

# Addendum

## LRIC Bottom-up model for interconnection

Accommodation Costs

DWDM equipment

Signalling Network

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In collaboration with Bureau van Dijk Management Consultants

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## **0. INTRODUCTION**

In this document, three topics will be treated. First of all, the BIPT/BvD approach for modelling accommodation costs in the bottom-up model will be dealt with. Next, an approach for modelling DWDM equipment will be presented and this document will be concluded with a clarification of the structure of the signalling network.

## **1. MODELLING ACCOMMODATION COSTS IN THE BOTTOM-UP MODEL**

On May 21, a meeting was held with the BIPT and its consultant, Belgacom and the platform of telecom operators. One of the topics of this meeting was the treatment of accommodation costs in the bottom-up model. The outcome of the discussion on accommodation costs, was that accommodation costs should be modelled on a per m<sup>2</sup> basis.

The BIPT/BvD will present an approach for calculating the number of m<sup>2</sup> needed. It is the BIPT's goal to model these costs as detailed as possible. However, since this might not always be a straightforward task, an alternative more aggregate approach will be presented for those operators that are not able to supply detailed information.

The model will try to determine accommodation costs for all components in the different switching and transmission centers. The surface requirements should only take into account the actual physical space requirements of the footprint. If different components are provided within the same equipment (e.g. concentrators and ports) two options are possible: or the operator should mention explicitly which components are included in the footprint, or the operator should make the split itself.

Space requirement for corridors, stairs, sanitary equipment, possible desk space, etc.. also need to be considered and are treated by means of a separate 'multiplying ratio' that can possibly vary for the different switching and transmission centers.<sup>1</sup> It should however be made clear that this ratio will be applied to the switching surface requirement, as well as the transmission surface requirements. This means that when switching and transmission centers are collocated, the input of these parameters by the operators should take into account that the ratio will be applied twice for the same building.

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<sup>1</sup> E.g. if the footprint of a specific equipment is 1,5 m<sup>2</sup> and the additional space requirements are 2 m<sup>2</sup>, then this multiplying ratio will be  $2/1,5 = 1,33$

**1.1 Accommodation requirements for the Remote Units and Local Distribution Centers**

**Question 1.1: The BIPT invites the operators to provide the following information regarding the modelling of accommodation costs.**

Preferred Approach

Footprint for line card equipment (X user lines)	m <sup>2</sup>
Number of end-user lines connected to this equipment (X)	
Footprint for concentrator equipment (Y x E1s)	m <sup>2</sup>
Number of E1's that can be concentrated (Y)	
Footprint for ports (Z x E1s)	m <sup>2</sup>
Total capacity of ports in number of E1s (Z)	
Overhead multiplying ratio <sup>2</sup>	

Alternative approach

Footprint of equipment (line cards, ports, concentrators)	m <sup>2</sup>
Number of end user lines	
Capacity of ports (in E1 equivalents)	
Capacity of concentrators (in E1 equivalents)	
% of footprint used for line cards	
Overhead multiplying ratio	

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<sup>2</sup> The overhead ratio will be the same for all of the equipment mentioned above.

## 1.2 Accommodation requirements for the Base Units

**Question 1.2: The BIPT invites the operators to provide the following information regarding the modelling of accommodation costs.**

### Preferred Approach

Footprint for line card equipment (X user lines)	m <sup>2</sup>
Number of end-user lines connected to this equipment (X)	
Footprint for concentrator equipment (Y x E1s)	m <sup>2</sup>
Number of E1's that can be concentrated (Y)	
Footprint for ports (Z x E1s)	m <sup>2</sup>
Total capacity of ports in number of E1s (Z)	
Footprint required for the switching matrix (N x E1s)	m <sup>2</sup>
Number of E1s that can be switched (N)	
Footprint required for processor (M x BHCA)	m <sup>2</sup>
Number of BHCA that can be processed (M)	
Overhead multiplying ratio	

### Alternative approach

Footprint of equipment (line cards, ports, concentrators, switching matrix, processor)	m <sup>2</sup>
Number of end user lines	
Capacity of ports (in E1 equivalents)	
Capacity of concentrators (in E1 equivalents)	
Capacity of switch (in E1 equivalents)	
Capacity of processor (in BHCA)	
% of footprint used for line cards	
Overhead multiplying ratio	

### 1.3 Accommodation requirements for the Covering Area Exchanges

**Question 1.3: The BIPT invites the operators to provide the following information regarding the modelling of accommodation costs.**

#### Preferred Approach

Footprint for ports (Z x E1s)	m <sup>2</sup>
Total capacity of ports in number of E1s (Z)	
Footprint required for the switching matrix (N x E1s)	m <sup>2</sup>
Number of E1s that can be switched (N)	
Footprint required for processor (M x BHCA)	m <sup>2</sup>
Number of BHCA that can be processed (M)	
Overhead multiplying ratio	

#### Alternative Approach

Footprint of equipment (ports, switching matrix, processor)	m <sup>2</sup>
Capacity of ports (in E1 equivalents)	
Capacity of switch (in E1 equivalents)	
Capacity of processor (in BHCA)	
Overhead multiplying ratio	

#### *1.4 Accommodation requirements for the Local Distribution Centers*

**Question 1.4: The BIPT invites the operators to provide the following information regarding the modelling of accommodation costs.**

Footprint for TMUX equipment in LDC (N x E1s)	m <sup>2</sup>
Capacity of TMUX in E1 equivalents	
Overhead multiplying ratio	

#### *1.5 Accommodation requirements for the Local Transmission Centers*

**Question 1.5: The BIPT invites the operators to provide the following information regarding the modelling of accommodation costs.**

Footprint for ADM equipment in LTC (N x E1)	m <sup>2</sup>
Capacity of ADM in number of E1s (N)	
Overhead multiplying ratio	

#### *1.6 Accommodation requirements for the Zonal Transmission Centers*

**Question 1.6: The BIPT invites the operators to provide the following information regarding the modelling of accommodation costs.**

Footprint for E1 cross connect (X x E1)	m <sup>2</sup>
Capacity of cross connect in number of E1s (X)	
Footprint for STM1 cross connect (Y x STM1)	m <sup>2</sup>
Capacity of STM1 cross connect in number of STM1 streams (Y)	
Footprint for ADM equipment in ZTC (N x STM1)	m <sup>2</sup>

Capacity of ADM in number of STM-1 (N)	
Footprint for DWDM equipment (M x STM-16) <sup>3</sup>	
Capacity of DWDM equipment in number of wavelengths with a maximum bit-rate of 2,5Gbps / 10 Gbps.	m <sup>2</sup>
Overhead multiplying ratio	

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<sup>3</sup> More detail on DWDM modelling will be provided in the next chapter

## 2. MODELLING DWDM EQUIPMENT

### 2.1 Introduction

As already stated in previous consultation documents, the bottom-up model will consider the use of DWDM (Dense Wavelength Division Multiplexing) equipment in the core network. DWDM takes full advantage of the inherent capabilities of optical fiber to multiply link capacity up to a factor of 40 to 100 (depending on the performances of the system used and the line speed per wavelength).

### 2.2 DWDM in the bottom-up model

The figure below illustrates the different components that are used to enable DWDM transmission in the core network.

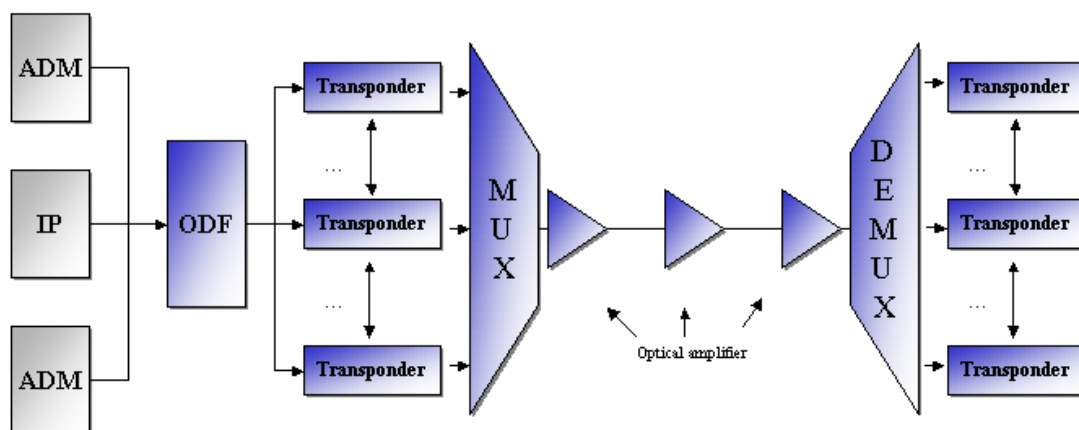


Figure 1: DWDM equipment

Different kinds of traffic (i.e. client equipment with optical interfaces, such as SDH ADMs, IP routers, ...) are routed by means of an optical distribution frame (ODF) to the DWDM equipment. No real optical cross-connects will be modelled. The different client signals are inserted/extracted into the DWDM multiplexor by means of transmitter/receiver cards, also called transponders. A different laser colour (wavelength) is then assigned to each client signal by the transponder, by means of O/E/O conversion. Before the signal is put on the fibre, it is first optically amplified. Additional optical amplification may be necessary to bridge larger distances ( $\gg 100$  km). At the other side, the different wavelengths are first demultiplexed into separate wavelengths by means of an optical demultiplexor before being sent to the transponder cards. On the receiving side, the transponder will typically perform an electrical regeneration of the signal, sometimes also a retiming. The output signal will typically be a fixed standard wavelength (for example, 1310 nm).

Current systems work with transponders that accept signal speeds up to 2,5 Gbps, or up to 10 Gbps, with a corresponding wavelength bit rate. Sometimes, an added functionality in the transponder card allows to multiplex in a TDM way several lower speed signals into one wavelength.

The BIPT would like to remark that, for short distances (3 to 4 km), a direct fibre link between the terminal equipment of two DWDM sites can be feasible. This means that no multiplexing or cross-connecting equipment is needed and that a connection can be provided on separate fibres for each wavelength. For these short distances, the increase in fibre cost may be smaller than the decrease in multiplexing equipment costs. This possibility is however dependent on the physical characteristics of the transponder interfaces. These effects will be taken into account in the bottom-up model.

Based on Figure 1, the BIPT and its consultant have defined the following components and cost drivers.

- **Optical distribution frame:** this cost represents the cost of routing the different optical data streams to the DWDM equipment. It should include all costs except accommodation costs that are related to the ODF, including cabling costs. The cost driver for the ODF is the number of optical connections that it should distribute;
- **Transmitter/receiver cards:** each client optical signal requires a separate transmitter/receiver card that handles the optical/electrical/optical conversion. The cost of these cards should be identified separately and the cost driver is consequently the bit rate per wavelength, as well as the possible presence of a TDM multiplexing function on the board.
- **DWDM terminal multiplexor:** This cost includes the DWDM equipment racks, the optical amplifiers that should be present in this rack, the multiplexing cards and other fixed equipment costs that are present in the DWDM racks. The number of wavelengths per rack and the modularity of the system is typically supplier dependent . The cost driver is thus the total number of wavelengths that it can handle and the bit rate per wavelength.
- **Optical Line Amplifier:** The optical amplifier is needed to repeat the composite lightwave signals when attenuation gets too big. However, normally for distances under 100 km, this should not be necessary. The cost of the optical amplifier is a fixed cost (e.g. for the maximum capacity of the system) with probably different possible modularities (depending on the optical budget of the spans to cover). The cost driver is the number of wavelengths it should be capable to amplify.

### 2.3 Input required from the operators

**Question 2.1: The BIPT invites the operators to provide the following costs regarding the modelling of DWDM equipment in the bottom-up model.**

- **Optical Distribution Frame**

<b>Supplier list price for ODF (N optical connections)</b>	
<b>Number of optical connections that can be distributed (N)</b>	
<b>Date of list prices</b>	

<b>Estimated yearly price change<sup>4</sup></b>	
<b>Percentage of discount on list prices given to operator</b>	
<b>Discount scheme</b>	
<b>Other special terms</b>	

**- Transmitter/Receiver cards**

<b>Supplier list price Transmitter/Receiver Cards</b>	
<b>Wavelength bit rate</b>	
<b>Type of input signals supported</b>	
<b>Type of output signal, maximum range (distance between client equipment and DWDM system)</b>	
<b>Do the cards perform electrical multiplexing ?</b>	
<b>If yes, type and number of signals multiplexed per wavelength</b>	
<b>Date of list prices</b>	
<b>Estimated yearly price change</b>	
<b>Percentage of discount on list prices given to operator</b>	
<b>Discount scheme</b>	

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<sup>4</sup> Price increase: positive percentage; price decrease: negative percentage

<b>Other special terms</b>	

- **DWDM multiplexor**

<b>Supplier list price for DWDM multiplexor (N x wavelengths)</b>	
<b>Capacity of DWDM multiplexor in number of wavelengths (N)</b>	
<b>Modularity of DWDM equipment (in number of wavelengths)</b>	
<b>Date of list prices</b>	
<b>Estimated yearly price change</b>	
<b>Percentage of discount on list prices given to operator</b>	
<b>Discount scheme</b>	
<b>Other special terms</b>	

- **Optical Line Amplifier**

<b>Supplier list price for Optical Line Amplifier (N x wavelengths)</b>	
<b>Capacity of Optical Amplifier in number of wavelengths (N) and wavelength bit rate</b>	
<b>Gain of the Optical Line Amplifier</b>	
<b>Span design rules (type of amplifier, maximum number of spans)</b>	
<b>Date of list prices</b>	
<b>Estimated yearly price change</b>	
<b>Percentage of discount on list prices given to operator</b>	
<b>Discount scheme</b>	
<b>Other special terms</b>	

### 3. MODELLING THE SIGNALLING NETWORK

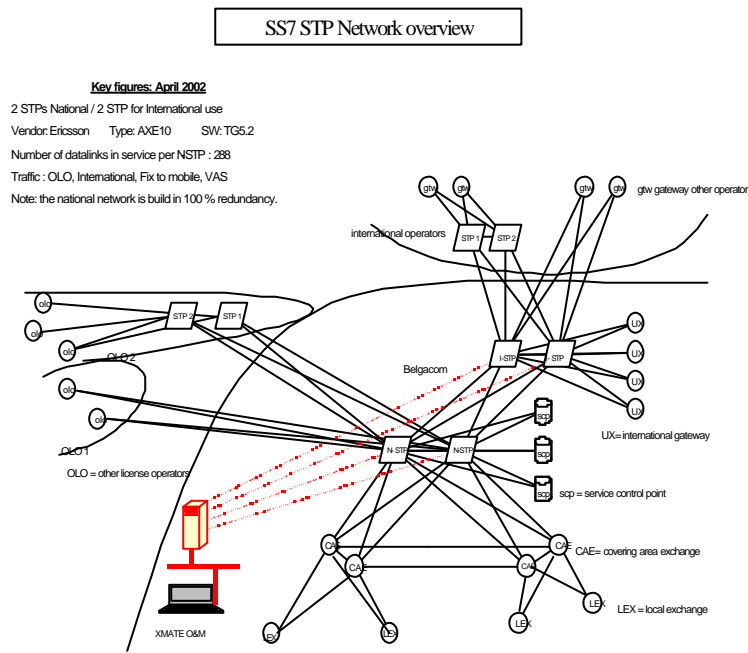
#### 3.1 Introduction

In the second consultation document, the BIPT presented an approach to model the signalling network in the bottom-up model. This approach was based on a meshed structure between the signalling points and the signalling transfer points. The reactions that the BIPT received pointed out that the modelling of this signalling network may not be an easy task, and this for several reasons.

First of all, signalling networks often seem to be over-dimensioned which implies that BHCA are not always a good cost driver. Second, a star topology might be more appropriate to model the signalling network.

#### 3.2 The Belgacom Signalling Network

Belgacom has a couple of years ago redesigned its signalling network from a meshed structure to a partially (double) star topology. The underlying figure describes the current situation of the Belgacom signalling network.



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Figure 2: Belgacom signalling network

There are 2 national Signalling Transfer Points (STP). OLOs have access to these STPs via Signalling Access Points (SEPs). These are integrated in the L-AGEs<sup>5</sup> and A-AGEs<sup>6</sup>.

Besides the 2 national STPs, 2 international STPs are present in the network to handle international traffic. These are irrelevant for the bottom-up exercise, as well as all network equipment (e.g. service control points) that is required to provide value added services since the bottom-up model will only take into account signalling investment that is needed to handle basic call set-ups.

### ***3.3 Decision of the BIPT***

The BIPT has decided to model a star topology approach for the signalling network as implemented by the incumbent operator. This decision is motivated by several factors: first of all, the recent redesign of the incumbent's signalling network indicates an important increase in efficiency. Second, no alternative solution was presented by other operators. Third, the impact of the signalling cost on the final tariffs will be very limited, which implies that the resources required by the BIPT to completely redesign the signalling network may better be used elsewhere in the model development.

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<sup>5</sup> L-AGE: Local Access Gate Exchange = LEX in which local interconnection is possible.

<sup>6</sup> A-AGE: Area Access Gate Exchange = CAE, the SEP in the CAE used to be referred to as a SAP (Signalling Access Point).

#### **4. PLANNING**

Reactions on this Addendum to the third consultation document should be submitted in writing before **Monday, July 15 at 17.00 p.m.** to:

**B.I.P.T.**

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