Routing strategies for **multilayer network** planning.

POLITECNICO MILANO 1863

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What we are going to see:

Step 1

Problem statement

Step 2

Approaches and examples

Step 3

Simulation

Step 4

Comparison

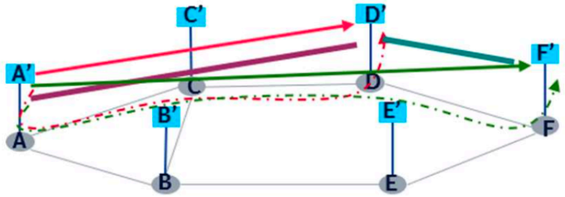
Step 5

Conclusion

Main goal:

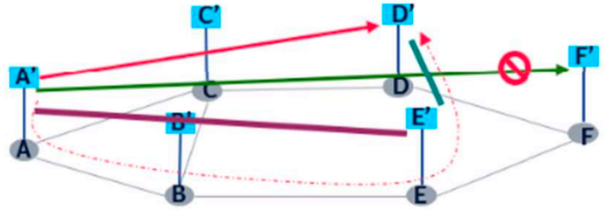
Addressing the challenge of routing demands generated randomly In Top-Down and Bottom-Up approach and comparing them!

Top-Down



- Design the optical network by starting from the Demands
- Creating multiple lightpaths within a single optical fiber
- We have intermediate grooming

Bottom-Up



- Defines the necessary number and types of WDM trails.
- Routing OTN services through the previously built virtual topology.
- Service cannot be route ,it is blocked.

What we going to Compare?

Objectives

- Deployed WDM trails
- Filling ratio
- Average fiber occupation

Which constraint do we have?

Constraints

WDM bandwidth: 4.8 THz in C-band

Max 96 channels at 50 GHz each

WDM trail Capacity

500 Gb/s	1300 km reach
400 Gb/s	2500 km reach

Demand Rate

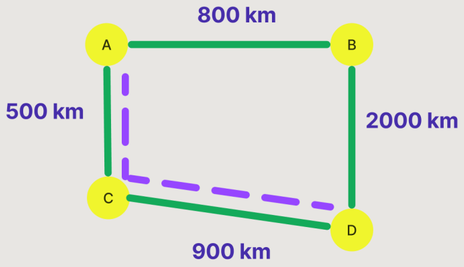
D1 = 100 Gb/s

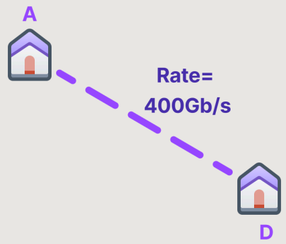
D2 = 400 Gb/s

Approaches examples

Top-Down

D1: A -> D 100 Gbps





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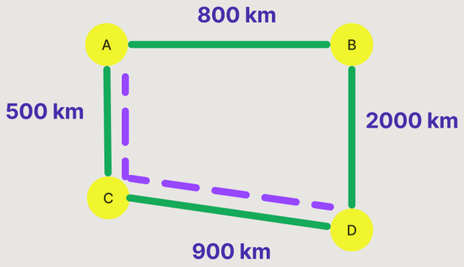
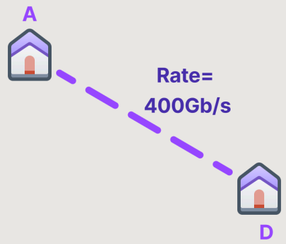
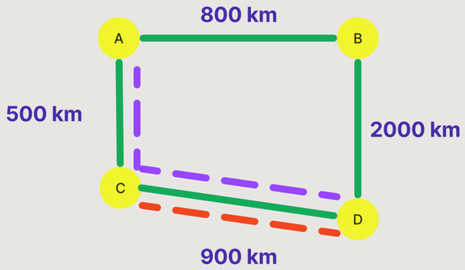
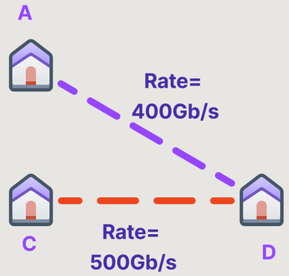




D2: C -> D 400 Gbps





	Constraints
WDM trail Capacity	WDM bandwidth: 4.8 THz in C-band
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Approaches examples

Top-Down

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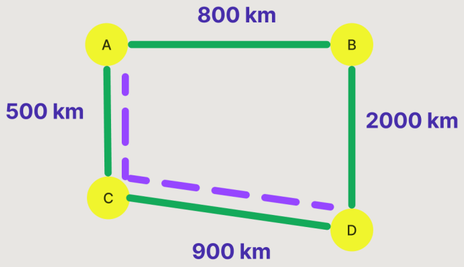

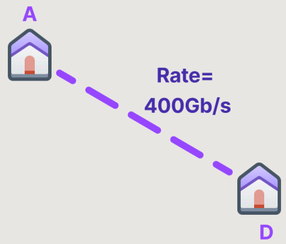

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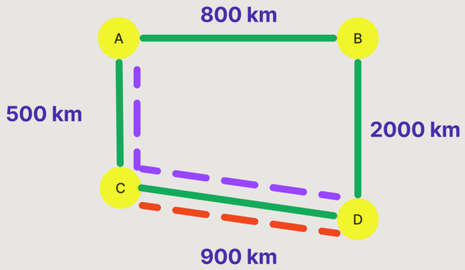
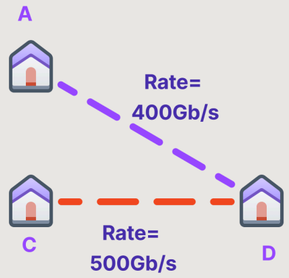
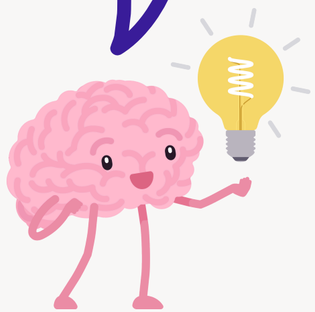




After grooming in a top-down approach, deploy new WDM trails until reaching a maximum of 96 WDM per link.

Grooming

Based on demands table
We groom the ones with same S &D and data rate.



Optimization algorithm

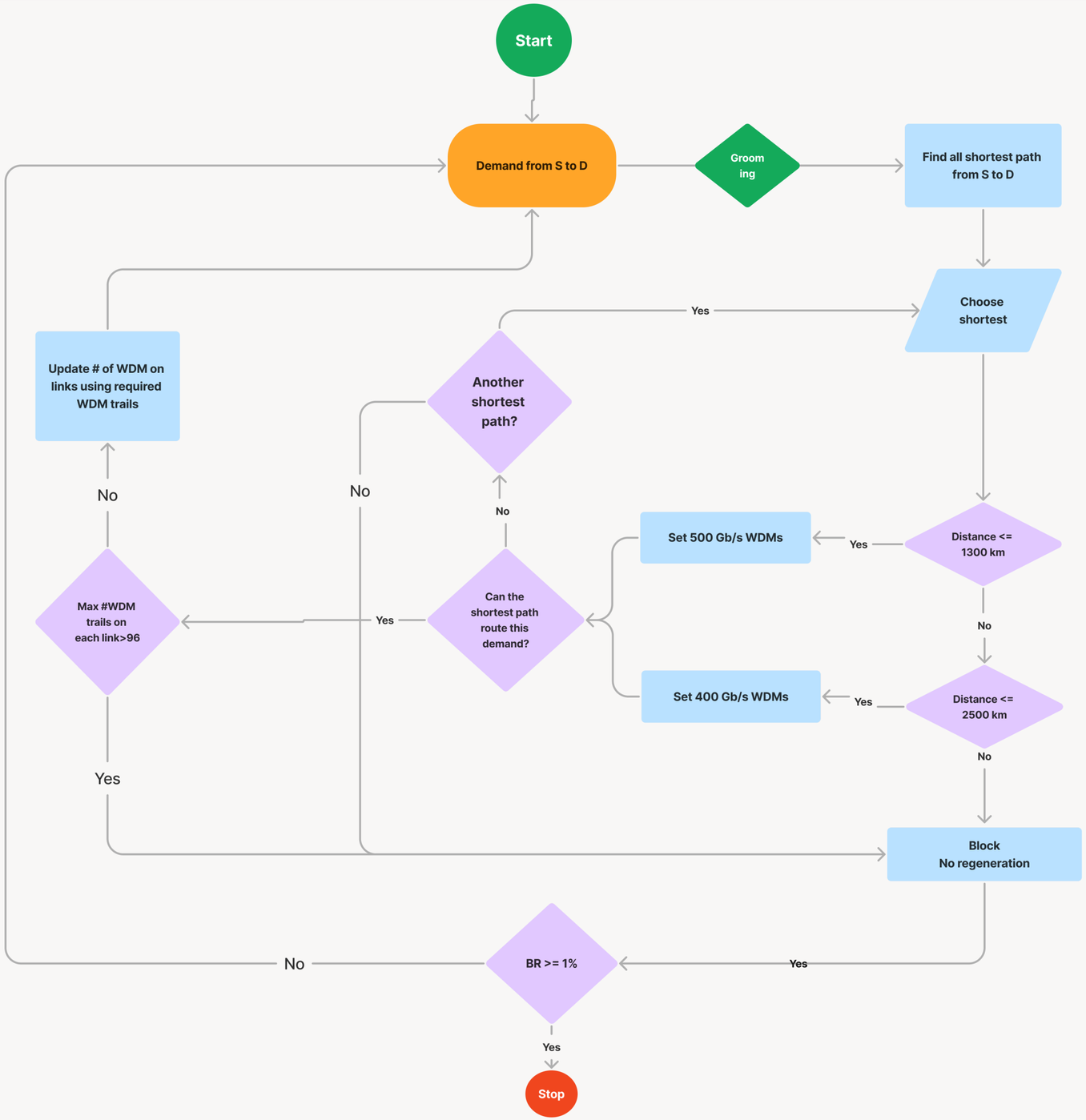
K- shortest path
knapsack

Future Grooming Ideas

Demand: 100 Gbps
Priority: 100 Gbps
200 Gbps
300 Gbps
500 Gbps
400 Gbps

Demand: 400Gbps
Priority: 400 Gbps
500 Gbps

Top-Down Flowchart



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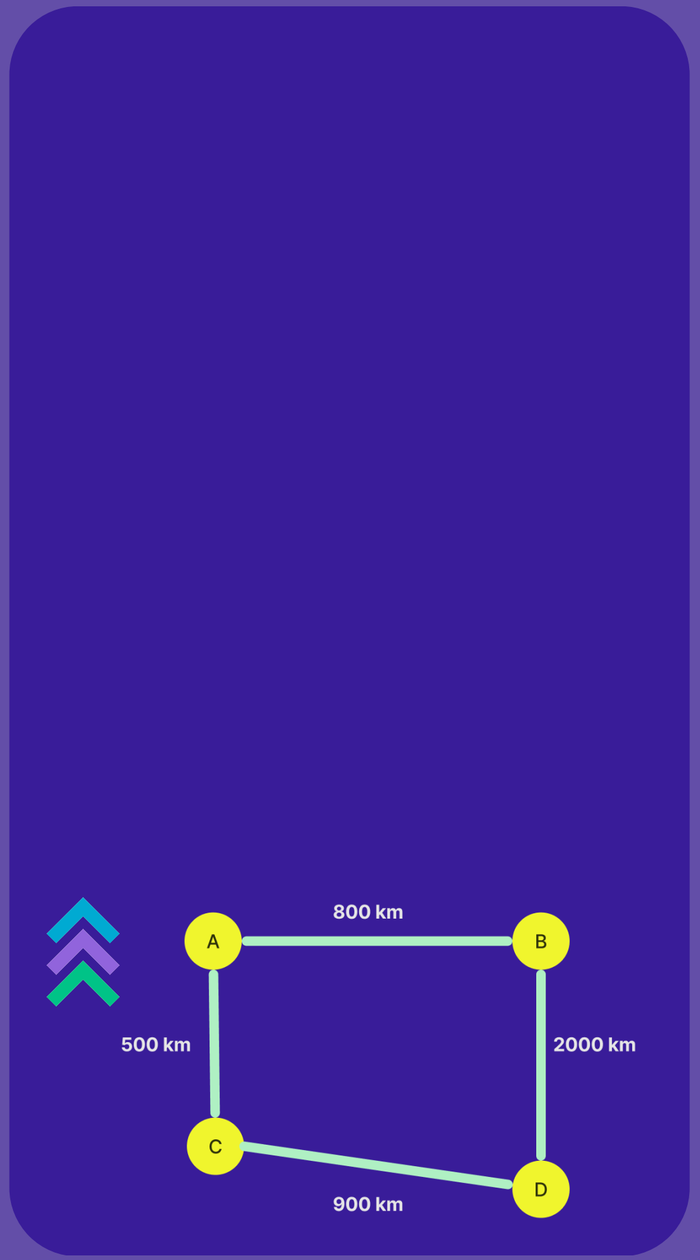
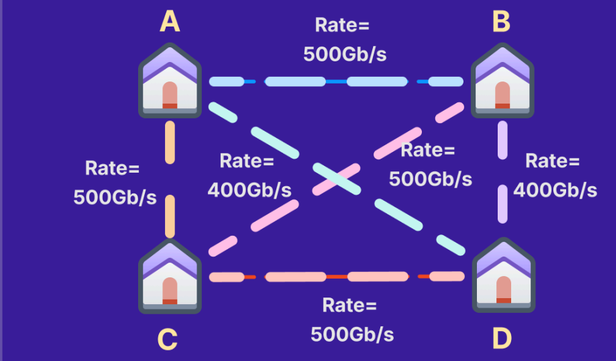
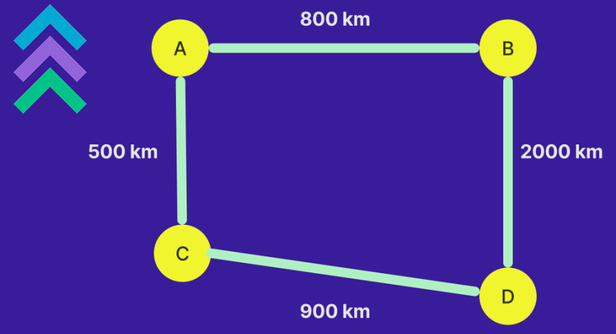


Bottom-up

Approaches examples

Deployment of WDM trails based on the K-shortest path continues until one link reaches the 96-channel constraint.





Bottom-up

Approaches examples

After the deployment of WDM trails, we start routing the demands:

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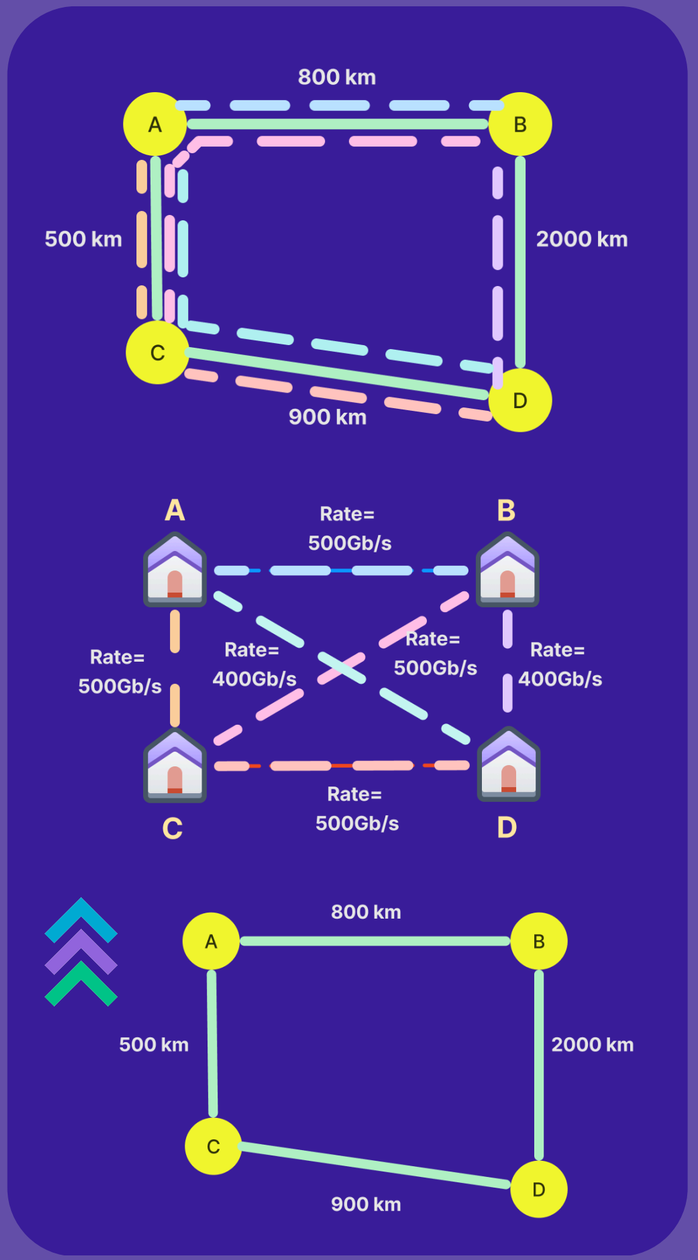


Bottom-up

Approaches examples

Deployment of WDM trails based on the K-shortest path continues until one link reaches the 96-channel constraint.

After the deployment of WDM trails, we start routing the demands:

D1: A -> D 100 Gbps

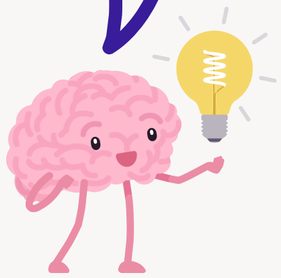
WDM trail(A,D): A-C-D

D2: C -> D 400 Gbps

WDM trail(C,D): C-D

Grooming

Based on demands table
We groom the ones with same S &D and data rate.



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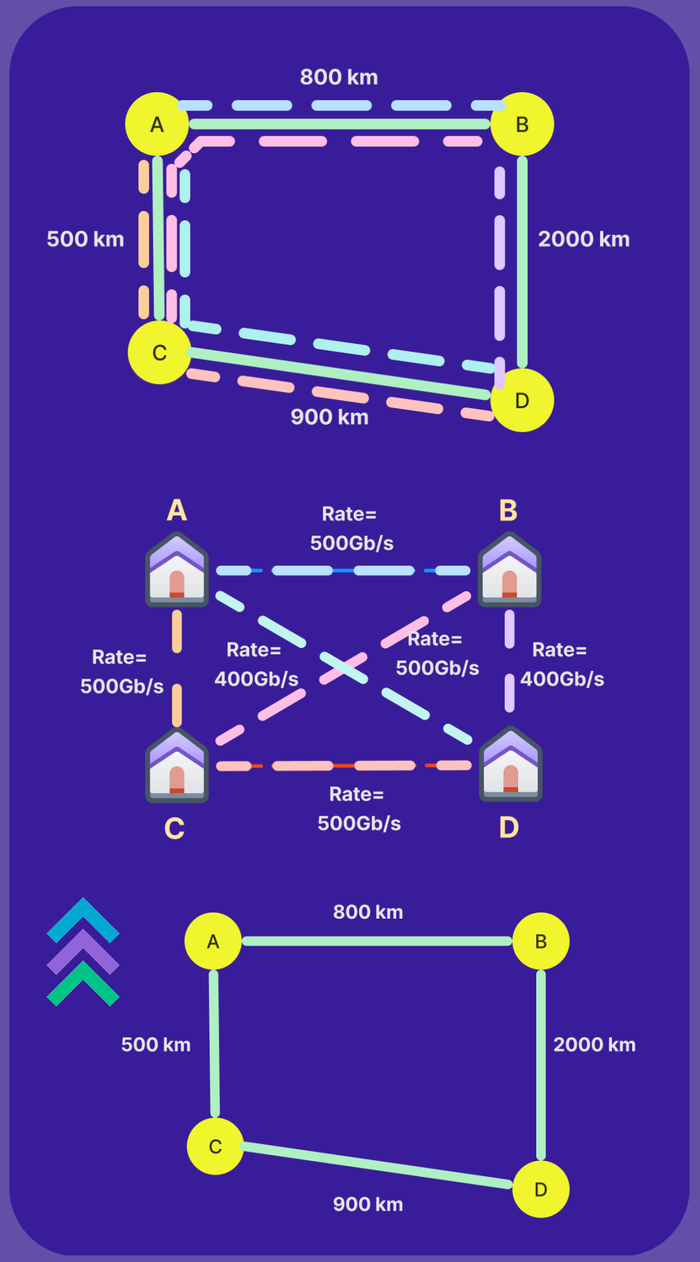
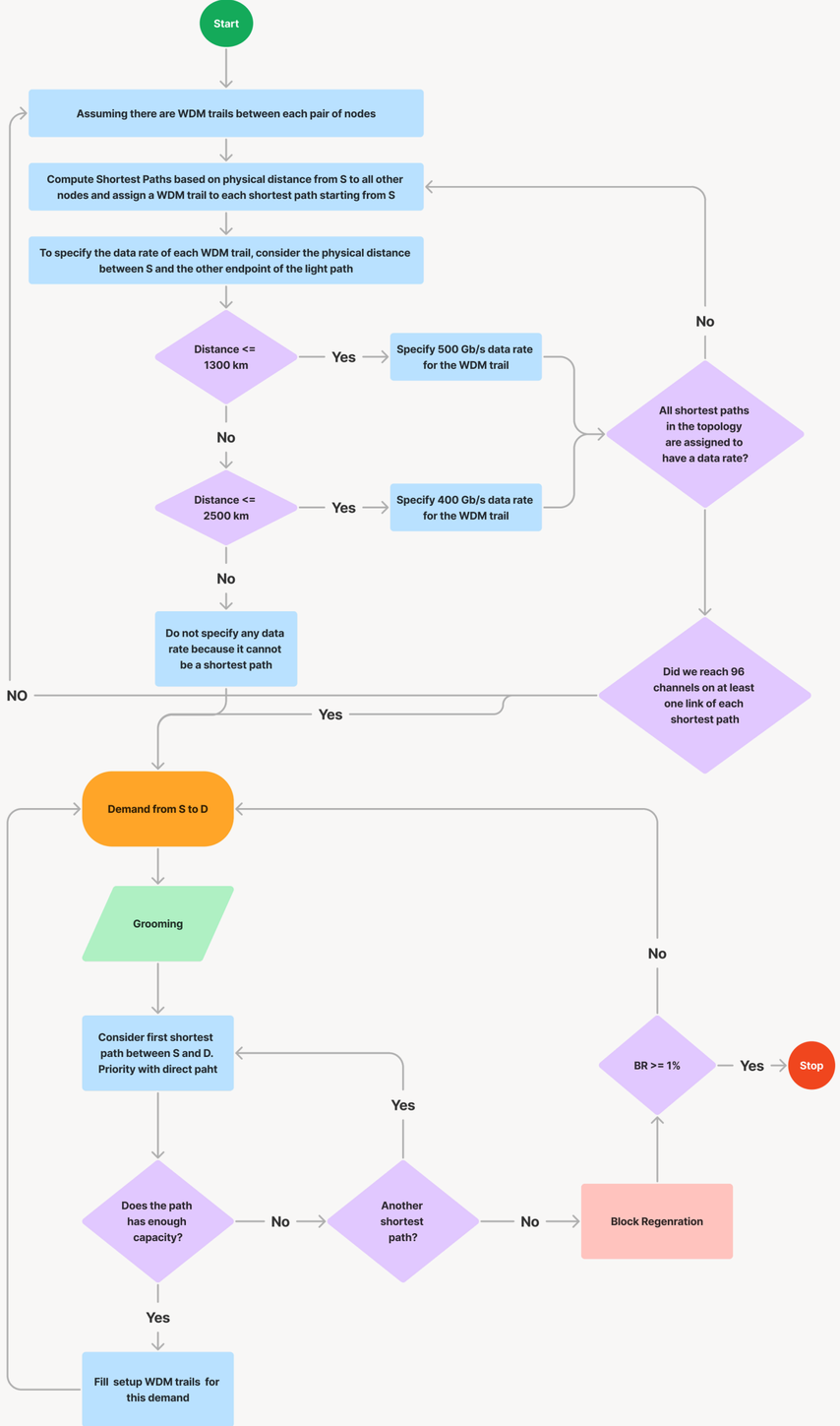
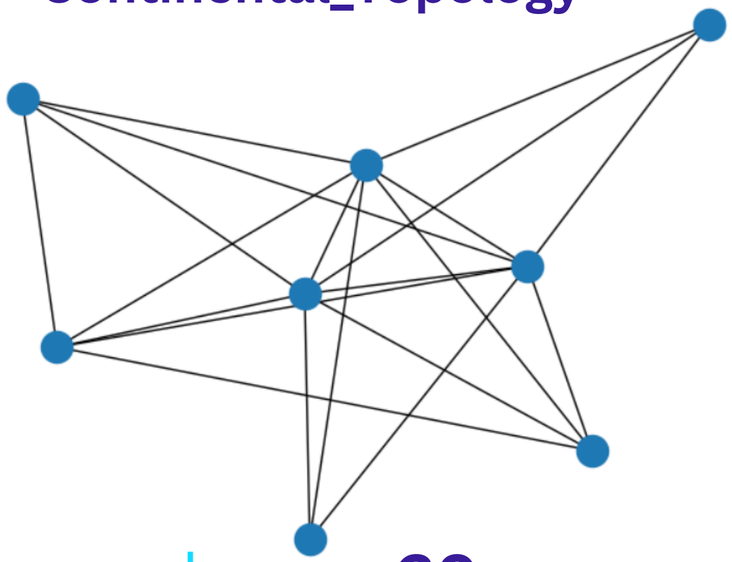


Bottom-up

Bottom-up flowchart

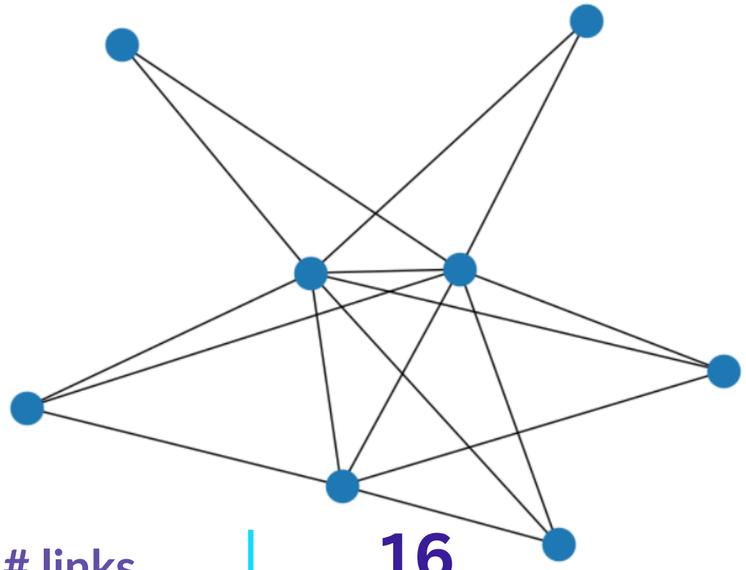


Continental_Topology



# links	20
# Nodes	8
Average	456
Max Link	1000

National_Topology



# links	16
# Nodes	8
Average	167
Max Link	400

Filling ratio

Measures how efficiently the capacity of the WDM trails is utilized.

Average fiber occupation

refers to the average number of WDM channels (or wavelengths) used in the fibers of the network.

Blocking Rate

Represents the proportion of service demands that cannot be routed.

Filling ratio

$$Filling\ Ratio = \frac{Used\ Bandwidth}{Total\ Available\ Bandwidth}$$

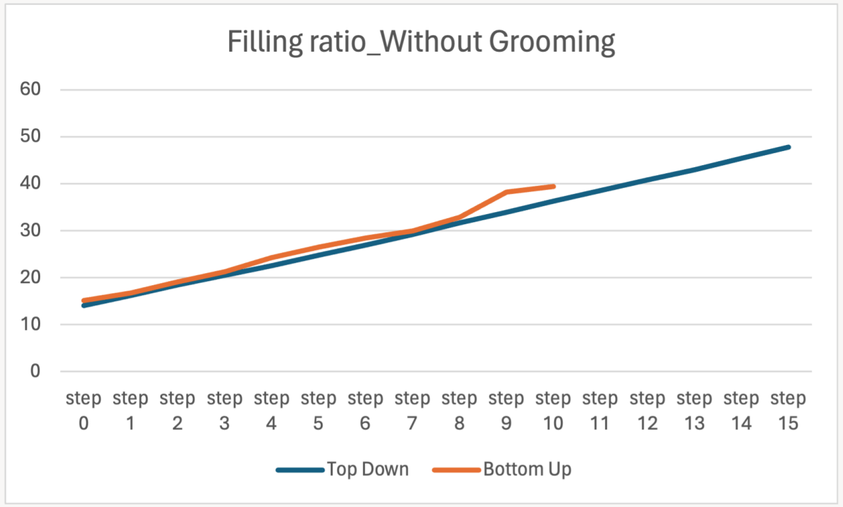
Average fiber occupation

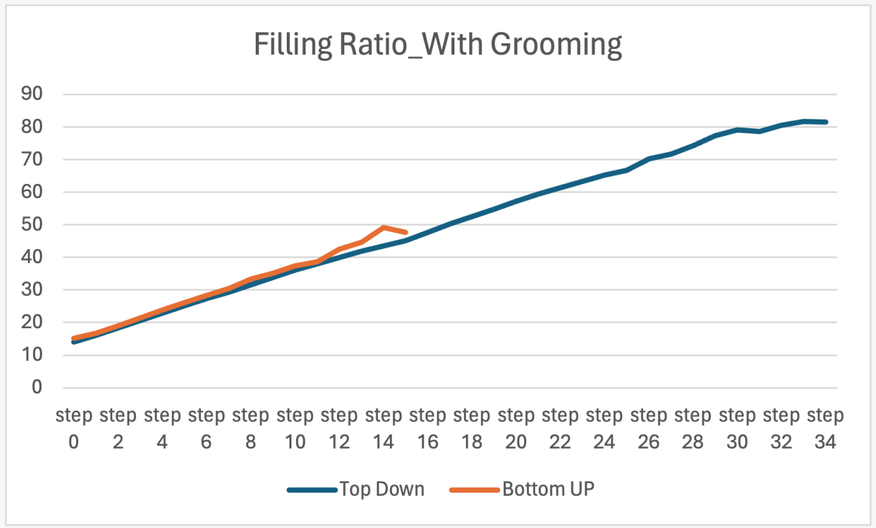
$$Average\ Fiber\ Occupation = \frac{Used\ Channels}{Total\ Channels}$$

Blocking Rate

$$Blocking\ Rate = \frac{Number\ Of\ Blocked\ Demands}{Total\ Number\ Of\ Demands}$$

Continental





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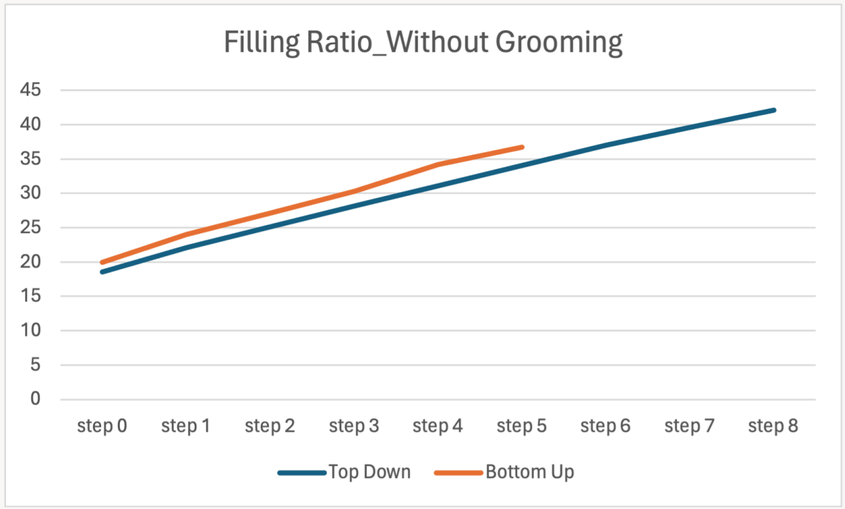

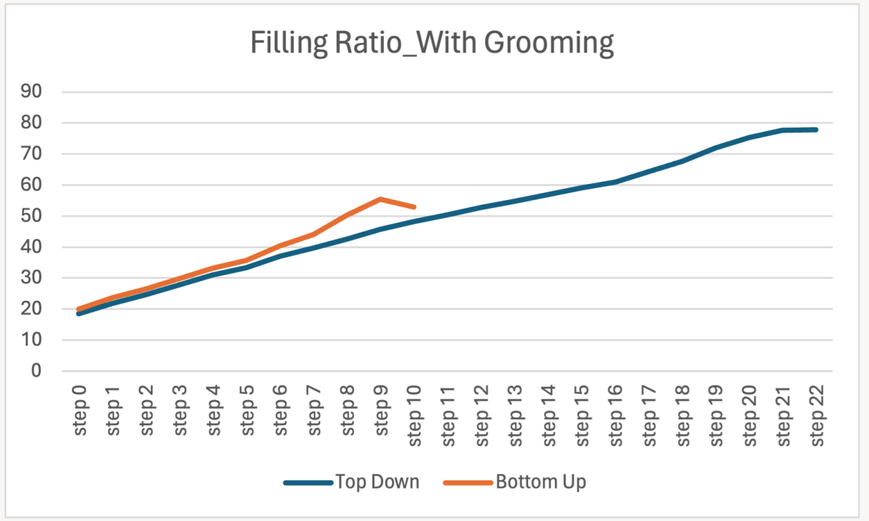

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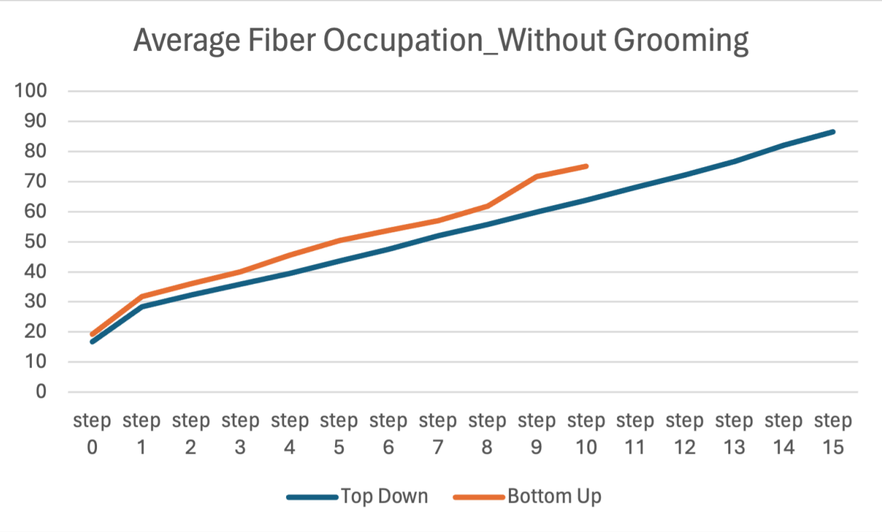

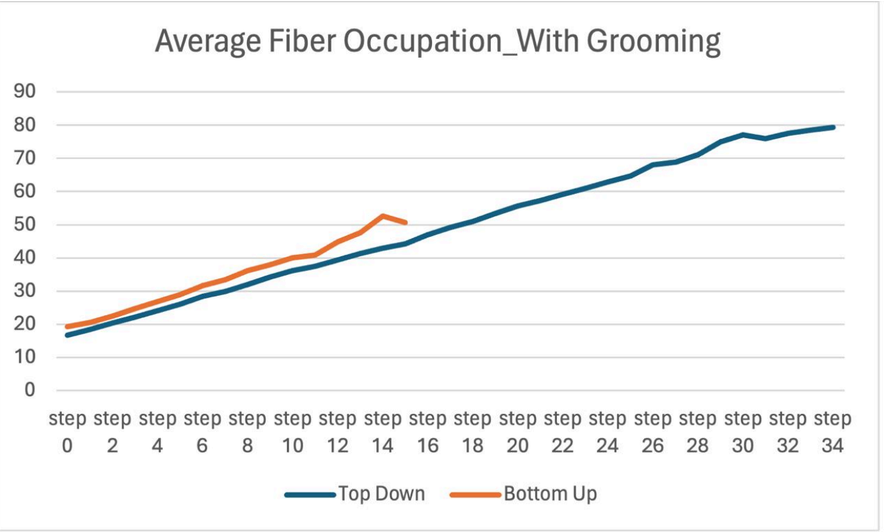

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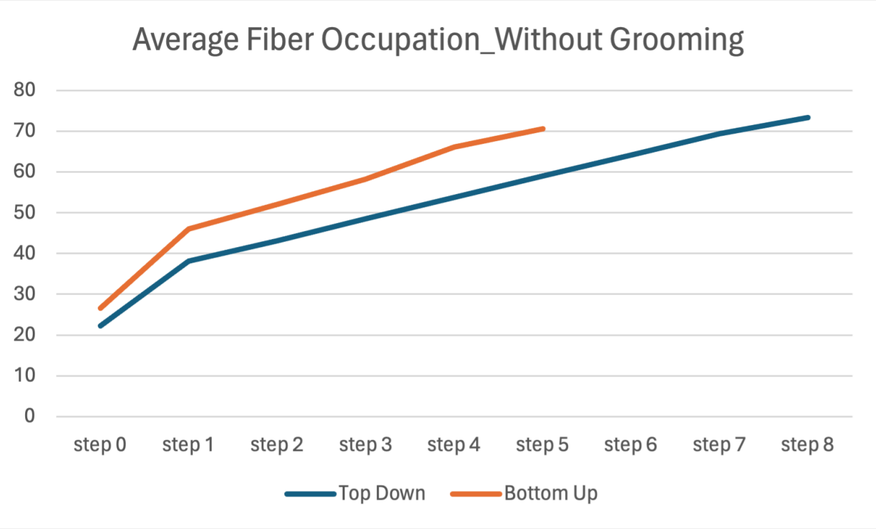

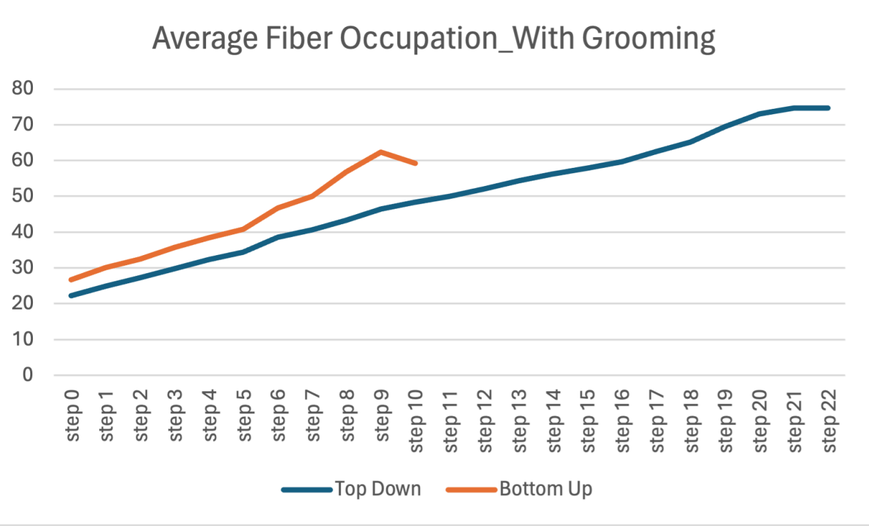

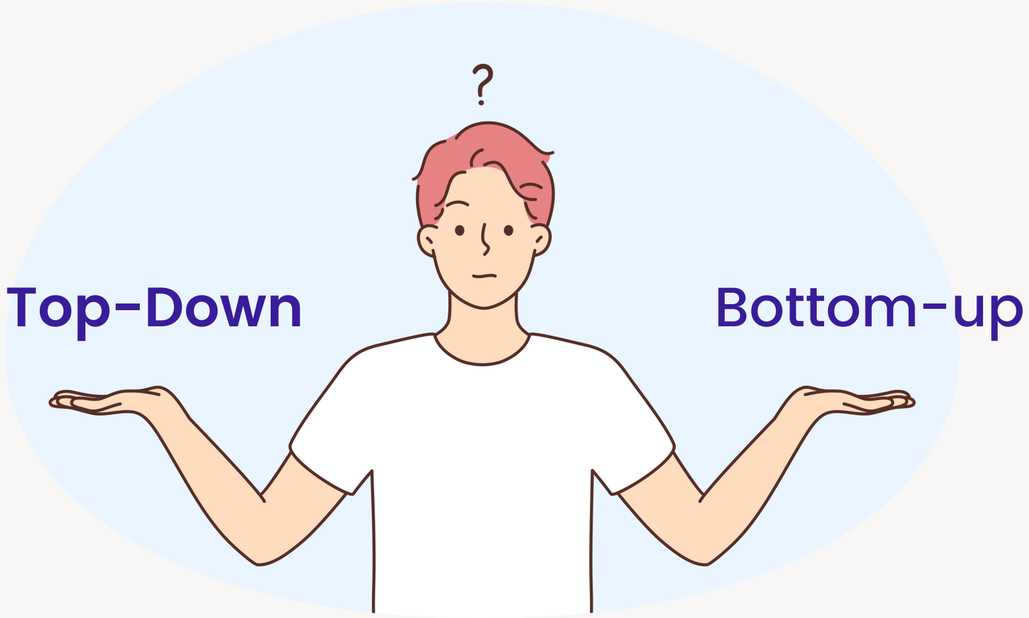
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Top-Down
Bottom-up

In nut shell, whenever we need more demands to pass we can go through top down approach as you saw we can have pass more demands and blocking rate happened not sooner as bottom up Contractly, we use bottom up when time is important for us, since in bottom up before looking at demands we create wdms and this may lead to better time response.

THANK YOU