Lecture on Technology Selection for Connecting a Community to a Broadband Transport Backbone (Establishing a "Middle Mile" Connectivity for Communities, Schools, Hospitals, etc.), including Selecting the Best Topology for a Multisite Network

Modern approaches to choosing the most suitable solution for building telecommunications networks

1 Evaluation of current trends and analysis of best practices

Key advantage: simplicity (low level of labor effort)
Key disadvantage: the conclusion is made on the basis of another's experience, not adapted to concrete realities

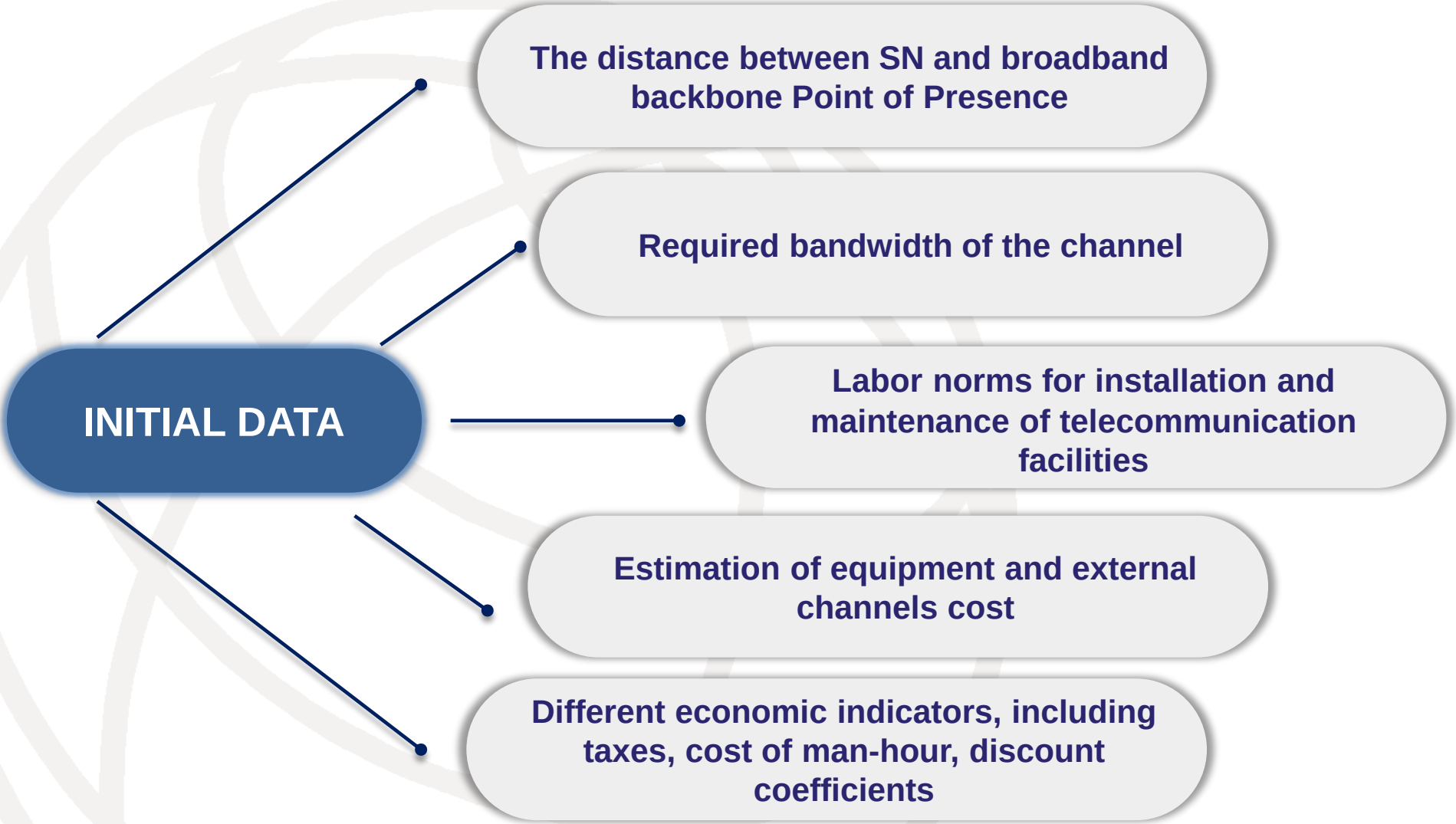
2 Expert assessment taking into account the current situation

Key advantage: possibility of taking into account the existing situation
Key disadvantage: high level of subjectivity, lack of economic evaluation

3 Simulation modeling for the purpose of economic feasibility assessment

Key advantage: high level of objectivity, possibility of taking into account economic feasibility
Key disadvantage: complexity (high level of labor effort)

Generalized algorithm for selecting affordable technology



Generalized algorithm for selecting affordable technology

Step 1 Determination of the cost of network construction or channel establishing

Step 2 Determination of the cost of annual network or channel maintenance

Step 3 Cost of ownership calculation

Step 4 Net Present Value Calculation (NPV)

Step 5 Choosing the best solution based on Cost of ownership or NPV

Step 3.5 Identification of potential income from providing extra resources to the rent (FOCL, RTS)

Given algorithm comprises simultaneous calculations by each of the further technology :

- FOCL
- RTS
- Cellular
- Satellite (if necessary)

Identification of potential income from providing extra resources optionally for FOCL and RTS

Choosing the best technological solution

Criterions for choosing the best technological solution

Total Cost of Ownership — Minimum from all calculated values of different technologies

Net Present Value — Maximum from all calculated values of different technologies

Potential Income — Maximum value for FOCL and RTS (if necessary)

General cost estimation of construction and maintenance

Total Cost of Ownership (TCO)

$$TCO = CAPEX + OPEX \times Y$$

Net present value (NPV)

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

where

$CAPEX$ **– estimated cost of communication channel organization, currency units;**

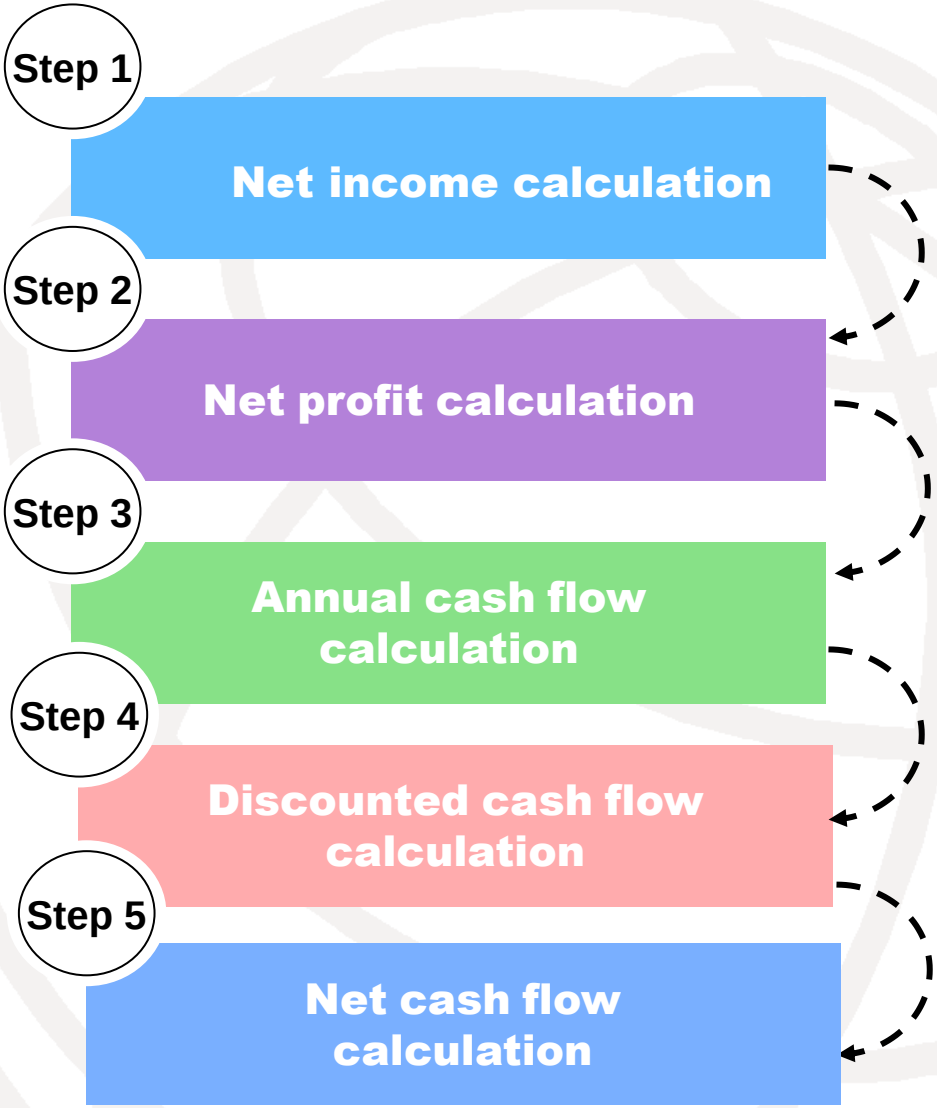
$OPEX$ **– estimated cost of annual communication channel maintenance, currency units per year;**

Y **– lifespan of the project estimation, years;**

CF_{disc} **– is the discounted cash flow, currency unit/year**

S_{inv} **– is the total investment costs for the construction of access networks, currency unit**

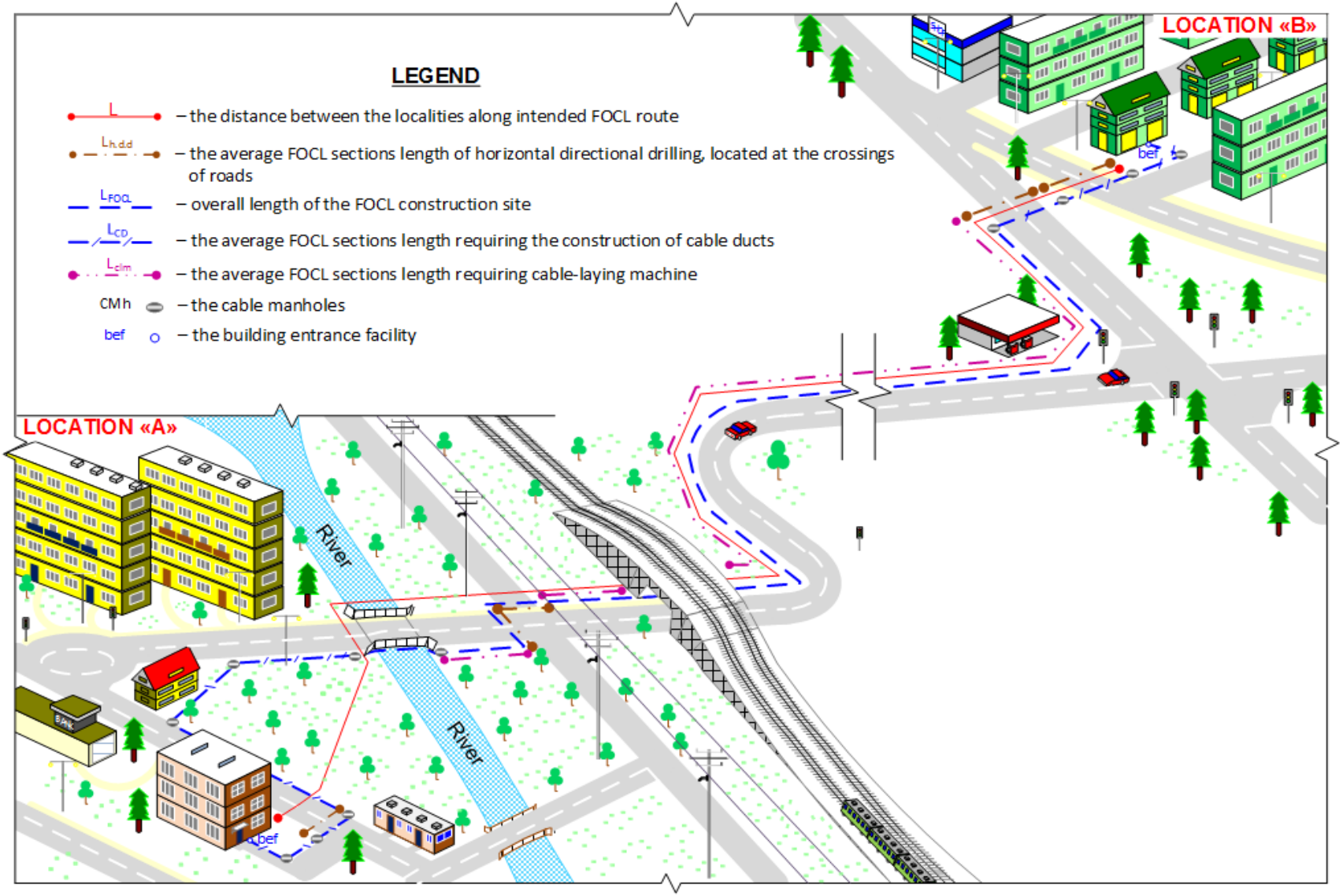
Algorithm for calculating NPV



NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time.

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

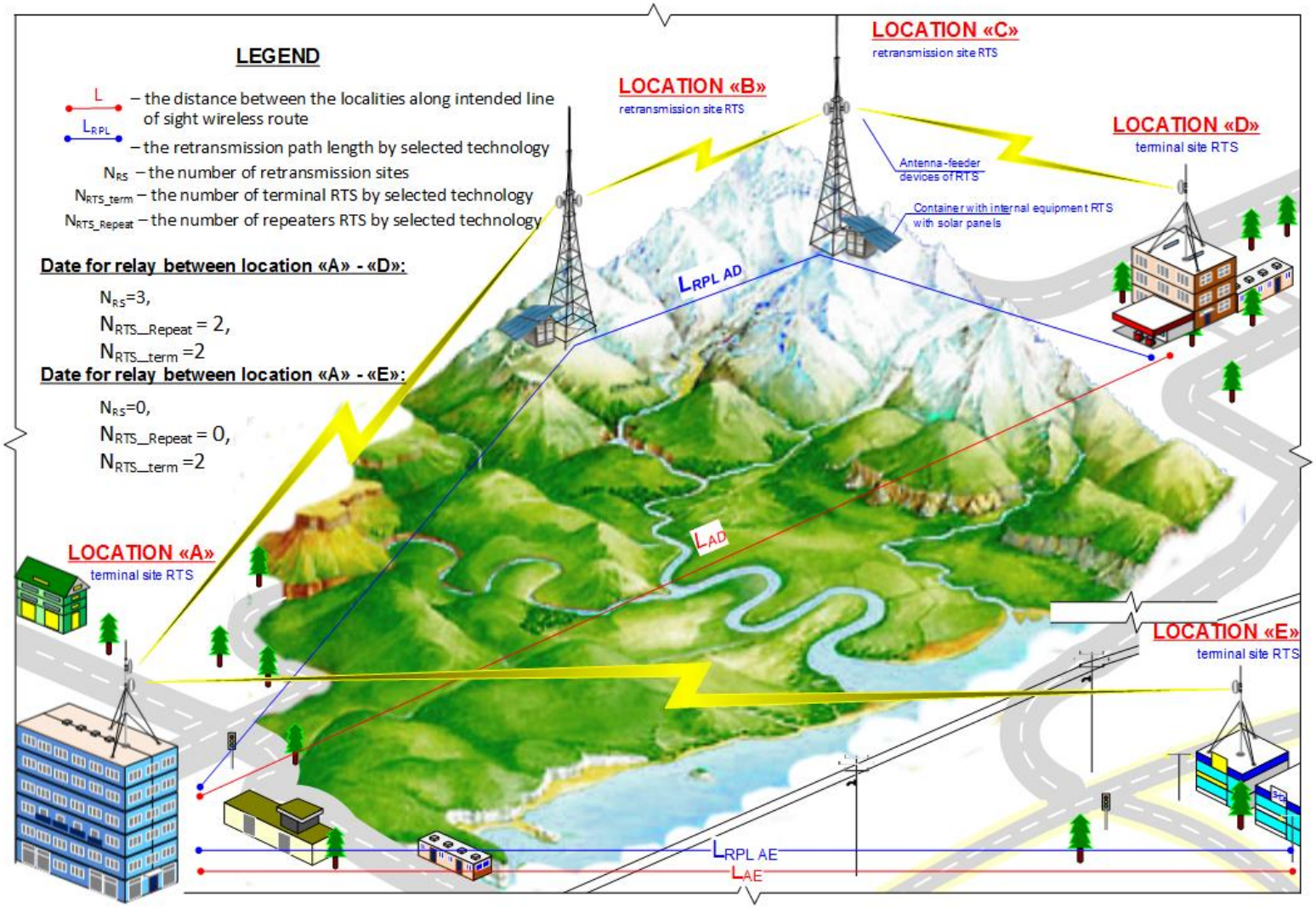
Scheme of organization of fiber-optic communication lines in the ground



Parameters determining the cost of FOCL construction and maintenance (CAPEX and OPEX calculation)

- Total cost of geodetic work along the object route
- Total FOCL cost along route
- Overall cost for FOCL sections construction of horizontal directional drilling
- Overall cost for FOCL section construction requiring the cable duct
- Overall cost for FOCL section construction requiring the cable laying machine
- Overall cost for FOCL signaling test
- Total cost of technical specifications design
- Total cost of design solutions coordination
- Design cost
- FOCL maintenance cost along the route
- Cable duct maintenance cost

Scheme of organization of point-to-point radiotransmission system communication channel



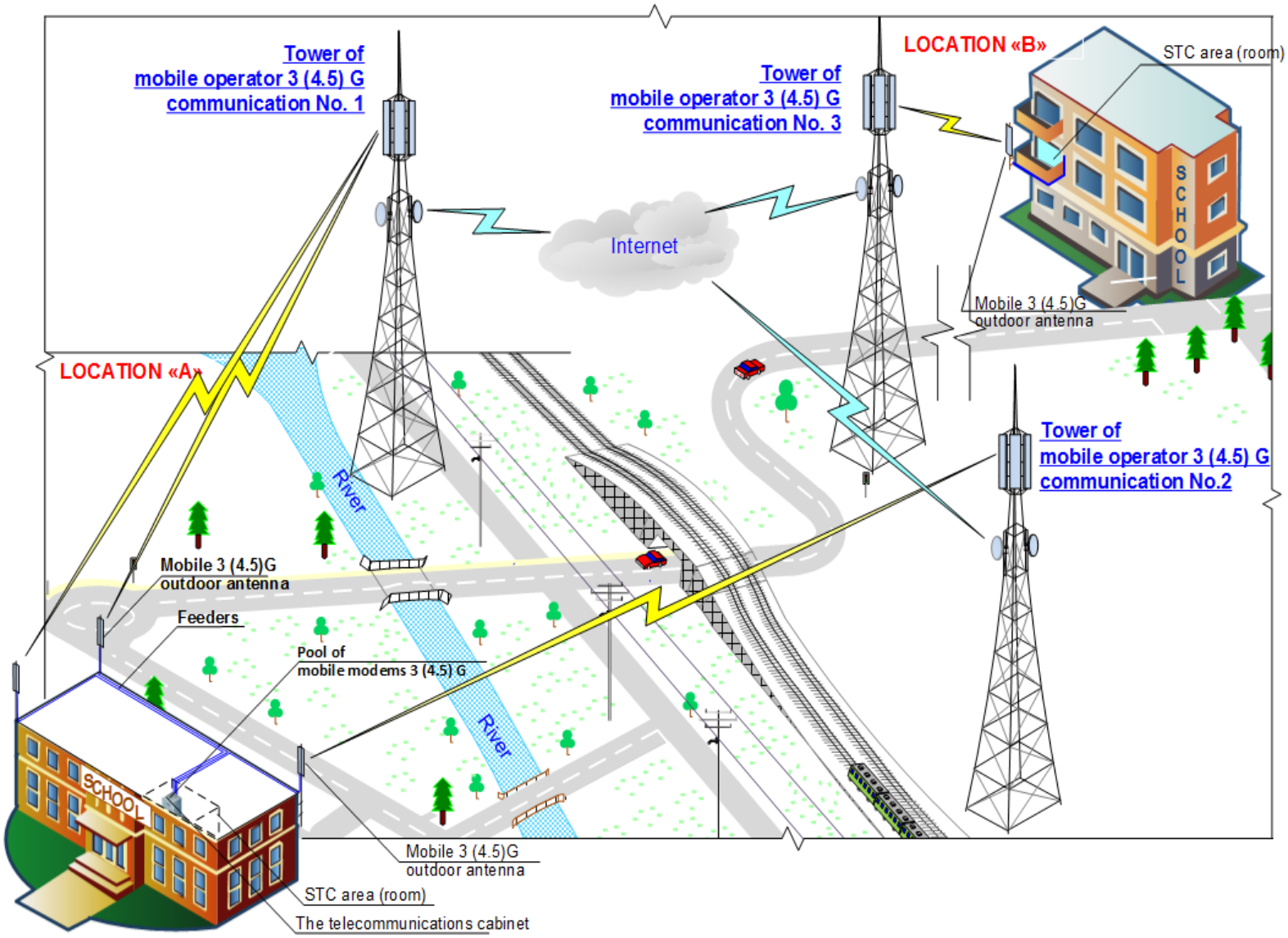
Parameters determining the cost of RTS construction (CAPEX calculation)

- Internal RTS devices total cost
- Antenna feeder devices total cost
- Main material total cost for RTS pylon construction
- Total cost for geodetic work at RTS pylon location
- Total cost for pylon construction of RTS antenna feeder devices
- Total cost for all antenna feeder devices installation and commissioning for along RTS route
- Total cost for internal devices installation and commissioning for RTS
- Total cost for design solutions coordination on RTS construction and design cost
- Width of frequency channel required for implementation of RTS channel
- Spectrum licensing cost per transmitter and for the for whole channel

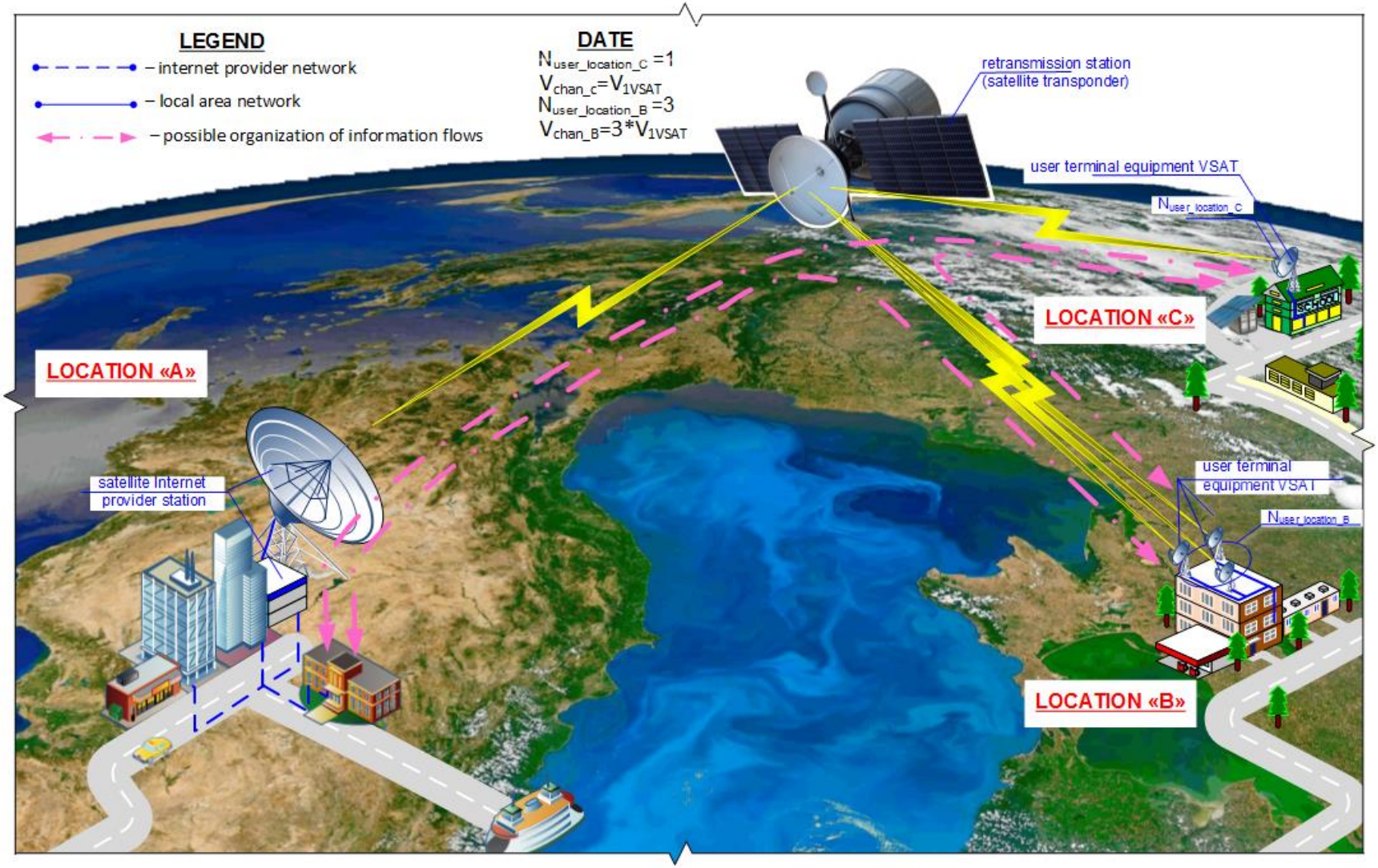
Parameters determining the cost of RTS maintenance (OPEX calculation)

- Total cost for all RTS pylon maintenance
- Total cost for all RTS antenna feeder devices maintenance
- Total cost for RTS internal devices maintenance
- Annual spectrum licensing cost per transmitter
- Annual spectrum licensing cost for whole channel

Scheme of organization of point-to-multipoint radiosystem communication channel (Cellular)



Scheme of organization of point-to-multipoint radiosystem communication channel (Satellite)

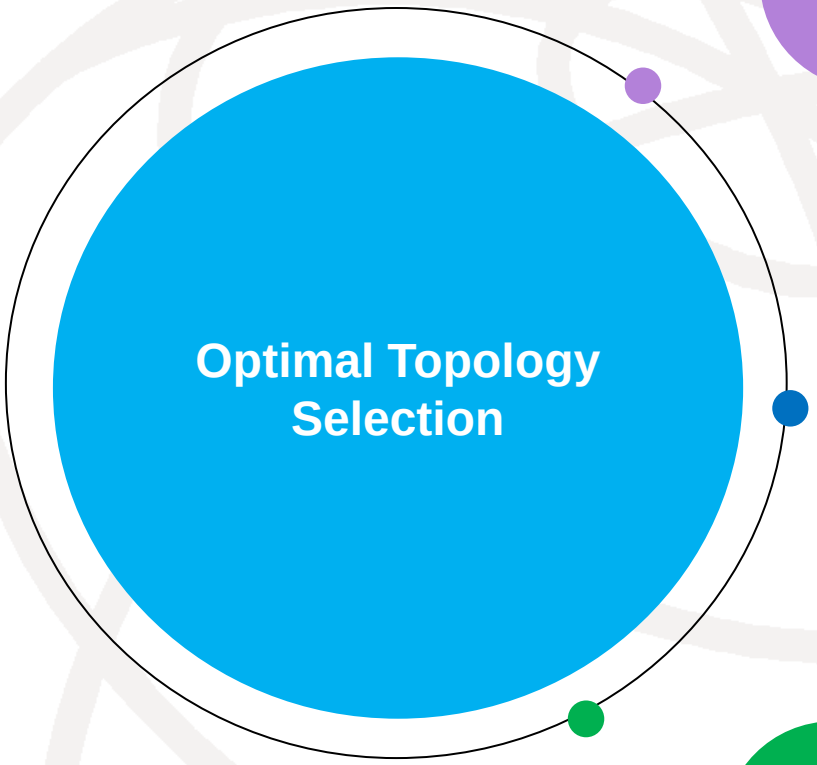


General cost estimation of point-to-multipoint radiosystem channel construction and maintenance

Parameters determining the cost of point-to-multipoint channel construction and maintenance (CAPEX and OPEX calculation)

- Required number of user terminal sets
- Total cost of user terminal equipment and installation materials
- Total cost of installation and configuration of all user terminal sets
- Design cost
- Rent cost for point-to-multipoint communication channels
- Total cost of user terminal set service

Optimal Topology Selection



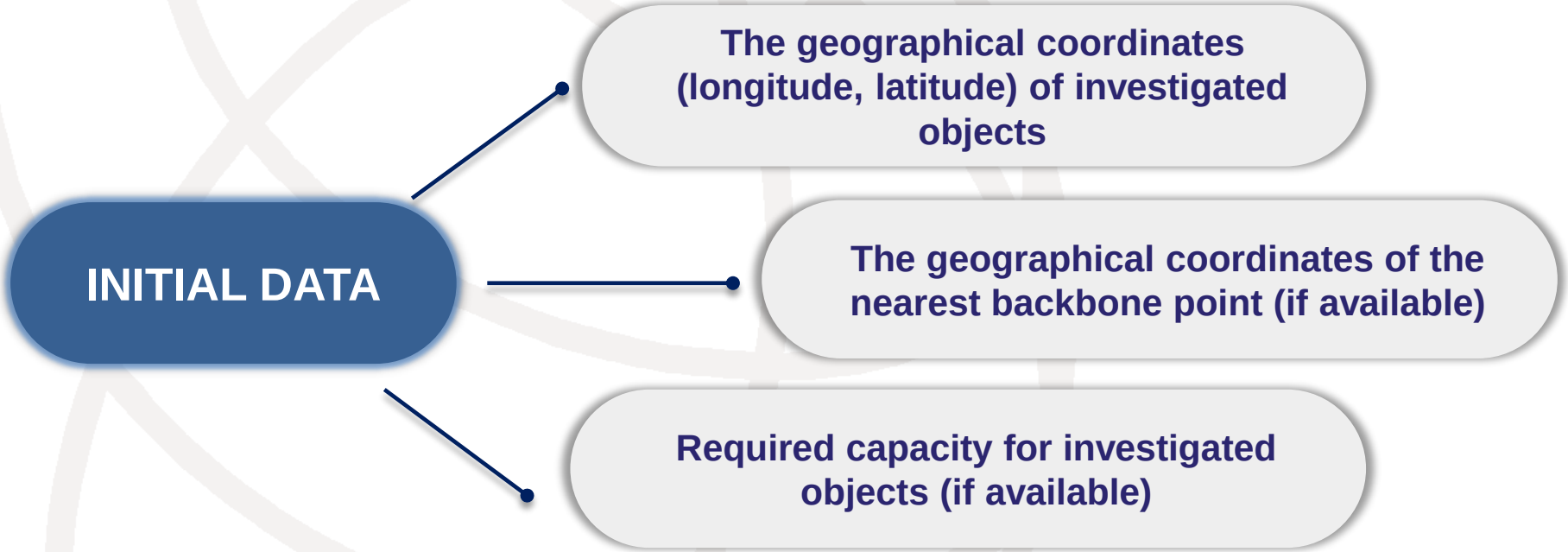
Combination of technologies between distant group of objects

Reasonable trade-off between cost of deployment and operation

Optimization of a technical solutions

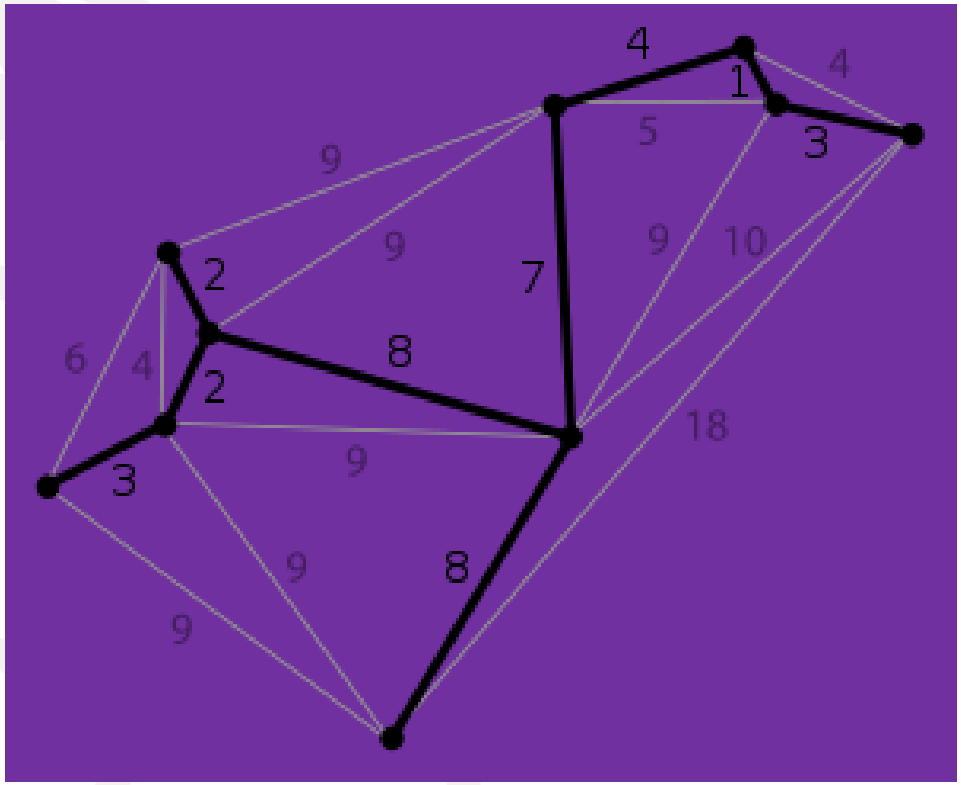
Optimal Topology Selection

Algorithm of Optimal Topology Selection implies the idea of larger NPV (cost of ownership) for optimal path between two objects or a large set of objects



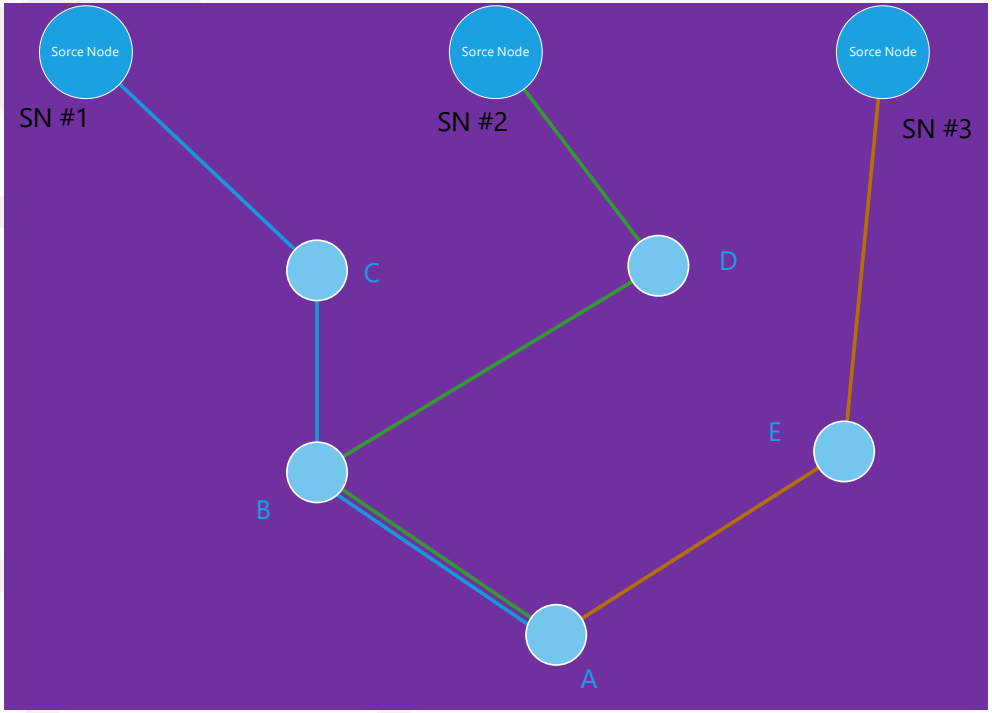
Generalized Algorithm of Optimal Topology Selection

- Calculate the geodetic or road distance $S[L, D]$ between adjacent objects (localities, etc.)
- Calculate the Net Present Values both for adjacent pair of objects and within a set of objects for each distance value in $S[L, D]$
- Optimal path selection between adjacent objects, implemented providing the principle of a larger NPV value, by variation of Dijkstra's algorithm for Widest Path



Network segmentation for optimal path selection

- fixing the source node SN;
- Network segmentation allows organizing selection by using several source points
- based on the maximum NPV value between each source point and every non-connected object
- Each of the non-connected point that has maximum value of NPV is connected to correspondent source point, other non-connected points is discarded
- recalculation of NPV for next source point performed until every non-connected point, will be detected



THANKS FOR ATTENTION