ANNEX A: DETERMINATION OF THE ROUTING FACTORS IN THE BOTTOM-UP MODEL

1. Introduction

In order to determine unit costs for the different communication types, routing factors have to be derived. These routing factors specify how many times a given resource pool, containing all costs regarding a well-defined (set of) network element(s), is used by a given communication type.

In this section, firstly we will define all resource pools and communication types. Subsequently, the principles applied for the determination of the routing factors will be explained. Finally, the results will be presented.

2. Definition of the resource pools

As already stated in paragraph 1.4 (page 9), the resource pools as defined in the Bottom-Up model are to be considered as *cost pools* that contain all direct and indirect CAPEX and OPEX costs that can be allocated to certain network functionality.

Please note that the sharing of the network components between the different services (e.g. PSTN/ISDN-services versus data services) and between the different parts of the network (e.g. local access network vs. core network) is considered in the dimensioning algorithms. This implies that the costs allocated to the resource pools of the Bottom-Up model are exclusively related to the PSTN/ISDN core network.

In the model, three generic categories of resource pools can be distinguished:

- Resource pools w.r.t. switching equipment:

    1. *Remote Unit (RU)*: This resource pool contains all costs related to the RUs and related to the core network;

    2. *Base Unit (BU)*: This resource pool contains all costs related to the BUs and related to the core network;

    3. *Covering Area Exchange (CAE)*: This resource pool contains all cost related to the CAEs and related to the core network.

- Resource pools w.r.t. transmission equipment:

    4. *Equipment LDC*: This resource pool contains all costs for the core PSTN/ISDN transmission equipment related to a LDC;

    5. *Equipment LTC*: This resource pool contains all costs for the core PSTN/ISDN transmission equipment related to a LTC. Moreover, also the cost of the LTC-part of the ZTCs is included[1];

[1] In the Bottom-Up model, costs related to the ZTCs are split in the costs for the LTC-functionality of the ZTC on the one hand, and the costs for the Cross-Connects on the other hand. Costs for the LTC-functionality are included in the resource pool 'Equipment LTC', while costs for the Cross-Connects are included in the resource pool 'Equipment ZTC'. Conceptually, this is a very important choice,

6. *Equipment ZTC*: This resource pool contains all costs for the core PSTN/ISDN transmission equipment constituting ZTC-functionality.

- Resource pools w.r.t. transmission infrastructure:

7. *Links LDC-host*: This resource pool contains all costs for the core PSTN/ISDN transmission link between the LDCs and their hosts on the regional rings (cables, ducts and trenches);

8. *Regional Ring Links*: This resource pool contains all costs for the core PSTN/ISDN regional rings links (cables, ducts and trenches);

9. *Core Links*: This resource pool contains all costs for the core transmission links (cables, ducts and trenches) related to the PSTN/ISDN-network.

3. Definition of the communication types

The definition of the communication types for the Bottom-Up model aims to ensure an optimal cost allocation between the non-regulated communication types and the regulated interconnection services. Therefore, the commercial structure of the "Belgacom-to-Belgacom" traffic is not relevant and definitions of the various ("technical") types of "Belgacom-to-Belgacom" traffic will be inspired by the structure of the network. The following types will be retained in the Bottom-Up model:

<u>Belgacom-to-Belgacom traffic</u>

- **Local Traffic**: Traffic between 2 subscribers, connected to the network on the same BU or on RUs that have the same BU as host;

- **IAA Traffic:** Non-local traffic between two subscribers that are connected on nodes (RUs or BUs) that belong to the same Access Area. Within the communication type 'IAA Traffic', one distinguishes two possibilities:
  - <u>*IAA Intra-Ring Traffic*</u>: Non-local traffic between two subscribers that are connected on nodes that are located on the same regional ring;
  - <u>*IAA Inter-Ring Traffic*</u>: Non-local traffic between two subscribers that are connected on nodes that are located on different regional rings, but that belong to the same Access Area.

- **EAA Traffic:** Traffic between two subscribers that are connected on nodes (RUs or BUs) that belong to different regional rings of different Access Areas;

- **Internet Traffic (BGC to BGC)**: Internet traffic that is switched on the PSTN/ISDN-network;

- **VAS Traffic**: This type comprises all VAS services that are switched on the PSTN/ISDN-network (e.g. Consultel);

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since it allows us to consider a ZTC as a LTC in the case where traffic just passes through the ZTC without leaving the regional ring.

Traffic between Belgacom and other operators[2]

- **National Transit: IAA & EAA Interconnection**: These two communication types are identical to the corresponding types as defined in the Top-Down model for interconnection;

- **Terminating: Local, IAA & EAA Interconnection**: The IAA & EAA types are the same as those defined in the Top-Down model for interconnection. Moreover, also a communication type w.r.t. local terminating is added, since Belgacom currently offers the possibility to OLOs to interconnect at a local level;

- **Collecting: Local & IAA Interconnection:** These two communication type are identical to the corresponding types as defined in the Top-Down model for interconnection;

- **Interconnection: BGC to Fixed (non-collecting part)**: this communication type is identical to the corresponding type as defined in the Top-Down model;

- **Interconnection: BGC to Mobile**: this communication type is identical to the corresponding type as defined in the Top-Down model;

- **International Traffic: Incoming, Outgoing & Transit:** These three communication type are identical to the corresponding types as defined in the Top-Down model.

4. General principles and hypotheses regarding the determination of routing factors

Since a switching node is always co-located with a transmission node, multiple possibilities exist for the connection of the subscribers on the network; subscribers can be connected on a ZTC-BU, LTC-BU, LTC-RU or LDC-RU[3]. As a consequence, per communication type different connection scenarios are possible, which are all characterised by their own *probability of occurrence* and their own *routing factor*[4]. Hence the final routing factor for a given communication type is found as the weighted average of the probability of the various connection scenarios and their specific routing factor.

In order to determine the distribution of probability and routing factors for the various connection scenarios, we adopt a well-defined methodology, identify and quantify certain parameters that are indispensable and finally put forward some important hypotheses, which all will be discussed hereunder.

4.1 Methodology applied for the determination of the distributions of probability

As already mentioned, per communication type, one has to exhaustively examine which connection scenarios are possible. In order to do so, we adopted the following methodology:

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[2] Often, other operators are referred to as OLOs', an acronym that stands for 'Other Licensed Operators'.

[3] In this text, these possibilities are called the different '*connection scenarios*'.

[4] For illustrative purposes, we mention that the case of a local call whereby two subscribers are connected on the same LTC-BU is characterised by a different probability of occurrence and routing factor than the case of a local call whereby the subscribers are connected on two different LTC-RU that have the same BU as host.

- First and foremost, one determines which are the possible connection scenarios for the subscriber that originates the call (hereafter also called '*user1*'). For every connection scenario, an adequate probability of occurrence has to be identified, also called the *a priori* likelihood.
- Subsequently, for each possible connection scenario of user1, one has to exame which are the possible situations for the 'receiving' subscriber (i.e. user1's correspondent, hereafter also called 'user2'). For every possible connection scenario for user2, a probability of occurrence is determined.
- Finally, the probabilities for user1 and user2 are combined into a so-called '*compound probability*', which represents the particular connection scenarios of user1 and user2.

4.2 Hypotheses taken into account for the determination of the routing factors

In order to control the complexity of the reasoning applied, the following hypotheses are taken into account for the determination of the routing factors:

- Per node, an *average number of subscribers* is retained. Hence in the calculations, it will be assumed that the same number of subscribers are connected to e.g. all LTC-BUs;

- A *uniform distribution* of subscribers, traffic a nd network nodes is assumed. This implies that we assume that all Access Areas contain the same number of subscribers, the same number of regional rings, the same number of nodes etc. Moreover, this implies that one considers the number of subscribers and the numbers of nodes to be equal for all regional rings;

- With respect to the traffic between the incumbent operator and OLOs, we assume that in order to realise interconnection at Access Area level, the OLO always connects to both CAEs of an Access Area. This hypothesis was also retained for the determination of the theoretical routing factors for the Top-Down model for interconnection, BRIO 2003. Hence, interconnection at Access Area level physically means interconnection on 2 CAEs;

- The last hypothesis concerns the distinction between adjacent and non-adjacent regional rings, which is relevant for the communication type 'IAA Inter-Ring Traffic'. One declares two regional rings to be adjacent when they have a ZTC in common, i.e. when a ZTC is located on both regional rings. As a consequence, two regional rings are called non-adjacent when they have no ZTC in common, i.e. no ZTC can be found that is located on both regional rings. We hereby adopt the hypothesis that the ZTCs of non-adjacent regional rings within a given Access Area always are connected by a direct 'Core Link'.

4.3 Identification and quantification of the necessary parameters

In order to allow the determination of the probability of occurrence of the various connection scenarios, we have to quantify a certain set of parameters regarding the structure of the network that is modelled.

- First and foremost, we have to identify how the subscribers are connected to the network. Therefore, we define the following parameters:

a : % equivalent lines connected to a LDC-RU *b* : % equivalent lines connected to a LTC-RU *c* : % equivalent lines connected to a LTC-BU *d :* % equivalent lines connected to a ZTC-BU

Please note that the combination LDC-BU does not occur in the network.

- Moreover, a number of parameters w.r.t. the structure of the network has to be determined.

Indeed, when one considers connection scenarios featuring one or two LDCs, the results w.r.t. the routing factors will depend on the fact whether the point-to-point link that connects the LDC to its host (i.e. a LTC or ZTC), arrives at a LTC-RU or whether it arrives on a LTC-BU or ZTC-BU. In order to quantify the relative proportion of both possibilities, we define the parameters *d* and *d'*:

d: % equivalent point-to-point connections from a LDC to a LTC-BU *d'*: % equivalent point-to-point connections from a LDC to a ZTC-BU

Evidently, the percentage of point-to-point connections (expressed in number of equivalent lines) that connect a LDC to a LTC-RU, is equal to $1-(d+d')$.

Finally, certain communication types require that a distinction be made between regional rings that possess a CAE, and those that don't possess a CAE. Therefore, we define parameter *e*:

e: the number of regional rings that possess a CAE / total number of regional rings

These elements allow the identification of the routing factors for all communication types.

5. The resulting routing factors

5.1 Routing factors for switching equipment

Trafiektype	RU	BU	CAE
Local Traffic	0,809	1,000	0,000
IAA Intra-Ring Traffic	0,693	2,000	0,486
IAA Inter-Ring Traffic	0,759	2,000	0,486
EAA Traffic	0,737	2,000	0,486
VAS	0,738	2,000	1,000
Internet	0,464	1,390	0,000
Terminating Local	0,303	1,000	0,000
Terminating IAA	0,339	1,000	1,000
Terminating EAA	0,339	1,000	2,000
Collecting Local	0,303	1,000	0,000
Collecting IAA	0,339	1,000	1,000

Transit IAA	0,000	0,000	1,000
Transit EAA	0,000	0,000	2,000
Int'al: In&Out	0,339	1,000	0,331
Int'al Transit	0,000	0,000	1,090
IC Others: BGC to FOLO	0,339	1,000	1,370
IC Others: BGC to MOLO	0,339	1,000	1,180

5.2 Routing factors for transmission equipment

Trafiektype	Equip LDC	Equip LTC	Equip ZTC
Local Traffic	0,104	1,507	0,000
IAA Intra-Ring Traffic	0,093	4,259	1,024
IAA Inter-Ring Traffic	0,099	4,758	2,406
EAA Traffic	0,096	4,441	2,512
VAS	0,097	4,598	1,963
Internet	0,068	2,467	0,459
Terminating Local	0,031	0,573	0,000
Terminating IAA	0,044	2,047	1,053
Terminating EAA	0,044	2,047	3,053
Collecting Local	0,031	0,573	0,000
Collecting IAA	0,044	2,047	1,053
Transit IAA	0,000	0,000	0,000
Transit EAA	0,000	0,000	2,000
Int'al: In&Out	0,044	2,631	1,657
Int'al Transit	0,000	0,000	1,090
IC Others: BGC to FOLO	0,044	2,047	1,793
IC Others: BGC to MOLO	0,044	2,047	1,413

5.3 Routing factors for transmission infrastructure

Trafiektype	Link LDC-LTC	Ring Link	Link ZTC-ZTC
Local Traffic	0,104	0,754	0,000
IAA Intra-Ring Traffic	0,093	2,129	0,512
IAA Inter-Ring Traffic	0,099	2,360	1,094
EAA Traffic	0,096	2,219	1,256
VAS	0,097	2,286	0,908
Internet	0,068	1,015	0,225
Terminating Local	0,031	0,287	0,000

Terminating IAA	0,044	1,024	0,526
Terminating EAA	0,044	1,024	1,526
Collecting Local	0,031	0,287	0,000
Collecting IAA	0,044	1,024	0,526
Transit IAA	0,000	0,000	0,000
Transit EAA	0,000	0,000	1,000
Int'al: In&Out	0,044	1,315	1,281
Int'al Transit	0,000	0,000	0,090
IC Others: BGC to FOLO	0,044	1,024	0,896
IC Others: BGC to MOLO	0,044	1,024	0,706