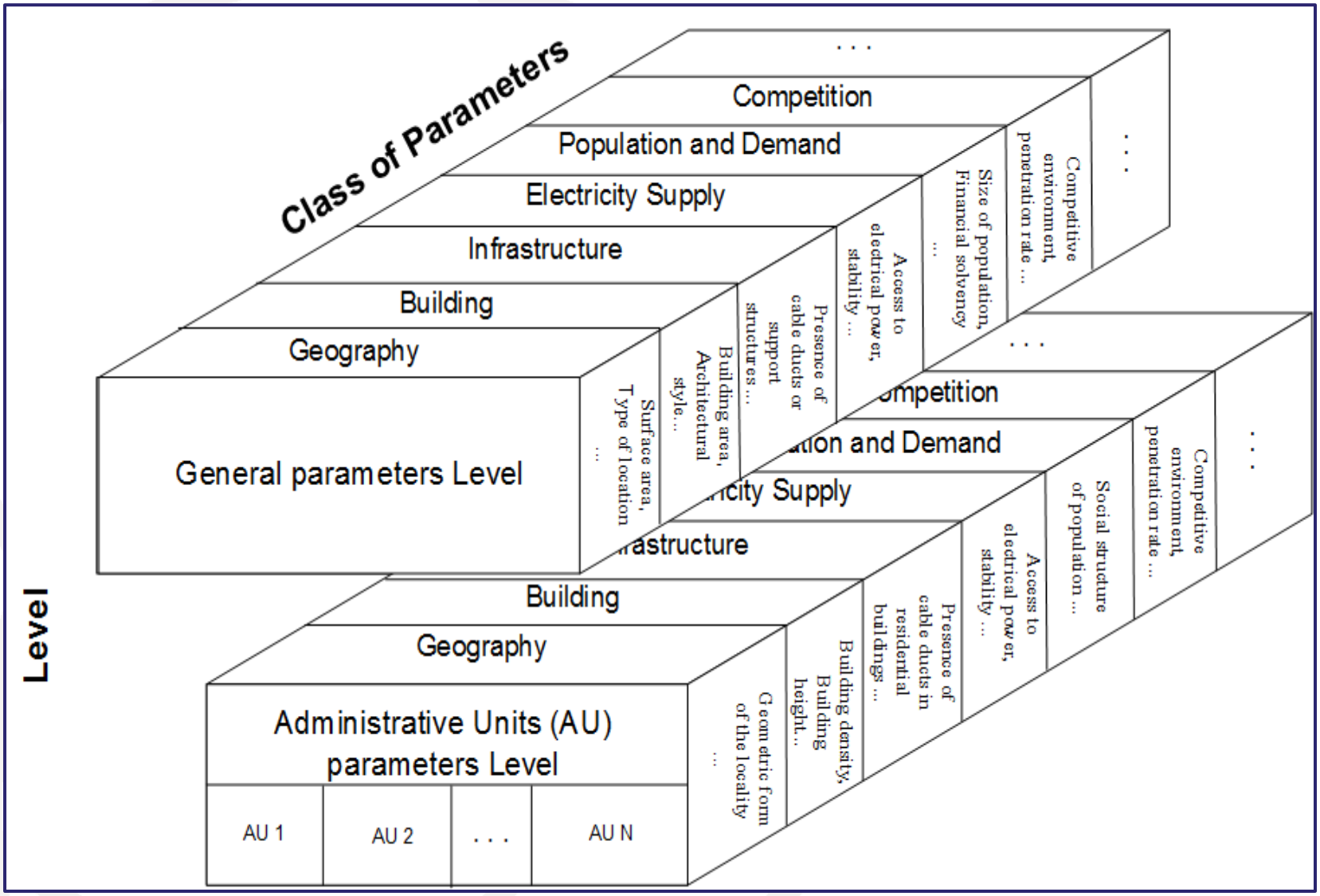
Last Mile Connectivity (LMC) training for Asia and the Pacific

Virtual, Oct 6 – 7, 2022

Lecture on the choice of technology for building broadband access networks in settlements

Generalized parametric model of a typical object (locality)



Generalized model for modern access network implementation

Equipment of a modern access network can be divided into two types:

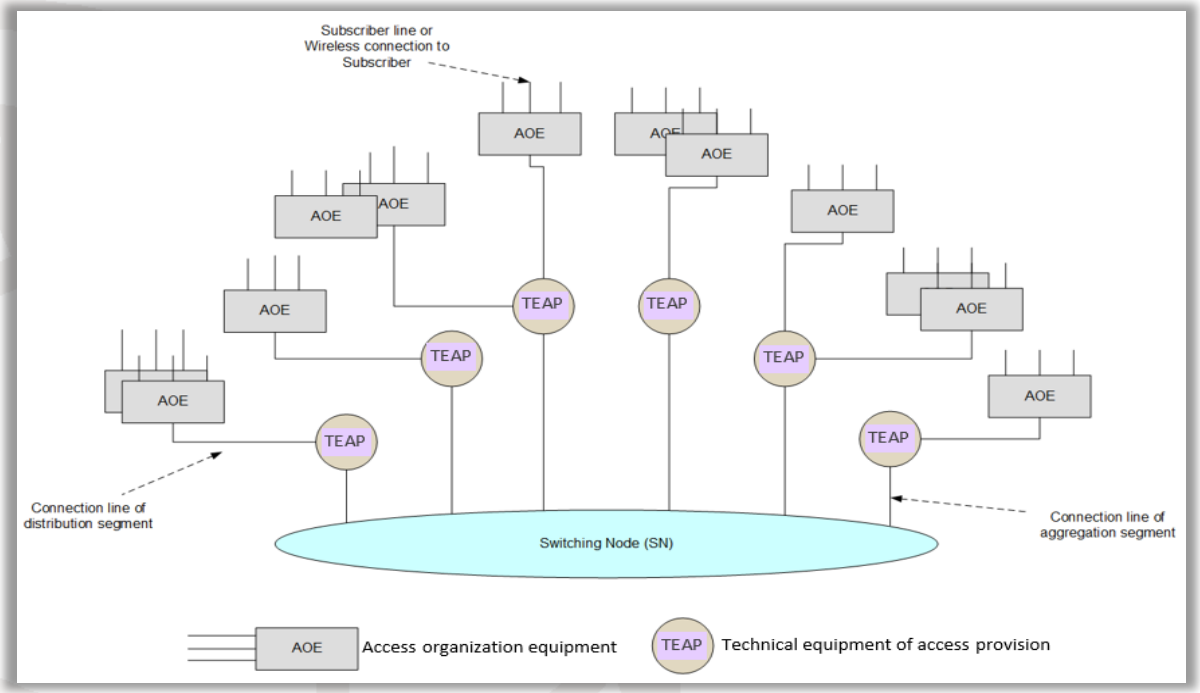
- Access organization equipment (AOE)
- Technical equipment of access provision(TEAP)

The interaction between different types of equipment is organized:

- from subscribers to AOEs (subscriber links);
- from AOEs to TEAPs (distribution segment links);
- from TEAPs to the Switching Node (aggregation segment links)

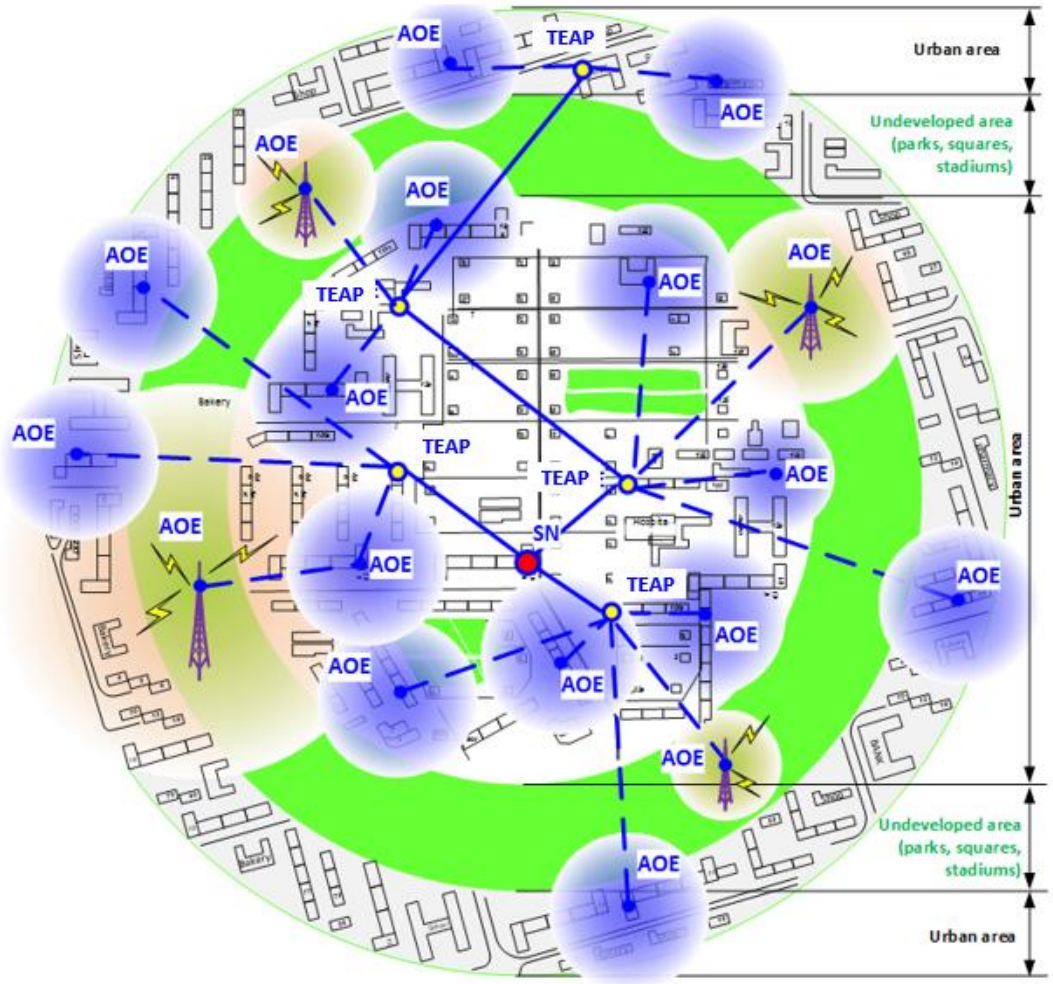
Generalized model for modern access network implementation

Generalized model for modern access network implementation

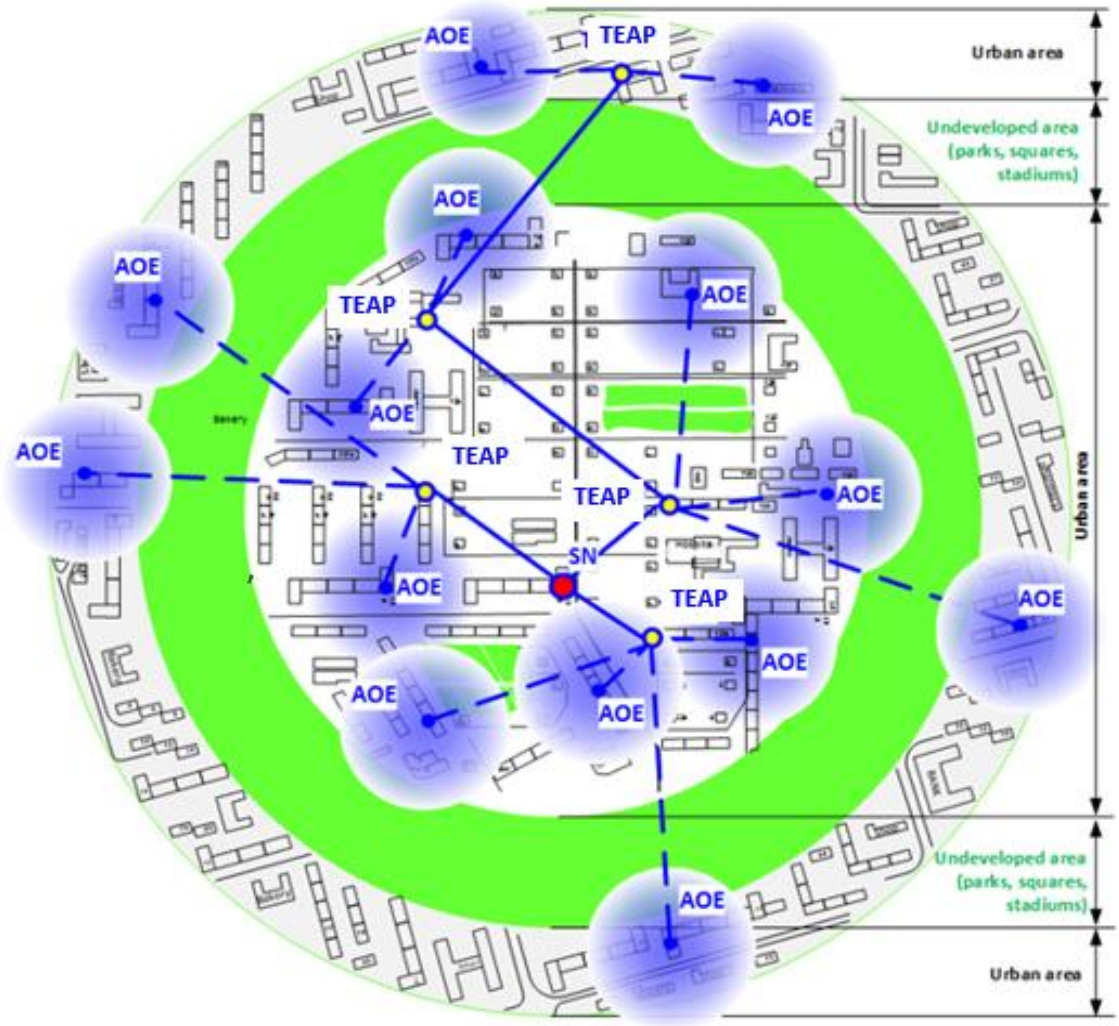


Overall principles of putting wired and wireless access equipment in the different types of buildings

Example of connecting subscriber equipment by wireless technologies



Example of connecting subscriber equipment by wired technologies



Legend

- access organization equipment (AOE)
- technical equipment of access provision (TEAP)
- switching node
- zone of possible location of subscriber lines
- coverage of wireless AOE
- distribution segment lines
- aggregation segment lines
- urban development plan

Parameters describing access technology

Qualitative parameters:

- Type of transmission medium for subscriber lines (the medium with which subscribers are connected to the switch, multiplexer, access point, base station)
- Type of transmission medium for links in distribution network (connecting active and passive equipment to each other within distribution or aggregation segments)
- usage of a Radio Frequency Resource (RFR) based on licensing or use of RFR with limitations

Parameters describing access technology

Quantitative parameters:

- service area radius for the territory covered by connections of one AOE unit;
- number of population that can be serviced by one AOE unit
- number of AOEs that can be connected to one TEAP
- maximum length of the communication line for distribution segment,
- cost of one AOE unit
- cost of one TEAP unit
- cost of equipment of the Switching Node

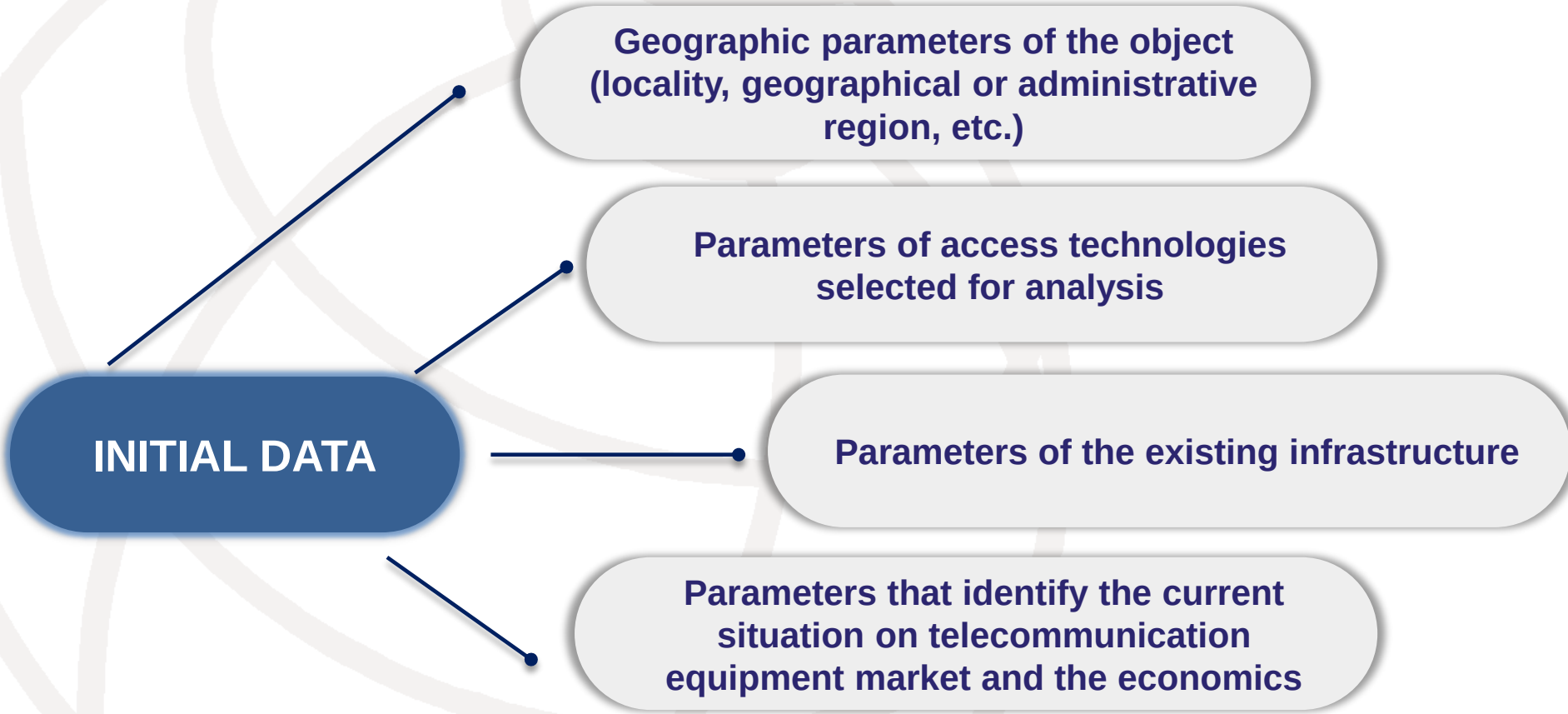
Generalized algorithm for technology selection

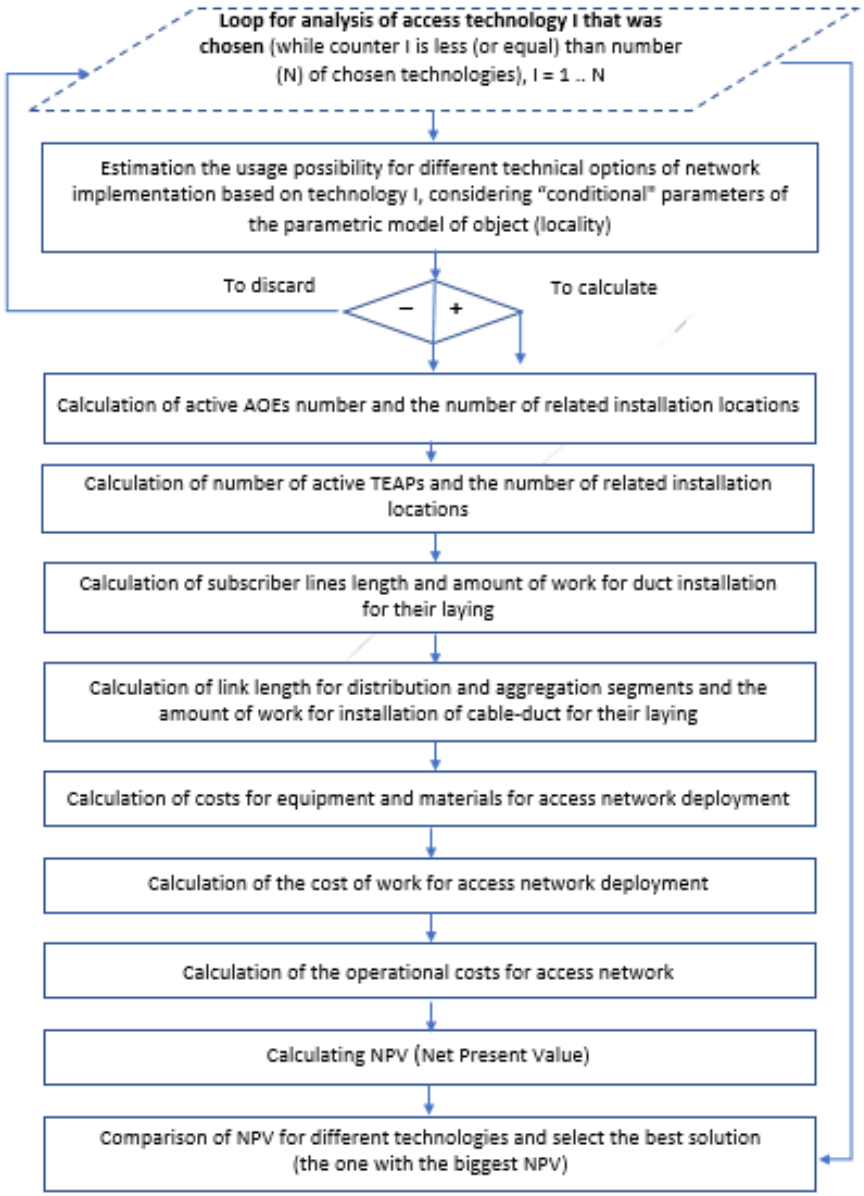
The proposed approach is based on simulation of the deployment and maintenance of the network.

The purpose of this simulation is to evaluate:

- Cost and time budget for network deployment
- Cost of network operation
- Expected financial revenues from the provision of services using a simulated infrastructure

Generalized algorithm for technology selection

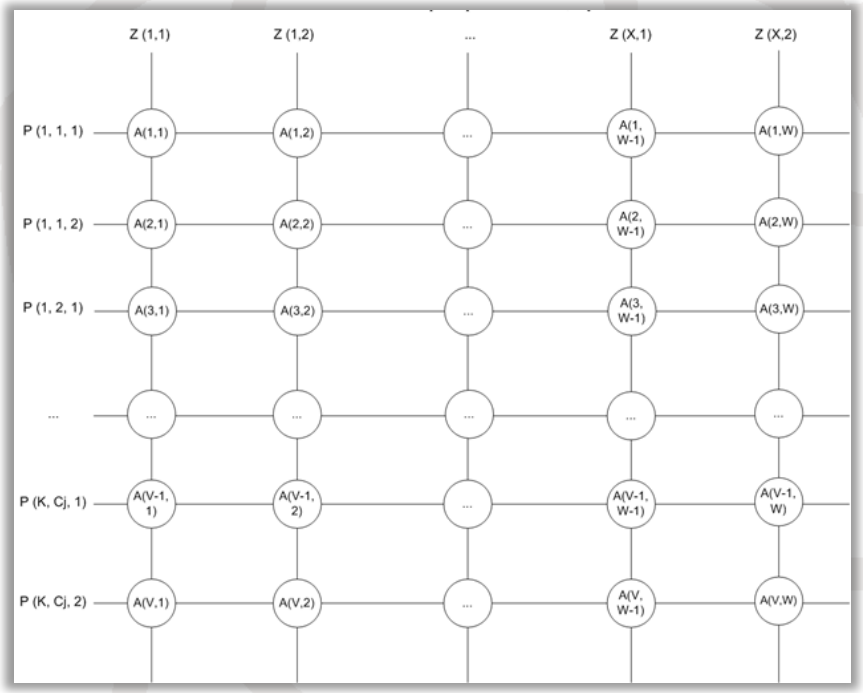




Generalized algorithm for the selection of technological solutions

- Simulation results based on the NPV indicator are used to compare technologies;
- The technology with the ***highest*** NPV value is considered the most promising.

Assessment of the possibility of network deployment using particular access technology



Matrix A is an array in which:

- the number of rows (V) is determined as the number of possible options for parameters values of the entire classes set of the object (locality) parametric model
- the number of columns (W) is determined as the number of possible options for qualitative parameters values of the access technology

Assessment of the possibility of network deployment using particular access technology

Rows number of the matrix A

$$V = \sum_{j=I}^{K} \left(\sum_{f=1}^{C_j} (q_{jf}) \right)$$

Columns number of the matrix A

$$W = \sum_{z=1}^{X} (q_z)$$

where

K – **the number of classes of the object (locality) parametric model;**

C_j – **the number of conditional parameters within the j-th class of the object parametric model;**

q_{jf} – **the number of possible values of the f-th conditional parameter of the j-th class of the object parametric model.**

X – **number of quality parameters of access technology;**

q_z – **the number of possible values of the z-th quality parameter of access technology.**

Numerical estimation of the compatibility can be done by determination matrix A element, which corresponds to a cell at the intersection of the values of these parameters within the corresponding matrix:

- "0" value corresponds to the absence of the influence of the conditional parameter value of the object parametric model on the network implementation.
- "0.5" value indicate the partial incompatibility of the parameter values.
- "1" value indicate complete incompatibility of the parameter values

Corresponding access technology is considered:

- ***unacceptable,*** if the condition $\sum_{g=1}^{V}(A(g,h)) \geq 1$ for any *h*-th value of the qualitative parameter of the access technology of a particular compatibility matrix A.

Evaluating the cost for deployment and operations of access networks

Cost of access networks deployment includes the following main stages

Step 1

Estimation of cost for commissioning work (including installation and configuration of AOEs and TEAPs);

Step 2

Estimation of costs for deployment and installation of subscriber lines, including the installation of indoor cable ducts (if necessary)

Step 3

Estimation of costs for installation of communication lines for distribution and aggregation segments, including the installation of cable ducts (if necessary)

Evaluating the cost for deployment and operations of access networks

Number of AOE units

$$M_{AOE\_act} = max(M_{AOE\_cover}, M_{AOE})$$

Number of TEAP's units

$$M_{TEAPact} = \lceil M_{AOE} \times N_{connect} / C_{TEAP\_AOE} \rceil$$

where

M_{AOE_cover} **– number of AOE units enough to cover the required number of subscribers,**

M_{AOE} **– Number of locations for AOEs installations,**

$N_{connect}$ **– Number of TEAP's ports required to connect one AOE ,**

C_{TEAP_AOE} **– Number of AOEs that can be connected to one TEAP,**

Evaluating the cost for deployment and operations of access networks

Length of the hanged-up cables of links for distribution and aggregation segments

$$(L_{aggr.extern.distr} + L_{aggr.extern.aggr}) - L_{hanged.distr.aggr} - L_{duct.distr.aggr}$$

where

$L_{aggr.external}$ **– Length of aggregated cables for outdoor lines,**

$L_{duct.SL}$ **– Length of subscriber lines in the outside cable ducts**

$L_{hanged.SL}$ **– Length of the hanged-up cables of subscriber lines**

$L_{aggr.extern.distr}$ **– Length of the aggregated cables of links of the distribution segment**

$L_{aggr.extern.aggr}$ **– Length of aggregated cables for aggregation segment links**

$L_{hanged.distr.aggr}$ **– Length of the hanged-up cables of links for distribution and aggregation segments**

$L_{duct.distr.aggr}$ **– Length of links for distribution and aggregation segments in the external cable ducts**

Evaluating the cost for deployment and operations of access networks

Total cost of equipment and materials

$$S_{equip.mat} = S_{equip} + S_{mat}$$

Total cost for access network deployment

$$S_{deployment} = S_{places.cost} + S_{inst.equip} + S_{cable}$$

where

S_{equip} **– Total cost of equipment,**

S_{mat} **– Total cost of materials,**

$S_{places.cost}$ **– Cost of installation work on the arrangement of locations for equipment ,**

$S_{inst.equip}$ **– Cost of installation and configuration of active equipment,**

S_{cable} **– Total cost of the installation of cable ducts and the installation of cable infrastructure**

Evaluating the cost for deployment and operations of access networks

Costs of the annual operation of an access network

$$S_{operation} = S_{oper.eqip} + S_{oper.lines} + S_{rent.cable.duc} + S_{rent.pillars}$$

where

$S_{oper.eqip}$ **– Equipment operational costs,**

$S_{oper.lines}$ **– Operational costs for communication lines and new infrastructure for hanging-up cables,**

$S_{rent.cable.duc}$ **– Rent costs the outdoor cable duct for the cable,**

$S_{rent.pillars}$ **– Rent cost the pillars for the hanged-up cable**

Algorithm for calculating NPV

Step 1 Calculation of the design and licensing costs

Step 2 Calculation of the total investment costs for construction of access networks

Step 3 Net income calculation and Net profit calculation

Step 4 Annual cash flow calculation and Discounted cash flow calculation

Step 5 Net cash flow calculation

NPV is used in capital budgeting and investment planning to analyze the profitability of a projected investment or project:

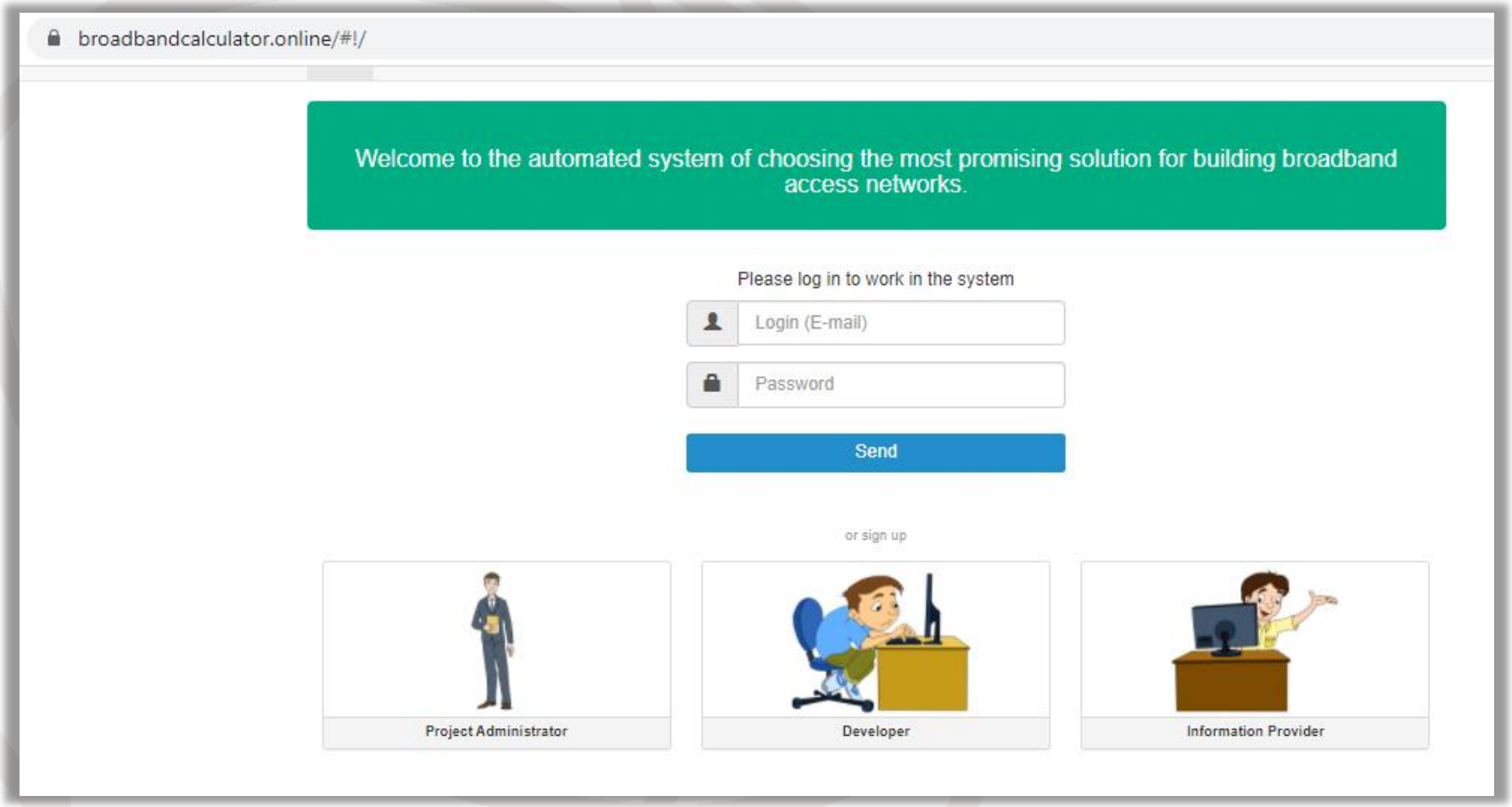
$$NPV = CF_{disc} - S_{inv},$$

CF_{disc} – Discounted cash flow,

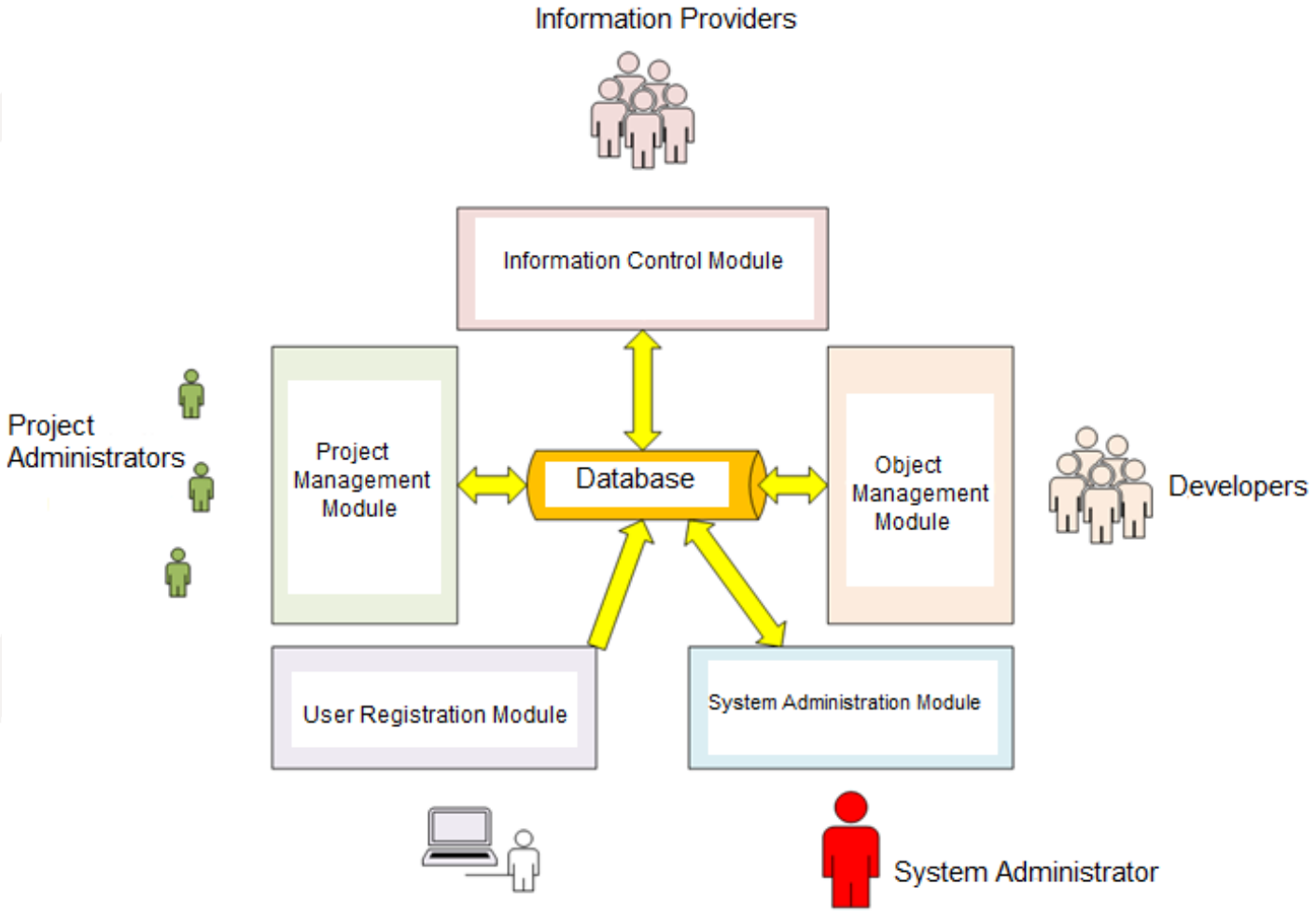
S_{inv} – Total investment costs for access networks deployment.

Broadband Calculation Tool

https://broadbandcalculator.online/



Broadband Calculation Tool



THANKS FOR ATTENTION