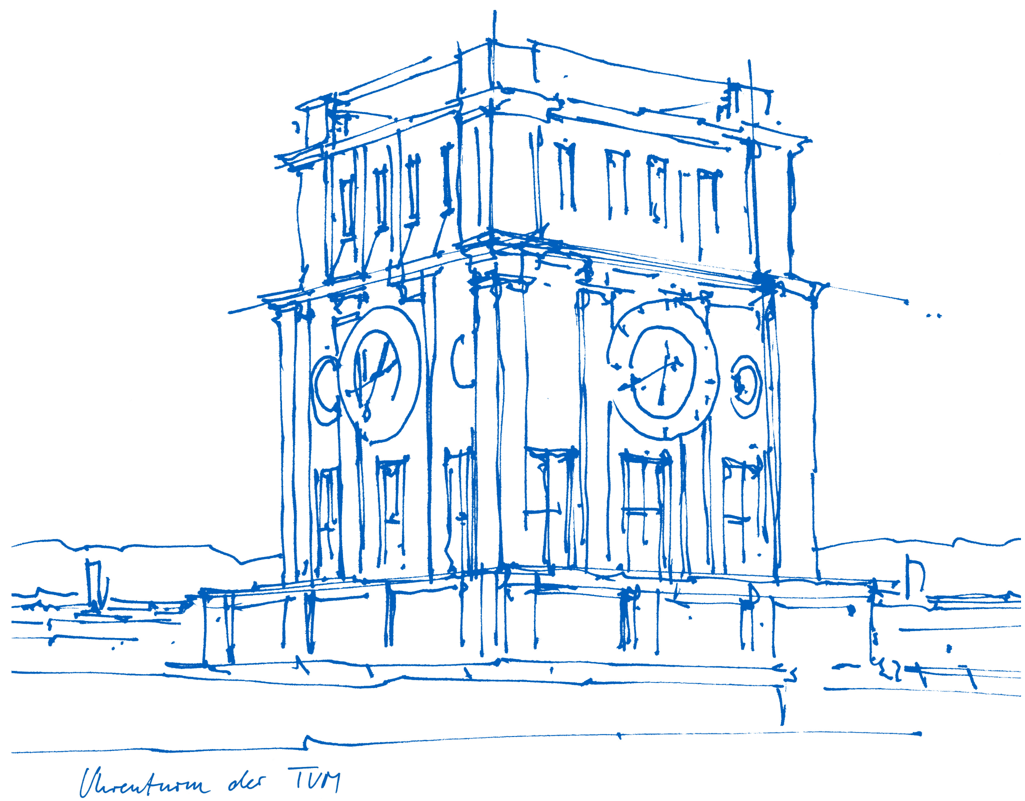
Chair of Communication Networks, Prof. Dr.-Ing. Wolfgang Kellerer
Department of Electrical and Computer Engineering
Technical University of Munich

Planning tool for optical access networks

ONDM 2017



Carmen Mas Machuca

cmas@tum.de

Agenda

- Motivation
- Methodology
- Models
- Planning tool overview
- Case Studies
- Conclusions and on-going work

Motivation

Operators

- Increase number of users
- Increase number of offered services
- Increase offered quality (BW, reliability...)
- At lowest cost

Users

- Connect more devices
- Access differenciated services
- Get higher quality
- Flexibility to change operator

Migrate/Upgrade the networks fast at lower costs→ Effective planning

Methodology

Problem

- RAN
- Optical access (FTTx)
- Converged access

Methodology

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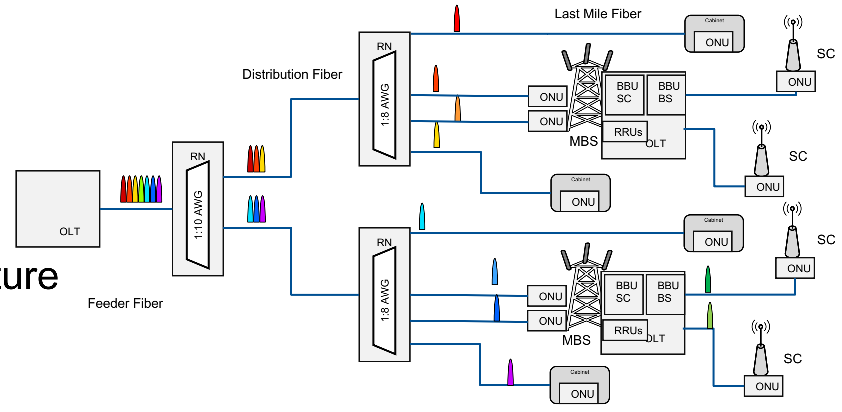
- Converged access

Scenario

- Area
- Requirements
- Cost models
- Technology/architecture
- Protection Scheme



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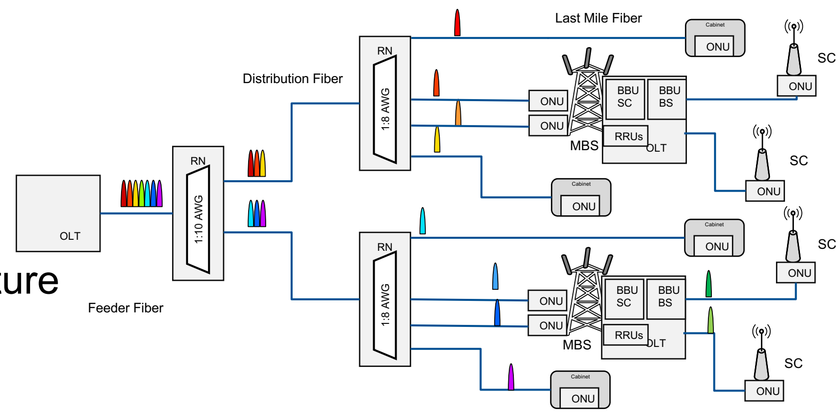
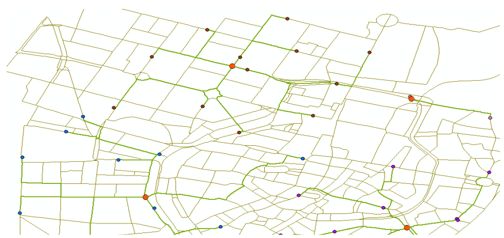


Planning

- Optimal placement of components
- Optimal fiber/duct layout



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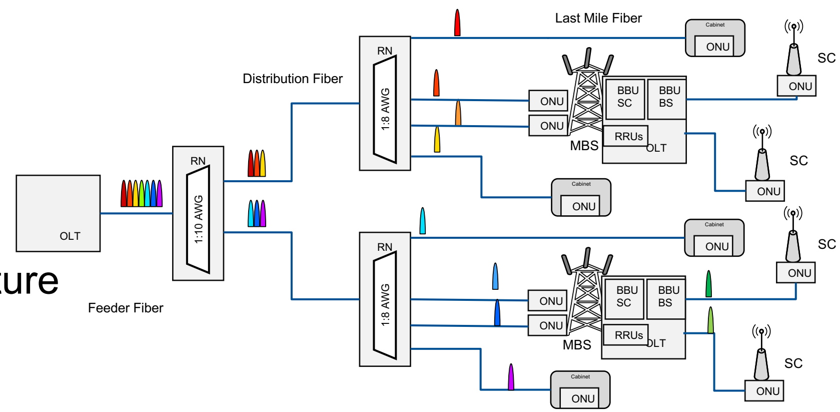

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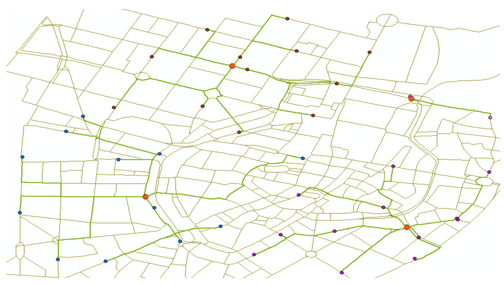


Techno-Economic

- Cost evaluation
- NPV, Payback period, etc.
- Sensitivity analysis

Models

- Geometric models
  - Based on average values (e.g. Buildings/km^2, distance between buildings)
    - Hard to follow changes
    - Hard to get values (depend on country)
  - Fast approximation
  - Examples:
    - Triangle model
    - Street models
- Geographical models
  - Solution for a particular area→ based on geospatial data
  - Accurate
  - Adapts to changes

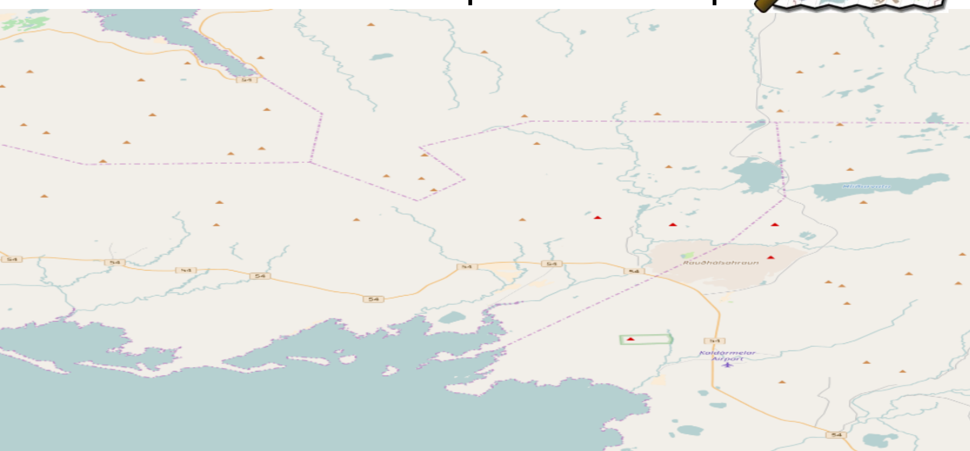
Planning tool overview

Planning tool overview

Area → Component placement → Fiber layout → Evaluation

Get the data from OpenStreetMap

Filter required data→ buildings, streets



Planning tool overview

Area → Component placement → Fiber layout → Evaluation

Get any data required for your study:

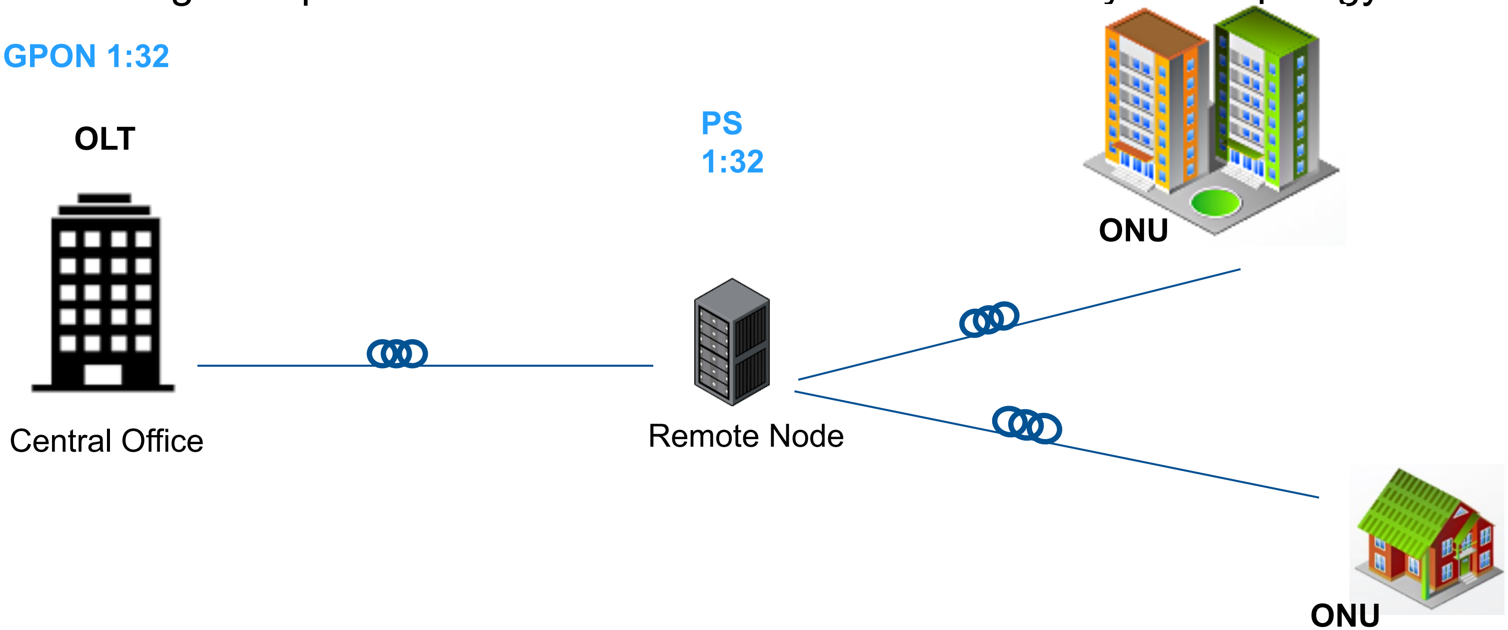
- Location of
  - Central Office
  - Base Stations
  - Small Cells
  - ...

We use ArcGIS(c) to plan our networks

Planning tool overview

Area → **Component placement** → Fiber layout → Evaluation

Clustering is required for most of the architectures→ mainly tree topology

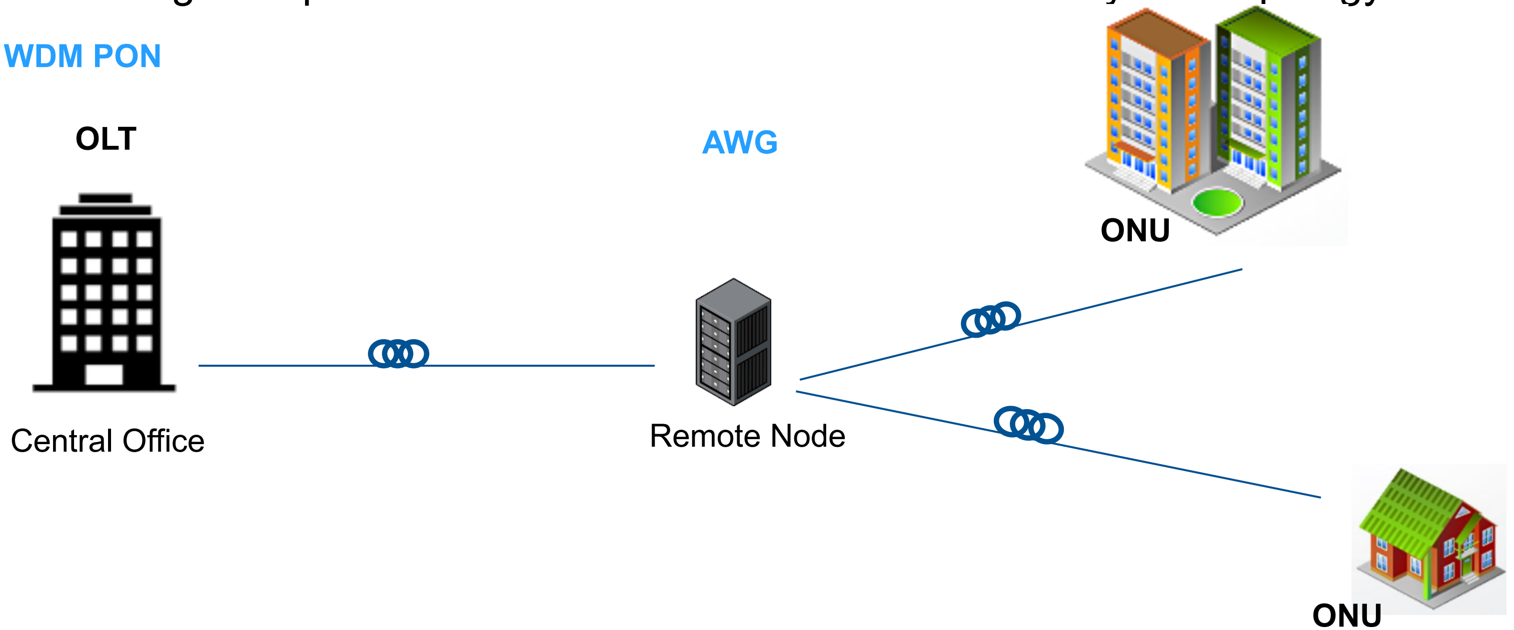


Planning tool overview

Area → **Component placement** → Fiber layout → Evaluation

Clustering is required for most of the architectures→ mainly tree topology

WDM PON

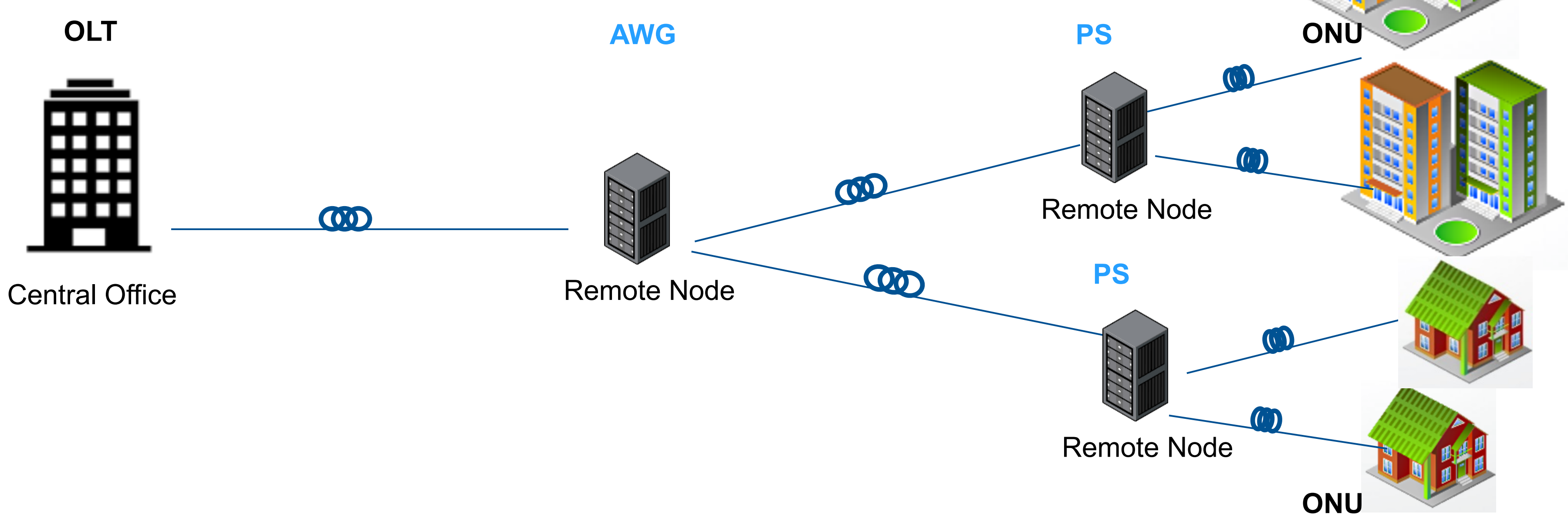


Planning tool overview

Area → **Component placement** → Fiber layout → Evaluation

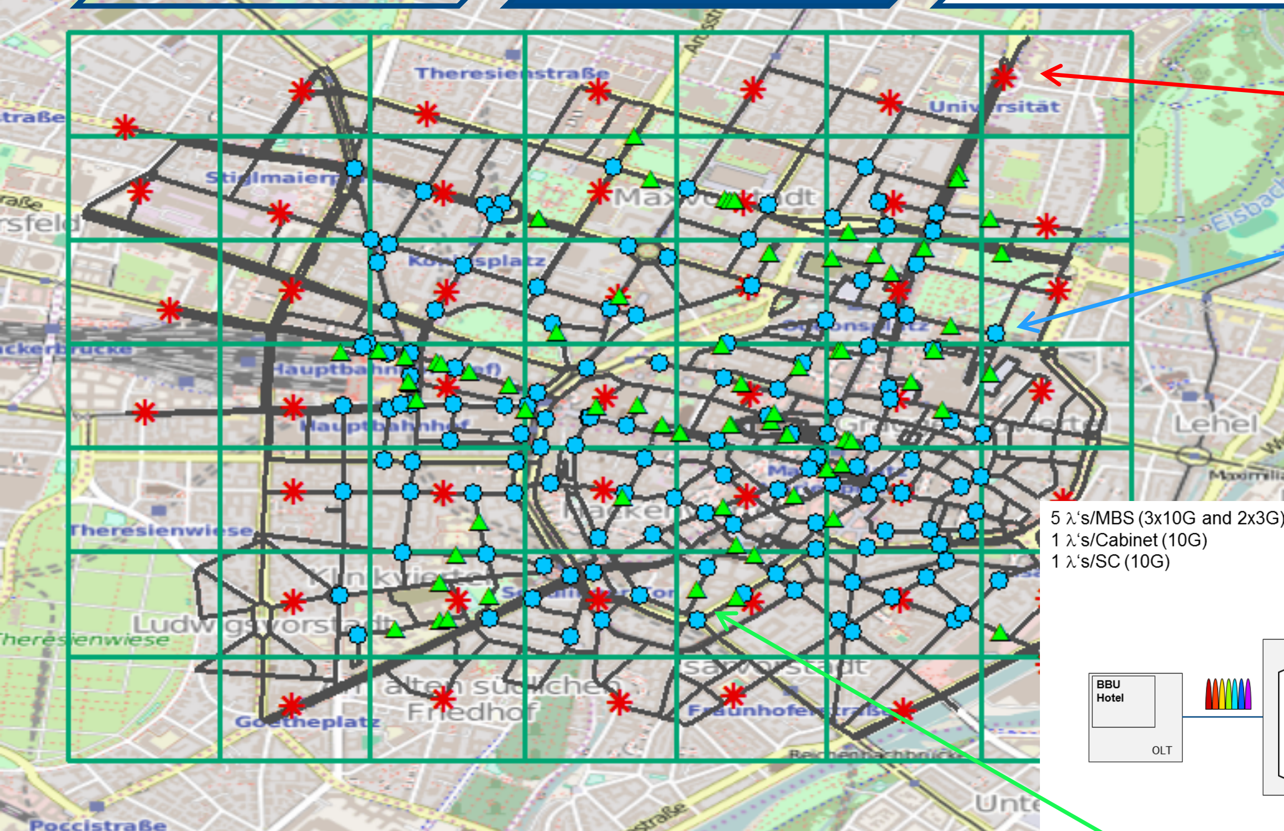
Clustering is required for most of the architectures→ mainly tree topology

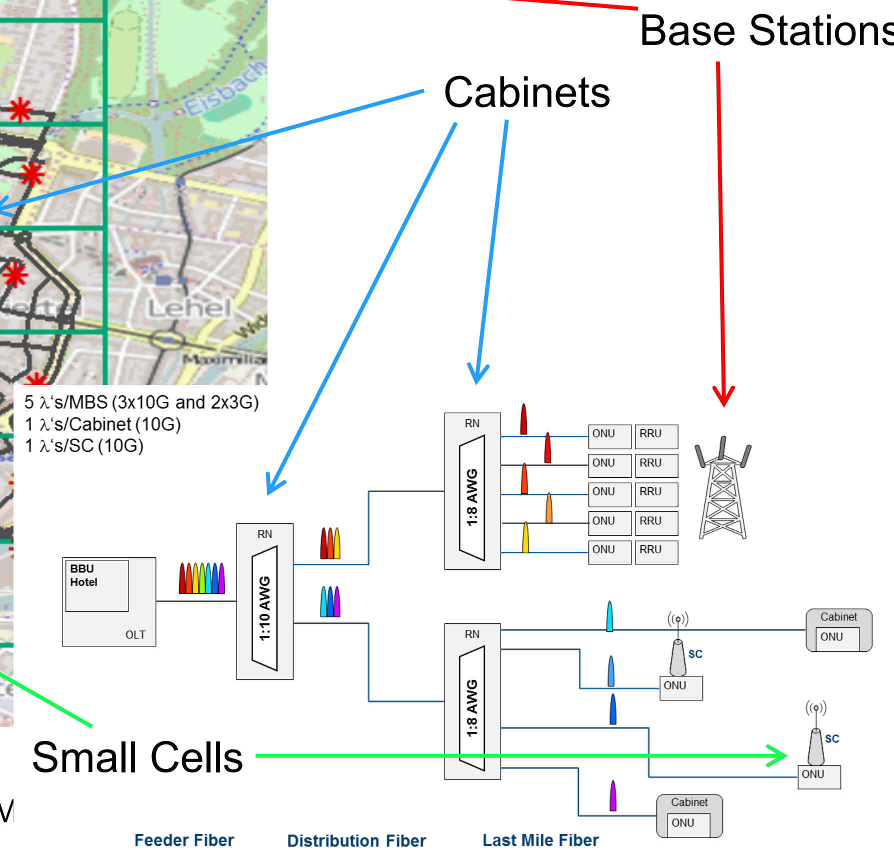
Hybrud PON



Planning tool overview

Area → **Component placement** → Fiber layout → Evaluation

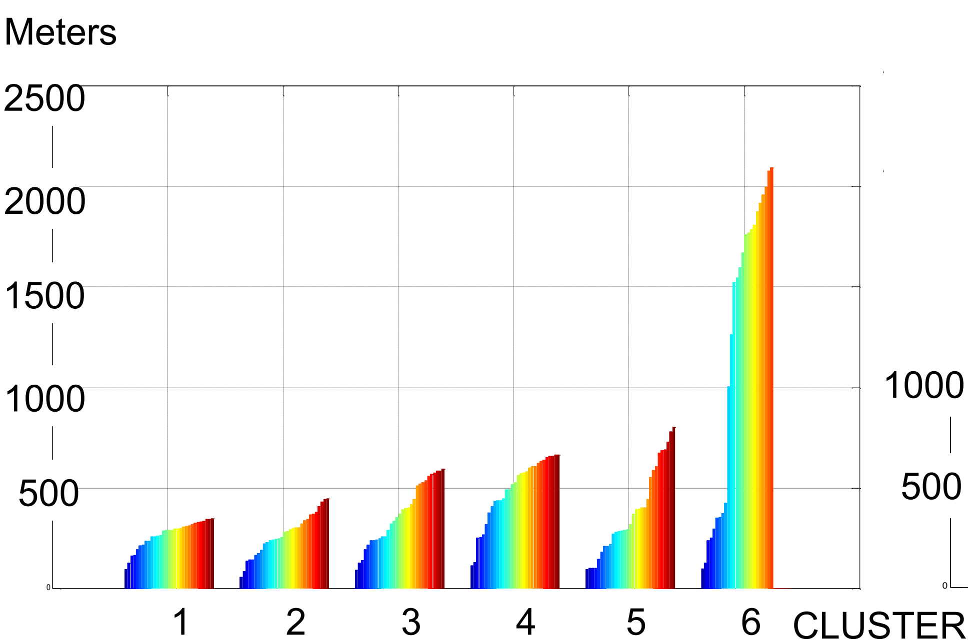




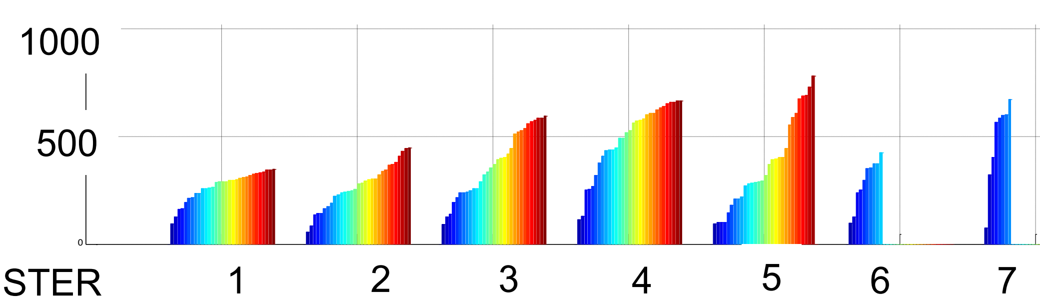
Planning tool overview

Clustering given the splitting ratio of the remote node

- Not all the ports are used
- Adding few clusters may decrease the required fiber



Proposed modified K-means „Dimensioning and Assessment of Protected Converged Optical Access Networks" COMMAG´17



Planning tool overview

Important to consider:

- Realistic location for remote nodes
  - Intersection points
  - Colocation with
    - Traffic lights
    - High buildings
    - Existing rooms/equipment/...

Planning tool overview

Area

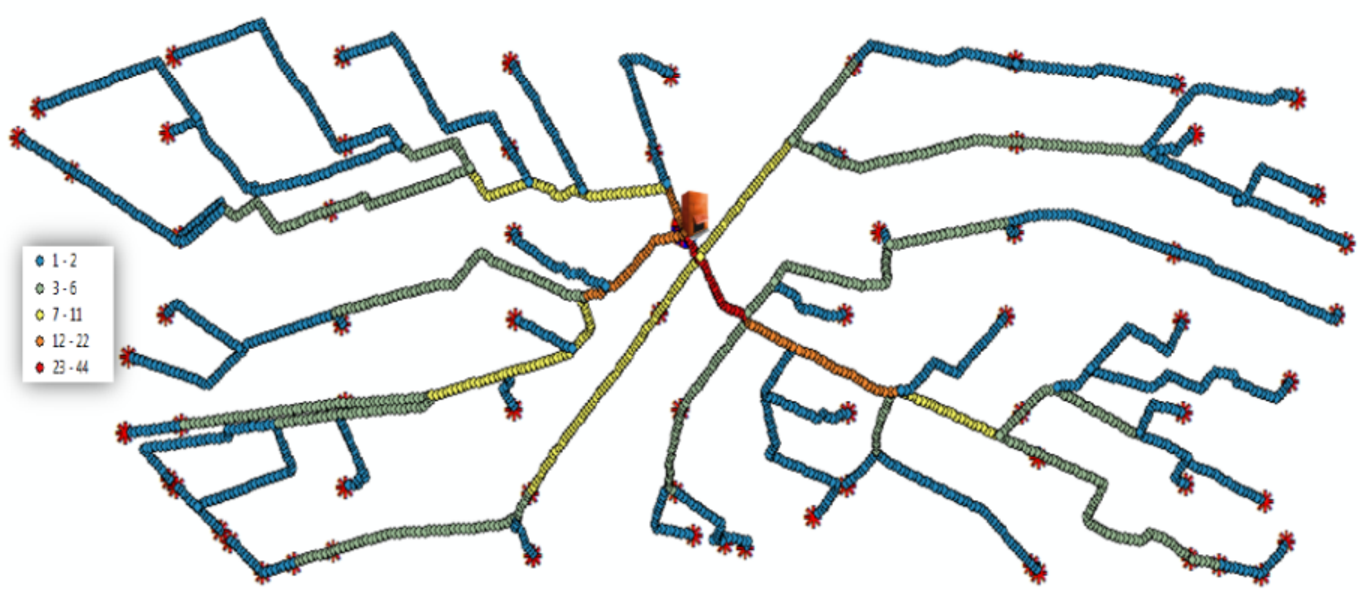
Component placement

Fiber layout

Evaluation

Interconnection of comments with fiber:

Trenching is the most costly aspect→ duct-sharing routing



Planning tool overview

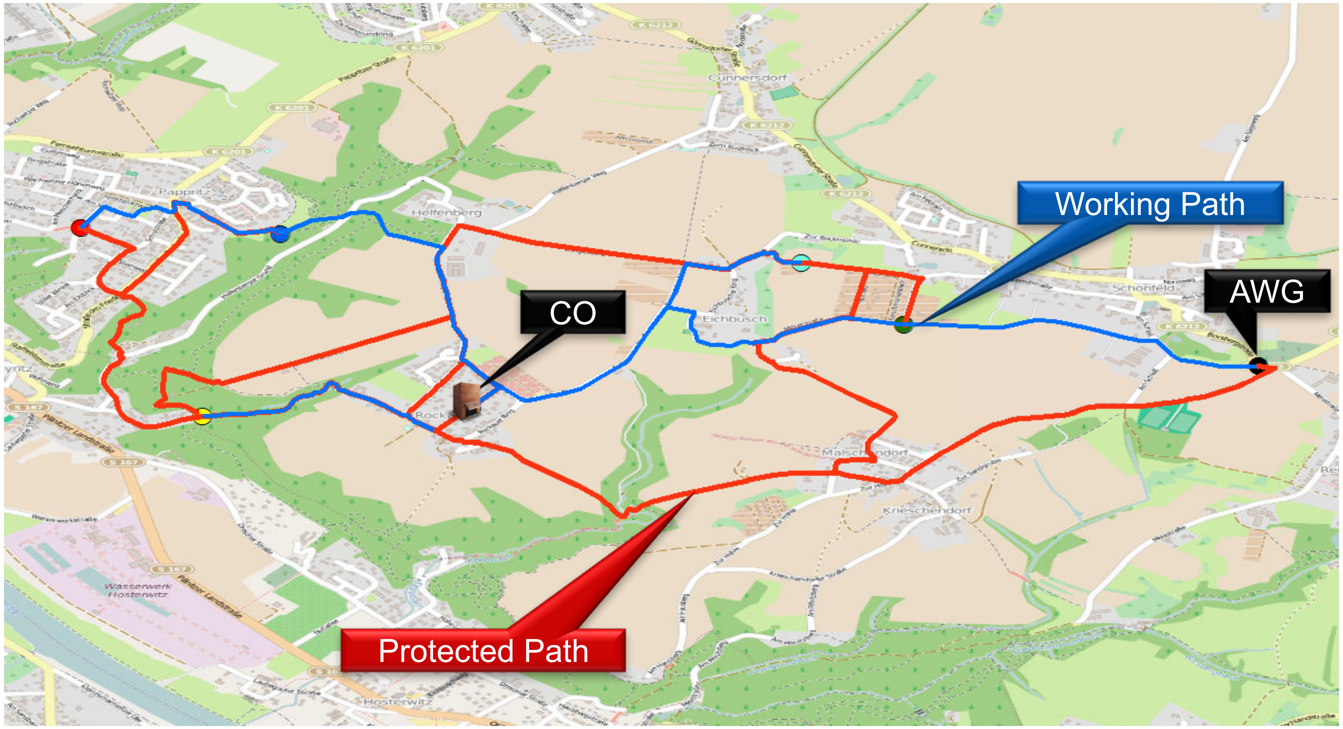
Area → Component placement → **Fiber layout** → Evaluation

Interconnection of comments with fiber:

Trenching is the most costly aspect→ duct-sharing routing

Protection?

→ Disjoint fibers



Planning tool overview

Area → Component placement → **Fiber layout** → Evaluation

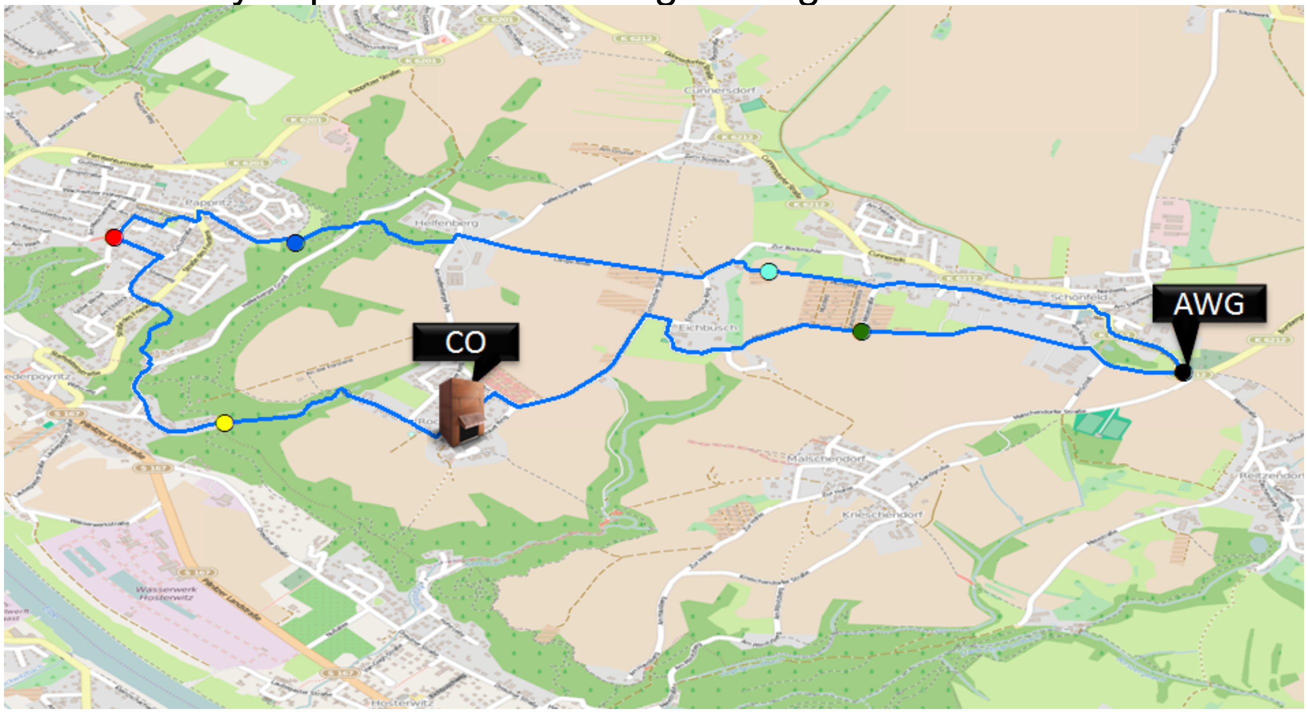
Interconnection of comments with fiber:

Trenching is the most costly aspect→ duct-sharing routing

Protection?

→ Disjoint fibers

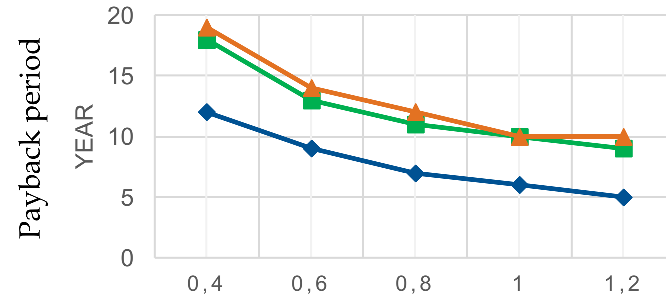
→ ring topologies→ TSP

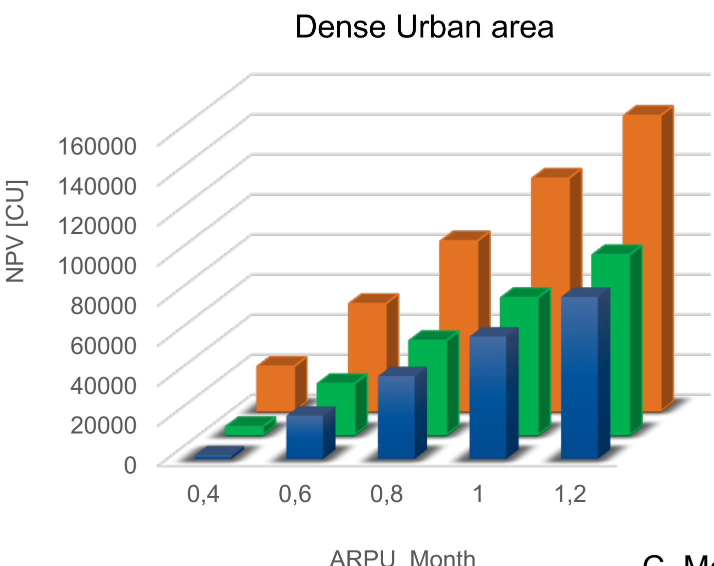


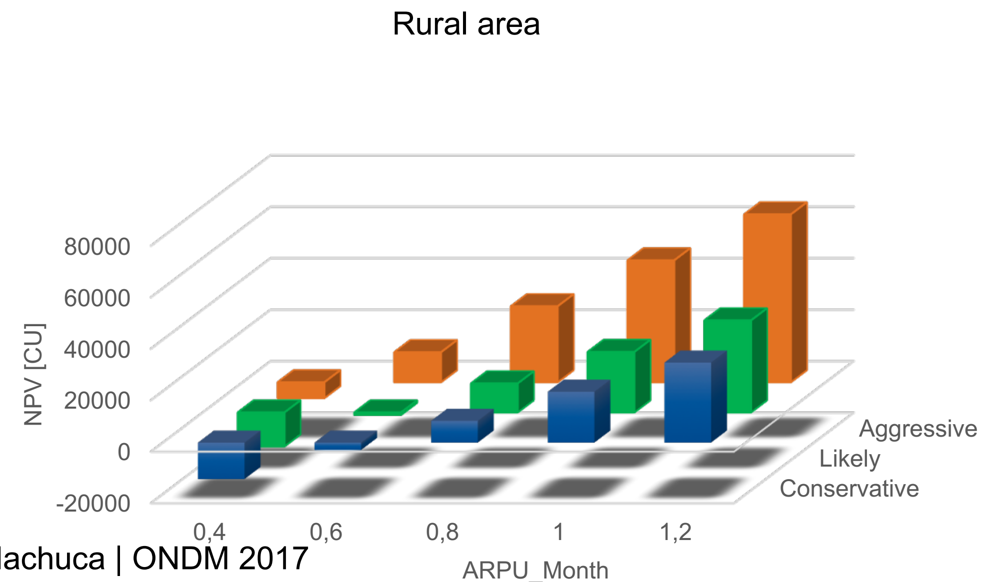
Planning tool overview

Area → Component placement → Fiber layout → **Evaluation**

- TCO: Total Cost of Ownership
- NPV: Net Present Value
- Benefits
- Payback period
- Analysis (e.g. sensitivity, risk)







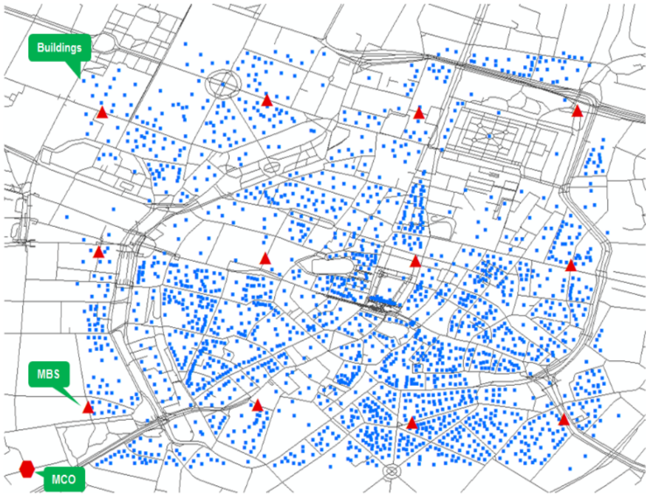
Case Studies

- Next Generation access networks→ at least 300Mbps/end user
- Converged access networks
- Protection schemes
- ITS
- Broadband access comparison in sparse areas
- Impact of
  - Different penetration curves
  - Different available infrastructure
  - Different clustering and fiber layout approaches

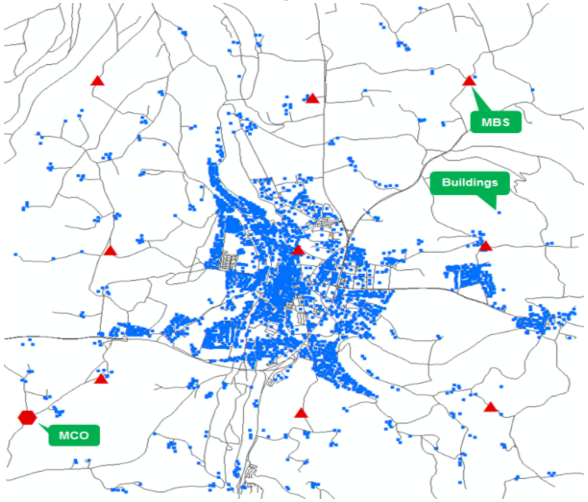
Case Study-1

Name	Type	Area	Total Buildings	Building Density	Total MBS	MBS Density
Munich	DU	$4\mathrm{km}^2$	2042	$510/\mathrm{km}^2$	12	$3/\mathrm{km}^2$
Miesbach	U	$28\mathrm{km}^2$	2730	$98/\mathrm{km}^2$	9	$0.3/\mathrm{km}^2$
Höhndorf	R	$150\mathrm{km}^2$	1163	$8/\mathrm{km}^2$	4	$0.02/\mathrm{km}^2$

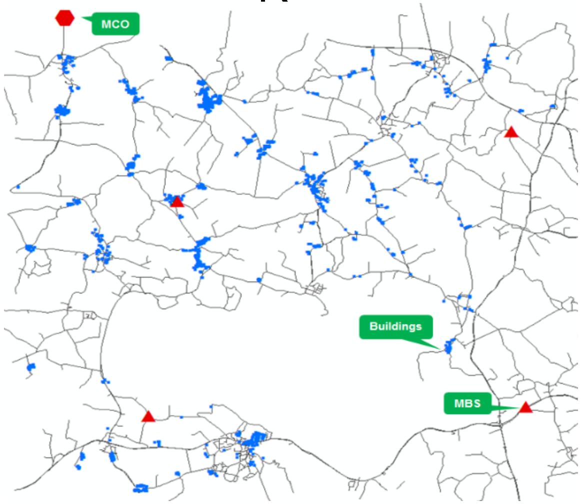
DU



U



R



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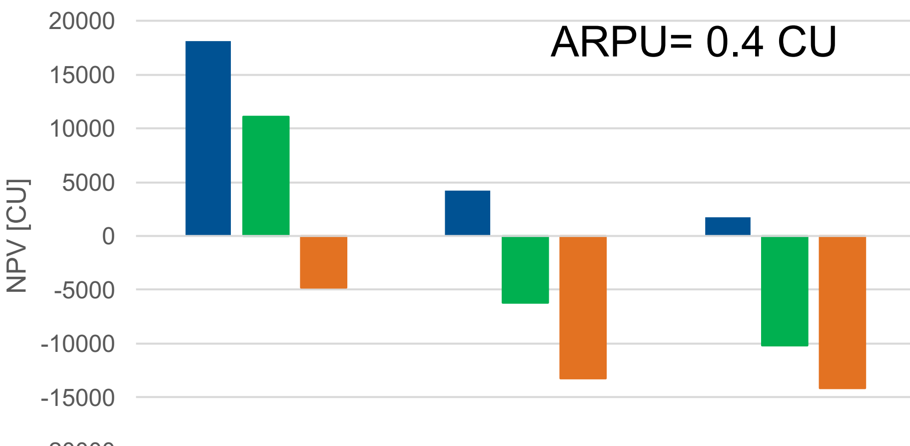
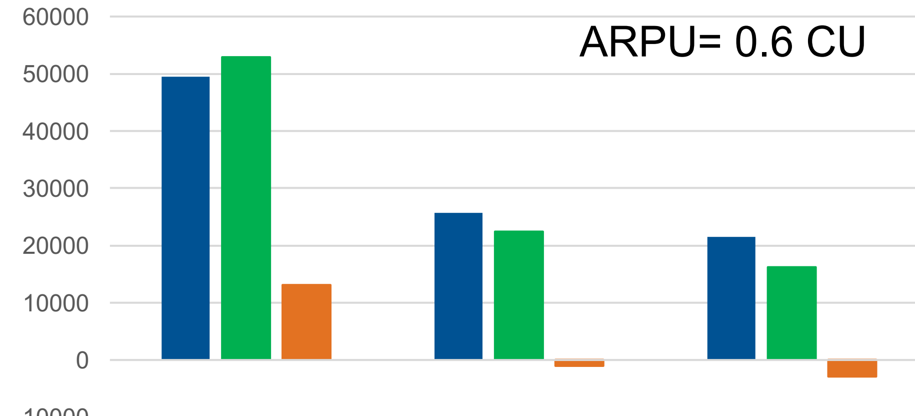
Greenfield Scenario
FTTB network+MBS



	Aggressive	Likely	Conservative
DU	18142,46181	4196,721747	1726,509212
U	11120,29631	-6191,643568	-10146,86141
R	-4807,073686	-13221,21872	-14166,57976



	Aggressive	Likely	Conservative
DU	49471,225	25660,86706	21534,41209
U	52967,88461	22515,25657	16287,11341
R	13049,00698	-976,4613604	-2852,768345

- Deficit of R can be subsidized by profit of DU & U in aggressive adoption type
- DU profit is not enough to cover deficit of R & U in likely & conservative types
- Connecting MBS in the first year is the best option since the revenues are higher than for fix users.

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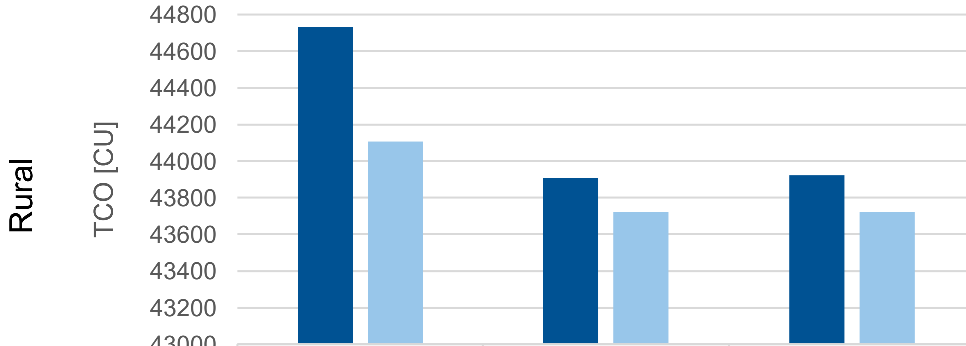
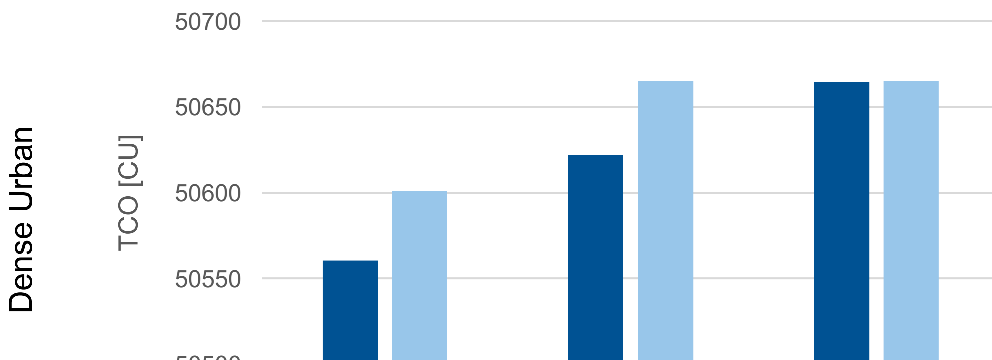
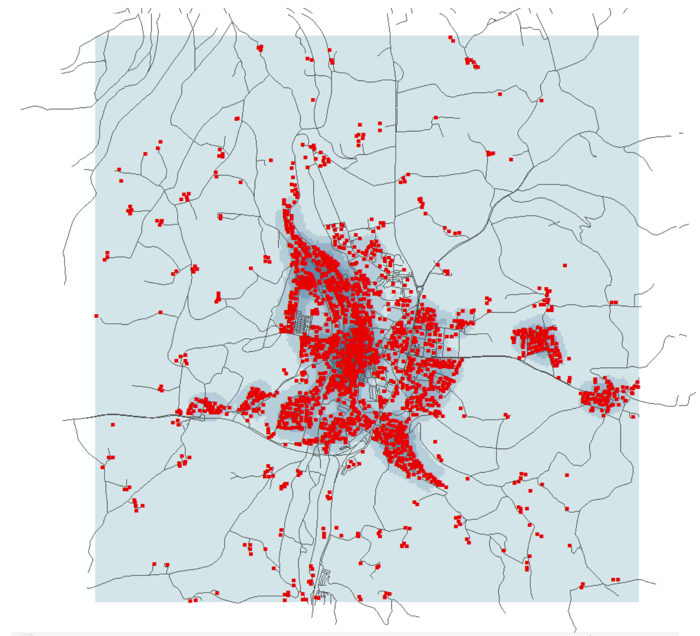
Penetration curves:
Random vs. Bass model



	Aggressive	Likely	Cinservative
Random	44734,71609	43909,18146	43921,37942
Bass	44107,94568	43722,81405	43722,81405



	Aggressive	Likely	Cinservative
Random	50560,40806	50622,03711	50664,47177
Bass	50601,138	50664,9886	50665,04137



Relative small TCO difference, which depends on the building and distribution density.

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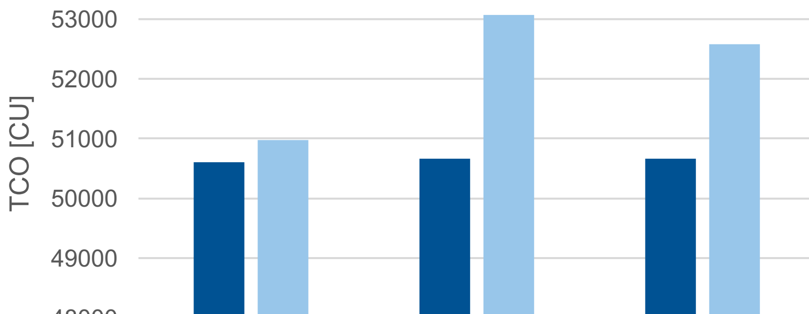
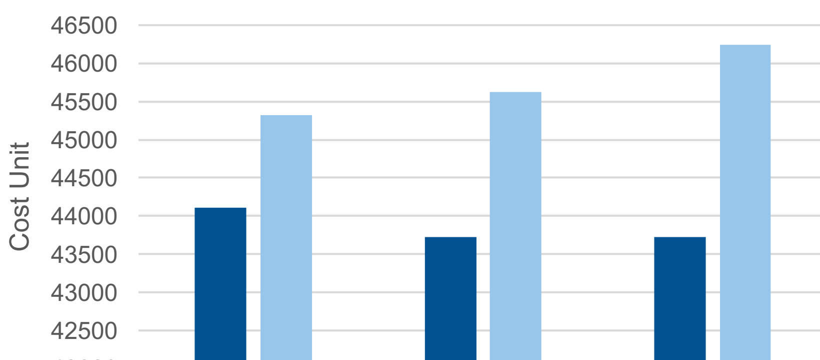


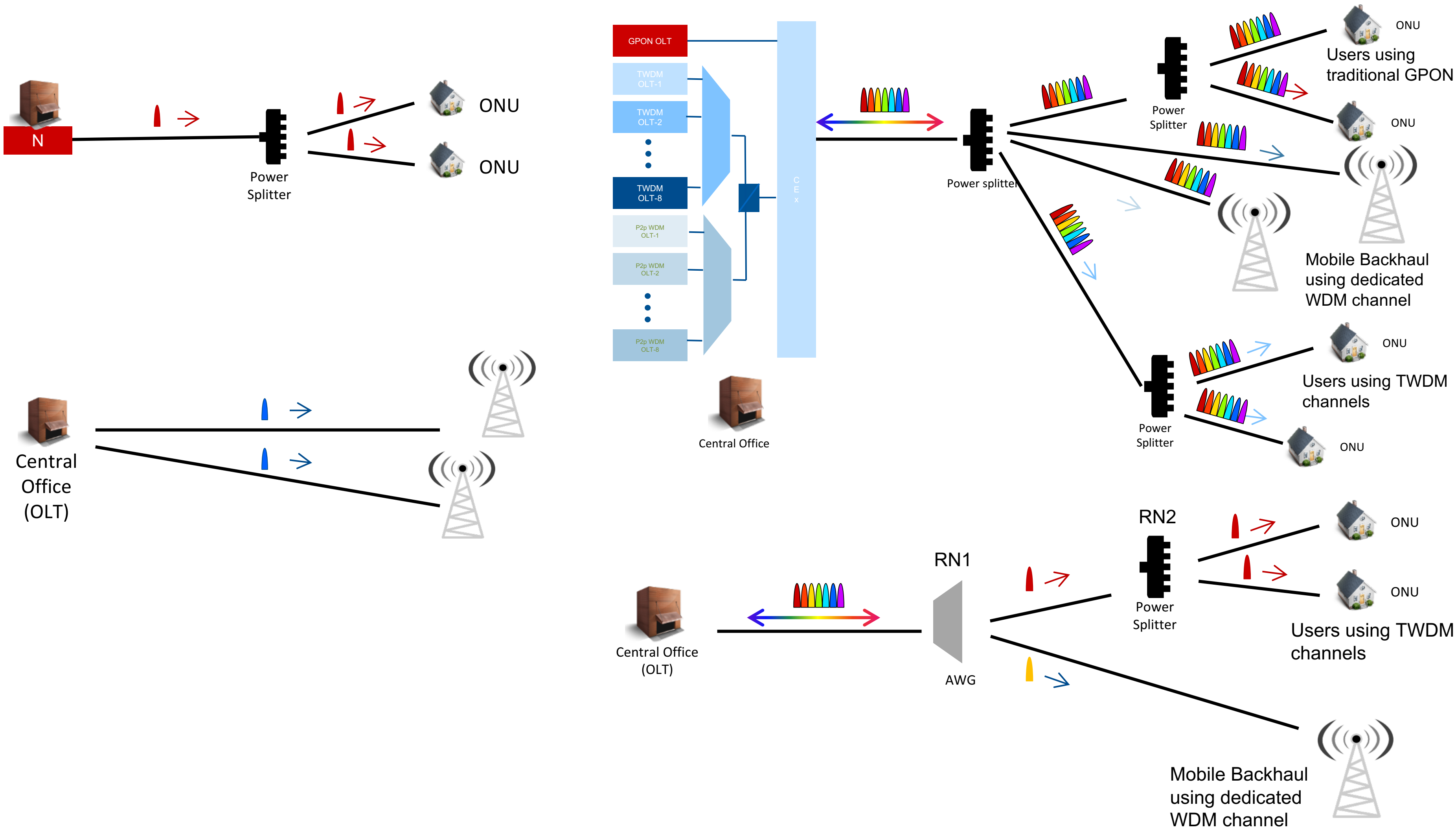
	Aggressive	Likely	Cinservative
Optimal	50601,138	50664,9886	50665,04137
Yearly	50982,15782	53066,64465	52587,71501

"Optimal Cluster" performs better in all areas



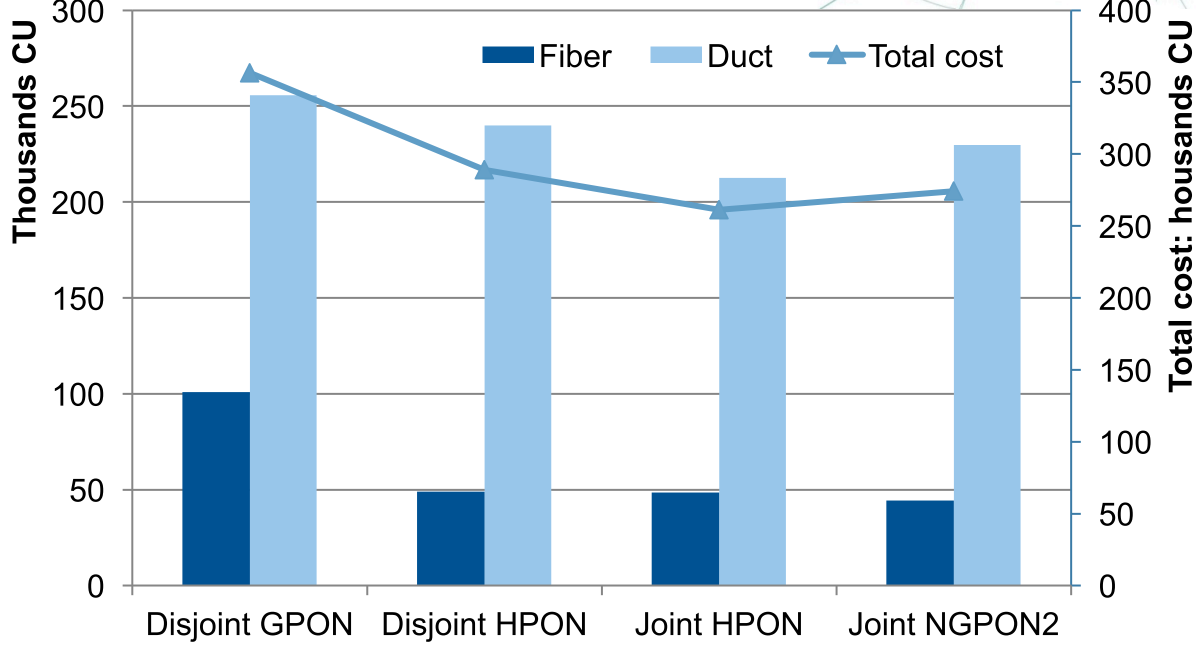
	Aggressive	Likely	Cinservative
Optimal	44107,94568	43722,81405	43722,81405
Yearly	45324,82752	45624,55343	46247,92668

Case Study-2 Joint vs. disjoint planning



Case Study-2 Joint vs. disjoint planning

- Darmstadt, Germany
  - 9.63 km^2
  - 6056 buildings
  - 32000 households



Disjoint HPON, Joint HPON and Joint NGPON2 planning options offer 19%, 29% and 23% savings, respectively, with respect the Disjoint GPON case

Conclusions and on-going work

- Available tool for real access network planning
- Advantages of geographic area data

- Extending with optimization tools and new heuristics
- Artificial topologies

Questions?