Chair of Communication Networks
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Demo of the automated network planning tool

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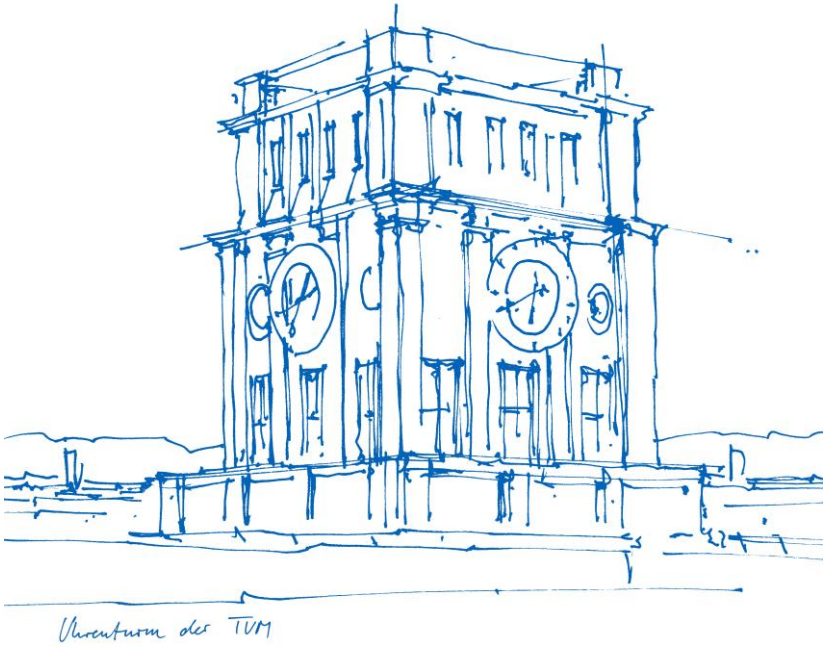


Fixed Network Planning

Problem Description

- Fixed network planning solutions in academia:
  - Mostly based on geometric models[1]
  - Not precise
  - Not reproducable

Results are not comparable

Not usable for other analyses

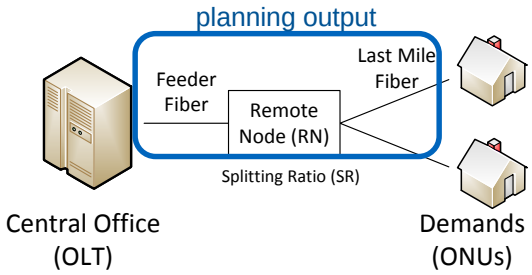
Not transferrable to the other scenarios

Planning tool for reproducible, meaningful and extandable planning results

1. A. Mitcsenkov, M. Kantor, K. Casier, B. Lannoo, K. Wajda, J. Chen, and L. Wosinska, "**Geometric versus geographic models for the estimation of an FTTX deployment**," Telecommunication Systems, vol. 54, no. 2, pp.113–127, 2013.

Fixed Network Planning

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

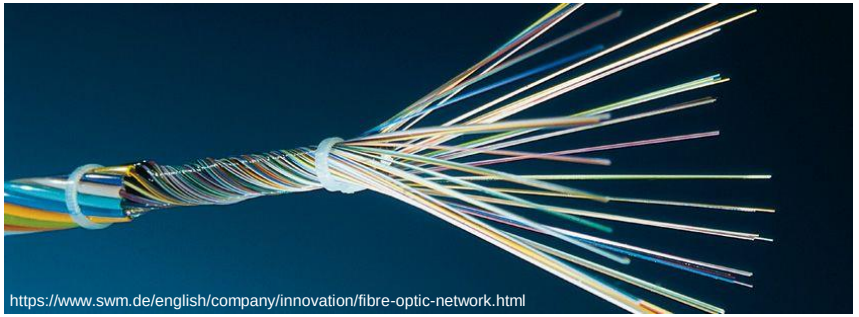


- Plan:
  - RN locations
  - Fiber routing

- Constraints:
  - Cost, availability, delay
  - Street length metric
  - Minimize civil works (duct lengths)

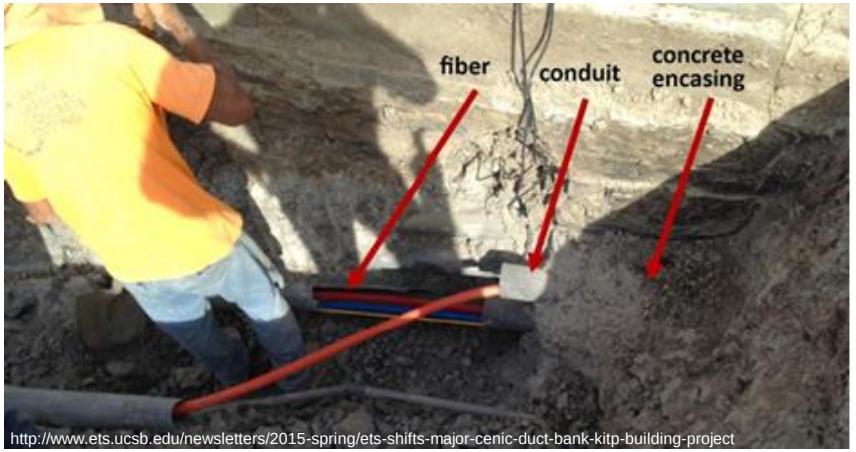
Planning Tool, LKN

- Materials:



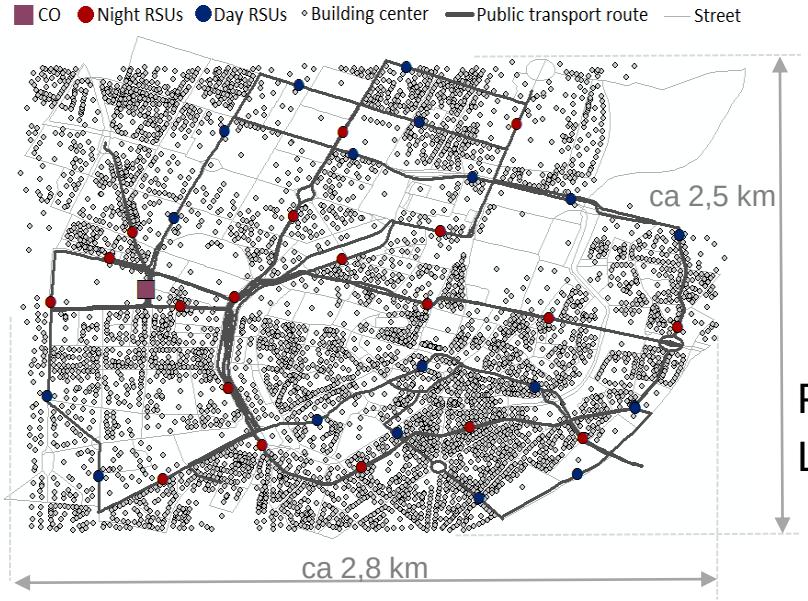
Fiber and cable lengths.

- Civil works:



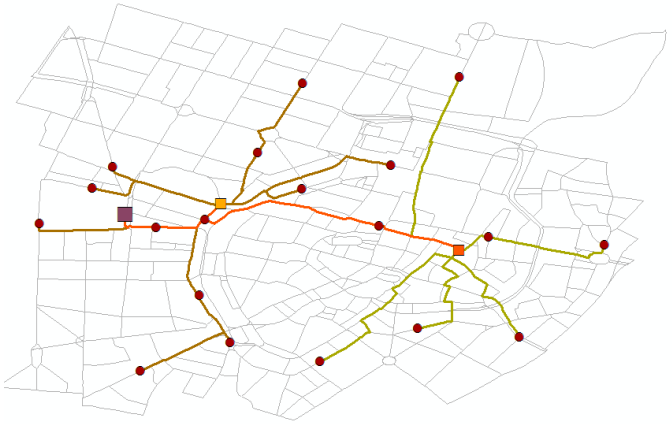
Trenching and installation of ducts.

Optical Backhaul for Intelligent Transport Systems: example

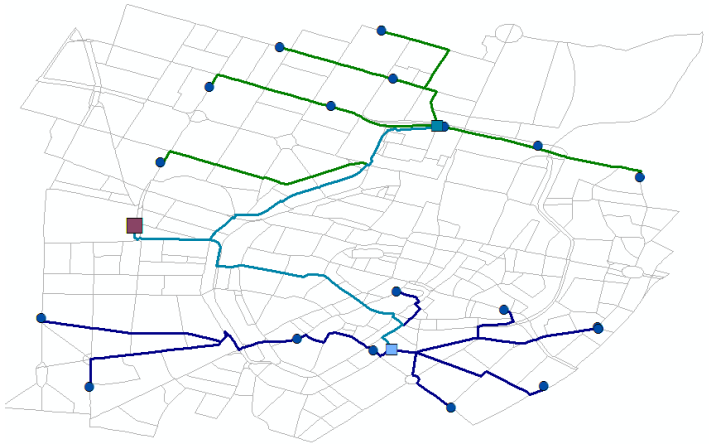


Input data for network planning, OSM-based.

Planning Tool, LKN



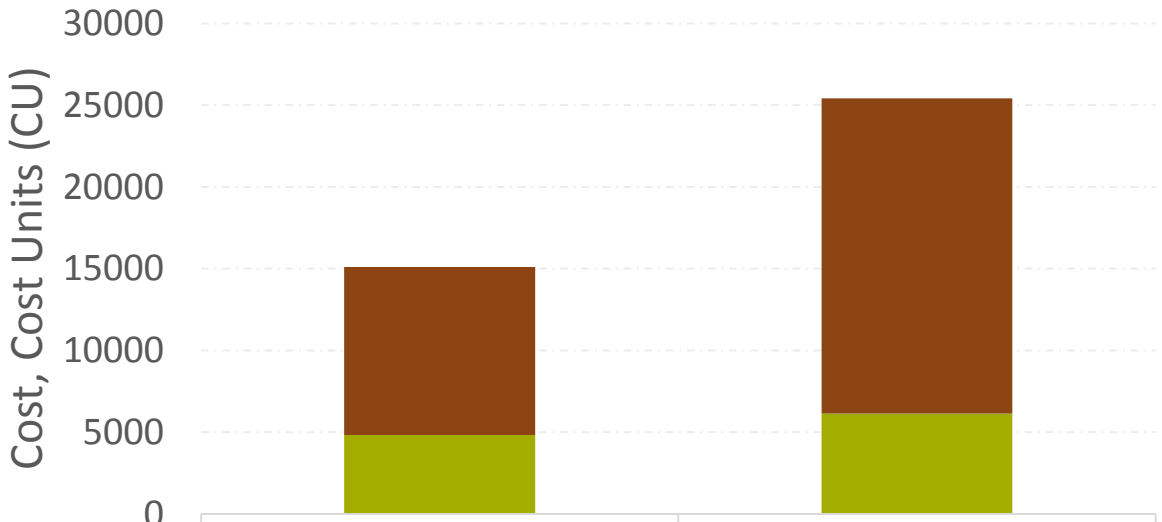
Fiber routing for the Night RSUs.



Fiber routing for the Day RSUs.

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

Cost Analysis Based on the Planning Results: Example



	Working path cost	Protection path cost
lmf_duct	10293,8	19270,2
lmf	0,4	0,7
ff_duct	4818,4	6142,7
ff	0,1	0,1

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

Methodology[1]

- Assigning demands to a Remote Node (RN) = clustering:
  - Location-Allocation Problem with capacity constraint[2]
  - 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)[3]
- Outputs:
  - RNs locations,
  - Fiber and duct lengths

} Input for cost, availability and further analyses

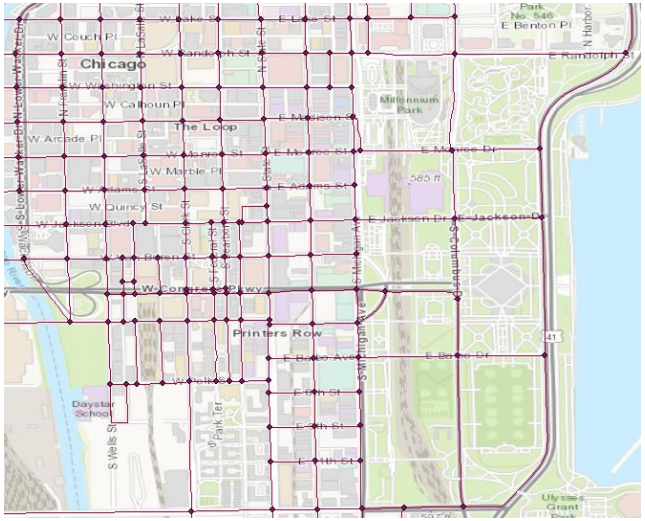
1. Shahid, Arslan; Mas Machuca, Carmen:
   Dimensioning and Assessment of Protected Converged Optical Access Networks.
   IEEE Communications Magazine Vol. 55, No. 8, 2017
2. Location-allocation, http://desktop.arcgis.com/en/arcmap/latest/extensions/network-analyst/algorithms-used-by-network-analyst.htm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

Planning Tool Demo

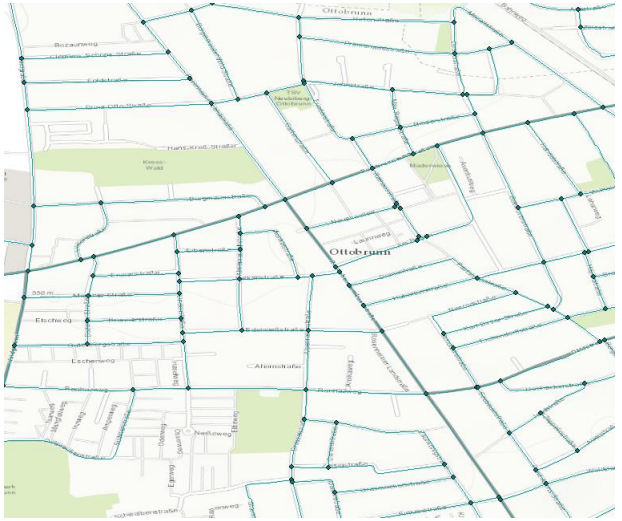
General Information

- 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

Input street topologies example



Chicago: urban area



Ottobrunn: suburban area

1. https://www.arcgis.com
2. https://www.openstreetmap.org/

FTTB and FTTCab Planning with SP Protection

Network Dataset
D:\GISworkspace\3_Demos\2_IndustryDay13072018\Topologies.gdb\Munich\Munich_N

FTTx

Feeder Fiber Shortest Path Protection (optional)

Demands
D:\GISworkspace\3_Demos\2_IndustryDay13072018\Topologies.gdb\Munich_test_sma

Possible RN locations
D:\GISworkspace\3_Demos\2_IndustryDay13072018\Topologies.gdb\Munich_test_sma

CO
D:\GISworkspace\3_Demos\2_IndustryDay13072018\Topologies.gdb\Munich_test_sma

FTTB: Splitting Ratio (optional)
32

FTTCab: SR1 (optional)
32

Last mile (optional)
fiber

FTTCab: SR2 buildings LMF (optional)
16

FTTCab: SR2 buildings initial (dsl or brownfield) (optional)
8

DSL reach (optional)
500

Joint planning: Base Stations (optional)

Base Station Locations (optional)
D:\GISworkspace\3_Demos\2_IndustryDay13072018\Topologies.gdb\Munich\Munich_B

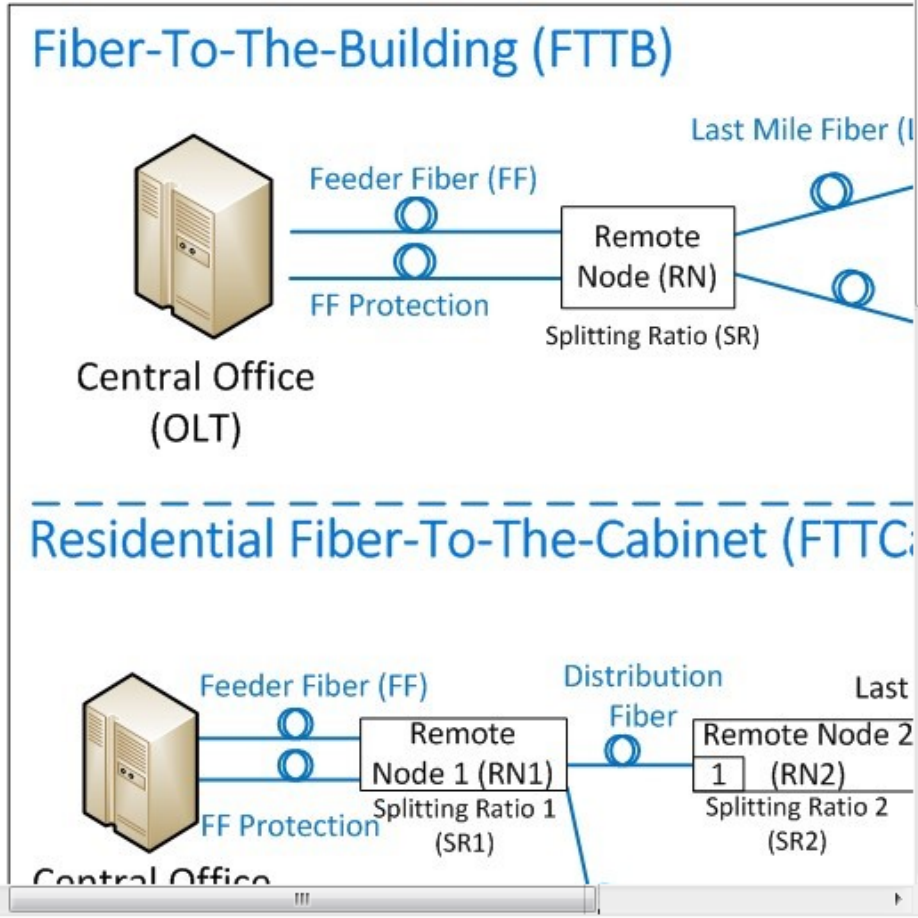
Output Directory
D:\GISworkspace\3_Demos\2_IndustryDay13072018\PlanningResults

Output Feature Dataset
D:\GISworkspace\3_Demos\2_IndustryDay13072018\Topologies.gdb\Munich_results

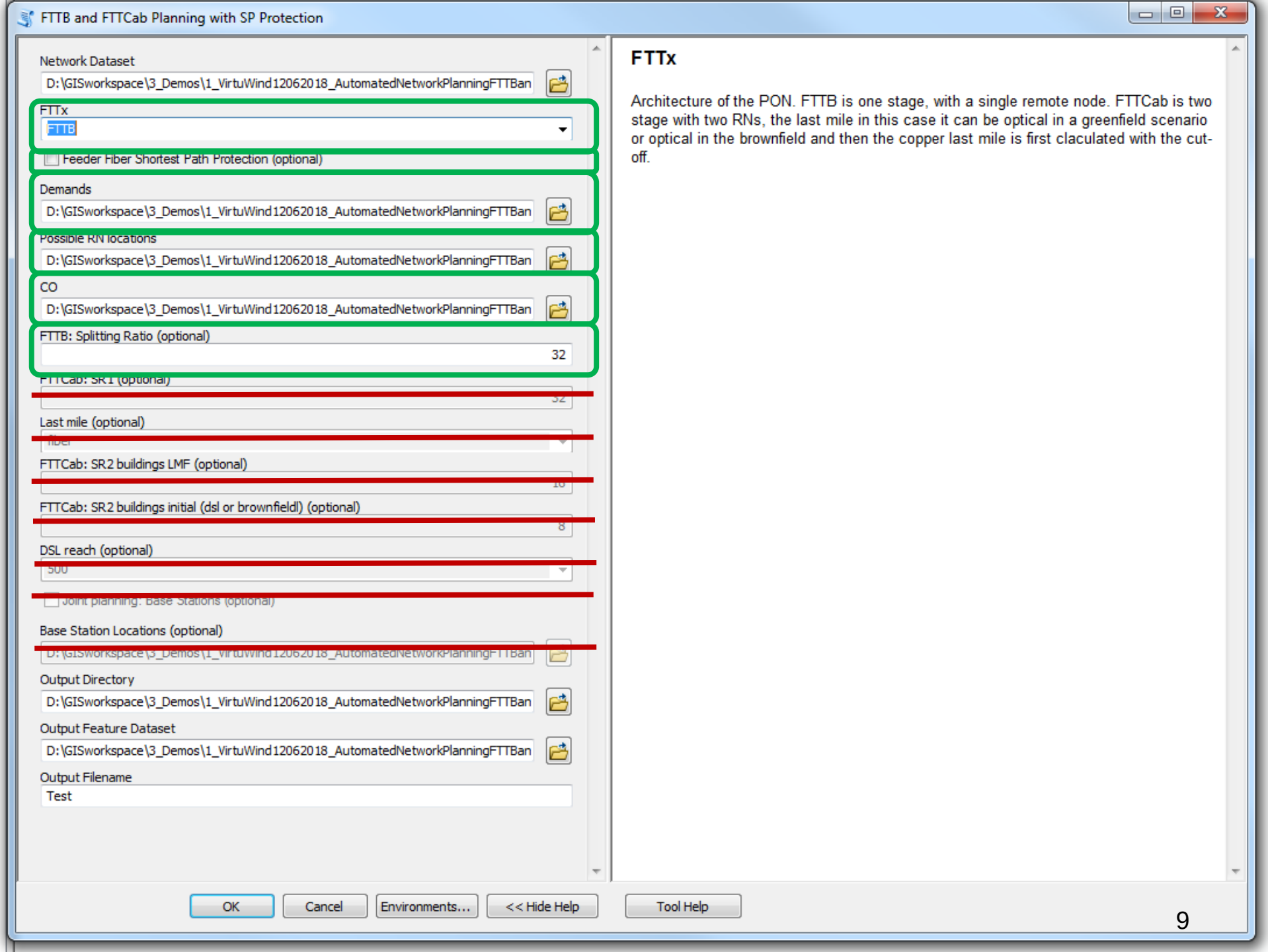
Output Filename
Test

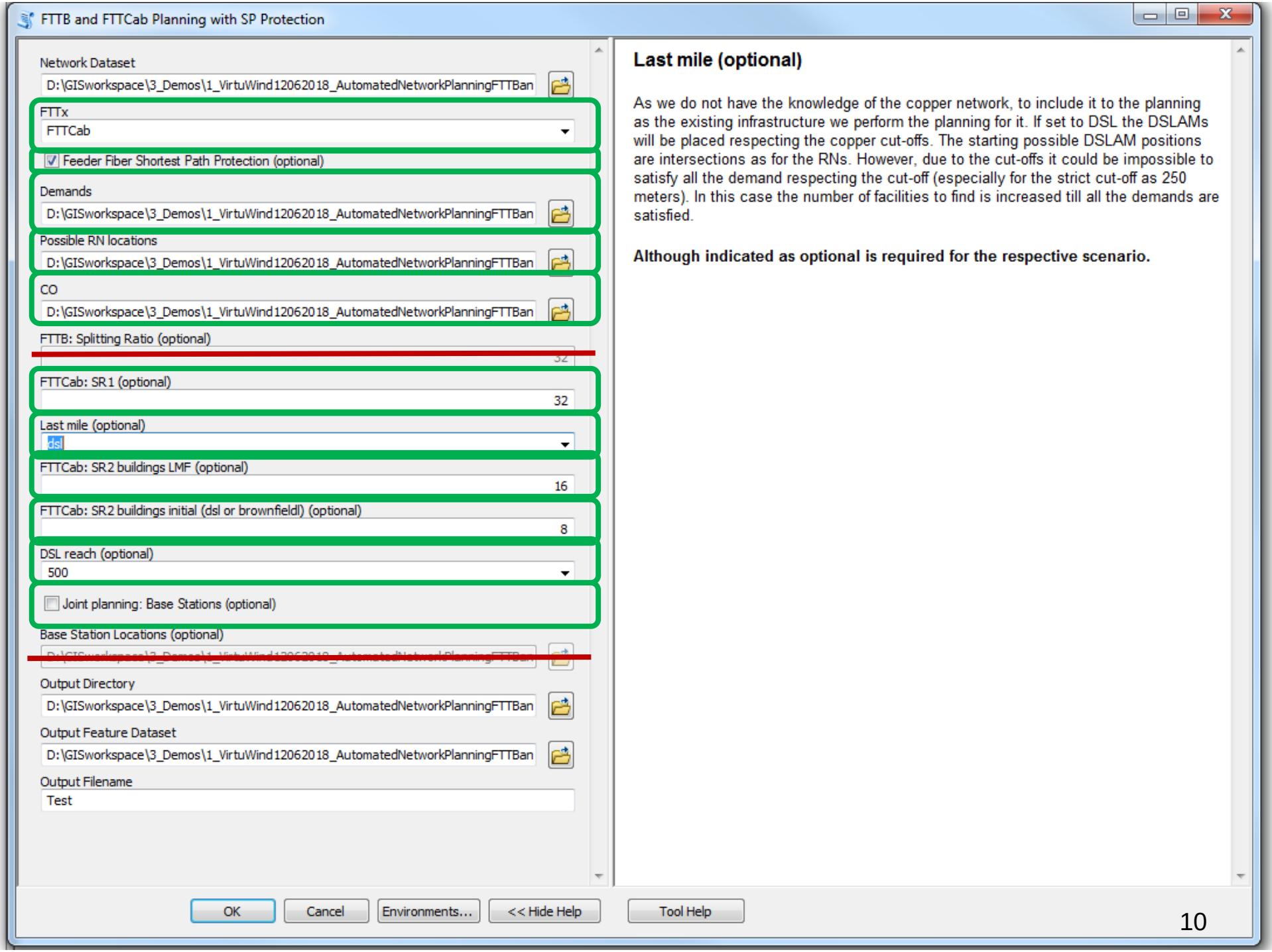
FTTB and FTTCab Planning with SP Protection

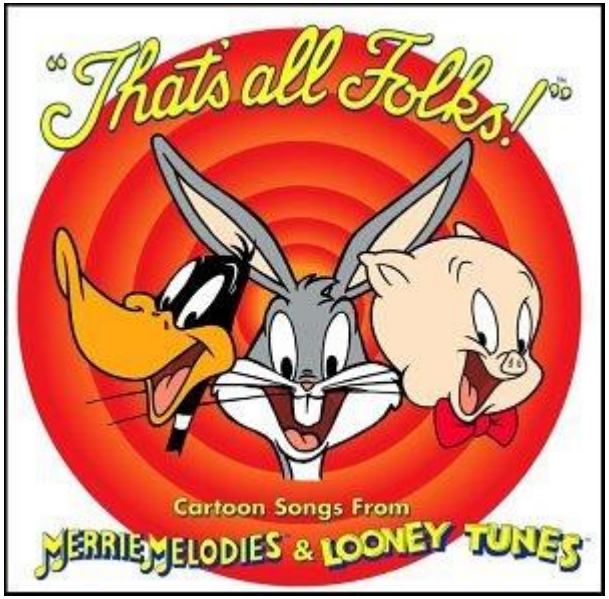
This script automates Remote Nodes (RNs) placement and fiber routing for all the stagesof the two scenarios: Fiber-To-The-Builing (FTTB) and Fiber-To-The-Cabinet (FTTCab).The focus is on the passive optical network deployment. The resulting duct and fiber lengts are outputed in a text file in the defined folder. FTTB does one stage planning, FTTCab does two stage planning: in a brownfieldscenario first the buildings are clustered to an RN2 (ONU) with a splitting ratio of DSL and maximum reach limiting the disance. The resulting RN2s are clustered to the RN1. The buildings are then re-clustered with the optical splitting ratio and with no cut-off for urban areas.



OK | Cancel | Environments... | << Hide Help | Tool Help


FTTB and FTTCab Planning with SP Protection
Network Dataset
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
FTTx
FTTB
Feeder Fiber Shortest Path Protection (optional)
Demands
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
Possible RN locations
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
CO
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
FTTB: Splitting Ratio (optional)
32
FTTCab: SR1 (optional)
Last mile (optional)
FTTCab: SR2 buildings LMF (optional)
FTTCab: SR2 buildings initial (dsl or brownfieldl) (optional)
DSL reach (optional)
500
Joint planning: Base Stations (optional)
Base Station Locations (optional)
Output Directory
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
Output Feature Dataset
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
Output Filename
Test
FTTx
Architecture of the PON. FTTB is one stage, with a single remote node. FTTCab is two stage with two RNs, the last mile in this case it can be optical in a greenfield scenario or optical in the brownfield and then the copper last mile is first claculated with the cut-off.
OK
Cancel
Environments...
<< Hide Help
Tool Help


FTTB and FTTCab Planning with SP Protection
Network Dataset
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
FTTx
FTTCab
Feeder Fiber Shortest Path Protection (optional)
Demands
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
Possible RN locations
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
CO
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
FTTB: Splitting Ratio (optional)
32
FTTCab: SR1 (optional)
32
Last mile (optional)
dsl
FTTCab: SR2 buildings LMF (optional)
16
FTTCab: SR2 buildings initial (dsl or brownfield) (optional)
8
DSL reach (optional)
500
Joint planning: Base Stations (optional)
Base Station Locations (optional)
Output Directory
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
Output Feature Dataset
D:\GISworkspace\3_Demos\1_VirtuWind12062018_AutomatedNetworkPlanningFTTBan
Output Filename
Test
Last mile (optional)
As we do not have the knowledge of the copper network, to include it to the planning as the existing infrastructure we perform the planning for it. If set to DSL the DSLAMs will be placed respecting the copper cut-offs. The starting possible DSLAM positions are intersections as for the RNs. However, due to the cut-offs it could be impossible to satisfy all the demand respecting the cut-off (especially for the strict cut-off as 250 meters). In this case the number of facilities to find is increased till all the demands are satisfied.
Although indicated as optional is required for the respective scenario.
OK
Cancel
Environments...
<< Hide Help
Tool Help



https://images-na.ssl-images-amazon.com/images/I/51K0DCKQ4FL.jpg