The Communications Regulatory Authority

Fixed BU-LRAIC model documentation

November 2012

Contents

1. Introduction

The purpose of this user guide is to describe the BU-LRAIC model formulated in MS Excel, present its structure and functionality as well as to present its user instructions. The terms used in this document are harmonized with the terms defined in the BU – LRAIC Reference paper for calculation of costs in fixed-line networks.

2. Model user instructions

BU-LRAIC model is prepared using the MS Excel 2007 application (part of MS Office Professional software package). In order to be able to see all the functionalities described in these user instructions, the user should have software version not lower than MS Excel 2007. If a lower version than MS Excel 2007 is used, a part of BU-LRAIC model may not be functioning.

The description of BU-LRAIC model is presented below.

2.1 Model structure

BU-LRAIC model consists of four main parts:

- Support page;
- Intro page;
- Input parameter pages;
- Calculation pages.

These parts are distinguished by different page colors: intro – blue, input parameters – orange, calculations – green.

The diagram presented below illustrates the model structure and interconnection between the model pages.

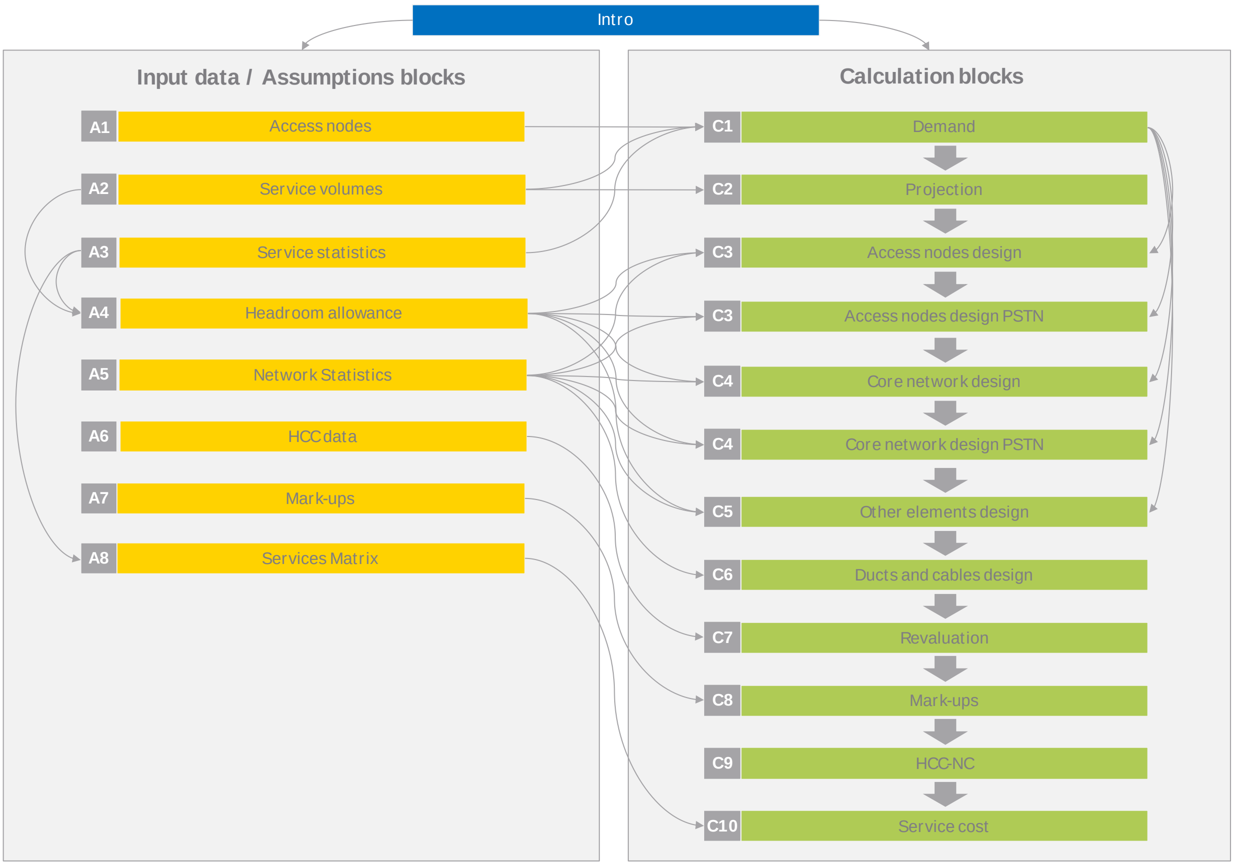

Diagram 1: Model Structure.

Note Nodes from A2 to C3, A2 to C4 and from A2 to C5 are not specified in this diagram.

The arrow that connects pages indicates the use of the input parameters or calculation results of one page (where the arrow starts) in another page (where the arrow ends). For instance, calculations on the page "C1 Demand" are performed by using data from the pages "A1 Access Nodes", "A2 Service Volumes" and "A3 Service Statistics".

2.2 "Support" page

This page contains data of the modeled operator network structure, types of fiber cables used in the model and voice codec information.

The first three tables present information regarding Local Nodes, Numbering Zones and Transit Nodes and the logical structure of the modeled operator network.

Firs table specifies each Local Node location. In particular it presents the following parameters:

- Local Node number – unique number of the Local Node.
- Local Node name NGN – unique name of the Local Node in NGN network structure.
- Transit Zone number (TZ) NGN - number of Transit Zone in which Local Node is located.
- Local Node name PSTN - unique name of the Local Node indicating its location according to scorched earth approach.
- Transit Zone number (TZ) PSTN – unique number of Transit Zone in which Local Node is located according to scorched earth approach.
- Transit Node (TN) location – presents the main location of each Transit Zone, where Transit Node is located according to scorched earth approach.
- International Switch - presents the main location of International Switch.

Second table specifies Numbering Zones (NZ) numbers in which Local Nodes are connected to.

Third table specifies the name of Transit Node for each Transit Zone and the optimal Transit Node locations.

Forth table includes types of fiber cables dimensioned in the model.

Fifth table included basic information regarding VoIP codec which can be used in the network, in particular codec name, codec bit rate and size of the voice payload.

2.3 "Intro" page

The purpose of "Intro" page is a management of model pages and predefinition of main input parameters.

The first section (lines 9-21) includes main input parameters, in particular:

- Language;
- Year of projection
- Aggregation Edge Ethernet Switch dimensioning;
- Core router dimensioning;
- Core network;
- Ducts and fibers revaluation;
- Annualization method;
- "CALCULATE" button makes calculations based on chosen main input parameters.

The second section (lines 23-51) presents structure of the model (see Diagram 1), which allows to navigate between pages.

By pressing the "Intro" button in the upper left corner of each model page, it is possible to go back to the "Intro" sheet.

2.4 Input parameter pages

The model has the following parameter pages:

- „A1 Access Nodes" page;
- "A2 Service Volumes" page;
- "A3 Service Statistics " page;
- "A4 Headroom Allowance" page;
- "A5 Network Statistics" page;

- “A6 HCC Data” page;
- “A7 Mark-ups” page;
- “A8 Service matrix” page.

As specified in Diagram 1, the data of each page is used in the specific calculation or other input parameters pages. Input parameter pages contain input data of two different types:

- Operator data collected in the questionnaire (cells are marked green –)
- Assumption presented in MRP (cells are marked light blue –)
- Ernst & Young data (cells are market in light red -)
- Data from previous model (cells are market in pink -)

The detailed description and of Input parameter pages have been presented in the questionnaire manual.

2.4.1 Page "A1 Access nodes"

This page contains data of the Access Nodes in the fixed line network, which are specified by:

- Access Node name (column B) – unique name of the Access Node used in the inventory system or network management system.
- Parent Local Node (column C) - unique number of the Local Node to which Access Node is directly connected based on "scorched node" approach.
- Parent Transit Node (column D) - unique number of the Transit Node which aggregates traffic from the Local Node presented in column C based on "scorched node" approach.
- Parent Local Node (column E) – unique number of the Local Node to which Access Node is directly connected.
- Volume of services (columns H-O) provided for each Access Node – volume of active services provided on each Access Node:
    - Voice services (columns H-J), which includes:
        - Voice services provided over pair of cooper cables (POTS).
        - Voice services provided over fiber cable (GPON).
        - Voice services provided point to point (P2P).
    - ISDN-BRA services (column K);
    - ISDN-PRA services (column L);
    - Internet access services – provided using xDSL technology (column M); .
    - Internet access services – provided using GPON technology (column N);
    - Internet access services – provided using P2P technolog7 (column O).
- Services presence (columns Q-S) provided for each Access Node – information if each group of services presented below is provided by particular Access Node. This parameter can take only "0" or "1" value, where "1" means than Access Node is a Points of Presence for particular group of services and "0" means than Access Node is not a Points of Presence for particular group of services. This information is provided this information for the following group of services:
    - TDM leased lines- up to 2Mbit/s (column Q): 64 Kbit/s, nx64 Kbit/s and 2 Mbit/s leased lines;
    - TDM leased lines - high speed (column R): STM-0, STM-1 and STM-4 leased lines;
    - ATM/Ethernet data transmission (column S): IP corporate and IP Access.

2.4.2 Page "A2 Service Volumes"

This page contains data of the subscribers' quantity (lines 8-43) and service volumes from 2010 to 2022 (lines 45-75).

The first part of this page contains services' quantities (lines 8-43). Quantity of services is defined as volume of voice services, Internet access services, TV services, TDM leased lines and ATM/Ethernet data transmission services.

Subscribers' quantities are presented for the following group of services:

- Voice services (lines 10-13) – yearend volume of active voice and ISDN services, in particular:
    - Yearend voice services – yearend volume of voice services provided over POTS, GPON and P2P technologies;
    - Yearend ISDN - BRA services - yearend volume of the ISDN – BRA services;
    - Yearend ISDN - PRA services - yearend volume of the ISDN – BRA services.
- Internet access services (lines 14-17) – yearend volume of Internet access services provided over pair of cooper cables (xDSL) or over fiber cable (GPON), in particular:
    - Yearend Internet access services - residential subscribers - yearend volume of Internet access services provided to residential subscribers;
    - Yearend Internet access services - business subscribers - yearend volume of Internet access services provided to business subscribers;

- Yearend Internet access services - wholesale subscribers - yearend volume of Internet access services provided to wholesale subscribers.
- TV services (lines 18-19) – yearend volume of television services provided over pair of cooper cables (xDSL) or over fiber cable (GPON), in particular:
  - Yearend IPTV services - yearend volume of active IPTV services provided over cooper or fiber cable.
- TDM leased lines (lines 20-23) - yearend volume of connected TDM leased lines, in particular:
  - Yearend analog leased lines - 64 Kbit/s – yearend volume of connected 64 Kbit/s leased lines.
  - Yearend digital leased lines - nx64 Kbit/s – yearend volume of connected nx64 Kbit/s leased lines.
  - Yearend digital leased lines - 2 Mbit/s – yearend volume of connected 2 Mbit/s leased lines.
- TDM leased lines - high speed (lines 24-29) yearend volume of connected TDM leased lines, in particular:
  - Yearend leased lines - E3 – yearend volume of connected E3 leased lines.
  - Yearend leased lines - STM-0 - yearend volume of connected STM-0 leased lines.
  - Yearend leased lines - STM-1 - yearend volume of connected STM-1 leased lines.
  - Yearend leased lines - STM-4 - yearend volume of connected STM-4 leased lines.
  - end leased lines - STM-16 - yearend volume of connected STM-16 leased lines.
- ATM/Ethernet data transmission - IP corporate (lines 30-35) – yearend volume of point-to-point data transmission services provided in ATM/Ethernet technology to corporate and business clients and other telecommunication operators, in particular:
  - 2Mbit/s – yearend volume of end-to-end data transmission services provided in ATM/Ethernet technology with throughput lower than 2Mbit/s.
  - up to 10Mbit/s – yearend volume of end-to-end data transmission services provided in ATM/Ethernet technology with throughputs from 2Mbit/s to 10Mbit/s.
  - up to 100Mbit/s – yearend volume of end-to-end data transmission services provided in ATM/Ethernet technology with throughputs from 10Mbit/s to 100Mbit/s.
  - up to 1Gbit/s – yearend volume of end-to-end data transmission services provided in ATM/Ethernet technology with throughputs from 100Mbit/s to 1Gbit/s.
  - up to 10 Gbit/s – yearend volume of end-to-end data transmission services provided in ATM/Ethernet technology with throughputs higher than 1Gbit/s.
- ATM/Ethernet data transmission - IP Access (lines 36-41) - yearend volume of services providing access to Internet in ATM/Ethernet technology to corporate and business clients and other telecommunication operators, in particular:
  - 2Mbit/s - yearend volume of services providing access to Internet in ATM/Ethernet technology with throughput lower than 2Mbit/s.
  - up to 10Mbit/s - yearend volume of services providing access to Internet in ATM/Ethernet technology with throughput from 2Mbit/s to 10Mbit/s.
  - up to 100Mbit/s - yearend volume of services providing access to Internet in ATM/Ethernet technology with throughput from 10Mbit/s to 100Mbit/s.
  - up to 1Gbit/s – yearend volume of end-to-end data transmission services provided in ATM/Ethernet technology with throughputs from 100Mbit/s to 1Gbit/s.
  - up to 10 Gbit/s – yearend volume of end-to-end data transmission services provided in ATM/Ethernet technology with throughputs higher than 1Gbit/s.
- Other - packet data services(lines 42-43) - yearend volume of other data transmission services, not included in the previous categories.

The second part of this page contains amount of traffic generated by listed above services, during each year, in particular:

- Voice calls traffic (lines 47-61) – yearly volume of the minutes for the retail and interconnection calls, excluding call set-up time and unsuccessfully calls, presented for the following services:

- Local calls – on-net calls (in the network of incumbent operator) - yearly volume of minutes for calls on own Operator network, realized in a single numbering zone;
- National calls – on-net calls (in the network of incumbent operator) - yearly volume of minutes for calls on own Operator network, realized in a several numbering zones;
- International calls (except calls to short telephone numbers) – yearly volume of minutes realized for calls to VoIP, PSTN and mobile networks in foreign countries;
- Calls to short telephone numbers - yearly volume of minutes realized for calls to VoIP, PSTN, mobile networks to short telephone numbers despite the call is charged or not;
- Interconnection calls – outgoing on local level - yearly volume of minutes for outgoing calls from the Operator network at the POI located in the same numbering zone as calling subscriber;
- Interconnection calls – outgoing on national level - yearly volume of minutes for outgoing calls from the Operator network at the POI located in the different numbering zone as calling subscriber;
- Interconnection calls – incoming on local level - yearly volume of minutes for incoming calls to the Operator network at the POI located in the same numbering zone as subscriber receiving call;
- Interconnection calls – incoming on national level - yearly volume of minutes for incoming calls to the Operator network at the POI located in the different numbering zone as subscriber receiving call;
- Interconnection calls – transit 1 - yearly volume of minutes transited through single Transit switch (inclusive);
- Interconnection calls – transit 2 - yearly volume of minutes transited from (to) Local switch (excluding that switch), located as near as possible to calling customer (called customer), where interconnection is already provided or can be provided, to (from) Transit switch (inclusive), where interconnection can be provided;
- Interconnection calls – transit 3 - yearly volume of minutes transited from Transit switch (excluding that switch), where interconnection is provided or can be provided, to Transit switch (inclusive), where interconnection is provided or can be provided;
- Interconnection calls – transit 4 - yearly volume of international call minutes transited through single International Transit switch (inclusive), when international call is originated in network in Lithuania;
- Interconnection calls – transit 5 - yearly volume of international call minutes transited from Transit switch (excluding that switch) to International Transit switch (inclusive), when international call is originated in networks in Lithuania;
- Interconnection calls – transit 6 - yearly volume of transit minutes originated abroad and terminated in Lithuania;
- Other connections - yearly volume of minutes for services not listed above

- Data traffic (lines 66-75) – yearly volume of two way data traffic (uplink and downlink) busy hour Gbit/s in the second layer (ATM / Ethernet), presented for the following services:
  - Internet access services – residential - yearly volume of data traffic in Busy hour Gbit/s measured at the first aggregation point (MSAN, DSLAM, OLT, ATM or Ethernet equipment) generated by residential subscribers connected over pair of cooper cables (xDSL) or over fiber cable (GPON / P2P);
  - Internet access services – business - yearly volume of data traffic in Busy hour Gbit/s measured at the first aggregation point (MSAN, DSLAM, OLT, ATM or Ethernet equipment) generated by business subscribers connected over pair of cooper cables (xDSL) or over fiber cable (GPON / P2P);
  - Internet access services - wholesale - yearly volume of data traffic in Busy hour Gbit/s measured at the first aggregation point (MSAN, DSLAM, OLT, ATM or Ethernet equipment) generated by wholesale subscribers connected over pair of cooper cables (xDSL) or over fiber cable (GPON / P2P);
  - IPTV services - yearly volume of data traffic in Busy hour Gbit/s measured at the firs Access Node (MSAN, DSLAM, OLT or Ethernet equipment) generated by IPTV subscribers connected over pair of cooper cables (xDSL) or over fiber cable (GPON / P2P). This volume should not be included in the above categories;
  - Video on demand services - yearly volume of data traffic in Busy hour Gbit/s measured at the firs Access Node (MSAN, DSLAM, OLT or Ethernet equipment) generated by VOD subscribers connected over pair of cooper cables (xDSL) or over fiber cable (GPON / P2P). This volume should not be included in the above categories;
  - ATM/Ethernet data transmission – IP corporate - yearly volume of data traffic in Busy hour Gbit/s measured at the first aggregation point (ATM/Ethernet equipment) generated by data transmission services realized over ATM/Ethernet technology;

- ATM/Ethernet data transmission - IP access - yearly volume of data traffic in Busy hour Gbit/s measured at the first aggregation point (ATM/Ethernet equipment) generated by Internet access services realized over ATM/Ethernet technology;
- Other data transmission services - yearly volume of data traffic in Busy hour Gbit/s measured at the first aggregation point (ATM/Ethernet equipment) generated by services not listed above – excluding leased lines;

2.4.3 Page "A3 Service Statistics"

This page contains routing factor matrix, statistical and technical parameters regarding particular services and information regarding POI in the Operator network.

The first section presents routing factors matrixes for voice (lines 13-29) and data services (lines 31-43). Routing factors present utilization of individual network elements in providing listed telecommunication services. The second section presents statistical and technical parameters regarding particular services and information regarding POI in the Operator network. The following modeling parts are specified in this section table:

- Priority factors (lines 47-58) reflecting specific quality parameters required by particular services, having impact on utilization of network resources.

  The prioritization of traffic is assured by quality of services (QoS) mechanism, which allows to handle the traffic generated by different class of services (CoS) with different priority. The class of service (CoS) defines specific quality parameters which are required by group of services with similar traffic characteristics. Based on those characteristics and quality requirements it is possible to define three basic class of service (CoS):

  - real time services – highest priority services which require guaranteed bit rate, low delay, low jitter and low packet loss ratio, eg. voice and video services.
  - business critical services – moderate priority services which require guaranteed bit rate e.g. IP corporate (VPN), IP access.
  - best effort – low priority services without guaranteed bit rate and not very sensitive to packet delays, jitter and packet loss.

  In model the priority factor should present additional throughput of the network which has to be assured to provide a service with defined quality parameters. The priority parameter presents ratio between required throughput for service provided with specific quality parameters (defied by CoS) and required throughput for the same services provided with best-effort quality.

- Busy Hour to Average Hour traffic ratio for voice and data services (lines 60-68) – presents ratio between traffic in Busy Hour and traffic in average hour at particular network layer. The ratio for data services is set to 100% as the Operator provided the traffic data in busy hour.
- VoIP assumptions (lines 69-82) – this section presents technical assumptions regarding VoIP technology, in particular:
  - voice codec used – chosen from the predefined list of VoIP codec;
  - payload of each network layer protocols: RTP / UDP / IP / Ethernet – presenting theoretical size of each protocol header;
  - Codec bit rate – presenting bit rate of chosen VoIP codec;
  - Voice Payload Size – presenting voice payload size of chosen VoIP codec;
  - Packets per second – presenting packets per second of chosen VoIP codec;
  - VoIP channel bit rate – presents bandwidth required for one VoIP channel. This parameter is calculated according to the (1) formula presented in the Reference paper.
- Voice services parameters (lines 84-101) – this section presents:
  - Unsuccessful call attempts as percentage of total calls;
  - Successful call - average length of successful call calculated as sum of call set-up duration for successful calls and call duration;
  - Call set-up duration for successful calls - average length of time required to set-up successful call between users. It is period of time between call initiation (calling party dial a number) and call set-up (called party answers the call);

  - Call set-up duration for unsuccessful calls - average length of time between call initiation (calling party dial a number) and call break (calling party breaks connection, due to called party did not answer the call);
  - Call duration - average call duration in minutes, excluding call set-up duration;
  - Equivalent voice channels – POTS – number of voice channels which can be provided thought POTS line;
  - Equivalent voice channels ISDN-BRA – number of voice channels which can be provided over ISDN-BRA line;
  - Equivalent voice channels ISDN-PRA - number of voice channels which can be provided over ISDN-PRA line.
- Internet access services statistics (lines 103-122) – this section presents:
  - Busy Hour to Average Hour traffic ratio for Internet services (lines 106 -109) – presents ratio between traffic in Busy Hour and traffic in average hour for Internet access services. This value is copied from line 64;
  - Internet access services (line 111-115) - volume of Internet access services provided to residential, business, wholesale subscribers and IPTV services in particular year chosen in intro sheet;
  - Internet access services average throughputs (line 117-122) – presents average throughputs of wholesale Internet access services with predefined nominal throughputs.
- Data - Points of interconnection (POI) (lines 124-129) – presents ratio of the data traffic from Internet access wholesale services outgoing at POI at each networks level, to the total traffic from Internet access wholesale services outgoing at POI.
- Parameters POI interfaces (lines 131-137) – presents capacities of POI interfaces, defined in number of E1 lines. This parameter should present nominal number of E1 lines which can be provided thought listed interfaces.
- Voice - Points of interconnection (POI) (lines 139-164) – this section presents:
  - Number of voice POI interfaces located at Transit Nodes (lines 143-148);
  - Number of voice POI interfaces located at Transit Nodes, presented in number of equivalent of E1 lines (lines 133-137). Number of equivalent E1 lines is calculated by multiplying the number of E1, STM-1 and STM-4 POI interfaces by their capacity defined in number of E1 lines;
  - Distribution of E1 ports (lines 158-164) – presents percentage of E1 lines which could be provided over existing E1, STM-1 and STM-4 interfaces.
- Leased lines average throughputs (lines 166-179) – this section presents:
  - Number of 64 Kbit/s TDM leased lines for year of calculation (line 169);
  - Calculation of average throughputs of 64 Kbps TDM leased lines (line 170).The average throughput of analog 64 kbps TDM leased line and 2Mbps digital leased line is calculated by multiplying leased line nominal capacity in Kbits by overbooking factor and priority factor specified for TDM leased lines;
  - Number of nx64 Kbps TDM leased lines for year of calculation (line 173);
  - Calculation of average throughput of digital nx64 kbps TDM leased lines (lines 174-175).The average throughput of analog nx64 Kbps leased line (line 175) is calculated by multiplying analog 64 kbps TDM leased line average throughput (line 170) by average number of 64 kbps channels provided over one digital nx64 kbps TDM leased line (line 174);
  - Number of 2 Mbps TDM leased lines for year of calculation (line 178);
  - Calculation of average throughputs of 2 Mbps TDM leased line (line 179).The average throughput of 2Mbps digital leased line is calculated by multiplying leased line nominal capacity in Kbits by overbooking factor and priority factor specified for TDM leased lines.
- High speed leased lines average throughputs (lines 181 - 195) – this section presents calculation of average throughputs of high speed TDM leased lines (E3, STM-0, STM-1, STM-4, STM-16).
- Data transmission services average throughput throughputs (lines 197 – 216) – this section presents calculation of average throughputs of data transmission services (ATM/Ethernet data transmission - IP corporate 10Mbit/s / up to 10Mbit/s / up to 100Mbit/s / up to 1Gbit/s, ATM/Ethernet data transmission - IP Access 2Mbit/s / up to 10Mbit/s / up to 100Mbit/s / up to 1Gbit/s, Other)

  This calculation is done by dividing the average throughput of data transmission services by volume of data transmission services and multiplying the result by priority factor. The average throughput of data transmission services is calculated by dividing total annual volume of traffic generated by data transmission services by number of seconds per year.
- TV services (lines 218-221) – this section presents statistics regarding television services, in particular:

- Maximal number of TV channels offered to subscriber – it presents maximal number of television channels which can be offered to subscriber;
- Average throughput of DTV stream - it presents average throughput of digital television stream in layer 2 - including payloads of each network layer protocols e.g. RTP / UDP / IP / Ethernet.

- Voice - tariff differentiation statistics (lines 223-227) – this section presents:
  - Peak to off-peak tariff differentiation ratio - ratio of peak tariff for retail calls to off-peak tariff for retail calls. This calculation is done by dividing peak tariff by off-peak tariff;
  - Peak traffic proportion – ratio of voice traffic in peak period to total daily traffic;
  - Off-peak proportion – ratio of voice traffic in off-peak period to total daily traffic.

2.4.4 Page "A4 Headroom Allowance"

This input parameter page is a table of network elements and their capacity parameters. The table consists of the following columns:

- Network element type (column B);
- Unit (column D);
- Design utilization factor at planning stage (column F);
- Planning horizon (column G, necessary for functionality purposes);
- Planning horizon 2 (column H)
- Network demand group (column I, necessary for functionality purposes).
- Network demand group 2 (column J)

Design utilization factor at planning stage (column F) takes into account operational and technical reserve. It represents (vendor designated) maximal level of equipments' utilization, which ensures that the equipment will not be overloaded by any transient spikes of traffic in the network. It reflects reserve for temporary equipment performance decrease or environmental conditions which not allows to utilize equipment with its nominal capacity. In our case Operator provided prices for the equipment with this factor in mind. Therefore the values are set to 100%.

Planning horizon (column H/G) presents the time required to make all the necessary preparations to bring new equipment online. This period can be defined from weeks to years, separately for each network element type.

Network demand group (Column I/J) determines the quantity (eg. volume of subscribers, traffic) which is used to calculate required capacity for each network element type.

Parameters presented above are used on the page "C2 Projection" to calculate Operational allowance for each network element type.

2.4.5 Page "A5 Network Statistics"

This input parameter page consists of the main two sections:

- Active network elements specification and statistics;
- Ducts and fiber cables specification and statistics.

2.4.5.1 Active network elements specification and statistics

First main section consists of specifications and statistics of the active network elements.

First section specifies volumes of MSAN for each category of leased lines and parameters of 2Mbit/s links:

- Volume of MSAN handling analog leased lines (line 8) – number of MSAN which are Points of Presence for analog leased lines calculated as a lowest value form volume of analog leased lines and number of MSAN which are defined on page "A1 Access nodes" as a Points of Presence for analog leased lines;
- Volume of MSAN handling nx64 leased lines (line 9) – number of MSAN which are Points of Presence for nx64 leased lines calculated as a lowest value form volume of nx64 leased lines and number of MSAN which are defined on page "A1 Access nodes" as a Points of Presence for nx64 leased lines;

- Volume of MSAN handling 2 Mbit/s leased lines (line 10) – number of MSAN which are Points of Presence for 2 Mbit/s leased lines calculated as a lowest value form volume of 2 Mbit/s leased lines and number of MSAN which are defined on page "A1 Access nodes" as a Points of Presence for 2 Mbit/s leased lines;
- Capacity of 2 Mbit/s line in Erlangs (line 14).

Second section specifies building elements (chassis and cards) and capacities of the network elements. Capacities of building elements should correspond to the prices provided in page A6 HCC data.

The following building blocks can be defined for each network element:

- Chassis / shelves – chassis / shelves which capacities are based on the number of card slots that it contains;
- Switching / processing card - cards switching / processing traffic in the network equipment. Capacities of subscriber cards are based on maximal processing / switching capacities of those cards defined in amount of traffic which they can handle;
- Subscriber cards - cards containing different numbers of ports and support different technologies and data rates which are used to directly connect subscribers. Capacities of subscriber cards are based on the number of ports that there contains;
- Trunking cards - cards containing different numbers of ports and support different technologies and data rates which are used to connect network elements. Capacities of trunking cards are based on the number of ports that there contains;
- Optical modules – optical modules which can be used in particular trunking cards.

This section specifies the following network elements:

- MSAN specification (lines 16-35) – this paragraph includes data regarding MSAN equipment used in the network.
    - Chassis – present types of MSANS's used in the network, and their capacities defined in:
        - Maximal number of subscriber cards, which can be installed in particular chassis type;
        - Maximal number of trunking cards, which can be installed in particular chassis type;
        - Maximal voice processing capacity in BHCA of particular chassis type;
        - Maximal switching capacity in Gbit/s of particular chassis type.
    - Subscriber cards – presents the capacities (defined in number of ports) for the following types of subscriber cards which can be used at MSAN:
        - Type 1 – ADSL – card providing subscriber ports in ADSL technology;
        - Type 2 – SHDSL – card providing subscriber ports in SHDSL technology;
        - Type 3 – POTS – card providing subscriber ports in POTS technology;
        - Type 4 – ISDN-BRA – card providing subscriber ports in ISDN-BRA technology;
    - Trunking card – presents the types and capacities (defined in number of Ethernet ports) of trucking cards used at MSAN.
    - Optical module – present types of optical modules which can be used in particular trunking card.
- OLT specification (lines 44-59) – this paragraph includes data regarding OLT equipment used in the network.
    - Chassis – present types of OLT's used in the network, and their capacities defined in:
        - Maximal number of subscriber cards, which can be installed in particular chassis type;
        - Maximal number of trunking cards, which can be installed in particular chassis type.
    - Subscriber cards – presents the capacities (defined in number of ports) for the following types of subscriber cards which can be used at OLT:
        - Type 1 – GPON – card providing subscriber ports in GPON technology;
        - Split ratio – amount of subscribers which can be served from one GPON port which is spitted in the lower parts of the network.
    - Trunking card – presents the types and capacities (defined in number of Ethernet ports) of trucking cards used at OLT;
    - Optical module – present types of optical modules which can be used in particular trunking card.
- Access Ethernet Switch (lines 61-78) - this paragraph includes data regarding Access Ethernet Switch equipment used in the network in Access Nodes location to aggregate traffic from subscribers connected with P2P technology.

- Chassis – present types of Access Ethernet Switches used in the network, and their capacities defined in number of card slots for trunking and switching cards that it contains. Different types chassis represent different capacities;
- Subscriber cards – presents the capacities (defined in number of ports) for the following types of subscriber cards which can be used at Access Ethernet Switch:
  - Type 1 –P2P – card providing subscriber ports in Gigabit Ethernet technology;
  - Type 2 –P2P – card providing subscriber ports in Gigabit Ethernet technology;
- Trunking card – presents the types and capacities (defined in number of GE ports) of trucking cards used at Access Ethernet Switches;
- Optical modules – present types of optical modules which can be used in particular trunking cards.

- Rings statistics (lines 80-82) – this paragraph includes maximal number of access nodes connected into logical ring.

- Edge Ethernet Switch (lines 84-112) - this paragraph includes data regarding Edge Ethernet Switch equipment used in the network to aggregate traffic from Access Nodes.
  - Chassis – present types of Edge Ethernet Switches used in the network, and their capacities defined in number of card slots for trunking and switching cards that it contains. Different types chassis represent different capacities;
  - Switching cards- presents the types of switching cards which can be used at Edge Ethernet Switches and their capacities defined in Gbit/s;
  - Trunking cards – presents the types and capacities (defined in number of 1GE and 10 GE ports) of trucking cards used at Edge Ethernet Switches;
  - Optical modules – present types of optical modules which can be used in particular trunking cards.
- Aggregation Ethernet Switch (lines 113-140) - this paragraph includes data regarding Aggregation Ethernet Switch equipment used in the network to aggregate traffic from Edge switches.
  - Chassis – present types of Aggregation Ethernet Switches used in the network, and their capacities defined in number of card slots for trunking and switching cards that it contains. Different types chassis represent different capacities;
  - Switching cards- presents the types of switching cards which can be used at Aggregation Ethernet Switches and their capacities defined in Gbit/s;
  - Trunking cards – presents the types and capacities (defined in number of 1GE and 10 GE ports) of trucking cards used at Aggregation Ethernet Switches;
  - Optical modules – present types of optical modules which can be used in particular trunking cards.
- Core Ethernet Switch (lines 142-169) - this paragraph includes data regarding Core Ethernet Switch equipment used in the network to aggregate traffic from Aggregation Ethernet Switches.
  - Chassis – present types of Core Ethernet Switches used in the network, and their capacities defined in number of card slots for trunking and switching cards that it contains. Different types chassis represent different capacities;
  - Switching cards- presents the types of switching cards which can be used at Core Ethernet Switches and their capacities defined in Gbit/s;
  - Trunking card – presents the types and capacities (defined in number of 1GE and 10 GE ports) of trucking cards used at Core Ethernet Switches;
  - Optical modules – present types of optical modules which can be used in particular trunking cards.
- IP routers Transit Node (lines 171-189) - this paragraph includes data regarding IP routers equipment used in the network at the Transit Nodes.
  - Chassis – present types of IP routers used in the network, and their capacities defined in number of card slots for trunking and switching cards that it contains. Different types chassis represent different capacities;
  - Switching cards- presents the types of switching cards which can be used at IP routers and their capacities defined in Gbit/s;
  - Trunking card – presents the types and capacities (defined in number of 10 GE ports) of trucking cards used at IP routers;
  - Optical modules – present types of optical modules which can be used in trunking cards.
- MGW (lines 191-210) this paragraph includes data regarding Media Gateway's equipment used in the network at the POI.

- Chassis – present types of MGW used in the network, and their capacities defined in number of card slots for trunking and switching capacity in Gbit/s. Different types chassis represent different capacities;
- Trunking card GE– presents the types and capacities (defined in number of 1GE) of trucking cards used to connect MGW to IP router;
- Trunking card E1/STM– presents the types and capacities (defined in number of E1, STM-1, STM-4 ports) of trunking cards used to provide interconnection ports in TDM technology to other operators;
- Optical modules – present types of optical modules which can be used in particular trunking cards.

- MGC (lines 212-218) this paragraph includes data regarding Media Gateway Controller's equipment used in the network at the POI.
  - Main unit – presents type of MGC used in the network, and its capacity defined in number of slots for expansion units;
  - Expansion unit – MGC – presents expansion unit of Media Gateway Controller and its capacity (defined in number of BHCA).
- IMS (lines 220-237) this paragraph includes data regarding IMS equipment. The IMS system includes the following parts:
  - IMS core service frame – present types of service cards used in the IMS core and their capacity. It can include the following service cards:
    - Service card - Type 1- A-SBG - presents service card providing access session border gateway functionality. Capacity is expressed in volume of subscribers;
    - Service card - Type 2- Telephony AS - presents service card implementing voice over IP function which capacity is defined in volume of subscribers;
    - Service card - Type 3 - CSCF & MRCF - presents service card implementing both - CSCF and MRCF, functions which capacities are defined in BHCA and volume of subscribers;
    - Service card - Type 4 - BGCF - presents service card implementing BGCF function which capacity is defined in BHE;
    - Service card – Type 5 – DNS server – presents service card implementing DNS server function which capacity is defined in volume of subscribers;
    - Service card – Type 6 – Service delivery AS – presents service card implementing service delivery application server function which capacity is defined in BHCA.
  - HSS service frame – present types of HSS service cards used in the network and their capacity. It includes the following service cards:
    - Service card - Type 1 – Control card – presents service card implementing control function which capacity is defined in volume of subscribers;
    - Service card - Type 2 – Database card – presents service card implementing database function which capacity is defined in volume of subscribers.
- IC billing system (lines 239-245). Billing system serving the wholesale traffic, responsible for pre-rating and rating of the traffic. It consists of:
  - Main unit– present types of wholesale billing system primary units used in the network, and their capacities defined in maximal number of expansion units;
  - Expansion unit - presents the types of expansion units which can be used to expand the processing capacity of the main unit, their capacities are defined in volume of call data records per day.

2.4.5.2 Ducts and fiber cables specification and statistics

Second main section of this page includes ducts and fiber cables specification and statistics.

- Length of fiber cables (lines 247-253), in particular network level and geoptype, in particular:
  - AN - TN Urban;
  - AN - TN Suburban/Rural;
  - TN - TN Urban;
  - TN - TN Suburban/Rural.

- Average number of fibers in cable for each network level (lines 255-258), in particular:
  - AN - TN – fiber cables type used between Access Nodes and Transit Nodes;
  - TN - TN – fiber cables type used between Transit Nodes.
- Types of ducts used in each geotype (lines 260-278) – statistics presenting duct types proportion for each geotype. This proportion of each type of duct should include ducts for the total network (access and core).
- Ground reconstruction, passages and ducts statistics for urban and suburban/rural geotype (lines 280-326):
  - Density factors – parameter presenting density of manholes and joints in the network located in urban and suburban genotype:
    - Manholes density - factor presenting average number of manholes per kilometer of ducts located in urban and suburban genotype;
    - Joints density - factor presenting average number of joints per kilometer of fiber cables located in urban and suburban geotype.
  - Ground reconstruction statistics – statistics presenting how the ducts have been build up in urban and suburban genotype:
    - Passages under obstacles – ratio of length of ducts build by making passages under obstacles to the total ducts length;
    - Ground reconstruction – ratio of length of ducts which required ground reconstruction to the total ducts length.
  - Ground reconstruction types – statistics presenting what types of ground reconstruction are made in urban and suburban geotype:
    - Grass reconstruction – ratio of length of ducts which required grass reconstruction to the total ducts length which require ground reconstruction in urban and suburban geotype;
    - Sidewalk reconstruction – Type 1 – ratio of length of ducts which required type 1 sidewalk reconstruction – to the total ducts length which require ground reconstruction in urban and suburban geotype;
    - Asphalt pavement reconstruction – ratio of length of ducts which required asphalt pavement reconstruction – to the total ducts length which requires ground reconstruction in urban and suburban geotype;
    - Concrete pavement reconstruction – ratio of length of ducts which required concrete pavement reconstruction – to the total ducts length which requires ground reconstruction in urban and suburban geotype;
    - No reconstruction – ratio of length of ducts which have not been required reconstructed – to the total ducts length which require ground reconstruction in urban and suburban geotype.
- Passages under obstacles – statistics presenting what types of passages under obstacles are made in urban and suburban geotype:
    - Passage under road (up to 15m) – ratio of length of ducts which have been built as a passage under road narrower than 15 meters to the total ducts length which have been built as a passage under obstacles in urban and suburban geotype;
    - Passage under road (above 15m) – ratio of length of ducts which have been built as a passage under road wider than 15 meters to the total ducts length which have been built as a passage under obstacles in urban and suburban geotype;
    - Passage under railway tracks – ratio of length of ducts which have been built as a passage under railway tracks to the total ducts length which have been built as a passage under obstacles in urban and suburban geotype;
    - Passage under rivers and channel – ratio of length of ducts which have been built as a passage under railway tracks to the total ducts length which have been built as a passage under obstacles in urban and suburban geotype;
    - Passage under other obstacles – ratio of length of ducts which have been built as a passage under other than listed above obstacles to the total ducts length which have been built as a passage under obstacles in urban and suburban geotype.
- Average volumes of ground reconstruction (lines 328-341) present average trench width for each type of ground reconstruction, and average passages under obstacles length for the each type of ground reconstruction.
- Additional works statistics (lines 343-347) present number of parcel per kilometer of ducts.

- PSTN network statistics (lines 349 – 382) – in this section the network statistics relevant to dimensioning of the PSTN network are transferred from the previous BU-LRAIC fixed-line model of 2005.

2.4.6 Page "A6 HCC data"

This input parameter page presents the economic data regarding network equipment for homogeneous cost categories:

- Current network equipment price, LTL (column D);
- Current network equipment price, EUR (column E);
- Total current network equipment price, LT (column F);
- Useful lifetime (column G);
- Average price change ratio (column H);
- Gross book value and gross replacement cost ratio (column J);
- Net book value (NBV) and gross book value (GBV) ratio (column K).

The minimal ducts cost may consist of trench cost, ground reconstruction cost and other earth works cost. The nominal ducts cost may consist of primary duct cost, secondary duct (HDPE tube) cost, manholes cost, ground reconstruction cost and other earth works cost. The type of the duct used in nominal network is determined by parameters presenting types of ducts used in each geotype (lines 260-278 form page "A5 Network Statistics").

The minimal fiber network cost consist of: fiber cables cost, joints cost and installing cost. The nominal fiber network cost consist of fiber cables cost, joints cost and installing costs. The type of the fiber cables and joins used for minimal and nominal network are determined by parameters presenting average number of fibers in cable for each network level (lines 247-253 form page "A5 Network Statistics").

HCC financial data is further used on the calculation page "C7 Revaluation".

This input parameter page also includes financial parameters for the chosen year of calculation:

- LTL/EUR exchange rate (cell C9) which is used for the calculation of EUR values of column E "Current network equipment price";
- Average weighted capital cost (WACC) (cell C10).

2.4.7 Page "A7 Mark-ups"

This input parameter page presents the values of mark-ups. The mark-ups used in BU-LRAIC model are based on the data provided by the operators extracted from Fixed Assets Register (FAR), financial management systems and modeled GRC values.

The mark-ups on network capital cost (GRC) would be calculated for the following cost categories:

  - Network operation, maintenance and planning expenses (operational cost);
  - Network management system (capital cost).

The mark-ups on network operational cost (OPEX), previously allocated on corresponding network elements, would be calculated for the following cost categories:

  - Administration and support activities (operational cost);
  - Administration and support activities (capital cost).

The following mark-ups groups are used in BU-LRAIC model and presented on this input parameter page:

- Mark-up - Network operation, maintenance and planning expenses calculated as operational costs to network capital cost (For NGN and PSTN networks) for cost category: network operation, maintenance and planning (lines 10-14).
  - Fiber cables and ducts;
  - Access node;
  - Transmission network;
  - Switching network.
- Mark-up of capital cost to network capital cost for cost category Network Management System (lines 16-19).
  - Access nodes;

  - Transmission network;
  - Switching network.
- Mark-up of administration and support activities operational cost to network operational cost (lines 23-26)
  - Access nodes;
  - Transmission network;
  - Switching network.
- Mark-up of administration and support activities capital cost to network operational cost (lines 28-31)
  - Access node.
  - Transmission network.
  - Switching network.

Mark-ups are expressed in percent and are further used on the calculation page “C8 Mark-ups”, where absolute mark-ups values are calculated.

2.4.8 Page “A8 Service Matrix”

This input parameter page establishes the average service usage factors in order to calculate the service costs per each network component later. These factors are transferred from routing matrix presented in sheet “A2 Service Statistics”.

Column B “Service type” presents modeled network services, cells C7 – O7 – network components, cells C11:O22 – service usage factors.

2.5 Calculation pages

The description of input parameter pages and model pages defines data sources, gives a general indication of further utilization of the results received. This part contains a description of the operating principles of the model and constituent parts of the calculation pages. The model consists of the following calculation pages:

- "C1 Demand" page;
- "C2 Projection" page;
- "C3 Access Node Design" page;
- "C4 Core Node Design" page;
- "C3 Access Node Design PSTN" page;
- "C4 Core Node Design PSTN" page;
- "C5 Other Elements Design" page;
- "C6 Ducts and fiber cables" page;
- "C7 Revaluation" page;
- "C8 Mark-ups" page;
- "C9 HCC – NC" page;
- "C10 Services cost" page.

In the calculation pages, calculations are performed in the majority of cells, therefore they cannot be deleted or otherwise changed. If this requirement is not followed, the model may function only partially or may fail to produce any results.

2.5.1 Page "C1 Demand"

Two main fields are specified on this calculation page:

- Routing matrix (voice services) (lines 11-47)
- Routing matrix (data services) (lines 48-79)

2.5.1.1 "Routing matrix (voice services)"

This field includes the following sections:

- Service and network elements matrix is the same routing factors matrix defined on the page "A3 Service Statistics", just extended with the lines of the quantities of voice services (lines 13-27).
- The weighted service volumes (line 29), i.e. the annual service volumes are multiplied by the respective service and networks elements routing factors from the table Service Matrix. Calculation is performed according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (5).
- Average utilization of network component – weighted average routing factor for each network elements (line 31). Calculation is performed according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (4).
- Average throughput per port - represents the average busy hour throughput of one voice line on particular network component, i.e. the quantities of mili Erlangs per voice line on each network elements (line 39). Calculation is performed according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (2).

  The average throughputs per port are further used in the model to calculate volume of busy hour voice traffic on network elements.
- Average volume of BHCA per port (line 44) - represents the average busy hour call attempts volume per one voice line on particular network component, i.e. the quantities of BHCA per voice line on each network elements. Calculation is

performed according to the formula which is presented in “Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network” Formula (20).

The average BHCA per port are further used in the model to calculate volume of busy hour call attempts on network elements.

2.5.1.2 “Routing matrix (data services)”

This field includes the following sections:

- Service and network elements matrix is the same routing factors matrix defined on the page “A3 Service Statistics”, just extended with the lines of the quantities of Internet access and data transmission services (respectively lines 48-52 and lines 58-60).
- The weighted service volumes, i.e. the annual service volumes are multiplied by the respective service and networks elements routing factors from the table Service Matrix, calculated separately for Internet access and data transmission services (respectively lines 54 and 62). Calculation is performed according to the formula which is presented in “Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network” Formula (5).
- Average utilization of network component – weighted average routing factor for each network element, calculated separately for Internet access and data transmission services (respectively lines 56 and 64). Calculation is performed according to the formula which is presented in “Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network” Formula (4).

  The average utilization of network components are further used in the model to calculate volume of busy hour data traffic on each network element.
- Service and network elements matrix is the same routing factors matrix defined on the page “A3 Service Statistics”, just extended with the lines of the quantities of leased lines and high speed leased lines services (respectively lines 68-70 and lines 72-76).
- The weighted service volumes (line 78), i.e. the annual service volumes are multiplied by the respective service and networks elements routing factors from the table Service Matrix, calculated for leased lines and high speed leased lines services. Calculation is performed according to the formula which is presented in “Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network” Formula (5).

This last field of this page includes the calculation of:

- Total input traffic – total volume of traffic generated by voice and data services for particular transmission levels:
  - Column F – total volume of voice interconnection minutes. This volume is used to calculate the ratio of minutes of calculated interconnection service to total volume of interconnection minutes. This ratio is used to calculate the part of IC billing system cost which are related to the calculated interconnection service;
  - Column M – total volume of traffic generated by voice and data services at AN-TN transmission level. This volume corresponds to the sum of cells AH151:AQ151 from sheet 'C4 Core Node Design';
  - Column R – total volume of traffic generated by voice and data services at TN-TN transmission level. . This volume corresponds to the sum of cells EO151:EO151 from sheet 'C4 Core Node Design'.

  Those volumes (columns M and R) are used to calculate the ratio of traffic generated by calculated service to total network traffic. This ratio is used to calculate the part of fiber cables and ducts variable costs which are related to the calculated service.

2.5.2 Page “C2 Projection“

This page consists of three tables:

- Traffic Projection
- Service demand growth
- Headroom allowance

Projection of services (subscribers and traffic) is performed by demand groups, which are defined on page. “A4 Headroom allowance”.

2.5.2.1 Table "Traffic Projection"

This table consists of the columns "Demand group" (column B), "Current time" (column D) and "Volumes" (columns F-R).

Lines 14-17 present volumes of each demand group calculated using data from the page "A2 Service Volumes, in particular column D of this section presents demand group volumes for current year (Year of calculation chosen on Intro page) and columns F-R presents demand groups volumes for years 2010 – 2022 defined in line 5.

Lines 9-12 present volumes projection for each demand group. Projection for each year (columns F-R) is calculated as a ratio between demand group volume for particular year and volume of demand group for the year of calculation chosen on Intro page.

2.5.2.2 Table "Service demand growth"

This table presents growth projection for each demand group for defined planning horizons (current time, 2-weeks, 1-month, 3-months, 6-months, 1-year or 2-years).

The projection (cells D23:J26) for the particular planning horizon (line 22) is calculated, based on values presented in lines 9-12, as a ratio between:

- Volume of particular demand group for year of calculation
- Volume of particular demand group for period which is planning horizon ahead from the year of calculation (i.e. year of calculation plus planning horizon)

  The planning horizons are set to either: current time, 2-week, 1-month, 3-month, 6-months, 1-year or 2-years. The service demand growth rates for planning horizons shorter than 1 year are calculated by normalizing 1-year service demand growth rate into corresponding planning horizon according to the formula presented below:

$$g = 1 + \frac{t_1}{t_0} \times \frac{w}{52}$$

Where:
g - service demand growth rate for given planning horizon

t_1 - service demand in one year ahead to the base year

t_0 - service demand in base year

w – planning horizon in weeks.

The service demand growth ratio (for a certain demand group and planning period) is used to calculate the headroom allowance values, described in next paragraph.

2.5.2.3 Table "Headroom allowance"

Headroom allowance (column D), shows what part of equipment capacity is reserved for future traffic growth. It determines the level of under-utilization in the network, as a function of equipment planning horizon and expected demand. Planning horizon shows the time required to make all the necessary preparations to bring new equipment online. This period can be from weeks to years (current time, 2-week, 1-month, 3-month, 6-months, 1-year or 2-years). Headroom allowance for particular network element type is taken from the "Service demand growth" table, taking into account planning horizon defined for this network elements on page "A4 Headroom allowance".

Operational allowance (column E) presents maximal level of network equipment utilization, taking into account:

- Design utilization factor at planning stage (defined on Page "A4 Headroom Allowance");
- Headroom allowance (column D).

2.5.3 Page "C3 Access Node Design"

Calculations of Access nodes quantities are made on this page. The main parts of this page are as follows:

- Section "Access Node" (columns A - D);
- Section "MSAN" (columns E - BC);
- Section "OLT and Access Ethernet Switch" (columns BE - CD);

- Section “Access Ethernet Switch”.

2.5.3.1 Section “Access Node”

This section contains the following data regarding the Access Nodes: Access Node name (column B), Parent LN (column C), Parent TN (column D). Those parameters, are taken from the input parameter page “A1 Access Nodes”

2.5.3.2 Section “MSAN”

This section contains the eight main parts:

- Services volumes (columns E – N);
- Leased lines volumes (columns P - W);
- Average throughput in busy hour (columns T – Y);
- MSAN dimensioning (columns AA – BC);
- Number of Access Nodes (columns CF – CH);
- Required throughput of Access Node (columns CJ – CL).

2.5.3.2.1 Services volumes

The first part “Services volumes“ contains the data regarding volumes of services located on each Access Nodes in particular:

- Volume of POTS lines (column E), taken from the input parameter page “A1 Access Nodes”;
- Volume of ISDN-BRA lines (column F), taken from the input parameter page “A1 Access Nodes”;
- Volume of ISDN-PRA lines (column G), taken from the input parameter page “A1 Access Nodes”;
- Volume of xDSL lines (column H), taken from the input parameter page “A1 Access Nodes”;
- Lines (column M) – volume of equivalent voice channels which could be provided through POTS and ISDN lines, calculated using algorithm defined in the Reference paper, formula (3).
- Traffic [ERL] (column L) – volume of busy hour voice traffic, calculated by multiplying number of voice lines by “Average throughput per port“ calculated on page „C1 Demand“ (line 39). This parameter is calculated according to the algorithm defined in the Reference paper, formula (2).

2.5.3.2.2 Leased lines volumes

The second part “Leased lines volume“ contains the data regarding volumes of leased lines located on each Access Nodes in particular:

- Rank – LL (columns L) – this parameter is used to determine size of the Access Node;
- Columns M - R - determines preliminary number of leased lines on Access Node using the data of sheet A1 “Access Nodes” and the parameter “Rank“. It is assumed that leased lines ports are provided at the biggest Access Nodes. The volume of Access Nodes providing leased lines is defined on page “A5 Network Statistics“ (lines 8-10). The preliminary amount of leased lines at AN location is calculated using the algorithm defined in the Reference paper, formula (37);

2.5.3.2.3 Average throughput in busy hour

In this section average throughputs of voice services, internet access services, IPTV, analog leased line, nx64 leased line and 2mbit leased line are transferred from “A3 Service Statistics” sheet. These statistics are further used in estimating the service demand on Access Node.

2.5.3.2.4 MSAN dimensioning

This section contains the dimensioning of MSAN network element, based on services and traffic volumes. The capacities for each element of MSAN are taken from the page “A5 Network Statistics“ and multiplied by “Operational allowance“ parameters defined on the page “C2 Projection”. The following MSAN elements are dimensioned:

- Subscriber cards, in particular:
  - ADSL subscriber cards (column AA).

    - SHDSL subscriber cards (column AB). It is assumed that leased lines are provided based on SHDSL.
    - POTS subscriber cards (column AC).
    - ISDN – BRA subscriber cards (column AD).

The subscriber cards are dimensioned according to the algorithm defined in the Reference paper, formula (17).

- Volume of aggregated traffic , in particular:
    - Volume of BHCA (column AL), which is estimated using algorithm defined in the Reference paper, formula (19);
    - Volume of voice traffic in Mbit/s (column AM) – Busy hour demand [Mbit/s] for voice services, which is estimated using the intermediate estimations done in column AF according to the algorithm defined in the Reference paper, formula (11);
    - Volume of data traffic in Mbit/s (columns AN) – sum of Busy hour demand [Mbit/s] for data services, which is estimated using the intermediate estimations done in columns AG – AJ according to the algorithm defined in the Reference paper, formula (13);
- Trunking interfaces, in particular:
    - Optical module (column AP). The amount of Optical modules is calculated using the algorithm defined in the Reference paper, formula (10);
    - Trunking card (columns AQ). The amount of Optical modules is calculated using the algorithm defined in the Reference paper, formula (18);
- Subscriber cards (columns AR). Here a sum of calculated subscriber cards in columns AA – AD is presented;
- Chassis (column AY - BC). Here the type and amount of main unit type (chassis) is calculated using intermediate calculations in columns AS – AW according to the algorithm defined in the Reference paper, formula (14).

2.5.3.2.5 OLT and Access Ethernet Switch

In this section, the amount of equipment to support subscribers connected via fiber cables is estimated. Depending on the technology used to connect with the subscriber (GPON or P2P), different types of equipment are dimensioned (OLT or Access Ethernet Switch accordingly). The dimensioning of these elements is done as follows:

- Services volume over fiber optics (columns BE – BL):
    - Volume of IPTV services in Access Node (column BE), taken from the input parameter page “A2 Service Volumes”;
    - Volume of Voice services over GPON (column F), taken from the input parameter page “A1 Access Nodes”;
    - Volume of Internet Access Services over GPON (column BH), taken from the input parameter page “A1 Access Nodes”;
    - Volume of IPTV services over GPON (column BI), proportionally taken from column BE.
    - Volume of Voice services over P2P (column F), taken from the input parameter page “A1 Access Nodes”;
    - Volume of Internet Access Services over P2P (column BH), taken from the input parameter page “A1 Access Nodes”;
    - Volume of IPTV services over P2P (column BI), proportionally taken from column BE.
- OLT dimensioning (columns BN – BU):
    - Busy hour demand [Mbit/s] (column BN) – is calculated by multiplying appropriate services by its average throughputs (described in section *2.5.3.2.3 Average throughput in busy hour*);
    - Optical modules for subscriber cards (column BO), are calculated taking into account split ratio and headroom allowance for OLT to serve the amount of subscribers connected to the Access Node;
    - Subscriber cards for OLT unit (column BP) – the amount of subscriber cards at Access Node is calculated using the algorithm defined in the Reference paper, formula (15);
    - Optical modules for trunking cards (column BQ) – the amount of optical modules for trunking cards is estimated by adjusting the busy hour demand (column BN) with headroom allowance;
    - Trunking cards for OLT unit (column BR) – the amount of trunking cards is calculated using the algorithm defined in the Reference paper, formula (18);

  - Chassis dimensioning (columns BS – BL) – the type and amount of chassis is estimated using the algorithm defined in the Reference paper (14).
- Access Ethernet Switch dimensioning (columns BW – CD):
  - Busy hour demand [Mbit/s] (column DW) – is calculated by multiplying appropriate services by its average throughputs (described in section *2.5.3.2.3 Average throughput in busy hour*);
  - Optical modules for subscriber cards (column BX), are calculated taking into account headroom allowance for AETH to serve the amount of subscribers connected to the Access Node;
  - Subscriber cards for AETH unit (columns BY – BZ) – the amount of subscriber cards at Access Node is calculated using the algorithm defined in the Reference paper, formula (16);
  - Optical modules for trunking cards (column CA) – the amount of optical modules for trunking cards is estimated by adjusting the busy hour demand (column DW) with headroom allowance;
  - Trunking cards for OLT unit (column CB - CC) – the amount of trunking cards is calculated using the algorithm defined in the Reference paper, formula (18);
  - Chassis dimensioning (columns CD) – the amount of chassis is estimated using the algorithm defined in the Reference paper (14).

2.5.3.2.6 Number of Access Nodes

In this section the total amount of Access Node equipment is presented as well number of GE and 10GE interfaces facing trunking side of the network.

- AN (column CF) – here the total amount of equipment present in Access Node location is estimated by summing the columns CG and CH;
- AN-GE (column CG) – here the number of Access Nodes with GE interface is estimated by dividing the Optical modules of AETH by two;
- AN-10GE (column CH) – here the number of Access Nodes with 10GE interface is estimated by dividing the optical modules of MSAN and OLT by two.

2.5.3.2.7 Required throughput of Access Node

In this section the generated throughput in Gbit/s of each Access Node equipment is presented as well the throughput in Gbit/s generated over GE and 10GE interfaces facing trunking side of the network.

- AN-GE (column CJ) – here the total amount of traffic going through GE interface to upper layer of the network is calculated;
- AN-10GE (column CK) – here the total amount of traffic going through 10GE interface to upper layer of the network is calculated;
- Total AN (column CL) – here the total amount of traffic going from Access Node to upper layer of the network is calculated by summing the columns CJ and CK.

2.5.4 Page “C4 Core Node Design”.

Calculations of Ethernet switches, IP routers and MGW quantities are made on this page. The main parts of this page are as follows:

- Section “Locations” (columns A - F)
- Section “Services volumes and traffic calculation” (columns G - BF)
- Section “Backhaul transmission“ (columns BH - BO)
- Section “Edge Ethernet Switches dimensioning“ (columns BQ - CM)
- Section “Aggregation Edge Ethernet Switches dimensioning“ (columns CO - DJ)
- Section “Core Ethernet Switches dimensioning“ (columns DL - EA)
- Section “ Transit Nodes dimensioning“ (columns EC - EZ)
- Section “MGW dimensioning“ (columns FB - GA)

- Section presenting all building elements (cards, chassis) of listed above core network equipment. (columns GC – IT).

  The cell E4 is a supportive cell indicating the usage of Aggregation Edge Ethernet Switch dimensioning approach.

2.5.4.1 Section "Locations"

This section contains the data regarding the locations of Local and Transit Nodes (C and E) in fixed network, optimal locations of Local Nodes (column D), assignment of each location to Transit Zone (column B) and Numbering Zone (column A). Column F represents the location of International Exchange.

2.5.4.2 Section "Services volumes and traffic calculation"

This section contains the two main parts:

- Services volumes (columns G - S)
- Demand calculation (columns U - BF)

2.5.4.2.1 Services volumes

The first part "Services volumes" contains the data regarding volumes of services in each location, in particular:

- Volume of equivalent voice channels (column G) – calculated by summing the volume of equivalent voice channels provided on Access Nodes which are connected to the location of Local Node;
- Volume of Internet access services(column H) - calculated by summing the volume of Internet access services provided on Access Nodes which are connected to the location of Local Node;
- Volume of leased lines (columns I - K) - calculated by summing the volume of TDM leased lines provided on Access Nodes which are connected to the location of Local Node;
- Columns L - P are used to calculate volume of high speed lines and data transmission services on Local Node location, in particular:
  - Columns M - N - determines preliminary number of high speed leased lines / data transmission services on Local Node. The preliminary amount of services at LN location is calculated by summing the amount of Access Nodes with high speed leased lines / data transmission services connected to the LN location;
  - Columns O - P – determines volumes of high speed leased lines / data transmission services on Local Node, which are estimated using the algorithm defined in the Reference paper, formula (36).
- Volume of interfaces from AN (columns Q - S), summed from page "C3 Access nodes design".

2.5.4.2.2 Demand calculation

The second part "Demand calculation" contains the calculation of input demand of services.

- Columns U - W presents the distribution of Internet access ports between retail, business and wholesale subscribers, which is taken from the page "A3 Service Statistics".
- Columns X - AG presents the average throughput of the following services:
  - Voice (column X)
  - Internet access– retail (column Y)
  - Internet access– business (column Z)
  - Internet access– wholesale (column AA)
  - IPTV (column AB)
  - Data transmission (column AC)
  - High speed leased lines (column AD)
  - Analog leased lines 64 Kbit/s (column AE)
  - Digital leased lines nx64 Kbit/s (column AF)
  - Digital leased lines 2Mbit/s (column AG)

  The average services throughputs are taken from the page "A3 Service Statistics".

- Columns AH-AQ presents the input traffic generated by the following services:
  - Voice (column AH). This parameter is calculated according to the algorithm defined in the Reference paper, formula (30);
  - The input demand for IPTV services (column AL) is calculated by summing the IPTV services throughput provided on Access Nodes which are connected to the location of Local Node and divided by 1024^2 to convert the units from Kbit/s to Gbit/s.

The input demand for the services listed below is calculated multiplying the volume of services (columns H-P) by respective average throughput in busy hour (columns X-AG) and divided by 1024^2 to convert the units from Kbit/s to Gbit/s.

  - Internet access– retail (column AI)
  - Internet access– business (column AJ)
  - Internet access– wholesale (column AK)
  - Data transmission (column AM)
  - High speed leased lines (column AN)
  - Analog leased lines 64 Kbit/s (column AO)
  - Digital leased lines nx64 Kbit/s (column AP)
  - Digital leased lines 2Mbit/s (column AQ)
- Columns AS- AV - presents the input traffic generated for the defined groups of network services, namely:
  - Voice (column AS) – volume of equivalent voice channels taken from column G.
  - Internet access(column AT) – sum of columns AI-AK
  - Leased lines (column AU) – sum of columns AO-AQ
  - Data transmission and high speed leased lines (column AV) – sum of columns AM-AN.
- Columns AX- AZ - presents the volume of data traffic outgoing at POI at the following network levels:
  - DSLAM-POI (column AX) – data traffic outgoing at POI located at Access Node level, calculated by multiplying the total volume of data traffic from Internet access wholesale services by ratio of the data traffic from Internet access wholesale services outgoing at Access Nodes level to total data traffic volume from Internet access wholesale services. It is calculated using the analog algorithm defined in the Reference paper, formula (66);
  - ETH – POI (column AY) – data traffic outgoing at POI located at Ethernet level, calculated by multiplying the total volume of data traffic from Internet access wholesale services by ratio of the data traffic from Internet access wholesale services outgoing at Ethernet level to total data traffic volume from Internet access wholesale services. It is calculated using the algorithm defined in the Reference paper, formula (66);
  - IP router (column AZ) – data traffic outgoing at POI located at IP level, calculated by multiplying the total volume of data traffic from Internet access wholesale services by ratio of the data traffic from Internet access wholesale services outgoing at IP level to total data traffic volume from Internet access wholesale services. It is calculated using the analog algorithm defined in the Reference paper, formula (66);
- Columns BB - BF - presents the volume of traffic incoming at each network level, in particular

  AN – ETH (column BB) – traffic incoming from Access Nodes to Ethernet Switch - traffic consists of voice, internet access, leased lines services, with routing factors applied, provided at AN in LN area;

  - Tx – ETH (column BC) – incoming traffic generated by data transmission services and high speed leased lines directly connected to Ethernet Switches with routing factors applied;
  - ETH - POI (column BD) – data traffic outgoing at the POI located in Ethernet Switches (number taken from column AY);
  - ETH – IP local (column BE) – traffic outgoing from Ethernet Switches to IP Routers - traffic consists of voice, internet access and leased lines services, with routing factors applied without the outgoing traffic at Ethernet level to POI.
  - ETH agreg (column BF) – total traffic to be handled by Ethernet which is estimated by summing the traffic mentioned above.

2.5.4.3 Section "Backhaul transmission"

This section contains dimensioning of logical transmission network structure between Access Nodes and Ethernet Switches. It consists of three main parts

- GE interfaces (columns BH – BK);
- 10GE interfaces (columns BL – BO);
- Input throughput of Edge Ethernet Switch.

2.5.4.3.1 GE interfaces

In this section amount of GE interface rings connecting Access Nodes and Edge Ethernet Switch is calculated.

- Number of AN connected into a ring (column BH) – number of Access Nodes connected into a GE ring is estimated taking into account the Access Nodes connected to Local Node location (column R) as well as throughput generated by the services and maximum amount of Access Nodes connected into a ring statistic, presented in sheet "A5 Network statistics" cell D82;
- Number of GE interfaces needed to connect Access Nodes to Edge Ethernet Switch (column BI) – here a number of GE interfaces needed to connect rings to the switch is estimated by multiplying the amount of rings by 2;
- Number of rings (column BJ) – number of rings connecting Access Nodes and Edge Ethernet Switch is calculated using algorithm defined in the Reference paper, formula (68);
- AN - ETH (column BK) – the throughput of GE backhaul transmission to be handled is calculated by taking a proportion of traffic calculated in previous section, column BB.

2.5.4.3.2 10GE interfaces

In this section amount of 10GE interface rings connecting Access Nodes and Edge Ethernet Switch is calculated.

- Number of AN connected into a ring (column BL) – number of Access Nodes connected into a 10GE ring is estimated taking into account the Access Nodes connected to Local Node location (column S) as well as throughput generated by the services and maximum amount of Access Nodes connected into a ring statistic, presented in sheet "A5 Network statistics" cell D82;
- Number of 10GE interfaces needed to connect Access Nodes to Edge Ethernet Switch (column BM) – here a number of 10GE interfaces needed to connect rings to the switch is estimated by multiplying the amount of rings by 2;
- Number of rings (column BN) – number of 10 GE rings connecting Access Nodes and Edge Ethernet Switch is calculated using algorithm defined in the Reference paper, formula (68);
- AN - ETH (column BO) – the throughput of 10GE backhaul transmission to be handled is calculated by taking a proportion of traffic calculated in previous section, column BB.

2.5.4.4 Section "Edge Ethernet Switches dimensioning"

This section contains dimensioning of Ethernet edge switches.

The first part of this section contains calculation of required number interfaces and switching capacity. In particular:

- Column BQ – calculates the number of 1GE ports required to provide data transmission and high speed leased line services provided from Edge Ethernet Switch;
- Column BR – calculates the number of 1GE ports required to transfer traffic from Edge Ethernet Switch to POI;
- Column BS – calculates required number of 1GE / 10GE ports to connect Edge Ethernet Switch with Aggregation Edge Ethernet Switch;
- Column BT – calculated the traffic generated throughput to be handled by Edge Ethernet Switch, transferred from column BK, described in previous section, and IPTV service throughput if it is present;

The second part of this section contains dimensioning of Edge Ethernet Switches elements. In particular:

- Column BV - calculates required number of GE ports. Calculation of this parameter is performed by summing the required GE interfaces in columns BS – BU and BI, described in the previous sections, and taking into account the headroom allowance;

- Column BW - calculates required number of 10 GE ports. As Operator provided information regarding its equipment and indicated that Edge Ethernet Switches have no 10GE interfaces, this parameter results into 0;
- Columns BY – CB – calculate optimal number of 10GE cards and 10GE optical modules. Calculation of this parameter is performed according to the algorithms defined in the Reference paper, formulas (61) – (62). Dimensioning of 10GE optical interfaces – due to adopted topology only LR interfaces are used.
- Columns CDF – CG – calculate optimal number of 1GE cards and 1GE optical modules. Calculation of this parameter is performed according to the algorithms defined in the Reference paper, formulas (59) – (60);
- Column CI - calculates required number of switching cards. Calculation of this parameter is performed according to the algorithm defined in the Reference paper, formula (58);
- Columns CK – CM - calculate optimal number and type of Edge Ethernet Switches chassis. Calculation of this parameter is performed according to the algorithms defined in the Reference paper, formulas (55) – (57).

2.5.4.5 Section "Aggregation Edge Ethernet Switches dimensioning"

This section contains dimensioning of Aggregation Ethernet edge switches.

The first part of this section contains calculation of required number interfaces and switching capacity. In particular:

- Column CO – calculates required number of 1GE ports to connect Edge Ethernet Switch with Aggregation Edge Ethernet Switch;
- Column CQ – calculates the number of 10GE ports required to transfer traffic from Aggregation Edge Ethernet Switch to Core Ethernet Switch;
- Column CR – calculated the traffic generated throughput to be handled by Aggregation Edge Ethernet Switch, transferred from column BV, described in previous section, and traffic from 10GE backhaul transmission rings;

The second part of this section contains dimensioning of Aggregation Ethernet Switches elements. In particular:

- Column CS - calculates required number of GE ports. Calculation of this parameter is performed by taking the GE interfaces to connect with Edge Ethernet Switches in column CQ and adjusting with the headroom allowance factor;
- Column CT - calculates required number of 10 GE ports. Calculation of this parameter is performed by taking the 10GE interfaces required to connect to Core Ethernet Switches (column CR), adjusting with headroom allowance factor and adding the amount of 10GE ports required to connect Aggregation Edge Ethernet Switches with 10GE backhaul transmission rings (column BM);
- Columns CV – CY – calculate optimal number of 10GE cards and 10GE optical modules. Calculation of this parameter is performed according to the algorithms defined in the Reference paper, formulas (61) – (62). Dimensioning of 10GE optical interfaces – due to adopted topology only LR interfaces are used.
- Columns DA – DD – calculate optimal number of 1GE cards and 1GE optical modules. Calculation of this parameter is performed according to the algorithms defined in the Reference paper, formulas (59) – (60);
- Column DF - calculates required number of switching cards. Calculation of this parameter is performed according to the algorithm defined in the Reference paper, formula (58);
- Columns DH – DJ - calculate optimal number and type of Aggregation Edge Ethernet Switches chassis. Calculation of this parameter is performed according to the algorithms defined in the Reference paper, formulas (55) – (57).

2.5.4.6 Section "Core Ethernet Switches"

This section contains dimensioning of Core Ethernet Switches.

The first part of this section contains calculation of required number of switches, interfaces and switching capacity. In particular:

- Column DO – calculates average traffic incoming from Ethernet layer.
- Column DP - calculates number of 10 GE ports required to connect Aggregation Edge Ethernet Switches, resulting from network topology.

The second part of this section contains dimensioning of Core Ethernet Switches elements. In particular:

- Columns DR – DU – calculates optimal number of 10GE cards and 10GE optical modules. Calculations are performed according to the algorithms defined in the Reference paper, formulas (70) – (71);

- Column DW - calculates required volume of switching cards. Calculation of this parameter is performed according to the algorithm defined in the Reference paper, formula (58);
- Columns DY – EA - calculate optimal number and type of Core Ethernet Switches chassis. Calculation of this parameter is performed according to the algorithms defined in the Reference paper, formulas (55) – (57).

Dimensioning approach is quite the same for all Ethernet Switches, therefore for more detailed information please refer to the previous paragraph.

2.5.4.7 Section "Transit Nodes"

This section contains dimensioning of Transit Nodes calculated as IP routers.

The first part of this section contains calculation of required number of interfaces and switching capacity. In particular:

- Columns EC - EF – calculates volume of voice traffic and required number of ports between Transit Node and MGW. IC traffic is calculated in the following steps:
  - Column EC presents the volume of voice traffic in ERL, which is calculated by multiplying amount of lines by the appropriate average throughput (estimated according to the algorithm presented in the Reference paper, formula (2);
  - Column ED – presents the volume of voice traffic in Gbit/s. The volume of voice traffic in Gbit/s is calculated by multiplying volume of traffic in ERL by VoIP channel throughput in Kbit/s and then converting to Gbit/s;
  - Column EE - presents the volume of GE interfaces required to connect MGW to IP Router. It is calculated by rounding up the volume of voice traffic in Gbit/s;
  - Column EF - presents the volume of voice traffic in number of E1 channels. The volume of voice traffic in number of E1 channels is calculated by dividing the volume of voice traffic in ERL by E1 channel capacity defined in number of ERL.
- Columns EH - EJ – calculates volume of data traffic outgoing from Transit Node to peering points. The amount of ports needed to connect with peering points is calculated using the algorithm defined in the Reference paper, formula (23);
- Columns EL – EO - calculate volume of traffic between Transit Nodes.
  - Columns EL - EN calculates volume of voice traffic between Transit Nodes in Gbit/s, according to the following algorithm defined in the Reference paper, formula (30);
  - Columns EO calculates volume of data traffic between Transit Nodes in Gbit/s, according to the following algorithm defined in the Reference paper, formula (31);

The second part of this section contains dimensioning of IP router elements. In particular:

- Columns EQ – ER – calculates number of 10GE optical modules.
  - Column EQ calculates number of short range 10GE optical modules. The calculations are performed according to the algorithm defined in the Reference paper, formula (22);
  - Column ER calculates number of long range 10GE optical modules. The calculations are performed according to the algorithm defined in the Reference paper, formula (28);
- Columns ET – EU – calculate optimal number of 10GE cards. The calculations are performed using the algorithm defined in the Reference paper, formulas (53) – (54);
- Column EW calculate optimal number and type of switching cards. The calculations are performed using the algorithm defined in the Reference paper, formula (52);
- Columns FY – EZ - calculate optimal number and type of Transit Nodes chassis. The calculations are performed using the algorithm defined in the Reference paper, formulas (50) – (51).

2.5.4.8 "Section "MGW"

This section contains dimensioning of MGW for national interconnection traffic and international interconnection traffic.

2.5.4.8.1 National IC Media Gateway

- Columns FB - FC - calculate number of 1GE optical modules and optimal number and type of 1GE cards. The calculations are performed using the algorithms defined in the Reference paper, formula (38) and (46);
- Columns FD - FG - calculate number of E1, STM-1 and STM-4 cards:

    - Dimensioning of MGW expansion cards Type 1, is performed using the algorithm defined in the Reference paper, formula (40);
    - Dimensioning of MGW expansion cards Type 2, is performed using the algorithm defined in the Reference paper, formula (43);
    - Dimensioning of MGW expansion cards Type 3, is performed using the algorithm defined in the Reference paper, formula (44);
    - Dimensioning of MGW expansion cards Type 4, is performed using the algorithm defined in the Reference paper, formula (45).
- Column FH – calculate number of voice processing cards, according to the algorithm defined in the Reference paper, formula (47);
- Column FI - calculate optimal number of MGW chassis. The calculations are performed using the algorithms defined in the Reference paper, formula (39).
- Column FJ – calculate number of Media Gateway Controller expansion cards. Calculations are performed according to the algorithm defined in the Reference paper, formula (49);
- Column FK - calculate number of Media Gateway Controller main units. Calculations are performed according to the algorithm defined in the Reference paper, formula (48);

2.5.4.8.2 International IC Media Gateway

- Columns FM- FP – calculates volume of international interconnection voice traffic and required number of ports between Transit Node and International MGW. IC traffic is calculated in the following steps:
    - Column FM presents the volume of voice interconnection traffic in ERL, which is calculated by multiplying amount of lines by the appropriate average throughput (estimated according to the algorithm presented in the Reference paper, formula (2);
    - Column FN – presents the volume of voice traffic in Gbit/s. The volume of voice traffic in Gbit/s is calculated by multiplying volume of traffic in ERL by VoIP channel throughput in Kbit/s and then converting to Gbit/s;
    - Column FO - presents the volume of GE interfaces required to connect International MGW to IP Router. It is calculated by rounding up the volume of voice traffic in Gbit/s;
    - Column FP - presents the volume of voice traffic in number of E1 channels. The volume of voice traffic in number of E1 channels is calculated by dividing the volume of voice traffic in ERL by E1 channel capacity defined in number of ERL.
- Columns FR – GA – dimension the International Media Gateway:
    - Columns FR - FS - calculate number of 1GE optical modules and optimal number and type of 1GE cards. The calculations are performed using the algorithms defined in the Reference paper, formula (38) and (46);
    - Columns FT - FW - calculate number of E1, STM-1 and STM-4 cards:
        - Dimensioning of MGW expansion cards Type 1, is performed using the algorithm defined in the Reference paper, formula (40);
        - Dimensioning of MGW expansion cards Type 2, is performed using the algorithm defined in the Reference paper, formula (43);
        - Dimensioning of MGW expansion cards Type 3, is performed using the algorithm defined in the Reference paper, formula (44);
        - Dimensioning of MGW expansion cards Type 4, is performed using the algorithm defined in the Reference paper, formula (45).
    - Column FX – calculate number of voice processing cards, according to the algorithm defined in the Reference paper, formula (47);
    - Column FY - calculate optimal number of MGW chassis. The calculations are performed using the algorithms defined in the Reference paper, formula (39).
    - Column FZ – calculate number of Media Gateway Controller expansion cards. Calculations are performed according to the algorithm defined in the Reference paper, formula (49);
    - Column GA - calculate number of Media Gateway Controller main units. Calculations are performed according to the algorithm defined in the Reference paper, formula (48);

2.5.5 Sheets "C3 Access Node Design PSTN" and "C4 Core Node Design PSTN"

In these sheets, elements of the old PSTN network are dimensioned. The dimensioning of the PSTN network is in line with the reference paper "BU-LRAIC model documentation", dated 2005 September 5th, of PSTN network dimensioning.

2.5.6 "C5 Other elements design"

This page contains two main sections:

- IMS dimensioning (lines 8 – 34)
- Billing IC system (lines 36 – 41)

2.5.6.1 IMS dimensioning

The first section contains dimensioning of IMS. In particular:

- Line 8 present volume of BHE (Busy hour Erlangs) which should be handled by IMS elements.

  The volume of BHE to be handled by IMS is a sum of:

  - Volume of traffic in ERL measured at POI for transit services;
  - Volume of traffic in ERL measured at AN for rest of the voice services.
- Line 9 present number of BHCA (Busy hour call attempts) which should be handled by IMS elements.

  The volume of BHCA to be handled by IMS is calculated according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (76).
- Lines 10 present volume subscribers which should be handled by IMS elements.
- Lines 12-34 presents calculation of IMS elements:
  - IMS - Cabinet, it is assumed that 1 cabinet is sufficient to meet the network requirements;
  - IMS – Service frame, it is assumed that 1 service frame is sufficient to meet the network requirements;
  - IMS – Service frame – Type 1, which includes the following cards:
    - IMS - Service card - Type 1 – A-SBG;
    - IMS - Service card - Type 2 – telephony AS;
    - IMS - Service card - Type 3 – CSCF&MRCF;
    - IMS - Service card - Type 4 – BGCF;
    - IMS - Service card - Type 5 - DNS server;
    - IMS - Service card - Type 6 - Service Delivery AS.

    For each IMS element volumes of extension cards (TDM processing, VoIP processing) are calculated.

    The number of required IMS cards is calculated using the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (79).

  - IMS - Service frame - Type 2 , which includes:
    - HSS - Service card - Type 1 – Control Card;
    - HSS - Service card - Type 2 – Database Card.

  The number of required HSS service cards is calculated using the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (80).

  - Licenses, which include:
    - IMS Licenses - Type 1;

- IMS Licenses - Type 2;
- HSS Licenses.

The volume of licenses is equal to volume of BHE, BHCA or number of subscribers.

2.5.6.2 Billing IC system

This section contains the dimensioning of the billing system dedicated for the interconnection traffic.

- Line 38 present volume of CDR (Call detail record) which should be handled by the Billing IC system.

  The volume of CDR is a sum of the interconnection services traffic multiplied by their CDR statistics (sheet "A3 Service Statistics", lines 99 – 101).
- Line 40 estimates number of billing system expansion cards. The number of billing system expansion cards is calculated according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (82).
- Line 40 estimates number of billing system main units. The number of billing system main units is calculated according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (81).

2.5.7 Page "C6 Ducts and fiber cables design"

This page contains two main sections:

- Ducts and fiber cables calculation (lines 13 – 58);
- Ducts and fiber cables statistics (lines 61 – 110).

2.5.7.1 Ducts and fiber cables calculation

The first section contains dimensioning of ducts and fiber cables. Ducts and fiber cables are dimensioned for 4 types of sections (Columns D – G):

- Sections between Access Nodes and Transit Nodes in urban area;
- Sections between Access Nodes and Transit Nodes in suburban/rural area;
- Sections between Transit Nodes in urban area;
- Sections between Transit Nodes in suburban/rural area.

The physical lengths of cables for each type of sections (line 9) are taken from input parameters page ("A5 Network Statistics"). Line 11 specifies the size of fiber cable for each type of sections.

Data defined in line 13 alongside with network statistics are used to calculate volumes of fiber and ducts network elements. In particular the following elements are dimensioned:

- A. Infrastructure:
  - Trench – in kilometers;
  - Primary duct - 1 hole, in kilometers;
  - Primary duct - 2 holes, in kilometers;
  - Primary duct - 6 holes, in kilometers;
  - Primary duct -12 holes, in kilometers;
  - Primary duct - 24 holes, in kilometers;
  - Primary duct - 48 and more holes, in kilometers;
  - Manholes, in pieces.
- B. Ground reconstruction:
  - Grass reconstruction, in square meters;
  - Sidewalk reconstruction, in square meters;

- Asphalt pavement reconstruction, in square meters;
- Concrete pavement reconstruction, in square meters.
- C. Passages under obstacles:
  - Passage under road (up to 15m), in pieces;
  - Passage under road (above 15m) , in pieces;
  - Passage under railway tracks, in pieces;
  - Passage under rivers and channel, in pieces;
  - Passage under other obstacles, in pieces.
- D. Additional works:
  - Project works, in kilometers;
  - Consent of the landowners, in pieces;
  - Geodetic service, in kilometers.
- E. Fiber cable
  - Fiber cable – 12 fibers, in kilometers;
  - Fiber cable – 24 fibers, in kilometers;
  - Fiber cable – 48 fibers, in kilometers;
  - Fiber cable – 72 fibers, in kilometers;
  - Fiber cable – 96 fibers, in kilometers;
  - Fiber cable – 144 fibers, in kilometers.
- F. Joints for fiber cables
  - Joint for 12 fibers, in pieces;
  - Joint for 24 fibers, in pieces;
  - Joint for 48 fibers, in pieces;
  - Joint for 72 fibers, in pieces;
  - Joint for 96 fibers, in pieces;
  - Joint for 144 fibers, in pieces;
  - Section measurement, in pieces.

The input parameters used to dimension each element of fiber and ducts net are taken from page ("A5 Network Statistics").

2.5.7.2 Ducts and fiber cables statistics

The second section includes ducts and fiber cables statistics. Those statistics presents distribution of each HCC related to ducts between 4 types of transmission segments mentioned above.

Those statistics are used on page "C9 HCC – NC" to allocate cost of ducts and fiber cables between Network Components. Statistics are calculated for all elements of fiber and duct network, listed in the previous section.

2.5.8 Page "C7 Revaluation"

In this calculations' page the current value of the network is established and investments received are converted to annual values. Column B "HCC name" contains HCC groups and their components. Column D "Volume" contains amounts of network elements, which are settled in calculations' pages: C3, C4, C5 and C6. Column E "Unit price total (LTL)" contains values of network elements, their values are taken from the page of input parameters "A6 HCC data". Column F "GRC value (LTL)" contains the result of multiplication of columns D and E, i.e. gross replacement cost (GRC). As previously mentioned, the investments are converted to annual values. This calculations' page includes the following three methodologies of investments conversion to annual values:

- Annuity method – (Column G)

- Tilted annuity method – (Column H)
- Straight-line method – (Column I)

Annuity method

The annual CAPEX costs under annuity method are calculated according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (84).

Tilted annuity method

The annual CAPEX costs under tilted annuity method are calculated according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (85).

Straight-line method

The annual CAPEX costs under straight-line method are calculated according to the formula which is presented in "Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network" Formula (83).

2.5.9 Page "C8 Mark-ups"

In this page of calculations, mark-ups (to cover network operation, maintenance and planning costs, network sites rental cost, energy costs, network management system costs, power plants costs) are added to annual network investment values, defined in the page "C7 Revaluation".

Column B (HCC name) contains HCC groups and their components. Column C "GRC Value (LT)" contains respective GRC values of network elements from the page of calculations "C7 Revaluation", column F "GRC value (LT)".

Column D "Chosen method" contains annual values of network investment, calculated in column J of the calculations' page "C4 Revaluation".

Columns E, F, G, H and I settle mark-ups as follows:

- Column E ("Mark-up A.") include the values of mark-ups to cover network operation, maintenance and planning expenses, which are calculated by multiplying the respective GRC value (column C) by a respective mark-up (page of input parameters "A7 Mark-ups", lines 11-14). In particular
    - In cells E10 – E47 the value of GRC is multiplied by mark-up to cover the cost related to fiber cables and ducts (page of input parameters "A7 Mark-ups", cell D11).
    - In cells E49 – E75 the value of GRC is multiplied by mark-ups to cover the costs related to access nodes (page of input parameters "A7 Mark-ups", cell D12).
    - In cells E77 – E114 the value of GRC is multiplied by mark-ups to cover the costs related to transmission network (page of input parameters "A7 Mark-ups", cell D13).
    - In cells E116 – E160 the value of GRC is multiplied by mark-ups to cover the costs related to switching network (page of input parameters "A7 Mark-ups", cell D14).
- Column F ("Mark-up C.") contains the values of mark-ups to cover administration and support operational costs, which are calculated by multiplying the value of operational costs (column E) by a respective mark-up (page of input parameters "A7 Mark-ups", lines 24-26). In particular:
    - In cells F49 – F75 the value of GRC is multiplied by mark-up to cover the cost related to access node (page of input parameters "A7 Mark-ups", cell D24).
    - In cells F77 – F114 the values of network OPEX (column E) are multiplied by mark-ups to cover the cost related to transmission network (page of input parameters "A7 Mark-ups", cell D25).
    - In cells F116 – F160 the values of network OPEX (column E) are multiplied by mark-ups to cover the cost related to switching network (page of input parameters "A7 Mark-ups", cell D26).
- Column G ("Mark-up B.") contain values of mark-up to cover administration and support operational costs which are calculated by multiplying respective values of network OPEX (column E) by a respective mark-up to (page of input parameters "A7 Mark-ups", cell D17 – D19). In particular:
    - In cells G49 – G75 the value of GRC is multiplied by mark-up to cover the cost related to access nodes (page of input parameters "A7 Mark-ups", cell D29).

- In cells G77 – G114 the values of network OPEX (column E) are multiplied by mark-ups to cover the cost related to transmission network (page of input parameters "A7 Mark-ups", cell D30).
- In cells G116 – G160 the values of network OPEX (column E) are multiplied by mark-ups to cover the cost related to switching network (page of input parameters "A7 Mark-ups", cell D31).

- Column H ("Mark-up D.") contain values of mark-up to cover administration and support capital costs which are calculated by multiplying respective values of network OPEX (column E) by a respective mark-up to (page of input parameters "A7 Mark-ups", cell D29 – D31). In particular:
  - In cells G49 – G75 the value of GRC is multiplied by mark-up to cover the cost related to access nodes (page of input parameters "A7 Mark-ups", cell D29).
  - In cells G77 – G114 the values of network OPEX (column E) are multiplied by mark-ups to cover the cost related to transmission network (page of input parameters "A7 Mark-ups", cell D30).
  - In cells G116 – G160 the values of network OPEX (column E) are multiplied by mark-ups to cover the cost related to switching network (page of input parameters "A7 Mark-ups", cell D31).

In column I (Yearly costs (LTL)) annual network investments with mark-ups are calculated by summing up the values of columns D, E, F, G and H.

2.5.10 Page „C9 HCC – NC"

This page consists of five main sections:

- Allocation of Homogenous Cost Categories on Network Components (lines 9-231);
- Calculation of incremental cost for access, traffic, voice traffic and data traffic (lines 234-253);
- Calculation of Network Component incremental unit cost (lines 263-268) for call termination;
- Calculation of Network Component incremental unit cost (lines 270-275) for call origination;
- Calculation of Network Component incremental unit cost (lines 277-282) for call transit;

2.5.10.1 Section "Homogenous Cost Categories on Network Components"

The first section (lines 9-231) of this page presents the allocation of HCC yearly cost to Network Components. In particular

In column B "HCC name" HCC groups and its components are provided. In column D "Yearly cost" network elements' annual cost are provided from calculation page "C8 Mark - ups" column I. These costs are distributed to network components. Network components are provided in F7 – R7 cells. Annual costs for network components are distributed in this calculation page's cells, indicating percentage of costs to particular network component.

2.5.10.2 Section "Incremental cost for access, traffic, voice traffic and data traffic"

This section is used to calculate common and joint cost related to each group of service (total voice services, total data services and access services) separately for each Network Component using an equal-proportional mark-up (EPMU) mechanism. This mechanism is based on the level of incremental cost incurred by each group of service (total voice services, total data services and access services). The calculation of common and joint cost related is done in the following steps:

- Calculation of NC costs in absence of the each group of service (Lines 236 – 240)
  - Line 236 – cost of NC when providing all group of services;
  - Line 237 – cost of NC when providing only access services;
  - Line 238 – cost of NC when providing only voice and data services;
  - Line 239 - cost of NC when do not providing voice services;
  - Line 240 - cost of NC when do not providing data services;
- Calculation of incremental cost of each group of service (Lines 242 – 245)
  - Line 242 - Incremental costs - traffic – Incremental cost of NC related to traffic calculated as a difference between cost of NC when providing all group of services (Line 236) and cost of NC when providing only access services (Line 237).

- Line 243 - Incremental costs - access - Incremental cost of NC related to access calculated as a difference between cost of NC when providing all group of services (Line 236) and cost of NC when providing data and voice services (Line 238).
- Line 244 - Incremental costs - voice traffic - Incremental cost of NC related to voice traffic calculated as a difference between cost of NC when providing all group of services (Line 236) and cost of NC when providing data and access services (Line 180).
- Line 245 - Incremental costs - data traffic - Incremental cost of NC related to data traffic is a difference between cost of NC when providing all group of services (Line 236) and cost of NC when providing voice and access services (Line 181).

- Calculation of common and joint cost related to each group of service using an equal-proportional mark-up (EPMU) (Lines 247 – 253)
  - Line 247 - Common costs access / traffic - common costs for access and traffic groups of services calculated as a difference between cost of NC when providing all group of services (Line 236) minus sum of Incremental costs - traffic (Line 242) and Incremental costs - access (Line 243);
  - Line 248 - Common costs traffic - common costs of traffic are calculated according to the formula:

$$CJC_{traffc} = CJC_{traffic/access} \cdot \frac{IC_{traffic}}{IC_{traffic} + IC_{access}}$$

Where,

CJC_{traffc} - Common and joint costs traffic;

$CJC_{traffic/access}$ - Common and joint costs traffic and access (line 247);

$IC_{traffic}$ - Incremental costs traffic (line 242);

IC_{access} - Incremental costs access (line 243);

  - Line 249 - Common costs access - common and joint costs of access are calculated according to the formula:

$$CJC_{access} = CJC_{traffic/access} \cdot \frac{IC_{access}}{IC_{traffic} + IC_{access}}$$

Where,

CJC_{access} - Common and joint costs access;

$CJC_{traffic/access}$ - Common and joint costs traffic and access (line 247);

$IC_{traffic}$ - Incremental costs traffic (line 242);

IC_{access} - Incremental costs access (line 243);

  - Line 251 - Common costs data / voice traffic - common and joint costs of data and voice traffic are calculated as a difference between Incremental costs - traffic (Line 242) minus sum of Incremental costs - voice traffic (Line 244) and Incremental costs - data traffic (Line 245)
  - Line 252 Common costs voice traffic - common and joint costs of voice traffic re calculated according to the formula:

$$CJC_{voice} = CJC_{voice/data} \cdot \frac{IC_{voice}}{IC_{voice} + IC_{data}}$$

Where,

CJC_{voice} - Common and joint costs voice traffic;

$CJC_{voice/data}$ - Common and joint costs voice and data traffic and access (line 251);

IC_{voice} - Incremental costs voice traffic (line 244);

IC_{data} - Incremental costs data traffic (line 245);

- Line 253 Common costs data traffic - common and joint costs of data traffic are calculated according to the formula:

$$CJC_{data} = CJC_{voice/data} \cdot \frac{IC_{data}}{IC_{voice} + IC_{data}}$$

Where,

CJC_{data} - Common and joint costs data traffic;

$CJC_{voice/data}$ - Common and joint costs voice and data traffic and access (line 251);

IC_{voice} - Incremental costs voice traffic (line 244);

IC_{data} - Incremental costs data traffic (line 245);

Finally, with the incremental costs and common and joint costs calculated, unit costs according to LRAIC+ and LRAIC++ are estimated:

- Line 257 network component cost – LRAIC+: unit costs are estimated by dividing voice increment (subtraction of line 236 and 239) by total voice demand on the network
- Line 261 network component cost – LRAIC++: unit costs are estimated by calculating voice traffic incremental costs (subtraction of line 236 and 239), adding the voice traffic common costs (line 252) and adding a proportion of common traffic costs by further dividing the result by the total network demand.

2.5.10.3 Section "Fixed termination"

This second section (lines 263-268) of the page presents calculation of Network Component termination incremental unit cost.

- Total Network Component cost less cost of incoming minutes (LTL) (Cells F265 – R265) presents annual costs of a particular network component. It is cost of network planned to utilize demand for total service volume less incoming minutes.
- Total Network Component incremental cost (LTL) (Cells F266 – R266) – presents the annual incremental costs for a particular network component and it is calculated as a difference between "Total Network Component cost" (Cells F236 – R236) and "Total Network Component cost less cost of incoming minutes" (Cells F265 –R265).

  Values in cells F265 – R265 are calculated using Visual Basic subroutines, which calculate cost of network dimensioned to handle the volume of services reduced by volume of incoming calls.
- In cells F267 – R267 network services termination annual traffic on particular network component is defined. Network services annual traffic data is taken from calculation page „ C1 Demand".
- In cells F268 – R268 unit network component incremental cost is calculated, dividing Total Network Component incremental cost (LTL) (Cells F266 – R266 by termination annual traffic (F267 – R267).

2.5.10.4 Section "Fixed origination"

The fourth section (lines 270-275) of this page presents calculation of Network Component origination incremental unit cost.

- Total Network Component cost less cost of outgoing minutes (LTL) (Cells F272 – R272) presents annual costs of a particular network component. It is cost of network planned to utilize demand for total service volume less incoming minutes.
- Total Network Component incremental cost (LTL) (Cells F273 – R273) – presents the annual incremental costs of a particular network component and it is calculated as a difference between "Total Network Component cost" (Cells F236 – R236) and "Total Network Component cost less cost of outgoing minutes" (Cells F272 – R272).

  Values in cells F272 – R272 are calculated using Visual Basic subroutines, which calculate cost of network dimensioned to handle the volume of services reduced by volume of outgoing calls.
- In cells F274 – R274 network services origination annual traffic on particular network component is defined. Network services annual traffic data is taken from calculation page „ C1 Demand".

- In cells F275 – P275 unit network component incremental cost is calculated, dividing Total Network Component incremental cost (LTL) (Cells F273 – R273 by origination annual traffic (F274 – R274).

2.5.10.5 Section “Transit”

The fifth section (lines 277-282) of this page presents calculation of Network Component transit incremental unit cost.

- Total Network Component cost less cost of transit traffic (LTL) (Cells F279 – R279) presents annual costs of a particular network component. It is cost of network planned to utilize demand for total service volume less transit traffic.
- Total Network Component incremental cost (LTL) (Cells F280 – R280) – presents the annual incremental costs of a particular network component and it is calculated as a difference between “Total Network Component cost” (Cells F236 – R236) and “Total Network Component cost less cost of outgoing minutes” (Cells F279 – R279).

  Values in cells F279 – R279 are calculated using Visual Basic subroutines, which calculate cost of network dimensioned to handle the volume of services reduced by volume of outgoing calls.
- In cells F281 – R281 network services origination annual traffic on particular network component is defined. Network services annual traffic data is taken from calculation page „ C1 Demand“.
- In cells F282 – P282 unit network component incremental cost is calculated, dividing Total Network Component incremental cost (LTL) (Cells F280 – R280 by origination annual traffic (F281 – R281).

2.5.11 Page „ C10 Services cost“

This page contains calculation service cost (SC), which are calculated based on Pure LRAIC, LRAIC+ and LRAIC++ principles. The costs of the following services are calculated:

- LRIC ++ unit cost of services (lines 11-24) calculated according to chosen annualization method;
- LRIC+ unit cost of services (lines 28 – 41) calculated according to chosen annualization method;
- Pure LRIC unit cost of services (lines 45 – 58) calculated according to chosen annualization method;
- Cost of outgoing minutes (LRIC++) with attributed joint cost of termination (difference between LRIC++ and pure LRIC) (lines 62-63) calculated according to chosen annualization method;
- Cost of outgoing minutes (LRIC+) with attributed joint cost of termination (difference between LRIC+ and pure LRIC) (lines 62-63) calculated according to chosen annualization method.

In columns D – F service costs are provided including call set-up, and columns J – L service costs are provided without call set-up. The initial call set-up costs are provided in column H.

In cells N11: Z56 network components units costs (calculation page „C9 HCC – NC“) are multiplied by services usage factors (input parameter page „ A8 Service Matrix“).

Formulas according to which the service costs are estimated can be found in “Reference paper for creating model for calculation of bottom up long run average incremental costs (BU-LRAIC) for operator of public fixed communications network” section *8.3 Service Cost*.

Appendix A Entry data updating methodology

Page	Data	Cells	Periodicity	Data revaluation source
A1 Access Nodes	Service volumes	Columns H - O	Data is updated 1 time in 2-3 years	Information is updated according to the data on sold services provided by Operators
A1 Access Nodes	Service presence	Columns Q - S	Data is updated 1 time in 2-3 years	Information is updated according to the data on sold services provided by Operators
A2 Service Volumes	Service statistics	Lines 11 – 75	Data is updated 1 time in a year	Information is updated according to the data on sold services provided by Operators
A3 Service Statistics	Routing factors	G15 – S43	Data is updated 1 time in 2 years	Information is updated by consulting Operators and telecommunication industry experts
A3 Service Statistics	Priority factors	G47 – G58	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	Busy hour to Average hour ratios	G63 – I67	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	VoIP assumptions	G71 – G76	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	Voice service parameters	G87 – G101	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	Data – Points of interconnection	G127 – G129	Data is updated 1 time in a year	Information is updated according to the information provided by Operators
A3 Service Statistics	Parameters of POI interfaces	G133 – G137	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	Voice – Points of interconnection	G143 – G164	Data is updated 1 time in a year	Information is updated according to the information provided by Operators
A3 Service Statistics	Leased lines average throughputs	G174	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	High speed leased lines average throughputs	G191 – G195	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	TV services	G218 – G219	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A3 Service Statistics	Voice tariff differentiation statistics	G223 – G225	Data is updated 1 time in a year	Information is updated according to the information provided by Operators
A4 Headroom Allowance	Network elements headroom allowance data	F9 – G24	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts

Page	Data	Cells	Periodicity	Data revaluation source
A5 Network Statistics	MSAN specification	D19 – J35	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	OLT specification	D47 – F59	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Access Ethernet Switch specification	D64 – D78	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Ring statistics	D82	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Edge Ethernet Switch specification	D87 – D111	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Aggregation Edge Ethernet Switch specification	D116 – D140	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Core Ethernet Switch specification	D145 – D169	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	IP Routers specification	D174 – D189	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	MGW specification	D194 – D210	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	MGC specification	D215 – D218	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	IMS specification	D222 – D237	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Billing IC system specification	D242 – D245	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Length of fiber cables	D249 – D253	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Average number of fibers in the cable	D257 – D258	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Types of ducts	D263 – D278	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts

Page	Data	Cells	Periodicity	Data revaluation source
A5 Network Statistics	Urban geotype	D283 – D302	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Suburban / Rural geotype	D307 – D326	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Volumes of ground reconstruction	D331 – D341	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
A5 Network Statistics	Additional works	D346 – D347	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts
D5 HCC Data	Current network equipment price	D13 – D171 or E13 – E171 (depends on the currency)	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
D5 HCC Data	Useful lifetime	G13 – G171	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
D5 HCC Data	Last five years price index average	H13 – H171	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
D5 HCC Data	GBV and GRC ratio	I13 – I50	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
D5 HCC Data	NBV and GBV ratio	J13 – J171	Data is updated 1 time in a year	Information is updated according to the information provided by Operators and telecommunication industry experts
D6 Mark ups	Mark-ups	G11 – G14 and D17 – D31	Data is updated 1 time in 2 years	Information is updated according to the information provided by Operators and telecommunication industry experts