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Automated Geography-Based Fixed Network Planning Tool

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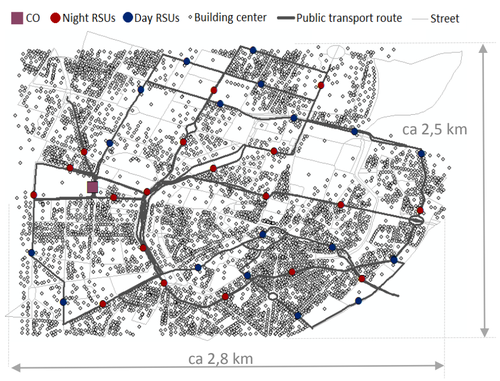
Fixed Network Planning

Inputs & Constraints

Given:
- City street topology,
- Central Office (CO) location,
- Demands,
- Possible Remote Node (RN) locations,
- Access Network Parameters

Constraints:
- Cost, availability, delay
- Street length metric
- Minimize civil works

Plan:
- **RN placement**
- **Fiber routing**

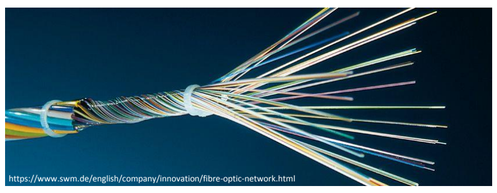


Input data for network planning.

I. Dias, E. Grigoreva, C. Mas Machuca, L. Wosinska, E. Wong
Energy-Efficient and Delay-Constrained Optical Backhaul for Intelligent Transport Systems.
under revision

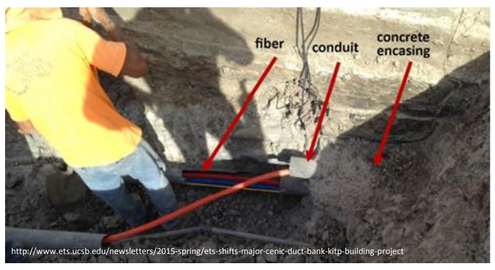
Planning Tool

- Materials:



Fiber and cable lengths.

- Civil works:



Trenching and installation of ducts.

Visualization

Fiber routing for the Night RSUs.

Fiber routing for the Day RSUs.

Automated Planning Tool Information

General Information

- Based on Geographic Information System (GIS) – ArcGIS[1]
- Real street topologies – Open Street Maps[2]
- Python-based implementation
- Ready to use tools with easy GUI

1. https://www.arcgis.com
2. https://www.openstreetmap.org
3. A. Shahid, C. Mas Machuca
   Dimensioning and Assessment of Protected Converged Optical Access Networks.
   IEEE Communications Magazine Vol. 55, No. 8, 2017
4. Location-allocation,
   http://desktop.arcgis.com/en/arcmap/latest/extensions/network-analyst/algorithms-used-by-network-analyst.htm
5. Dijkstra's algorithm,
   http://desktop.arcgis.com/en/arcmap/latest/extensions/network-analyst/algorithms-used-by-network-analyst.htm

Methodology[3]

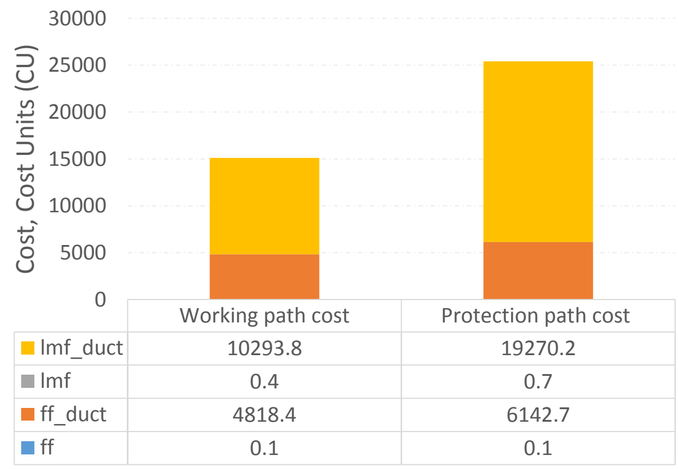
Assigning demands to a RN = clustering:
- Location-Allocation Problem with capacity constraint[4]
- Cluster head defines the RN position
- Performed for every stage of the network
- Cut-off

Shortest path routing:
- Relies on the street topology (not Euclidian distances)[5]

Outputs:
- RNs locations,
- Fiber and duct lengths

} Input for cost, availability and further analyses

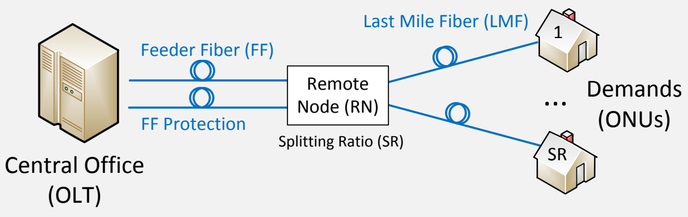
Cost Analysis Example



E. Grigoreva, E. Wong, M. Furdek, L. Wosinska, C. Mas Machuca
Energy Consumption and Reliability Performance of Survivable Passive Optical Converged Networks: Public ITS Case Study.
Journal of Optical Communications and Networking (JOCN) Volume: 9, Issue: 4, 2017, C98 - C108

Implemented Planning Scenarios

Fiber-To-The-Building (FTTB)

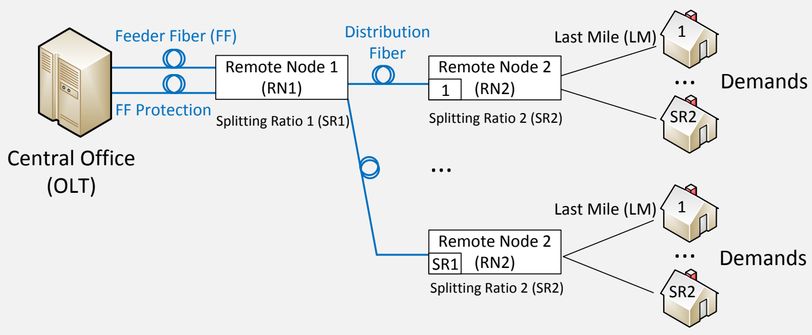


Splitting Ratio (SR):
- Dependent on the equipment: e.g., Power Splitter (PS) can have 2^n ports
- With (80%) or without (100%) ports reserved for the future use
- Link-disjoint path protection
- Shortest path fiber

Greenfield: planning from scratch
- All possible RN locations, e.g., street intersections

Brownfield: reusing existing infrastructure
- RN locations – constraint with existing ones
- Duct reuse – encouraging using the existing duct

Residential Fiber-To-The-Cabinet (FTTCab)



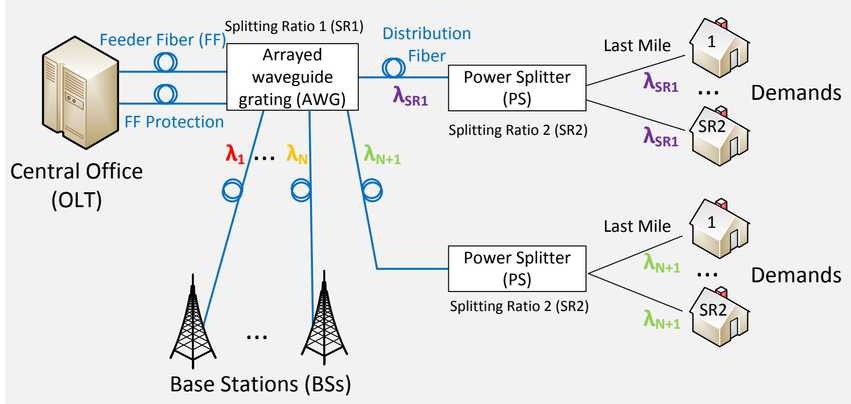
Brownfield: Last Mile Copper → Fiber

Copper:
- Calculated to get the possible RN2s locations for the fiber case to reuse
- RN2 in this case is ONU and a DSLAM
- Cut-off of 250m to 4000m

Fiber:
- The RN2 possible locations from the copper LM
- RN2 → Power Splitter

Greenfield: Last Mile Fiber
- RN2 can be placed at any possible location
- Power Splitter at RN2

Joint Fiber-To-The-Cabinet (FTTCab)



Joint Planning:
Physical infrastracture is shared between the residential users (time division multiplexing) and BSs (full wavelength).

NG-PON2 or Hybrid PON (HPON):
- RN1 is an AWG
- BSs and RN2 are clusterd together

Optical Access Seamless Evolution.
Technical Assessment and Comparison of Next- Generation Optical Access System Concepts,
Deliverable 4.2.1. Technical report, 2011.