0	18,0	-	-	-
Switching in DSLAM and ATM network	Man-minutes		100%	0,0	6,0	-	-	-
Transport time to Exchange and ATM network	Man-minutes		100%	0,0	24,6	-	-	-
Visit by technician at end-user adress	Man-minutes		50%	0,0	70,5	-	-	-
Transport time to end user	Man-minutes		50%	0,0	20,0	-	-	-

In the revised model the time consumptions seem to have been carried over from the existing model but without the weights. Therefore, the 20 minutes transport now weighs 100 pct. This overestimates the cost of the services.

DBA agrees with Telia and Telenor.

The model has been updated with the weights from the existing model.

Transportation time
Telia and Telenor do not believe that the transport times stated in the model reflects the planning of an efficient operator. An operator aiming to reduce costs would pool technician visits in the same geographic areas together, so that on Monday the technician visits end customers on Vesterbro, on Tuesday on Nørrebro and so on. This will vastly reduce the transport time needed compared to the situation where the operator sends the technician to end customers in the same order that the installation orders arrive. Telia and Telenor believe that efficient planning would reduce the transport times needed in the model.

To check up on this, DBA should ask TDC for copies of the service contracts TDC has with subcontractors carrying out technician work. Such contracts could also be used to do a sanity check on the time consumptions for the actual technical work being carried out (e.g. the "Installation" minutes in column Q in sheet "Colo and other services" in the core model).

DBA notes that pooling of the technician visits in the same geographic areas has already been taken into account in the model.

In section 10.2.2 (Handling double-counting of order processing and transport) it is stated that:

"*In relation to each service, NITA has evaluated to which extent a task is a natural extension of another service and to which extent transport is shared with other services. Moreover, it has evaluated whether the SMP operator with reason might bundle orders within the same geographical area and, thus, share the time for transport between several orders. The following principles have been applied:*

If a task in relation to service B is always carried out as an extension of a task related to service A, and service A is a technical pre-requisite for service B, then service B should only contain the incremental cost derived from the extra work process undertaken in relation to service B. This implies that no party can be brought to pay for tasks not related to the ordered service.

If a task in practice is carried out at the same time as a task related to another service, but the services are not necessarily pre-requisites for each other, an adequate allocation of time consumption should be made. In the actual model, the allocations are made by applying a weighting factor. This is shown in column G of the I_Resource sheet"

If Telia and Telenor do not agree with the weights set in the model, DBA would like to receive documentation on what these weights should be.

Change of line speed

Telia and Telenor states regarding the fee for change of line speed (in current model: “Change of speed BSA”), that they would like to note that such a fee should only be paid if TDC personnel are required to carry out the order. If the wholesale customer changes the line speed himself by accessing TDC’s technical systems (e.g. through the system “DSLman”), then there should be no fee, as no TDC personnel resources are required. This reasoning goes for all automated processes where the wholesale customer is able to complete the order without assistance from TDC personnel.

DBA agrees with Telia and Telenor that the fees should not apply in situations where TDC personnel are required to carry out the order.

New installation of BSA/VULA without co-production

Telia and Telenor notes that DBA has apparently introduced a new fee called “Additional fee for new installation of "BSA/VULA without co-production” (row 92 of sheet Pricing in core model). Taken at face value and given that co-production with PSTN is becoming rare, the implication would be an additional set-up charge of DKK 515 for over 90 per cent of all BSA/VULA new installations. That is, a set-up cost inflation of over 100 per cent on average.

In the current model, the corresponding fee is zero based on the fact that no personnel minutes are required. Hence, Telia and Telenor expect this is an error which will be corrected in the next model revision so that the time consumption, and thus the fee, is also zero here.

DBA agrees with Telia/Telenor.

This fee has been set to zero as in the existing model.

Fees for VULA uncontended

Telia and Telenor notes that fees related to VULA uncontended seems to be missing from the model and should be included.

DBA agrees with Telia and Telenor that the fees for these services should be specified in the model. DBA notes that the fees for VULA and VULA uncontended are the same.

DBA has added the fees for VULA products in the model.

Resilience issues

Telia and Telenor note that on p. 21 of the consultation note DBA invites the industry to comment about appropriate MSAN/switch resilience levels. Telia and Telenor would like to refer to Telia's statements given to DBA in email of 5 March 2014 where Telia described both maximum number of customers per DSLAM and maximum number of customers per switch. Please note, that one rack can house two subracks with one DSLAM each, as described in paragraph "Subracks and MSAN dimensioning rules".

> DBA is of the view that the switch design rules sent by Telia and Telenor on the 5th of March are the design rules that have been implemented in the core network cost model: the model tries to connect as many MSAN to each aggregation switch in order to minimize the number of aggregation switches needed. However, due to the single point of failure norm, there are a maximum of 1536 customers that can be connected to the same MSAN.
>
> **Therefore DBA does not believe that any changes are needed.**

Heat exchangers

Telia and Telenor would like DBA to elaborate a bit more regarding the deployment rules for heat exchangers. A comment in the model says *"The number of heat exchanger units is driven by the list provided by TDC and wherever more than 4 line cards are installed".* The formula in Network costing, cell S98, counts the number of sites where TDC according to the list has ventilation, and the formula furthermore add ventilation on sites with more than four cards installed. A site like Ab12 is both on TDCs list and it has more than four cards installed. The used formula allocates two heat exchanges to the Ab12 site – one because it is on TDCs list, and another one because it got more than four cards installed. Is it the intension that more than one heat exchanger can be used per site?

Furthermore several sites have both air conditioning and heats exchanger plates. Is it the intension that some air conditioning sites also need heat exchangers?

> DBA agrees with Telia/Telenor that at most only one heat exchanger should be installed in each site and that if a site is equipped with an active AC unit then this site does not need any heat exchanger.
>
> **The model has been updated by equipping the sites with at most one heat exchanger and none when an active AC unit is already installed.**

Multicast

Telia and Telenor notes that the Core model calculates multicast in the BH Traffic sheet. Cell L60 calculates the multicast traffic from distribution to edge. The formula multiplies the traffic with the number of distribution routers (13). The 97 edge routers belong to 21 different rings, i.e. the formula should multiply the traffic with the number of edge rings (21).

Cell L61 calculates the multicast traffic from POI2 to POI1. The POI1 switches belong to 173 aggregation rings, so Telia and Telenor believe that the multicast traffic shall be multiplied by the number of aggregation rings, and not by the number of edge rings, as done in cell L61.

DBA agrees with Telia and Telenor that the number of edge rings should be used instead of the number of distribution routers in order to compute the multicast traffic between the distribution routers and the edge routers.

DBA also agrees with Telia and Telenor that the multicast traffic calculation from POI2 to POI1 should be based on the number of aggregation rings instead of the number of edge rings.

The spreadsheet "BH traffic" has been updated by using the corrections proposed by Telia and Telenor.

Rack space requirement

Telia and Telenor notes that the model assumes that one rack occupy 1.5 square meter. Telia and Telenor assume that standard racks are used, i.e. 60 cm width and 40 cm depth. If the racks are placed next to each other in a row, the 1.5 square meters leave room for a 2.1 meter wide aisle in front of the rack (1.5/0.6-0.40). This seems to vastly overdimension the room needed for aisle, especially if racks are placed back-to-back.

Confidential Appendix 6 shows Telia's Herberg co-location at Byen. Telia has room for 20 racks on 13.5 square meter floor space, i.e. the space for one rack is 0.7 square meter on average. Telia does not know the exact measures of the co-location area at Byen. The drawing shows space for a total of 145 racks. If it is possible for DBA to get the exact measures of the room, it is possible to check if the 0.7 square meters per rack is representative for the whole room. Telia and Telenor request DBA to adjust the LRAIC model assumption about rack space requirement, since it is obvious that the racks require less space than 1.5 square meters.

Given the data submitted by Telia and Telenor, and especially the fact that in the colocation room in Byen site, 20 racks fit in 13.5 square meters, DBA agrees that the space of one rack should be 13.5/20=0.675m²

The spreadsheet "Network dimensioning rules" has been updated by setting the rack size to 0.675m².

Rack space 40 vs 45 RU

Telia and Telenor note that in Network dimensioning rules, I143, it is assumed that one rack is 40 RU. A note says that a rack is 45 RU but 5 RU is not used. In Network assets and costs it is assumed that one rack correspond with 45 RU, see e.g. Y62. In Network costing a round up function is used when calculating the space. Because of the 40 vs. 45 RU confusion, the formula concludes, that one rack need the space of two racks. The error can be corrected if the value in Network dimensioning rules, I143 is set to 45 RU.

DBA agrees with Telia/Telenor that the input in the sheet "Network assets and costs" leads to dimension the space of 2 racks for one rack.

DBA however disagrees with Telia/Telenor on how to address this issue. Out of the 45 RU in each rack there are some that are not used. This is the case of the 5 RU located at the bottom of each rack due to dust and technician working position.

The model has been updated by decreasing in the sheet "Network assets and costs" for each rack the space needed from 45 RU to 40 RU.

Annual workdays

Telia and Telenor notes regarding annual workdays that DBA states on page 69 of the consultation answer that Telia and Telenor do not take maternity leave into account and DBA therefore concludes that absence related to sickness, children's sickness, injury and maternity leave should be 9 days instead of the proposed numbers from Telia and Telenor of 7.38 and 3.75 days.

According to the data from Danmarks Statistik, fulltime employed telecom technicians had 1.64 days of maternity leave in 2012. If maternity leave is taken into account, the number of absence days should be adjusted for the part of the leave that is not paid by the operator.

Companies who pay salary to employees on maternity leave are entitled to reimbursement from the state. According to http://www.virk.dk/home/myndigheder/udbetaling-danmark/barseldagpenge/arbejdsgiver.html the reimbursement rate is 4,075 DKK a week in 2014. In the model, a technician earns 9,988 DKK a week (519,361 / 52), thus almost half the technicians salary during the maternity leave is not paid by the operator and can be spent on paying other technical personnel.

If the employee during a part of the maternity leave receives subsidies from the state (barselsdagpenge) the operator has no salary costs to the employee during this period and can therefore spend the employee's entire salary on other personnel.

Thus, a number of yearly maternity leave days of 1.64 overstates the real cost burden on the operator of maternity leave. Based on the above, at maximum half of these days are financed by the operator and should be counted as absence. Therefore Telia and Telenor believe that if Danmarks Statistik is used as data source, a yearly number of absence days, including maternity leave, of 8 is more realistic than 9. Furthermore, Telia and Telenor believe that the modeled number should be even lower than 8 based on Telia's number of absence days of 3.75 which is also in line with the average absence days of 3.50 experienced in Telenor's network department (2012 data). Adding maternity leave to this number, 4 or 5 annual absence days seem fitting.

DBA agrees with Telia and Telenor.

The number of days of absence related to sickness, children's sickness, injury and maternity leave has been set to 8 in the model.

Site preparation

Concepy would like to understand which tasks are included in the site preparation in order to ensure that these tasks are not included in other installation/maintenance costs.

The site preparation of the remote CO includes the cost of the physical shelter of the cabinet, and the DSLAM rack. The cost includes therefore an empty cabinet and its foundation.

Site maintenance

Concepy would like to understand which tasks are included in the site maintenance in order to ensure that these tasks are not already included in other installation/maintenance costs.

In order to avoid double counting, DBA will update the model in order to include solely a site cost which accounts for the site preparation/construction and its maintenance.

The model has been updated by merging site preparation and site maintenance.

Specific comments on Access model

Price trend for trenches
<u>TDC</u> cannot follow DBA's arguments regarding the high price trend for trenching.

Since DBA's finds that a three year view on "index for jordarbejde" is too short a timeframe, TDC has submitted data from"Danmarks statistic showing that the average yearly price trend 1995-2014 is 2,9% (See Appendix 7 - DST.pdf)

[Section redacted]

Secondly TDC finds that if TDC, due to effective negotiation processes, is able to obtain contracts in which the indexation are better than some EU average, TDC data should be used since the LRAIC-model should reflect a efficient operator. It is indeed efficient to obtain good contracts with trenching contractors.
As an example of TDCs ability to obtain efficient prices on trenching TDC has attached contracts from 2002 and 2014 (Please refer to Appendix 8 - *Trenching contract 2002-2014 viborg.xlsx*). From this it can be seen that on equivalent services (traditional trenching) a yearly price increase in the range between XX % and XX % is observed.
Third TDC finds it odd to use a 10 year old reference (Europe Economics) and in which the Italian inflations is used as argument.

Therefore TDC find that given the arguments above, the price trend on trenching should be set on a level no higher than 2,5 %.

DBA agrees with the methodology used by TDC, but is however not able to reconcile with the value of 2.9% calculated by TDC.

In the appendix 7 provided by TDC, the table shows only two relevant costs, which are asphalt and earth. An annex cost "veje" can also be considered as relevant.

The Table below shows the level of costs for trenches on asphalt, earth and roads. The annual trend observed is between 3.11% and 3.80%.

The national distribution of the different types of ground is approximately 66% for earth and 7% for asphalt (source: model "Access Fv4.22", sheet "A8_C_Trench and Duct", lines 46 and following).

DBA estimates that "Veje" can be considered as a good compromise, and therefore that **3.37% is the relevant long-term price trend that should be used for trenches**.

Table 3 - Trenches price trends and national distribution of ground types

Label	Type of ground	T1 1985	T1 2013	Years	Annual evolution	National distribution
Asfalt- arbejde	Asfalt	100	195.72	18	3.80%	7%
Jord- arbejde	Earth	100	173.65	18	3.11%	66%
Veje	Road	100	181.58	18	3.37%	

Source: DBA

Trench width filling

Telia and Telenor notes that DBA deploys a trench width filling factor of 60% in the model (40% empty space between cables).

Global Connect has confirmed to Telia and Telenor that such a low width filling factor has no hold in actual practice and in particular that such a requirement is not part of relevant contractual arrangements that they have experienced. In areas with a high intensity of heavy traffic, empty space between cables or duct could play a role when compacting. However, below pavement or earth surface this plays no role in practice. Telia and Telenor will be happy to help to establish contact between Global Connect and DBA to clarify this issue.

If TDC claim that such a rule is enforced in practice, this should clearly be an integral term of the contractual setup between TDC and the contractors. Consequently DBA should request TDC to document this claim rather than ask for evidence from alternative sources that it is not the case.

TDC have provided information regarding the standard used to dig their trenches in Denmark. GlobalConnect has confirmed to DBA that this factor reflects the standards used in Denmark.

DBA will therefore continue to model the network using this rule.

Therefore DBA does not believe that any changes are needed.

Enlarged trenches

In connection to the trench width filling rule which TDC claim to comply with, cf. above, TDC also argue for enlargement of large parts of the trenches in the access network (supposedly at least 22,000 km) because only one 110 mm duct will fit into a standard trench width/depth wise.

First, Telia and Telenor does not accept the premise that TDC in practice does establish trenches in accordance with the "rules" TDC have argued for in the bilateral meetings with DBA. The "rules" reflect desk talk which has no bearing on actual practice. This has been confirmed by independent network access provider Global Connect which regularly engages in co-digging projects with TDC. Furthermore, visual evidence is readily available on an everyday basis by strolling past trench/duct work in cities.

Second, given that ducts are no longer considered relevant to deploy in the copper access network, Telia and Telenor consider the specific point moot anyway.

DBA is asked to confirm that TDC's argument has had no impact on trench enlarging in model.

Following talks with Global Connect it has been confirmed to DBA that the standards for trenching in Denmark would lead to rules close to the engineering rules provided by TDC. DBA will therefore follow the rules provided by TDC.

Therefore DBA does not believe that any changes are needed.

Cost for trenching

DBA uses trenching cost for different surfaces in calculation the average trench meter cost per switch zone. According to a comment in the sheet the percentage of each surface comes from the former Access model. TDC, however, cannot replicate these percentages from the former model (when weighting with the amount of trenches in each geo zone). Furthermore, the percentages does not sum to 100%.

In general, TDC finds the trenching meter price lower that TDC's own calculations and lower than cost used elsewhere, see Appendix 1, sec. 3.3.2.

TDC's requests DBA to describe the conversion from the former access model and to explain why the distribution of surfaces does not add up to 100%.

DBA deducts the cost of 1 x duct handling when calculating the "raw meter prize". However since the model deploy cables directly into the ground some of the time, it would be more fair to deduct a weight between the costs of duct handling and cable handling. This because the prices obtain by TDC from its vendors reflects a common handling spread and not a 110 mm duct in general

TDC requests DBA to recalculate the "raw meter prize".

TDC will submit their calculations along with the hearing response (please refer to Appendix 9 - Trenching analysis -TDC.

TDC has determined the geotype for each CO. This information was not present in the former LRAIC model.

In principle DBA is of the view that using an average distribution across the whole country should give the same results as applying a specific geotype for each CO.

TDC has not provided the data justifying the determination of the geotype for each CO, so DBA has not been able to investigate the reason for the difference in results.

DBA would like to have the calculation of the geotype for each CO, and will on this basis investigate TDC's suggested method.

DBA notes that the distribution does not add up to 100% because the type of soil "Soil, eg. ploughed cable" was used in the former model (from where the current distribution is taken) but there was no corresponding unit price from TDC for this type of soil. **This has been corrected in the new version of the LRAIC model by integrating the category "Ploughed cables" in the unit cost calculation.** DBA has used actualized unit costs from the former model in order to integrate this type of ground.

With respect to the handling costs, trenches unit costs provided by TDC until now include the handling of one item (this item is either a duct or a cable directly underground).

DBA had previously removed the handling cost of one duct to reflect the fact that the cost of one duct is already accounted for separately (this was completed in the LRAIC model in spreadsheet "Network CAPEX", line 744) and therefore avoid double counting between trench unit cost and duct unit cost.

However the copper network does not use ducts, therefore the handling of cables should be deducted instead of the handling of a duct. But for CATV, FTTH and core networks, this is correct to remove the handling of one duct because the networks are fully ducted.

As it is not possible to have two different trench calculations, it is proposed to remove the average cost of handling one duct and of one typical cable.

DBA has therefore decided to calculate the cost for trenching based on the unit cost to dig a trench minus half the handling cost of a

duct, ¼ the handling cost of a cable <20mm and ¼ the handling cost of a cable <40mm.

New EU rules will result in lower trenching costs
Telia and Telenor notes that the New EU regulation will lower the costs for deploying broadband is on its way, cf. http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/trans/141234.pdf. The Council and the European Parliament have already agreed on the text, and the new regulation is expected to enter into force in the member states from 1 July 2016.

The directive will cut costs for deploying broadband by allowing telecom operators access to existing civil engineering infrastructure owned by other network operators. This is independent of the current SMP regime – all infrastructure owners will be obliged to meet reasonable requests for access to their infrastructure.
When the new rules enter into force, they will lower the deployment costs of the LRAIC model's efficient operator. The LRAIC model should therefore be prepared for allowing a civil engineering discount following implementation of this regulation.

DBA is aware that the new EU regulation can lower the costs for deploying broadband. However, DBA believes that it is too early to assess the impact of this new set of rules in the new LRAIC model.

Trench sharing
TDC states in relation to FTTH deployment in cooperation with DONG utilities that this type of network deployment cannot be directly compared to solo telecom deployment.

With the purchase of the DONG fiber network TDC also adopted the opportunity to co-dig with the 0,4kV cable laying project. TDC has for the last 4-5 years been a part of several of DONG digging projects and therefore have insight in the costs associated.

The deal made with DONG is that TDC has to cover XX% of the costs associated with TDC participating in the digging project. This includes DONG administration, DONG supervision and contractor fee (extra trench width, tunnelling).

The notes about trench width made in the first consultation come in to play also when co-digging with DONG. Since the electric cables fill up the trench in a large percentage of the stretches the trench has to be widened at the cost of TDC. Every road crossing is charged with XX% since for production technical reasons they have to make them separate for telecom and electric.

DONG charge TDC for the use of project manager (XX DKK/hour), project assistant (XX DKK/hour) and field support visor (XX DKK/hour). These services are mandatory when co-digging with DONG.

All in all the average payment to DONG results in a trench meter price for TDC of XX DKK/meter over the last 4 years.

TDC requests DBA to update the model accordingly, hence introduce a DONG co-trenching price of XX kr/meter rather than discounting the existing digging price, since these different trenching circumstances cannot be compared.

TDC would also like to inform DBA that only 65% of the trenches can be shared due to safety distance around gas distribution pipes. In the co-digging TDC deploys empty ducts (cables to be deployed later) alongside DONG cables. However due to safety reasons fiber ducts must be deployed at least 1 meter from the gas distribution pipes. DONG deploys their cables directly into the ground and do not take the safety distance into account. Hence some of the DONG trenches are not useable for TDC. It is TDC's experience that DONG does not project their trenches with respect for TDC needs. As a consequence TDC in some cases has to abandon a project or part of a project.

In principal TDC finds that if LRAIC principles are used, i.e. over night deployment, a historical opportunity (obtained by another company) should by definition not enter the model, and further more it would very unlikely that other utilise would have neither the need at that time nor the readiness to corporate in trenching-work.

Therefore TDC requests that no trenching corporation other than the internal platform benefits, are introduced.

If DBA ignores these LRAIC principles and to some extend introduce trenching sharing TDC requests DBA to incorporate the relevant cost of these tasks into the model.

Telia and Telenor notes that in the first consultation, Telia and Telenor argued that trench sharing/cooperation should be taken further into account.

According to the consultation note (page 61) DBA agreed that trench sharing between TDC and other infrastructure providers should be taken into account.

Regarding the DONG area network the model has been updated with trench sharing parameters. However, it appears as if trench sharing/cooperation with other infrastructure providers in other parts of Den-

mark (and most notably with various power/utility companies, Global Connect, Nianet and Colt) have not been implemented in the model. In this context it is also relevant to refer to industry agreement on co-digging which is published on the webpage of the Danish Telecom Association (Teleindustrien)
http://www.teleindu.dk/branchesamarbejde/samgravning/

DBA is asked to also relate to co-digging/trench sharing opportunities in parts of Denmark outside of the DONG area.

DBA notes TDC's and Telia/Telenor comments regarding trench sharing. DBA would like to distinguish between three different situations:

1) The internal cost allocation of trench cost between utility and fibre that DONG applied when the network was deployed.

2) The trench sharing agreement between DONG and TDC for future projects.

3) Trench sharing between TDC and other telecom operators.

Regarding the first point, DBA notes that an extensive analysis of the internal cost allocation was made when revising the former model. DBA has already implemented this split of cost for the DONG network in the model and finds no reason for changing this.

Regarding the second point, DBA is aware that TDC has made an agreement with DONG regarding trench sharing for future projects. DBA believes that this agreement should be reflected in the model.

Regarding the third point, DBA does not agree with TDC that the assumption of an overnight deployment makes it inconsistent to assume trench sharing with other operators. DBA agrees with Telia and Telenor that an efficient operator would co-dig with other operators. On the basis of a meeting with Global Connect, DBA is of the view that it is normal practise for both TDC and alternative operators to co-dig with other telecom operators. Therefore, DBA believes that TDC co-dig activities with Global Connect Nianet etc. should be reflected in the model.

DBA will ask TDC for information regarding the percentage of trench sharing with other telecom operators.

Discount on trenching services

TDC notes that DBA considers introducing a discount level to reflect the comprehensive use of trenching services.

While it would seem obvious for everyone that this would apply, TDC would like to point out that provided prices already reflect discounts due to large volume purchase of trenching services.

The market mechanism works with a caped volume of resources and low elasticity. For this very reason TDC operates with 20-30 different contractors at a time. There is no further discount to collect by offering more volume to a reduced number of contractors.

Taking market mechanisms to its extreme, a very high demand for trenching services (national coverage over night), and by definition a nationwide limited number of employes, Bobcats, drilling machines etc, would lead to dramatic price increases (text book example in micro economics)

In conclusion, TDC finds no evidence for discounts in an ‘over night’ approach. DBA should note that such discounts are not used elsewhere, see Appendix 1, sec. 3.3.2.

Telia and Telenor acknowledge the improved transparency regarding digging cost based on contractor input submitted by TDC. However, Telia and Telenor also agree with DBA that this cost input is biased because it is based on small scale projects and further agree that significant discounts can be achieved in a more relevant wide area roll out scenario. Clearly, with a nationwide roll-out, the procurement process will also target multinational bidding consortiums instead of settling for framework contracts with a number of small local contractors.

Experience from large scale/wide area roll out project is limited in Denmark but Telia and Telenor has been in dialogue with Global Connect - the leading wholesale network supplier in Denmark. Global Connect has confirmed that larger projects as exemplified with a length digging contract of 1 km trench would result in significantly lower unit costs (indicative mentioning of 20% discount) compared with the framework contracts similar to what has been submitted by TDC. By LRAIC standard a 1 km length digging contract is, however, still a relatively small scale procurement project aimed at national contractors. Hence, it is not unrealistic to assume larger discounts than 20% in a LRAIC setting.

Digital surveying, network design and cable handling are some of the unit costs most affected by larger scale with likely discounts of 60% or more on list prices obtainable in all but the smallest projects.

Given that Global Connect is a current wholesale supplier, Telia and Telenor do not have access to full costing information. However, Telia and Telenor will be happy to help setting up a meeting between Global Connect and DBA to further clarify this and other related issues.

DBA has noted TDC's comments regarding discounts. However, it is still DBA's view that the invoices received from TDC reflect small scale projects where TDC pays standard prices (i.e. based on framework agreements with the contractors).

From discussions with Global Connect, it is DBA's understanding that discounts can be obtained for bigger projects, especially when a sufficient planning period is possible. Global Connect has informed DBA that when doing a tender, discounts of around 20 to 30 percent are normal for projects of 2 to 3 kilometres or more.

It is DBA's view that a national deployment of network, would likely give rise to even larger discounts.

On the other hand DBA considers that TDC may already be able to efficiently negotiate discounts for low-scale projects due to the size of the company. Therefore it might not be possible to directly compare the discounts Global Connect obtains with the discounts TDC obtains on framework agreements with the contractors.

TDC will ask TDC for more information regarding the level of discount in parallel with the third consultation period.

In relation to TDC's comment on 'text book microeconomics', DBA believes that this is a very hypothetical discussion. However, for the sake of the discussion, DBA does not agree that a national roll out would lead to increasing prices. Since Denmark is not a closed economy supply of labour and material can be expected from neighbouring countries. For instance, DBA would expect large projects as e.g. Storebæltsbroen and the Copenhagen Metro has given rise to lower "unit costs" compared to smaller projects.

DBA notes that ComReg, in its decision D01/10 has used a similar approach: *"Subsequent to ComReg Document No. 09/39, Eircom submitted, on a confidential basis, the revised contractor rates, based on recently re-negotiated contracts. The model was subsequently updated with this more recent information. In addition to the updated contractor rates, ComReg has adjusted the contractor rates for economies of scale to account for the benefits that might arise from deploying a new and larger network."*

Trenching strategy - road crossings
TDC insists that this calculation is revised since it cannot be used as a method for deciding between diggings in one or both road sides. Consider following example:

[Figure redacted]

Roadside digging 300 m x XX DKK/meter = XX DKK each roadside.
TDC approach: 12 road crossings, 9 meter each at XX DKK/meter = XX DKK. Hence digging both roadsides is optimal.

DBA approach: 12 road crossings, 9 meter each at XX DKK/meter = XX DKK. Hence digging only one roadside is optimal.

TDC requests that DBA revise the calculations to reflect a correct use of the method described in section 3.4.9 of the model documentation.

See also '*Comments on the SQL-code'* below.

DBA has adjusted the calculation for the trenching strategy. In order to take into account TDC's comment, a cost-factor has been introduced in order to differentiate a roadside trench and a crossroad trench. An algorithm has been introduced that performs an optimisation by comparing costs rather than an optimisation by comparing prices.

It has been supposed that the cross-road was always performed using tunnelling, and roadside was using the national distribution of ground types, except tunnelling.

This leads to a cost ratio (called 'Trenches_RoadCrossToSideCostRatio' in the model) of 5.14, meaning that crossing the road is 5.14 times more costly than digging alongside the road.

A parameter 'Trenches_RoadCrossToSideCostRatio' has been introduced in the SQL model (in the table "Parameters").

The SQL calculation has been adjusted in order to take into account this parameter for the choice of the optimal trenching strategy.

Price trend for cables.
TDC states that DBA has rejected to include TDC's suggested price trends. TDC dispute DBA conclusion and has provided further documentation; see Appendix 1, sec. 3.3.3.

DBA notes TDC's comment. The year 1989 chosen by TDC corresponds to a temporary peak as it can be seen on other sources[3]. DBA does therefore not find the values provided by TDC relevant.

It can be observed from the source provided that the period form 1984-1987 has been a stable period. As 30 years period is close to the 35 years used for the cables asset life, it seems reasonable to take 1984's value as a reference for the starting year. Over the past 30 years, the copper cost went from 1,501USD in March 1984 to 6,650USD in 2014. This represents an increase of 443% in 30 years, which leads to an annual trend of 5.1%. DBA finds therefore relevant to keep the copper cables price trend to 4%.

Therefore DBA does not believe that any changes are needed.

Lifetime for sea cables and chambers
<u>TDC</u> states that given that the 35-year lifetime approach is sustained, TDC finds that lifetime for sea cables and chambers should be aligned with 35 year lifetime.

DBA does not agree with TDC that the lifetime for sea cables should be aligned with the lifetime of the other assets. DBA has analysed the asset lifetime of access cables, and does not believe that there is a rational for aligning the lifetime of core assets with the lifetime of access assets.

DBA would like TDC submit further information on the lifetime of these assets.

Use of trays
<u>TDC</u> finds it odd that DBA can conclude on the use of trays based on two-tree observations on site visit when DBA on the other hand focus on detailed geographical modelling on the access network in order to avoid statistical sampling error.

TDC has not always used trays in its historical network. However, for modern cabling in staircases etc. trays are used – not only due to TDC rules but mainly due to requirement from building owners etc.

TDC shall requests use of trays in the modelling of a modern network.

DBA notes that the discussion of modern equivalent asset is normally related to cost efficiency i.e. which asset would provide the best capacity at the lowest cost. To DBA's understanding, trays are mainly

[3] http://www.indexmundi.com/commodities/?commodity=copper&months=360

deployed for cosmetic reasons and do not improve quality or lifetime of the network. On this basis, DBA does not see the question of deployment of trays as related to defining the modern equivalent asset.

Therefore, DBA is of the view that the actual deployment of trays should be captured in the modelling of the networks.

As TDC today uses trays for new fibre deployments (and to a very limited extend have deployed fibre without using trays), it is DBA's view that trays should modelled for the entire fibre network.

DBA understands that trays are not deployed for a large part of the copper and coax networks. Therefore, DBA will not model trays for these networks.

On several occasions, DBA has asked TDC for the actual deployment of trays for the copper and CATV. TDC has not been able to provide this data. On this basis, DBA will not model trays for the copper and CATV network. If TDC can provide sufficient documentation on the actual deployment of trays, DBA are willing to reconsider this decision.

NTP
TDC highlights that DBA states that these costs are already captured. TDC request DBA to show in which asset this cost is captured. TDC furthermore request that the cost calculations are decomposed for the operators evaluate. As a minimum it should show:

- Cost of materials
- Installment services and costs

Specifically explain how is the wall perforation captured, and what is the cost? Cost for mounting is captured how? I.e. explain the timeframe allocated for each installment and the wage rate used. If any mass production optimization is incorporated please explain how much and how.

TDC requests this area to be revised. TDC requests that the documentation is updated to reflect this area.

DBA notes that TDC has brought forward a cost of 1500 DKK for the installation of NTP in the first consultation round. As stated in the consultation note for the first consultation round, DBA cannot investigate the cost level proposed by TDC as it lacks details.

In order to have a NTP installed, the end-user must pay for the fee "Installation of Net Temination Point" and "New Installation- Ingineer assisted". DBA notes that the modelling of these fee has not changed compared to the last model.

The fee “Installation of Net Temination Point” includes the cost of the NTP and working time for the technician to install it. Other cost such as the transportation is captured in the fee “New Installation- Ingineer assisted”.

If DBA should be able to assess TDC’s proposed cost level for the installation of net termination point, the information provided by TDC needs to be more detailed.

Ducts Inbuilding
TDC notes that the model still contains 15.242 km ø110mm duct and 606 km 40mm duct for inside use. TDC requests that these are replaced with proper cable trays, as submitted in the answers to DBA’s questions of April 2, 2014.

DBA agrees with TDC that it is not correct to model ducts for inside use.

The ducts inside buildings have been removed from the model.

Regarding the modeling of cable trays, please see the section “Use of trays”.

Ducts and trench size
TDC states that the access model contains 95.147 km 110mm duct and 129.488 km (107.410 km for copper and 22.078 km for fiber) 40mm duct. 206 km trench is expanded from the standard depth/width. Although DBA states that this has been corrected TDC doubt that this calculation has been done properly.

TDC would expect ducts for fiber cable to be deployed alongside ø110 ducts a high percentage of the time, since both BTO and large copper cables are widespread in dense urban areas.

Keeping in mind that a trench is containing a 110mm duct it would need to be enlarged if any other duct is deployed in the same trench.

TDC requests that the method for trench enlargement is revised.

On the basis of TDC’s comment, DBA has reviewed the calculation of trenches depth and width. **A rule ensuring that the two biggest cables can fit in the dimensioned trench (in terms of width) has been added in the LRAIC model to respond to TDC’s comment that a trench containing a 110 mm duct (or the biggest cable) would need to be enlarged if any other duct (or the biggest cable) is deployed in the**

same trench. If this constraint is not met, the trench needs to be deeper.

However DBA wants to remind TDC that the copper network do not use ducts, and therefore trenches would most of the time not require to be enlarged as much as a ducted network.

The trench size is determined by using the following rules provided by TDC:

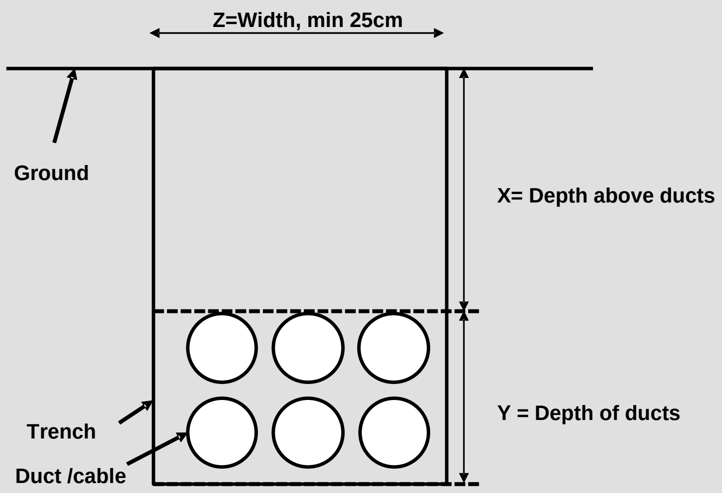
- A trench has a standard height of 60cm and a standard width of 25cm;

- A cable (or duct) must be at least 40cm under the ground (Figure below, X = 40cm);

- The width of the trench must not be filled by more than 60%;

- The height of the trench where cables are located must not be filled by more than 60%.

Figure - A trench



Source: DBA

In order to estimate the space used by ducts in a trench, a volume is attributed to cables (or ducts). As there should be at least 60% of empty space between cables, the volume considered for cables, including this 60% of space is calculated by the formula: .

Following this diagram, one additional rule is considered: the value of Y should be twice the value of Z.

A 3-step approach is required to assess the size of the trench based on the design rules listed above:

- a. Check if the standard trench size is sufficient: This is the case if the sum of all cables (or ducts) diameter is less than 60% x 25cm. It means that the width of all cables (and ducts) aligned horizontally in the trench and separated by space with a length of 60% of their size is below 25cm. If this is not the case, configuration “b” is tested.
- b. Check if a trench with standard width and increased depth is sufficient: In this case, the depth is increased up to when the trench section (YxZ) is higher than the sum of the volumes of cables (volume including free space as explained above). If this is not the case when Y reaches 50cm (2xZ), then configuration “c” is chosen.
- c. c. Digging more is not sufficient, enlarging the trench is also required: In this case, the width and the depth increase at the same time following the rule Y = 2 x Z, by ensuring that the total volume of cables (calculated as explained above) fits in the trench..

On top of these rules, a cross-check rule is applied to respond to TDC’s comment: the two biggest cables (or ducts) must fit in the trench, and being spaced by 60% of space. The depth is therefore calculated as the maximum between the depth calculated above and (Diameter1 x 1.6 + Diameter2).

MDF/ODF costs

TDC requests that these cost are decomposed into material, technician and administrative costs. TDC would expect a large percentage of the costs to be technician wages. Therefore is does not seem proper that that the jump from MDF10000 to MDF50000 only is 2x the cost. The ODF2000 cost of 60.000 dkr seems to be an error.

DBA agrees with TDC that the cost of the MDF and the ODF should be split between asset and installation time instead of asset and a mark-up as it is currently implemented in the model. This would increase the model transparency.

As stated in the answer to the comment “MDF/Street cabinet I”, MDF costs should be similar to the PDP costs of the access network cost model.

The MDF costs have therefore been reviewed. In particular, the cost of the asset MDF50000 is now five times the cost of the asset MDF10000.

The cost of the ODF2000 has also been reviewed as it was incorrect. It has been set to 235,000 DKK.

The spreadsheet "Network assets and costs" has been updated by setting new prices for assets 1 to 15.

Deployment of chambers in the fibre model

Telia and Telenor state that in the FTTHP2P setting, dimensioning of the model leads to deployment of 1,363,963 chambers - most of which deployed between PDP and SDP. In addition, the model calculates deployment of 536,407 distribution points.

According to the model documentation, a joint is used from the SDP to the PDP every time two cables have to be aggregated and a chamber is installed at every cross-road where a joint is installed.

Telia and Telenor are puzzled by this deployment of chambers and more generally by the fact that 1.9 million de facto distribution points are needed or represent an optimal network roll out in a network covering 3.4 million premises. In particular, it is not clear how it can be optimal to deploy that many distribution points compared to an alternative roll out relying on far fewer joints/aggregation points of the individual fibre cables. Telia and Telenor encourage DBA to check with TDC what the distribution point per household ratio is in the DONG fibre network.

In the current model, chambers amount to bDKK 15 in CAPEX that is 28% of the total CAPEX. Telia and Telenor would very much have liked to have had the opportunity to meet with DBA's consultants prior to the second round of consultation to have these key design issues further illuminated. Instead further insights will have to await the scheduled meetings after the current consultation.

DBA has held a meeting with GlobalConnect on the 13th of May to get input on the issues raised by Telia and Telenor.

As deployment of chambers depends on the number joints, DBA will mainly focus its answer on the joints modelling. DBA would first like to remind Telia and Telenor that in the previous consultation, joints modelling had been adjusted:

- For the aggregation part (SDP to premises), for copper and fibre, a dedicated duct has been rolled out between the SDP and the premises. There is therefore no more need for joints in this part of the network.
- For the SDP part (between PDP and SDP), in the first consultation, a joint was installed automatically at each cross road, even if only one cable is incoming from other sections (and therefore does not require any joint). This was adjusted in order to deploy a joint at each section (longer than 15m) only when two cables need to be aggregated. This was implemented for the copper part for the second

version of the LRAIC model and DBA has now implemented it for fibre before the 3rd round of consultation..

- For the PDP part (between PDP and CO), for copper a joint is installed on each section crossed by a PDP cable being longer than 70m (SQL parameter “MinSectionLengthForJoint_PDP”). This leads to an average distance between joints of 300m for copper. For fibre, the same value was used in the first consultation. However, having considered the fact that GlobalConnect explained during a meeting with DBA (see below) that joints were less often needed in FTTH compared to copper, the SQL parameter is set to 100m for FTTH.

The adjustment for the FTTH modelling leads to a modelled network that requires 737,615 joints in the FTTH P2P scenario for SDP and PDP parts. The cost attributed to chambers is bDKK è;à in CAPEX. This is therefore much smaller than the numbers quoted by Telia and Telenor.

For copper, GlobalConnect indicated that the design rules used in the model are reasonable. DBA further checked with other available data (confidential data from another European country). The “distribution point per premises” ratio was in line with Danish figure (around one every two premises). As a consequence, DBA believes that there is no reason for modifying this for the copper scenario.

With respect to FTTH, GlobalConnect said that there are two possible approaches to deploy joints:

1) to have many joints and optimised size of cables;

2) to have long cables but optimised number of joints.

GlobalConnect considered that the two approaches were acceptable but indicated they implement the second one. As explained above, GlobalConnect also stated that joints were less often needed in FTTH compared to copper.

DBA notes that Telia/Telenor has not brought forward any alternative dimensioning rules, and no clear argument to support the second modelling.

DBA notes that the number of joints for FTTH network is 15% higher than the number of joints for the copper network (645,362 for the copper scenario vs 737,614 for the FTTH P2P scenario). However the biggest cables in the FTTH network are much smaller than biggest cables in the copper network. This justifies the need for more joints.

DBA does therefore not propose to change the way it is modelled, unless it can be justified that this approach is inefficient.

Use of joints
<u>Telia and Telenor</u> notes that for the PDP part of the access network it is stated in the documentation (page 35) that:

> *"A joint is installed at each section if the section length is longer than 40 meters. The size of the joint corresponds to the size of the PDP cable."*

For the SDP part of the access network it is stated (page 36):

> *"From the SDP to the PDP, a joint is used every time two cables have to be aggregated as shown on the Figure 26 below. If the section is smaller than 30 meters, no joint is installed.*
>
> *Each time a joint is installed, a jointing hole is required to install the joint. A jointing hole can be shared by several joints."*

In the latest model version, 672,656 joints are being deployed between PDP and SDP and 189,642 are being deployed between CO and PDP at a total capex of approximately bDKK 3.4.

Telia and Telenor firmly believes that the extended deployment of joints in the network is based on a misunderstanding from DBA's side. According to the model documentation, The PDP's and SDP's appear to be deployed in the network for the very same purpose joints are deployed for – namely to distribute/aggregate the network. There are more than 500,000 distribution points (with jointing boards) deployed in the model and adding more than 1,200,000 new de facto distribution points in the shape of additional jointing boards/boxes leads to a highly inefficient network design with high costs and low quality of service due to the high jointing frequency of the cables. In effect, DBA plans for deployment of more than 1,700,000 distribution points which is 4 times the number of distribution points deployed in the existing model.

Telia and Telenor have interviewed network design experts from Global Connect regarding the use of joints in the network. The experts' take is that buried joints are used in the fault repair phase, e.g., after accidently digging across a cable, and not in a new roll out phase. Telia and Telenor will be happy to help to establish contact between Global Connect and DBA to clarify this issue.

DBA should consequently reconsider the deployment of distribution points in the network and in particular the use of joints as a means to aggregate cables at all crossroads which appears inefficient compared to deployment of smaller sized dedicated cables for different routes from PDP to SDP. The cable cost savings from deploying, say, one 400 pair cable instead of two 200 pair cables are indeed more than off-set if this implies deployment of a joint at a cross-road nearby. In this context it is also important to be aware, that the costs of handling two 200 pair cables are only marginally higher than the costs of handling one 400 pair cable.

DBA has noted Telia and Telenor's comment that the number of copper joints in the model may have been over-estimated.

When investigating this issue, DBA has received no proposal for alternative design rules from the respondents. TDC has been unable to provide more detailed information on the joints count in its network. During a meeting with DBA, GlobalConnect has confirmed that DBA's implementation of copper joints looked reasonable, as explained above.

DBA has investigated practices regarding joint deployment for FTTH in France. ARCEP has published in 2012 a synthesis of deployment engineering practices used by operators to roll-out a FTTH network[4].

It can be observed from diagrams provided by different operators (page 7 and following) that many joints are installed between the "SDP" and the "PDP" in operators' architectures (NB: "épissures" means "joints"), in accordance with the engineering rules implemented in the LRAIC model.

DBA has also contacted a network designer On-X, specialized in fibre networks design in France (www.on-x.com). They have confirmed that they suggest to their clients the architecture that DBA has implemented, that is to say installing a joint as soon as two cables need to be aggregated. Three main arguments have been raised:

- the total cost of cable handling is reduced (less cables);
- the space required in ducts is reduced, so the total duct material and handling cost is reduced; and

it adds points of flexibility in the network which is quite important to reduce the cost of repairing faults.DBA see therefore no reason to change its modelling.

Joint cost inputs have been asked to several operators involved in FTTH deployments in order to cross-check costs that have been provided by TDC. DBA will therefore analyze answers that will be provided by these operators in order to adjust implemented costs if necessary.

At this stage, DBA does not believe that any changes are needed.

[4] http://www.arcep.fr/fileadmin/reprise/dossiers/fibre/synth_contraintes_ingenierie_reseau-sept2012.pdf

Modelling of chambers and ducts in copper network
<u>Telia and Telenor</u> state that in the second version of the draft model ducts and chambers are not used for the copper network as stated by DBA on page 58 in DBA's consultation note. Telia and Telenor support that ducts and chambers should not be used for the copper network.

However, ducts and chambers are still dimensioned for the copper network in the second draft version of the model. The modeled costs for ducts and chambers in the copper network are later removed by the percentages in the "Share of costs taken into account" section in sheet Parameters in the Access Excel file.

Telia and Telenor find it counterintuitive to dimension unnecessary assets and introduce an artificial modeling step where the costs for these assets are subsequently removed. In the current model version a sheet like "Key figures" is directly misleading because the subsequent removal has not been taken into account.

To improve transparency in the model, DBA is asked to consider a more direct modeling approach where duct and chambers are not adding in the first place when modeling the copper network.

DBA agrees with Telia and Telenor that this would improve transparency.

DBA has removed the dimensioning of ducts for the copper access network from the SQL model. Furthermore the DBA has adjusted the Excel part of the model in order to reflect the change in the SQL model.

Error regarding deployment of duct in the copper access network
<u>Telia and Telenor</u> state that in Cell K115 in the "Parameters" sheet in the access model has not been set to zero. Deploying duct in the private section of the access network is not in accordance with DBA decision to shorten the lifetime of trenches and not to model duct and chambers in the copper network, cf. page 58 in consultation note.

DBA agrees and has made this adjustment. **The cell K115 in the "Parameters" sheet has been set at zero in the new version of the model.**

Ducts dimensioning
<u>Telia and Telenor</u> state that in the first consultation, TDC argued that it is a "common rule" only to deploy one fiber cable per 40 mm duct.

Telia and Telenor has presented Global Connect with this TDC view. Global Connect does not at all recognize the existence of such a standard or rule. In fact, Global Connect argues that it is common practice to deploy two fiber cables in a 40 mm duct if needed.

Clearly TDC alleged common rule does in practice restrict contractors and will lead to increase in costs if applied. It is very difficult for Telia and Telenor to provide direct evidence that TDC does not restrict contractors in this manner. Hence DBA should instead ask TDC to verify the alleged existence by submitting actual arrangements with contractors where these roll-out restrictions are stipulated.

DBA had a meeting with GlobalConnect on the 13th of May. GlobalConnect has confirmed that multiple cables can be installed in a 40 mm duct. As a consequence, DBA agrees with Telia and Telenor that a 40 mm duct can host multiple cables.

However, having one or several cables in a given 40mm duct is not a design rule as such but more an observation as a result of the application of the design rule. The fundamental design rule used for trench dimensioning (as explained by TDC and as explained in section 4.4.1 of the model documentation), consists in comparing the inner surface of ducts with the outer surface of cables (plus a rule that duct cannot be filled by more than 75% of their surface) to calculate the number of cables in a given duct. It is obvious that only this rule can ensure that cables can be installed inside ducts.

This is the rule that is used and this rule is not inconsistent with the observation that multiple cables can be installed in a 40 mm duct (this ability is just the consequence of the fundamental rule).

The fundamental rule is already the one implemented in the model.

As a consequence, no change is needed.

Also, DBA would like to highlight that for the final drop, this issue is even less relevant as there is always only one cable per duct.

Use of opex from a new network

TDC states that according to DBA, page 47, the opex level should be based on a opex required for a new network. TDC disagree in this perception. LRAIC models are modelled to ensure cost recovery over the lifetime of the assets and the belonging maintenance cost. By adapting an opex level of a new network, the SMP will never obtain cost recovery when opex increases over time. In order to ensure cost recovery the opex level should correspond to mid aged efficient network.

Alternatively the depreciation profile should be adjusted to factor in the decline value of the investment (due to higer yearly maintenance costs).

TDC requests DBA to consider an opex level of a mid aged efficient network.

DBA would first of all like to note that the LRAICprinciple does not guarantee the calculated cost level corresponds to the regulated operators historically incurred cost. The LRAICmodel considers the level of OPEX and CAPEX for a newly build network, where only efficiently incurred cost should be taken into account. It is likely that this principle underestimates TDC’s OPEX but also overestimates TDC’s CAPEX compared to the historical incurred costs.

Further, DBA does not necessarily agree that TDC will never get cost recovery if the OPEX level of a new network is used. That is, the development in OPEX is unclear taking potential productivity gains, inflation and higher LFI into account.

Therefore, DBA does not agree with TDC that the OPEX level of a mid-aged efficient network should be considered.

In practise, however, it is difficult to assess the OPEX level in a new network as there is not a lot of benchmark information on new build copper networks. Therefore, DBA has used TDC’s historical OPEX (from the regulatory accounts) as the starting point of the analysis of OPEX.

For the specific case of OPEX related to ‘Operation and maintenance’, the information on historical OPEX has been analysed against available benchmark data for a newly build network. Results from this analysis (see section “Comments on LFI analysis”) show that the level of faults observed in TDC’s network are not higher than the level of faults of a new network. In this case, no adjustments have been made to TDC’s historically incurred OPEX.

For the remaining OPEX categories, ‘Support/Overhead’ and ‘Design/Planning’, DBA has not been able to verify the cost levels based on the information provided by TDC. Therefore, DBA would like TDC to supply additional information regarding these two OPEX categories.

OPEX related to ‘Operation and maintenance’ has been updated from DKK XXXm to DKK XXXm. The remaining categories have been kept at DKK 0 but will be updated based on information provided by TDC.

Opex for ducts vs. cables
TDC states that DBA has introduced a network layout in the copper part that doesn't make use of ducts. In contrary to the network with ducts, capex for ducts as well as opex for ducts are removed in the model. In TDC's opinion, the opex have been put on ducts somehow arbitrarily by a mark-up in order to reach a total opex cost for the access network. In practice TDC finds no opex related to duct. When the network has been laid down in the ground, the faults that initiate fault handling are the cables that have been compromised. TDC never receive a fault on ducts where the cable works properly.

TDC finds that when avoiding ducts, the opex from ducts should be shifted to a higher opex level on cables. This should be seen both from a model perspective to ensure a fair and reasonable opex level on the copper network, and from a actual network view where ducted cables ensure faster and cheaper maintenance and fault repair compared to directly buried.

TDC requests DBA to reallocate opex from ducts to cables and in general to increase the opex level in the copper access modelling in order to simulate faults on less protected directly buried cables.

DBA believes that it is very difficult to identify OPEX related to ducts as access network OPEX are almost always related to cables. DBA agrees that duct OPEX can be seen as zero. As a consequence, it is indeed relevant to reallocate these OPEX which were allocated to ducts to cables.

DBA has allocated ducts OPEX to cables and calibrated the model in order to reach a relevant level of OPEX (i.e. duct OPEX + cable OPEX). To conduct this calibration, DBA has used what is called the "Event driven opex" in lines 59 to 69 of the network opex spreadsheet. These "Event driven opex" have been increased to reach the required level of OPEX (i.e. with former duct OPEX).

As is explained in the next comment, access network OPEX have generally be recalibrated in this round of consultation (see next comment).

Access opex in copper model scenario
TDC finds no relationship between the outcome of the LFI analysis (commented below) and the opex used in the model. Furthermore, TDC finds huge deviations to the copper related opex inputted by TDC despite that DBA is modelling in larger net. In the table below, TDC has made the comparison between second draft and TDC's submission to DBA.

Besides huge reduction in the operations and maintenance cost (which DBA attempts to model in the LFI analysis), DBA seems to ignore cost for support/overhead (the part which are not IT-related) and cost for design and planning.

Table 3. Access opex comparison.

Copper access Opex, mDKK/Year	**LRAIC, 2. draft, ex. IT/NMS and Corporate overhead**	**TDC TD, LRAIC relevant, ex. IT/NMS and Corporate overhead**
Operation and maintenance	172*	XX
Support/Overhead		XX
Design and Planning		XX
Total	**172**	**XX**

*) Opex allocated in sheet 'Costs allocation', row 22.

DBA should further be aware that such low access opex level is not see elsewhere in Europe, see Appendix 1, sec. 3.3.1.

TDC requests DBA to update the LFI-analysis and to update the model with cost for support/overhead and design and planning.

DBA notes TDC's comments. DBA would like to highlight that the value of XXX mDKK for copper access OPEX as present in the second version of the LRAIC model was underestimated. As explained in the previous comment, ducts generate part of the OPEX. The model had been calibrated on the right level of OPEX before removing the ducts for copper, and therefore the remaining amount of XXX mDKK was not relevant anymore.

Operation and maintenance costs should be taken into account as they are related to the operation of the network and the maintenance that ensure a reasonable level of OPEX for the future years.

DBA believes that Support/Overhead costs are not to be included in the access model as they are already part of the markup introduced in the core/pricing model. If these costs are considered by TDC as not included in the Overhead costs present in the Core part of the LRAIC model, TDC should specify the type of costs that are included in this cost category. DBA finds these costs not relevant for the considered scope and TDC comparison is flawed.

TDC has explained that design and planning costs include costs that are not capitalised. DBA shares TDC's view that part of design and planning costs can be part of the OPEX. However, due to the high amount of this cost category, more justifications on the nature of these costs should be provided to assess if these costs should be included in the LRAIC model. In the meantime, DBA will disregard this cost category.

DBA agrees with the rest of the analysis provided by TDC in the file “Historical network and wholesale cost for TDC 2012 (confidential) v4.xlsx”, that means that xxx mDKK for operation and maintenance have to be included for the OPEX in the access modelling.

DBA has compared the LFI of TDC with the LFI of an efficient operator. It appears that the LFI that TDC observes is close to the LFI of an efficient operator, and therefore OPEX observed by TDC can be considered as the OPEX that an efficient operator would observe in a newly deployed network.

DBA is therefore of the view that the relevant level of OPEX of TDC network that should be considered is XXX mDKK instead of XXX mDKK in the current version. In the LRAIC model, it can be observed that the level of OPEX has been calibrated to reach XXX mDKK (see spreadsheet “Key figures” line 64).

Comments on LFI analysis
<u>TDC</u> states that regarding the actual use of TDC fault data, TDC has found that DBA uses the wrong figure to compare TDC LFI with international benchmark. DBA has used the number of raw copper faults (and associated LFI 6,7%). However, the raw copper statistics do not reflect the general fault level of the access network – e.i. primarily the physical network between distribution points in the network – only specific faults related to the product – e.g. cabling in the MDF.

In DBA’s attempt to scale TDC opex base, the right LFI to compare is the one produced from cable faults,, “Kabler”, that is XX yearly faults. When dividing with the number of active pairs (without taking CATV into account) the LFI in TDC’s net to compare with international standards is 4 %, thus the cost base should not be adjusted down wards. One could argue that the cost base should be lifted to deal with the copper pairs used for the included CATV-customers in the copper scenario.

In general, TDC doubts if a fault level of 4% is representative, see appendix 1, sec. 3.2.

TDC requests DBA to adjust the opex level to reflect that TDC is on par with international benchmark, and to reflect that the model deals with a larger network.

DBA has reviewed TDC's information and observes indeed that the LFI for "raw copper" (i.e. part of the access network between the NTP and the MDF) is very close to 4%.

DBA has collected information indicating that a full new copper network would have a LFI of 4% (this information comes from another European country but identity of the country cannot be disclosed for confidential reasons) which is well below many or all of the LFI observed in other countries (TDC has provided benchmark information in this respect, based on publicly available data which confirms this).As a consequence, it can be concluded that the LFI of TDC's existing copper network is close to the LFI of a new network and therefore does not require adjustments.

The level of OPEX in the LRAIC model is calibrated to reach the level of OPEX that TDC observes in it network. It has been performed by modifying the cell J65 of the spreadsheet "Network opex" to ensure that the cell F64 of the spreadsheet "Key Figures" reaches XXX,000,000 DKK.

Jointing holes

During the previous consultation, DBA has included jointing holes at each jointing location in the copper network.

DBA has investigated on the necessity of such jointing holes in the case it is possible to perform the jointing above ground. To do so, DBA has asked questions to TDC and Global Connect.

TDC has argued that jointing is performed directly in the trench, and therefore requires jointing holes with sufficient space for splicing equipment, tent etc.

DBA has asked Global Connect during a meeting on the 13th of May to comment about this practice. GlobalConnect have stated that copper jointing for a new network could be performed above ground, and therefore that joints would not require such holes.

DBA agrees that jointing holes are not needed for a new network. As the new network is deployed, jointing can be performed above ground and thereafter placed in the trench. In this case, a jointing hole is not needed.

DBA has therefore decided to remove jointing holes for the copper network.

Specific comments on CATV model

TDC has following comments based on DBAs description in the Draft specification document.

TDC quotes DBA's text in the section *Equipping the cable-TV network on page 48:*

"DBA considers that a modern efficient operator would deploy the second configuration ("FTTC")"

TDC agrees with DBA, that a modern efficient operator would use this model.

"Furthermore, when studying the maps sent by YouSee, it appears that the first configuration cannot be modelled due to the very low number of last amplifiers locations provided."

TDC does not agree that the number of last amplifiers supplied is very low. For private networks TDC does not always have information about amplifiers and their locations, but it is absolutely possible to model the network anyway based on the supplied engineering rules.

"*When studying the list of addresses provided by YouSee, it appears that many cable-TV active lines are located far from the closest PAP/FTTC node and that some PAPs/FTTCs are located far from the closest active line.*
These issues are due to a lack of correlation between YouSee's technical systems and YouSee's customer systems.
As a consequence, the following rules have been proposed by YouSee:

- *Very small customer areas ((<10 Homes passed) that are far (> 2 km) from the nearest home passed are disregarded;*
- *Small customer areas ((< 100 Homes passed) that are far (> 5 km) from the nearest active construction (PAP, FTTC) are disregarded;*
- *For big customer areas (≥ 100 Homes passed) that are far (> 5 km) from the nearest active construction (PAP, FTTC), a FTTC node will be added.* "

TDC agrees that it for modeling purposes is sensible to disregard Homes Passed cf. the description. Nevertheless the Homes Passed are real, and it must be anticipated, that the cost of supplying these homes are above average.

TDC would like to know, how DBA have compensated for this fact in the modeling.

DBA agrees that TDC has provided an inventory of Yousee's owned amplifiers, that was close to be exhaustive for Yousee's footprint.

However, DBA has not been able to collect information on private networks amplifiers, and has therefore not been able to reach an exhaustive inventory on the national CATV network. Therefore amplifiers have not been used due to the fact that some were missing, and that could lead to modelling errors. DBA has indeed followed engineering rules provided by TDC in order to model the network bottom-up.

Therefore, DBA does not believe that any changes are needed.

TDC quotes the section Preliminary work on cable-TV network inputs p49

"*Equipment has been modelled on the following process:*

- *A coax distribution point is installed for every 4 premises;*
- *FTTC nodes are modelled bottom-up. Starting from the edge of the network down to the aggregation point, every time the number of premises aggregated is above 50, a FTTC node is installed;*
- *from each FTTC node, a fibre is linked to the aggregation point;*
- *at the aggregation point, if some premises are not aggregated by a FTTC node, a new node is added; and"*

As a coax distribution point is installed for every 4 premises, TDC anticipates that this means the distribution point covers 2 premises on each side of a road. Therefore TDC anticipates that road-crossings will be involved for 50% of the Homes passed in areas with detached housing (SDU's).

TDC request DBA to explain the calculations for road-crossing.

These rules are a result of discussions (emails and conference calls) with TDC during October and November 2013 and have been validated by TDC. In particular, in a mail dated from the 8th of November 2013, TDC has stated:

"*If we draw on our experience it can be a reasonable assumption that small plants that are far (> 5 km) from the nearest active construction should be disregarded .*

When we talk about small plants in this context we mean plants with less than 100 Homes passed"

Also, the homes that have been removed represent 156 addresses (0.01% of Yousee's network) on 115 different road sections (0.02% of considered sections to model the CATV network), and 88 "islands". Therefore the impact of this, which has been agreed by TDC, is extremely limited.

TDC quotes the section Roll-out of the network, p. 51

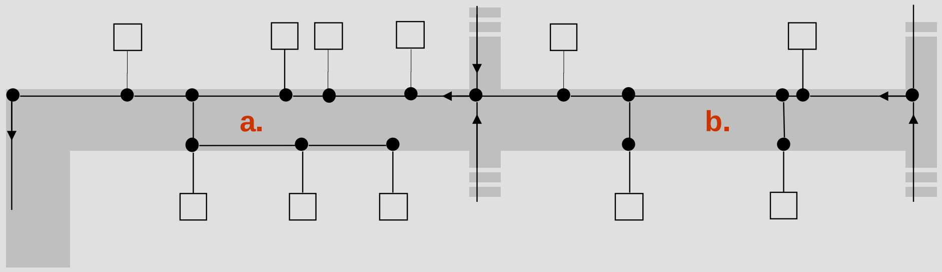
As a coax distribution point is installed for every 4 premises, TDC anticipates that this means the distribution point covers 2 premises on each side of a road. Therefore TDC anticipates that road-crossings will be involved for 50% of the Homes passed in areas with detached housing (SDU's).

TDC requests DBA to explain the calculations for road-crossing.

As for the copper network, trench digging is optimised. If digging trenches on both sides is more cost efficient, this option will be chosen. The model documentation describes how trenches are dug on section 3.4.9 extracted below:

When trenches have to be dug on both sides on the road, there are two main configurations for trenches length (see figure below)

Figure - Road sections configurations



Source: DBA

The first case (a) corresponds to a situation where trenches are dug on both sides of the road, and then the road is crossed once, the case (b) corresponds to a situation where trenches are dug on the main side of the road and then the road is crossed once for each address on the second side.

4 lengths are defined:

- Left_OneCrossLength: length of linking all buildings on the left side (distance between the last and the first building) + crossing the road once

- Left_ManyCrossLength: length of crossing the road once for each building on the left side
- Right_OneCrossLength: length of linking all buildings on the right side + crossing the road once
- Right_ManyCrossLength: length of crossing the road once for each building on the right side

This is calculated in order to minimize the length of trenches dug, by the following process:

1) Identifying on both sides the address closest to the central office and the address the farthest to the central office.

2) Identifying the number of addresses on both sides.

3) Calculating for both sides the length required to send all addresses to the other side by using the case (a), and the case (b) (in the SQL referred as Left_OneCrossLength and Left_ManyCrossLength).

4) Identifying the main side, by identifying smallest combination left length + right length using the value described above.

5) Identifying the trench strategy (one cross or many crosses) by selecting the one minimizing the length.

The trench length on the second side is then the one selected.

It has to be noted that the road width is weighted by a factor in order to take into account the additional cost for tunnelling compared to roadside trenches.

On the main side the length is either the length generated by aggregating houses to the next SDP, or the section length if the road section is used by a route PDP to central office, central office to central office or BTO. In the SQL part of the LRAIC model, this is performed in the procedures “A05_TrenchesStrategy_Calculation” and “A08b_Trenches_Lenghts”.

Regarding section CATV assets mapping, P 115 Table 1 TDC highligts that in the first line in the table it stated that:

- Cable: Single cable per MDU.

It should be single cable per MDU and per SDU. In general, TDC would like to know how the model handles the internal cabling in the multistory buildings – i.e. from the basement to the single flat.

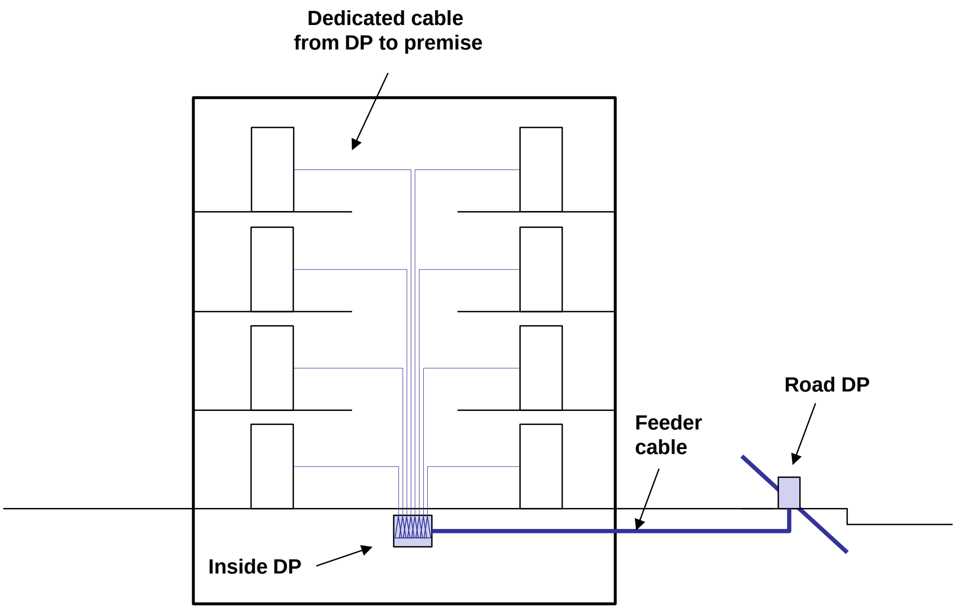
DBA agrees that it should be a single cable per MDU and per SDU in the private part. Height of stairs and length of cables to reach the doors from the stairs are parameters of the model. The following explanations have been included in the model documentation section 5.4.2:

The internal cabling of MDU is handled in a similar way as for the copper network.

A distribution point is installed in the basement of the building, it is fed by a single cable coming from the street.

A dedicated cable is installed from this distribution point up to each flat. The length of each cable calculated based on the height per floor (3.5m), the number of floors and the distance between the staircase and the apartment (4m) (See Fig. 1).

Figure 1



Source: DBA

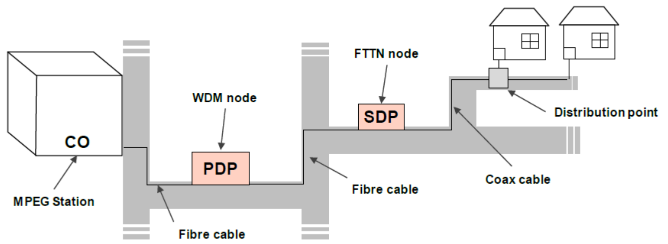
- Trench: Private Property Trench.

How is accounted for road-crossings?

The road crossing is handled as for the copper network. It is not included in the "private" part of the network, but on the "aggregation" part of the network. Every time a road crossing is required, the road width is added to the total length of trenches required. See answer page 108~~107~~ above. This is performed in the "A05_TrenchesStrategy_Calculation" procedure in the SQL part of the LRAIC model.

Cost allocation in access model sheet 'Costs allocation CATV'

Figure 42 – Cable-TV network rolled out



Source: DBA

	MPEG-station	MPEG-PDP	PAP	PDP - SDP	FTTN	SDP - DP	DP	Drop-line
Medium		Fiber		Fiber		Coax		Coax
Cost-allocation		Customers		Frequency-allocation		Frequency-all.		50/50

It is TDC's impression that DBA uses different keys for allocation of costs between TV and Broadband for different parts of the network:

1) Droplines: Costs are divided 50/50 between TV and Broadband

2) SDP – DP: Costs are allocated based on the services relative usage of frequency spectrum

3) PDP – SDP: Costs are allocated based on the services relative usage of frequency spectrum

4) MPEG – PDP: Costs allocated equally over customers

TDC has the following comments to the cost allocation principles:

Re 2) and 3):
TDC supports the basic principle, but has a number of comments to the actual distribution keys.

Frequency allocation is dynamic. The planned allocation for 2015 is reflected in the table below.

Table 4. Frequency allocation

	Channels	%	Redist %
Blocked/technical use	13	11,6%	NA
Broadcast TV/Radio	66	58,9%	66,7%
DVB on Demand	6	5,4%	6,1%
IP (incl. US)	27	24,1%	27,3%

Not available channels and channels used for technical purposes (pilot-tones, Filters etc are disregarded in the redistributed frequency allocation leaving 27,3% for IP and 72,8% for TV (including ODTV).
TDC is currently considering the introduction of specialized services over IP, which means that not all of the IP-spectrum will be allocated to broadband.

Since IP (narrowcast) is the main driver for the need to segment the network, it could be argued, or IP should carry a relatively higher share of the cost than the relative use of frequency spectrum (especially in the PDP – SDP part of the network).

From 2016 TDC plan to start introducing DOCSIS 3.1, which will mean a major shift in the frequency allocation. Firstly the spectrum used will increase from 0-865 Mhz to 0-1,000 Mhz. Secondly a larger share of the spectrum will be allocated to upstream IP.

The model should ready to handle this transition in a way that supports TDC's interest in investing in this upgrade of the network.

TDC requests DBA to consider these forward looking characteristics on the CATV-network.

Re 4):

It is TDC's understanding that:

- One fiber is used for broadcast services (TV).
  The cost for this fiber should be allocated over the total number of TV-subscribers connected (in the relevant area)
- One fiber is used per DWDM-system.
  The cost for these fibers should be allocated over the total number of broadband customers in the relevant area.

This is a simplified approach, since the fiber allocated for TV is also used for upstream Broadband and because DVB narrowcast (Video-on-Demand) uses the fibers allocated for Broadband.

The allocation of costs of the CATV access network has been updated as follows:

The allocation of the dropline is allocated to three services: TV, Broadband upstream and Broadband downstream.

For SDP-DP and PDP –SDP, DBA agrees that it should be related to the frequency plan and plans to use TDC's one. As the frequency plan can evolve over the time, DBA considers that this should be part of the yearly update. This frequency plan has been included in the spreadsheet "Historical inputs – Access" and is used in the spreadsheet "Costs allocation CATV".

For the MPEG-PDP part of the network, DBA believes also that the frequency plan should be used too since all services use the same fibres.

The costs will therefore be allocated based on the following rules:

- **For the dropline (Inbuilding + Private parts), 50% for the TV service, 25% for the Broadband upload, 25% for the Broadband download.**

- **From the edge of the private property up to the MPEG station (Aggregation + SDP + PDP parts), the allocation will be based on TDC frequency plan that will be part of the yearly update.**

DBA should further note that the referred drawing is not correct since the MPEG is not located on each of the COs but on 30 centralized locations in the network. In the model, the allocation method is only used up to the CO (in the access network model).

TDC requests DBA to use allocation key 4 correctly in the access and core model.

As explained during the meeting with TDC, the PDP part includes fibres from the "PDP point" (no equipment) to the MPEG station going through the closest CO. The length between COs to reach the MPEG station is therefore included.

Comments on the SQL-code
TDC has investigated the output files from the SQL query and has following comments.

Calculation of length of road crossing
In the 'Demark_model_v2, output table 'Results_Trenches', the rows 'Trenches_MainSide_Length' and 'Trenches_SecondSide_Length' contains the trenching length for the (defined) main side of the road, and the second side of the road, if road crossing is not used. The length in 'Trenches_SecondSide_Length' is only a fraction of the length of

‘Trenches_MainSide_Length’ (1,6%) meaning that road crossing is used frequently.

- TDC cannot see where the number of road crossings are summarised?
- TDC cannot see where the length of road crossing (number of crossings times the width of the road) is calculated?
- TDC cannot see in which row the road crossing length is exported to excel-calculation?

As road crossing is already taken into account in the trench unit cost calculation per CO (counted as tunnelling), the SQL modelling does not keep the information of the number of the total length of road crossing.

However it has been possible to extract from the SQL model that **the road crossing due to premises on both sides counts for 1,681,000m** in the copper scenario.

- TDC does not understand why ‘Trenches_SecondSide_Length’ is typically an integer values?

The second side length is a combination of trench on roadside and road crossing. The road width has been approximated by an integer value, therefore if the strategy to cross the road is “one cross per building”, the length is a multiple of the road width, and therefore an integer.

- How is Trenches_MainSide_Length and Trenches_SecondSide_Length allocated to Aggregation, SDP, PDP, CORE and BTO in the access file?

TDC asks DBA to clarify the above questions. TDC suggests that the amount of road crossing is calculated directly from the SQL-data instead of using a percentage from the previous model.

Trenches_Second_Side is allocated between Aggregation and SDP based on the following rules:

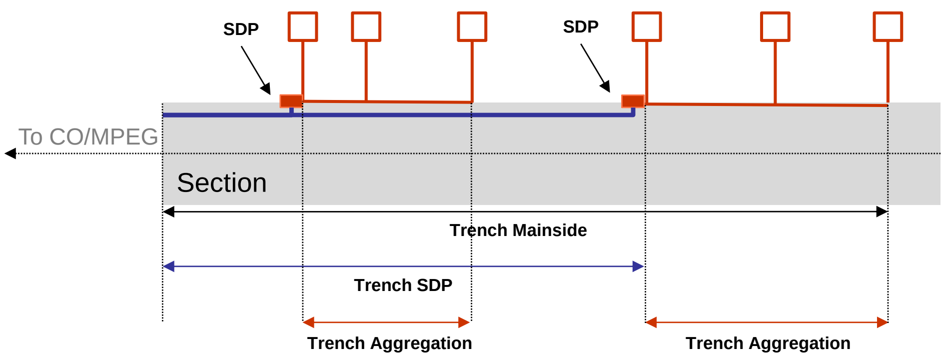
- If no SDP is installed on the second side, all is allocated to Aggregation

- If a SDP is installed on the second side, the length of trenches used by SDP length is calculated, the length of trenches used by the aggregation is calculated. The total trench length is allocated based on the ratios "LengthSDP"/("LengthSDP"+"LengthAggregation") and "LengthAggregation"/("LengthSDP"+"LengthAggregation")

For the main side, the same principle is used. The distances used are calculated as follow:

- If a core link uses the section, the core length is the section length.
- If a BTO link uses the section, the BTO length is the section length.
- If a PDP link uses the section, the PDP length is the section length.
- If the section aggregates a section that had a SDP, if the section holds a PDP, the length SDP to the PDP is used, otherwise the length of the section is used.
- If the section does not aggregate any section that has a SDP and has at least a SDP, if the section holds a PDP, the max length between the first and the last SDP and between the SDP and the PDP is used. If the section does not holds a PDP, the length between the last SDP and the beginning of the section is used (See Fig. 3 below).
- If the section does not aggregate any section that has a SDP and no SDP is installed on the section, 0 is used for the SDP length.
- For the aggregation length, the length of trenches used between the premises and SDPs is used (See Fig. 3 below).

Figure 2



Source: DBA

Length to premises entry point

<u>TDC</u> states that the row 'Length_To_Section' is the distance from the road segment to the front of the house. The average distance is app. 13,8 meter, which is approximate the distance called 'BO_BP' in the previous

model (BO_BP=14,1 meter, see appendix B in the model documentation of the previous model). The cable is however not necessarily drilled through the wall in the front of the house. This can as well be on the sides or on the back of the house. In the previous model this distance was in average 5,7 meters making the total distance 19,8 meter. The sample size in the previous model was large. TDC therefore does not believe that the deviation is caused by sampling errors.

TDC requests DBA to clarify if the calculation failure with regard to the distance from road to premises entry point lies in the previous or draft model.

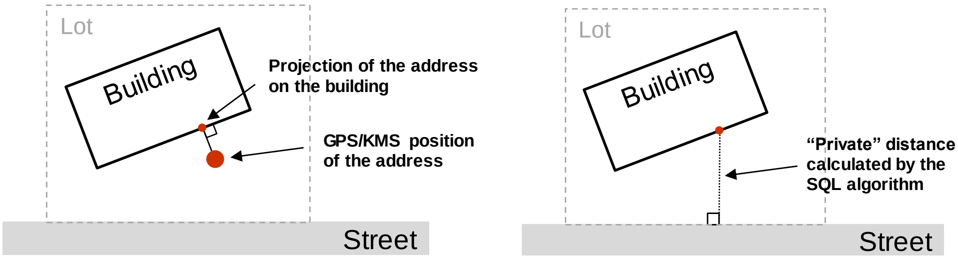
DBA considers that this point has been addressed in the previous round of the consultation, when a non-linear factor for the private property part of 120% has been introduced.

The SQL algorithm outputs a distance for the private part of the network corresponding to a straight line between the projection of the address on the wall of the building and the shortest way from this entry point to the road (see fig. 1 below).

The Excel part of the LRAIC access network cost modle adjusts this value by introducing 20% of additional trenches and equipment to be deployed in the private part of the network, in order to take into account non-linear paths and shifted entry points.

It is also to be noted that the previous model was basing its values on a sample which is less accurate than what is conducted in the new model.

Figure 3



Source: DBA

Distance to pedestrian
TDC acknowledge that the location of the FDP can differ between the previous and draft model. However, a small distance from the parcel to the trench along the road has to be modelled – typically from the parcel

demarcation (fence or hedge) to the pedestrian where the cable along the road is trenched.

TDC requests DBA to include the distance from the parcel to the trench in the drop wire length.

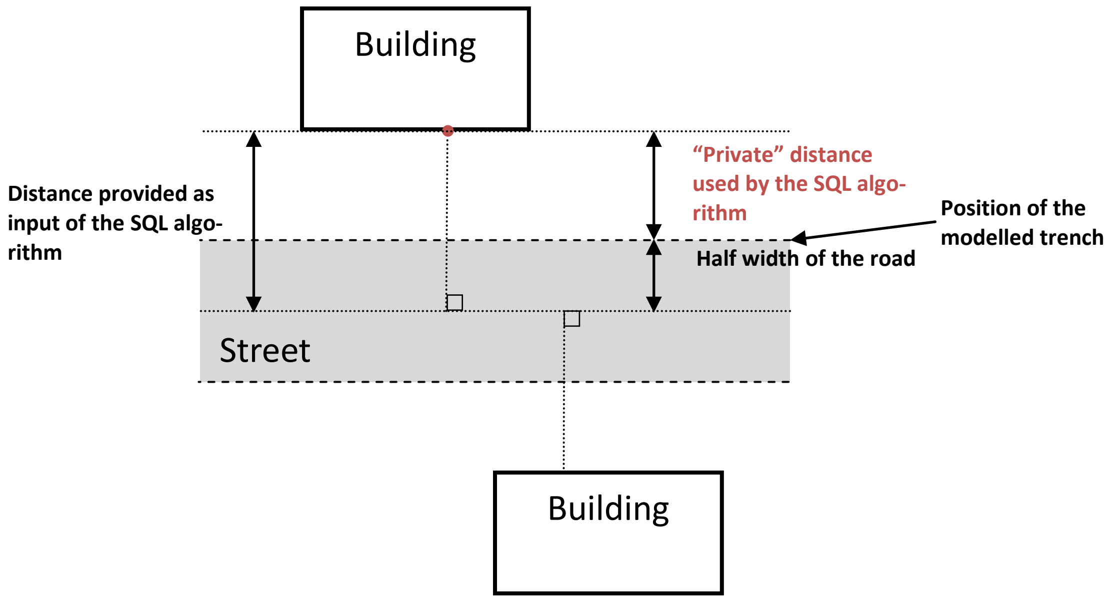
DBA has modelled the network based on the middle of the road (see fig. 2 below):

- The trench on a given side is considered to be positioned at half of the road width to the middle of the road, and

- the length between the wall of the building and the trench is the length between the wall and the middle of the road, minus half of the road width.

DBA considers that no additional distance has to be added.

Figure 4



Source: DBA

Specific comments regarding Leased line

Comments regarding 'Contention ratio calibration'
<u>TDC</u> is surprised about DBA answer to TDC proposal to use the correct figure for the service. As TDC stated 'IP via Fibre' is a well known service in the LRAIC model and TDC has supplied BH figures for this service in the yearly update.

TDC has explained that the figure from the graph includes a double-counting whereby the figure should not be used for calibration.

DBA should consider the derived consequences of rejecting TDC's figure – This is a central part of the yearly update – not just an ad-hoc figure retrieved for the revision process. If DBA fundamentally does not trust these figures, DBA is jeopardizing the yearly update process – how is TDC able support DBA in the yearly update process, if DBA rejects to use TDC measurements?

Given the international traffic TDC's submits to DBA's questions of April 2nd 2014, TDC finds no further major differences between the traffic levels, and therefore finds no reason for traffic calibration. However, if DBA are to use a traffic calibration this should be used on all services and not just the leased line parts: A calibration is done if traffic – in DBA's point of view – is not measured correctly. These potential measurements errors can as well occur on voice or broadband or multicast services (e.g. some ports are missing in the measurement). Therefore it makes no sense to adjust only the leased lines with a calibration factor.

TDC requests DBA to use the figure provided by TDC in the yearly update. TDC furthermore request DBA to make a general calibration on all services if needed in DBA's point of view.

Following the 25th of April meeting with TDC and TDC's answers to the questions submitted at the end of the first round of consultation, DBA is now confident with the figures provided by TDC: after several requests, TDC has provide sufficient material to reconcile the traffic being modelled in the LRAIC core network cost model with the figures provided during the data collection phase.

As stated in the answer to the comment "Traffic services" DBA agrees therefore to update the contention of the "IP via LL service" to 0.05% and to change the way the recalibration factor is working: there is a 9% gap between TDC's figures and the traffic modelled reflecting for a part the international traffic that does not enter the network and that is not measured and for the other part some issues with the traffic measurement. The traffic recalibration will therefore be applied to all services instead of only the leased lines services and will represent only half of the gap observed in order to take into account the international traffic.

The model has been updated to update the contention ratio of the "IP via LL" service and the amplitude and the scope of the traffic recalibration option.

Comments regarding 'Contention ratio for 'IP via LL''
TDC refers to TDC's answer above regarding the 'IP via Fibre'. TDC sees no meaning in taking approved measurements on specific services into hostage when DBA doubts the general traffic level.

DBA cannot be surprised about the low contention of IP via LL. Such low figures have been provided in the yearly updates (total BH Gbps and number off connections have been inputted). The low utilisation comes from lines where the customers' demands are for fixed connections rather than for a high bandwidth and where the lowest bandwidth available is typically sold to the customer despite very low peak hour traffic.

TDC therefore requests DBA to use the 'IP via LL' contention for the 'IP via LL' connections.

TDC notes that a "Contention ratio provided by TDC" of 60% is written in the LL file sheet 'Parameters'. TDC is not aware of this figures and don't see it has any relation to leased line congestions.

As stated in the answer to the previous comment, the model has been updated by setting the "IP via LL" contention ratio based on the traffic submitted by TDC.

DBA also agrees with TDC that the reference to a 60% contention ratio in the LL file sheet should be removed.

The model has been updated by computing the "IP via LL" contention ratio based on TDC's traffic and by removing the reference to a 60% contention ratio.

Pricing issues

CATV-pricing
TDC states that DBA finds that cost drivers in the CATV model is a pricing issue. However, in order to have options to decide in-between, cost drivers should be modelled properly in the model.

DBA should especially be aware that the allocation of cost between upstream and downstream cannot be used for pricing (like it is used in the current model), since upstream cost are modelled as 'incremental' to the downstream cost. E.g. no upstream costs are allocated to 'Inbuilding' and 'Privat' – here 50% are allocated to TV and 50% to downstream.

TDC requests DBA to consider proper modelling in order to be able to support pricing of the Coax-BSA.

DBA will adjust the model in order to allocate the costs from the final distribution point to the MPEG station based on the frequency plan of Yousee.

The 'Inbuilding' and 'Private' parts will be allocated 25% to broadband upstream, 25% to broadband downstream and 50% to TV access (see Fig. 5 below).

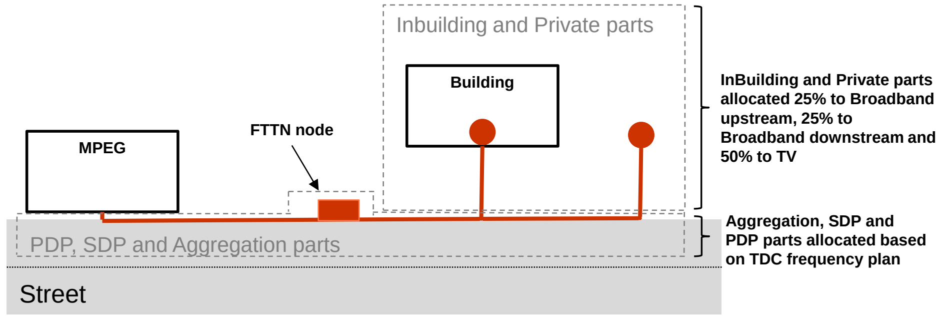


Figure 5

Source: DBA

VULA modelling approach

TDC understand that DBA will decide on the VULA-pricing later on in the pricing phase. DBA should however be aware that if the VULA pricing will be a blend of cost from remote DSLAM and CO based DSLAMs, volume of the blend is required in the years update. Furthermore, TDC suggests the naming of the services in the 'pricing' sheet table 1 to be altered from 'VULA' to 'BSA produced on remote DSLAMs' in ordre to reflect the production method rather than the pricing name.

DBA agrees with TDC that the volume of the blend of remote DSLAMs and CO based DSLAMs needs to be updated yearly. DBA agrees with TDC that it is more.

Furthermore, DBA believes that it is more transparent to rename VULA to 'BSA produced on remote DSLAMs' as suggested by TDC.

Errors

PON scenario not working
TDC states that the number of splitters in the PON scenario is not listed in the access model and hence not imported to the core model. As a result, no GPON MSANs, cards or splitters are added to network modelling, (cells H110-H2935 on sheet *Import from access model* in the Core model and cells H110-H2935 on sheet *Export to core model* in the access model).

TDC Requests DBA to ensure that the PON scenario is proper working end-to-end.

The model has been updated in order to correct the issue raised by TDC.

PTP-scenario
TDC states that when the PTP scenario is chosen, errors occurs on fibre BSA costs in the pricing sheet. TDC request DBA to correct the error.

The model has been updated in order to correct the issue raised by TDC.

Shapely-Shubik
TDC states that in section “2 Shapley-Shubik services permutation”, in the permutation “4 L”, the total opex and/or yearly cost for some MSANs and the “CO and PDP site” produce a “#DIV/0!” result (rows 265–269). These “#DIV/0!” then feed into rows 1232 and 1234 where they prevent the cost allocations of “MSAN – xDSL” and “CO and PDP site” between the four groups of services (voice, broadband, prioritised and leased lines).

The model has been updated by correcting the formula computing cooling cost in the spreadsheet “Network costing” between lines 95 and 100 that was causing the error described by TDC.

TDC states in section “3 Cost allocation”, the labelling of the network permutation in column DE, row 1143 and 1217, should be “BL” rather than “L” as it should be a permutation of two services, not just one.

The model has been updated in order to correct the issue raised by TDC by changing the label in the spreadsheet “Shapley-Shubik”.

TDC states in section “6 Allocation of the network cost”, the “MPEG stations” assets have a “#N/A” value for their “Network level” and “Driver” (cells N/O1394-1396). As a result, they have no cost allocation between the four groups of services (remainders of rows 1394 and 1396).

These costs are not allocated by on traffic. These are part of the cost computed per port. These costs are therefore not allocated in the spreadsheet “Shapley-Shubik but solely in the spreadsheet “Capacity based”.

DBA is therefore of the view that no change is needed.

TDC states they have observed that for both the “Aggregation Switch” and “Aggregation Site” assets, the annualised costs are lower for the network carrying all increments than when carrying only some increments. This is counterintuitive, since it implies there are fewer assets in the network carrying all increments.

This effect is due to allocation of site costs between aggregation switches, edge routers, distribution routers and core routers.

E.g.: in an edge site, the site costs are allocated between aggregation and edge layers. If, when selecting an increment, there are less edge routers, then more site costs are allocated to the aggregation layer. Therefore the aggregation costs of this increment can be higher than the aggregation costs when all increments are selected.

DBA is therefore of the view that no change is needed.

TDC states the mark-up for opex used in section “9 Service unit cost” (subsection “2 With mark-up for non-network costs and IC specific costs”) is a negative mark-up. It is calculated in the “Non network & IC costs” sheet, cell “G128”.

This mark-up was used to reflect the cost of working capital on Opex. However, following other comment, this mark-up has been removed from the modelling.

DBA is therefore of the view that no change is needed.