SDN-controlled Dynamic Front-haul Provisioning, Emulated on Hardware and Virtual Testbeds

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Experimental Scenario: Metro Front-haul Provisioning
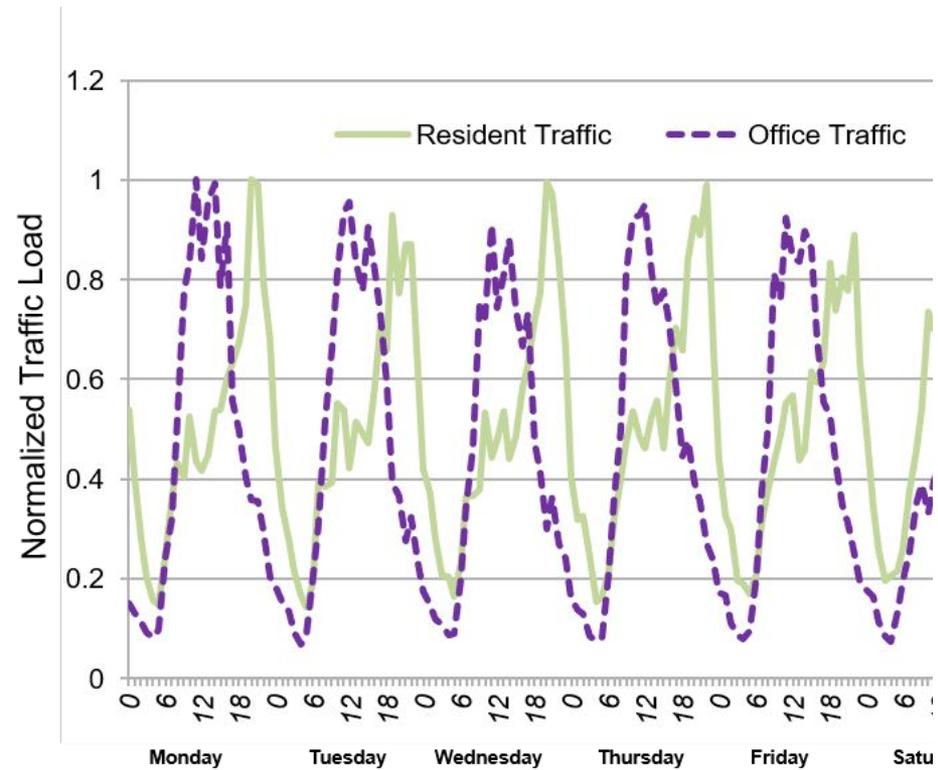
Digitized RF streamed between remote radio units (RU) and baseband units (BBU)

Diurnal traffic variation of Residential vs. Office traffic

Model on COSMOS[1] Optical x-haul testbed

Comb

Port 1

10 km

Port 1

bypass

Port 4

line out -> line in

25 km

Port 1

bypass

Port 4

25 km

line out -> line in

line out -> line in

R1

R2

R3

R4

R5

R6

Port 1

line in <- line out

Port 1

Port 4 bypass

line in <- line out

Port 4 bypass

line in <- line out

10 km

25 km

25 km

Port 1

Node1

Node2

Node3

Node4

◯ Connection thru Calient

Calient S320
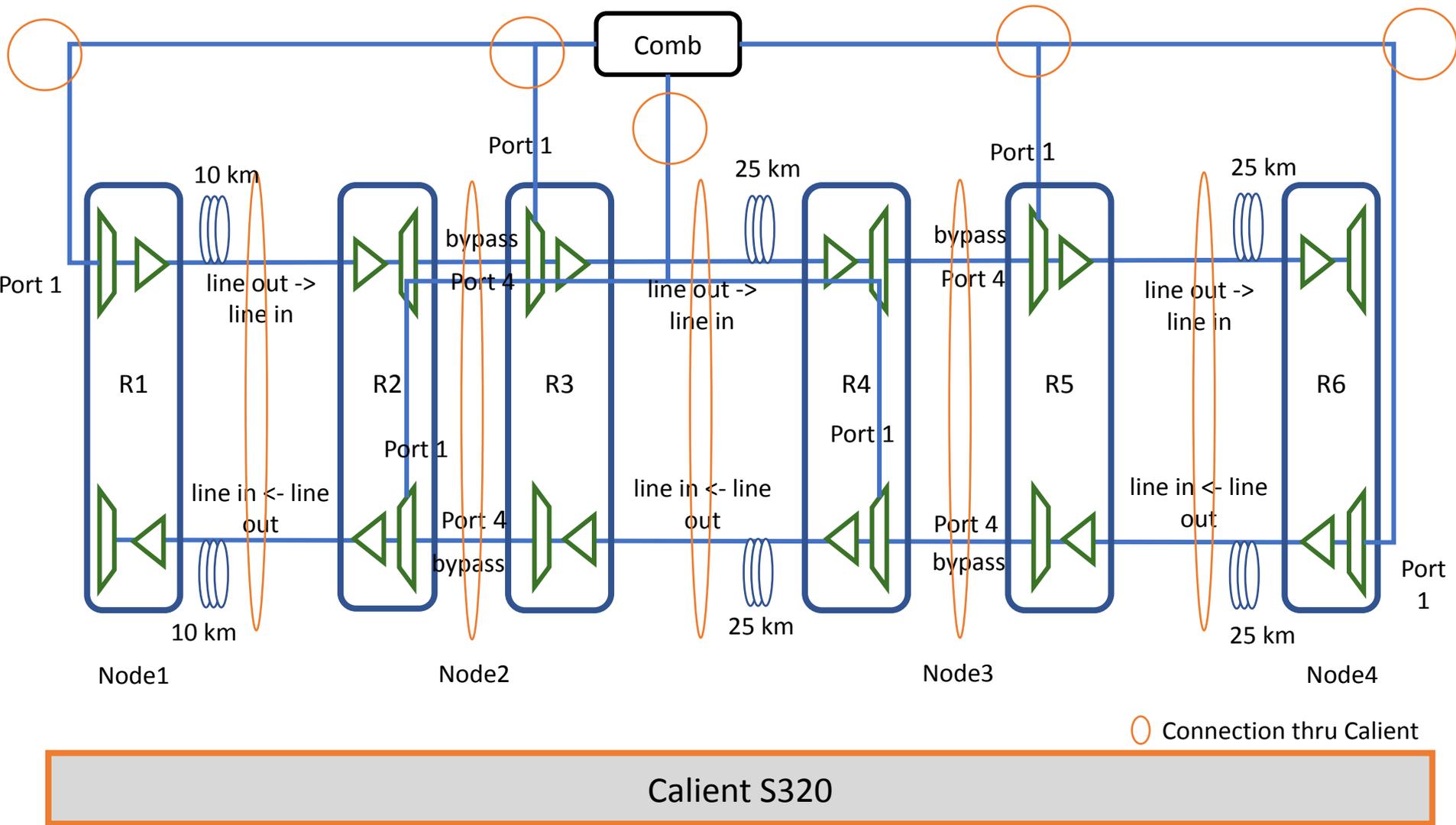
1. **"Challenge: COSMOS: a city-scale programmable testbed for experimentation with advanced wireless,"** *ACM MobiCom'20*

Mininet-Optical: our Packet-Optical Network Emulator

Experimental scenario model on Mininet-Optical
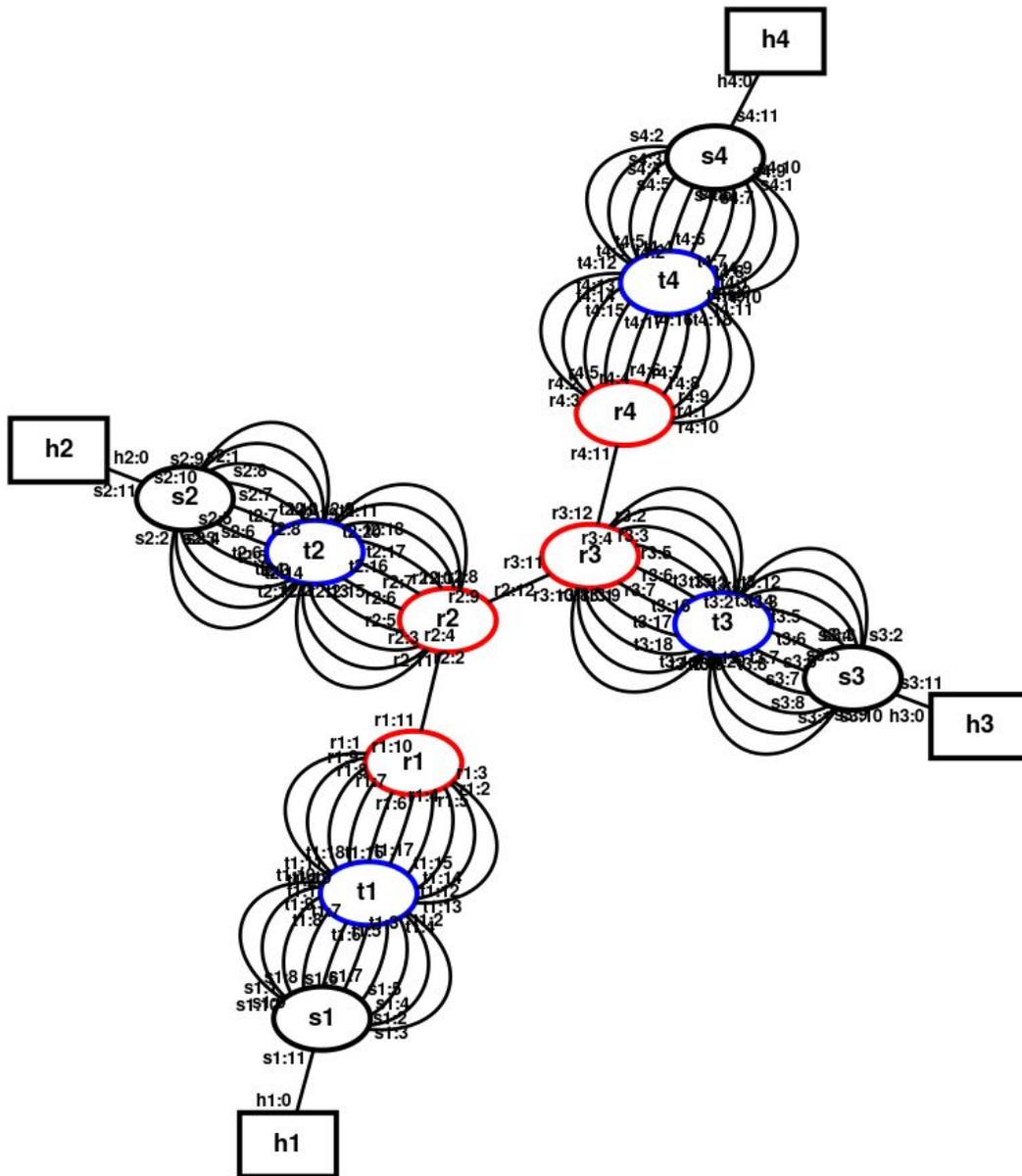

Four ROADMs:

(r1,r4): 1-degree

(r2,r3): 2-degree

Links are fiber pairs (i.e. both directions)

Endpoints: Data Centers (h1, h4); RU aggregation (h2, h3)

90 transceivers/channels per endpoint

End-to-end model with Optical (ROADM rN, Terminal tN) as well as packet (Host hN, Router sN) elements

COSMOS testbed model on Mininet-Optical
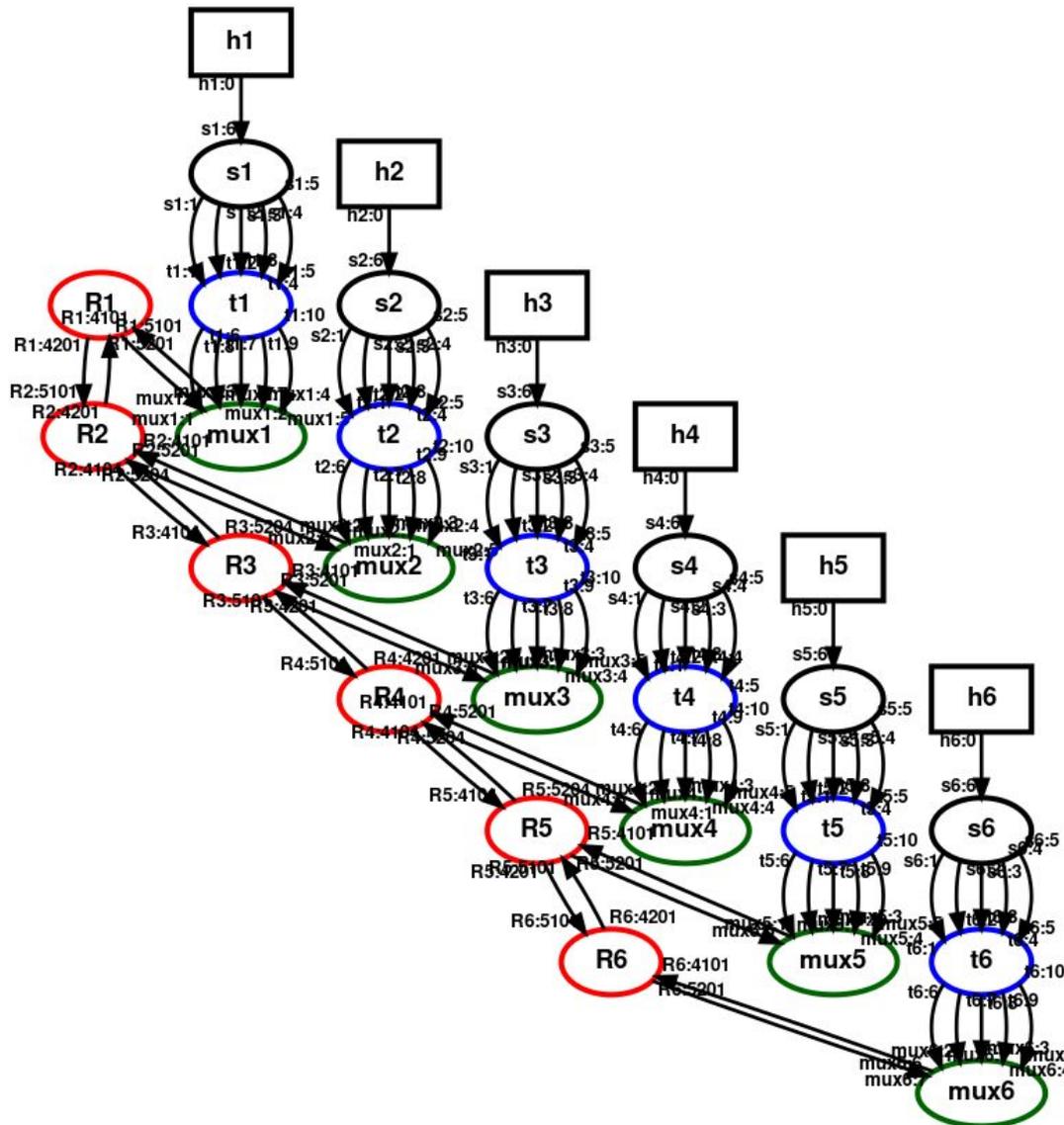
Unidirectional links; 6 split/paired ROADMs based on Lumentum; identical port numbers; comb source modeled using transceivers attached to MUX

Our SDN Controller can control both Virtual and Hardware Networks

Virtual network in Mininet-Optical
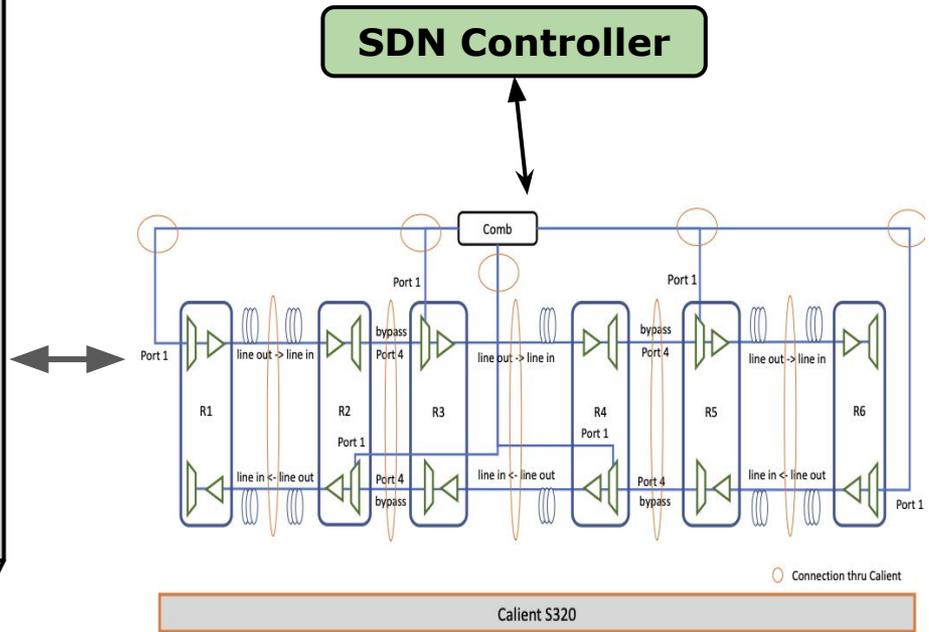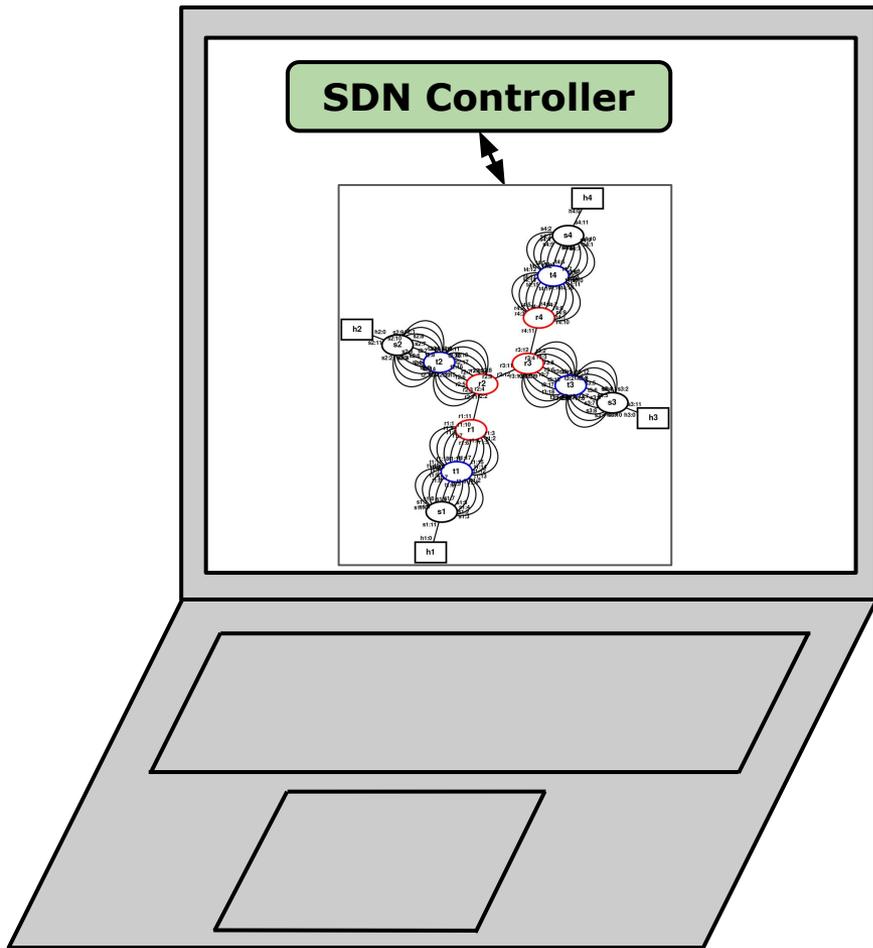
Hardware network on COSMOS Optical x-Haul testbed

Live Demo: SDN-controlled dynamic front-haul provisioning, emulated with Mininet-Optical
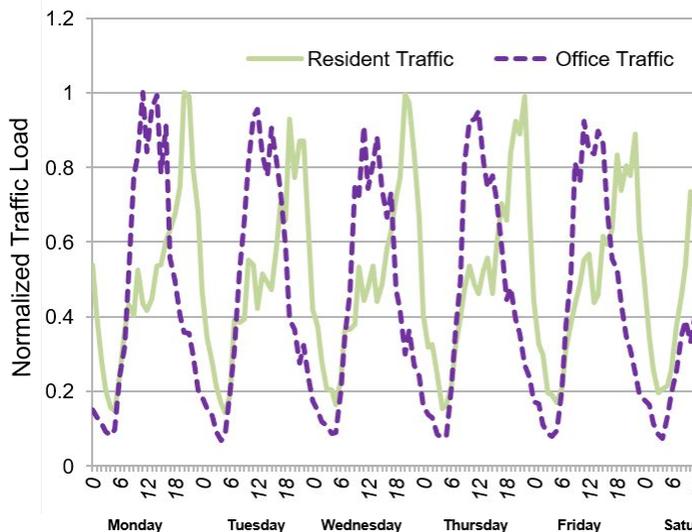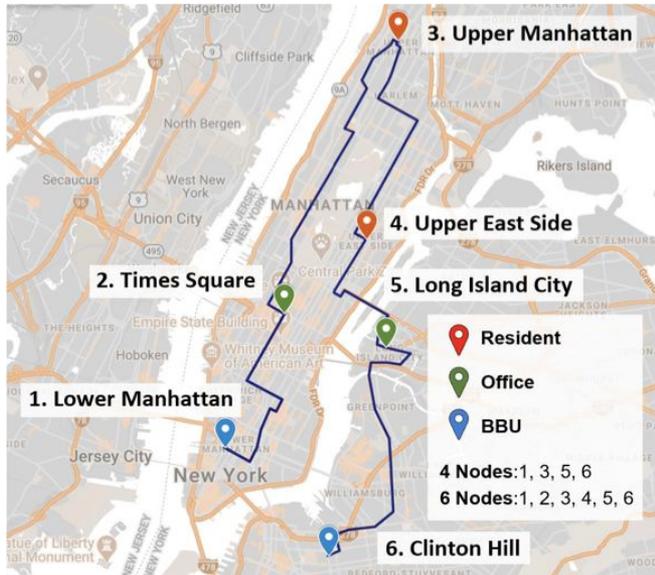
- Modeling a metro network routing front-haul RF (DRoF) signals, encoded as 24.3 Gb/s CPRI streams from remote radio units (RU), aggregated at ROADM nodes and transmitted to baseband units (BBU), located at data centers (DC)

- We prefer nearest DC, but DC2 doesn't have enough capacity to handle peak demand, so load must be split

- Controller provisions lightpaths, assigns data streams to lightpaths, and monitors received gOSNR; we tried to select a margin that was close to the threshold

- If gOSNR drops below threshold, SDN controller can lower the modeled data rate and modulation from 200 Gb/s (16QAM) to 100 Gb/s (QPSK) or even 50 Gb/s (BPSK), rerouting and re-provisioning as necessary

- Empty lightpaths (with no traffic) are torn down

Demo Results

## Power Spectrum Monitoring

As the emulated experiment runs, we can examine the input power spectrum at each ROADM and observe how channels are added and removed over time. We also monitor received gOSNR at the transceivers.
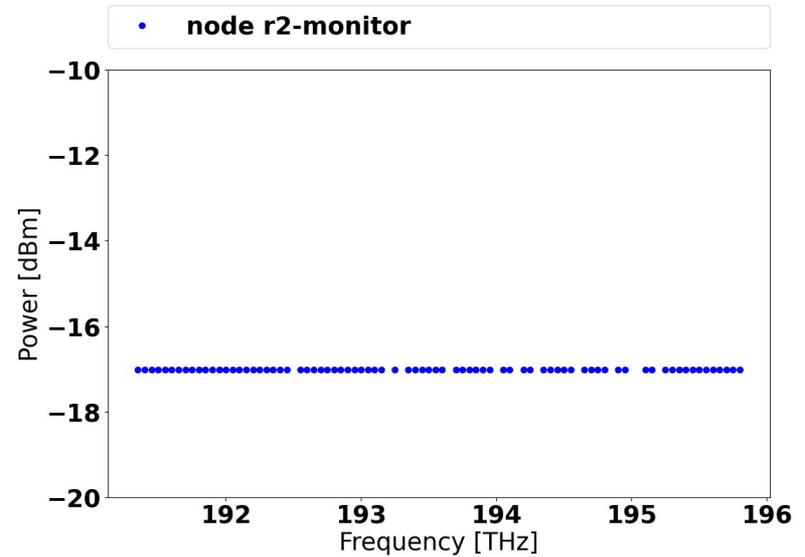

Lightpath Provisioning

As the emulated experiment runs, we record the lightpath provisioning, so we can examine how it evolves over time in response to demand. We can see how new lightpaths are provisioned, how lightpaths become underutilized, and that our rerouting algorithm hardly ever triggered. (We might still need it in a larger network, etc.)

Lightpath provisioning results
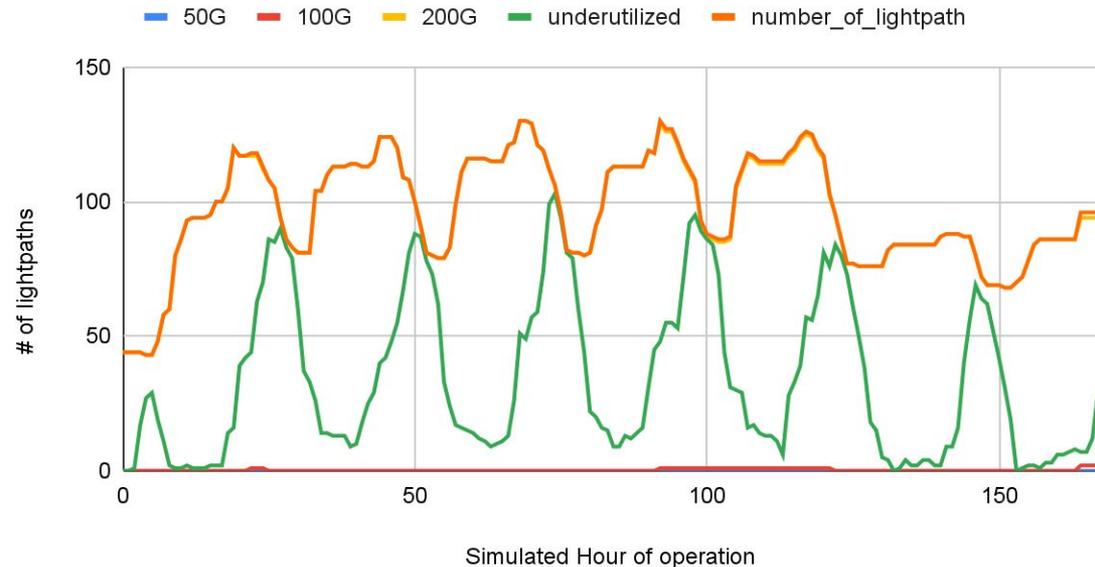
Video Demo: SDN-controlled dynamic front-haul provisioning, emulated on COSMOS optical x-haul testbed
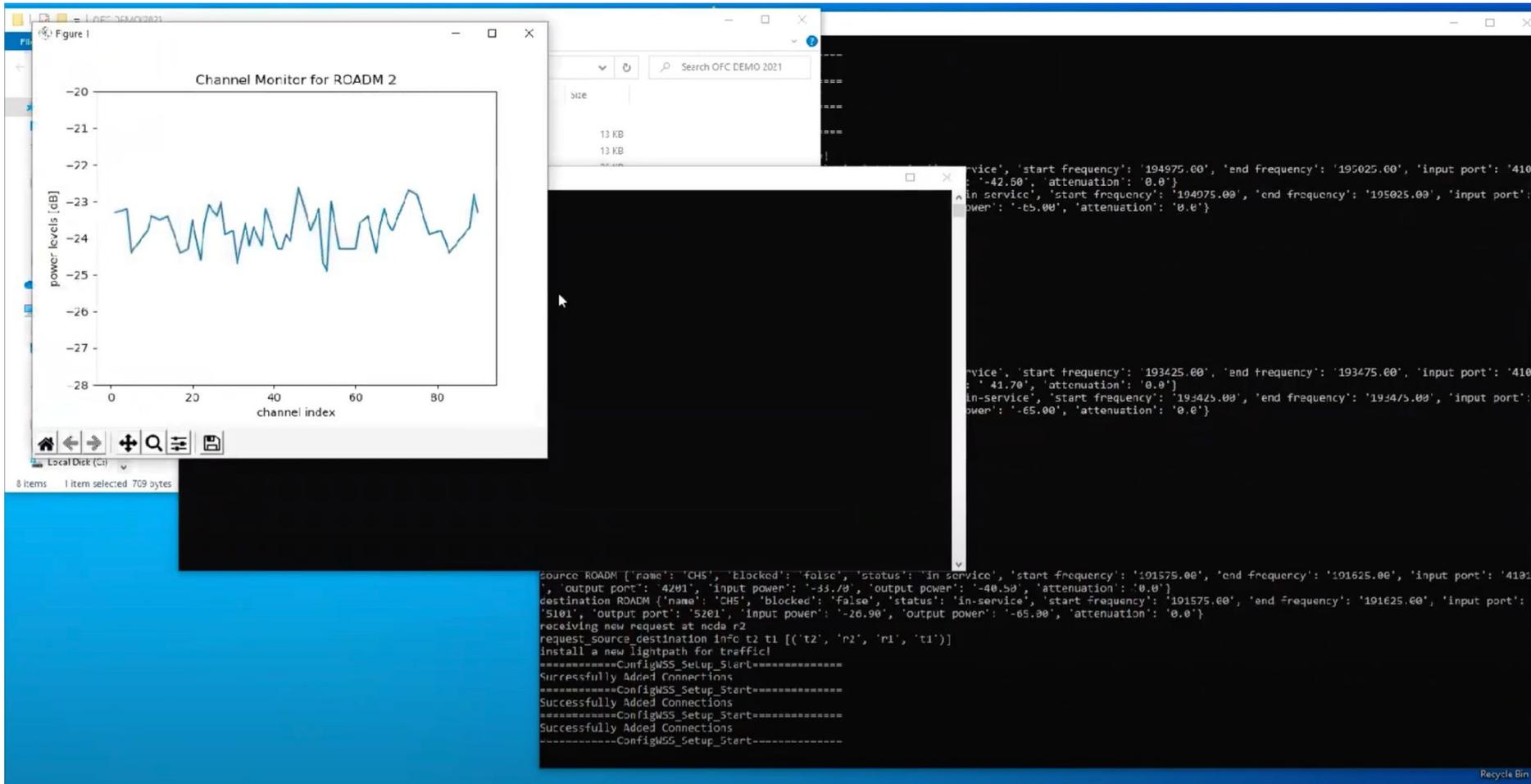
In the video demo, Jiakai will show the SDN Controller provisioning lightpaths on the hardware test network, implemented on the COSMOS optical x-haul testbed

Check out our live demo

(Today only) Join our **live demo/chat** during the 30m break after this session.

(Anytime) Watch our **demo video**:

https://www.ofcconference.org/en-us/home/program-speakers/demo/demo/?id=3567434

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(if you get a 404 error, try opening up another web browser window and pasting the link in manually)