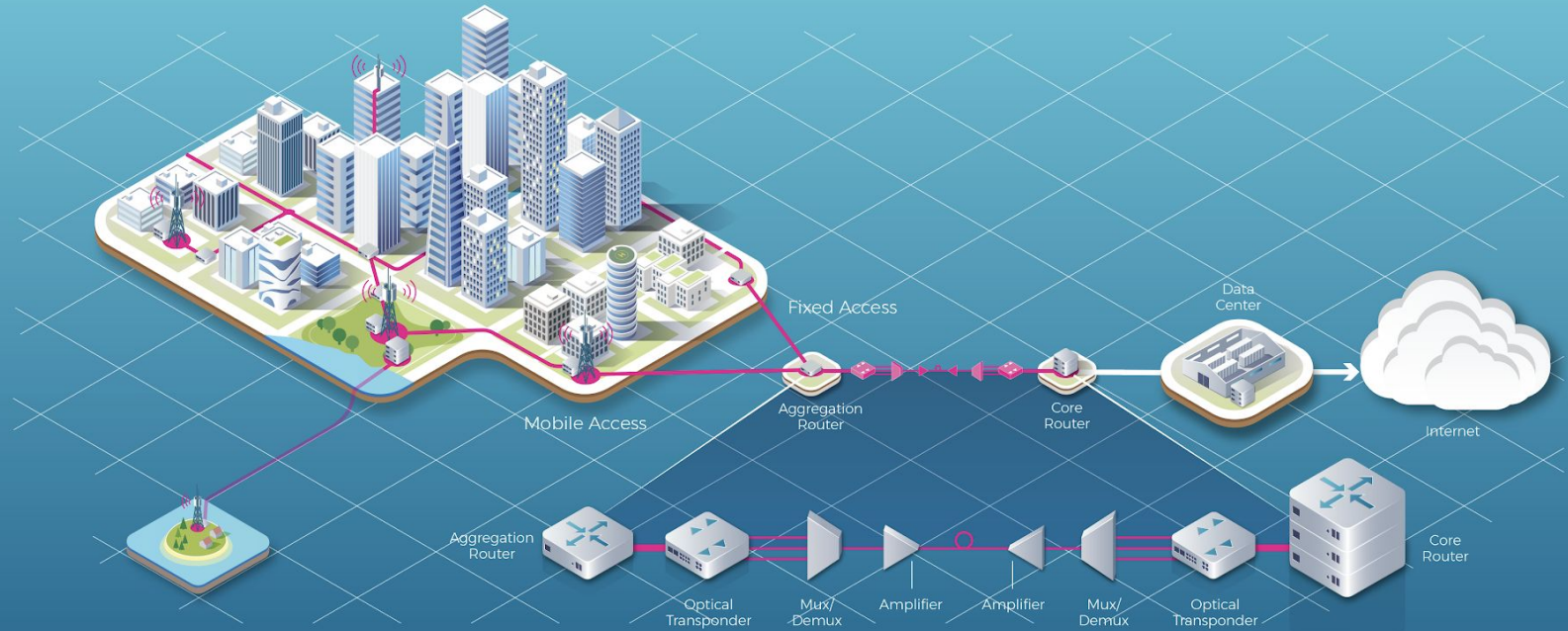


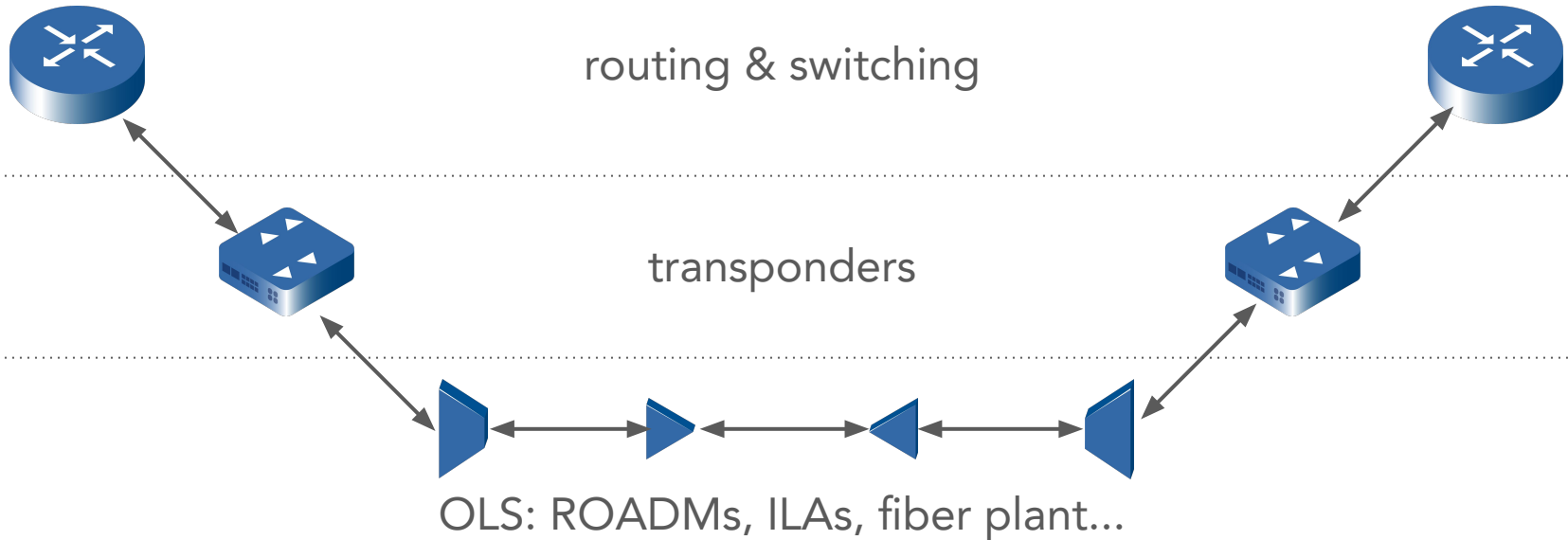


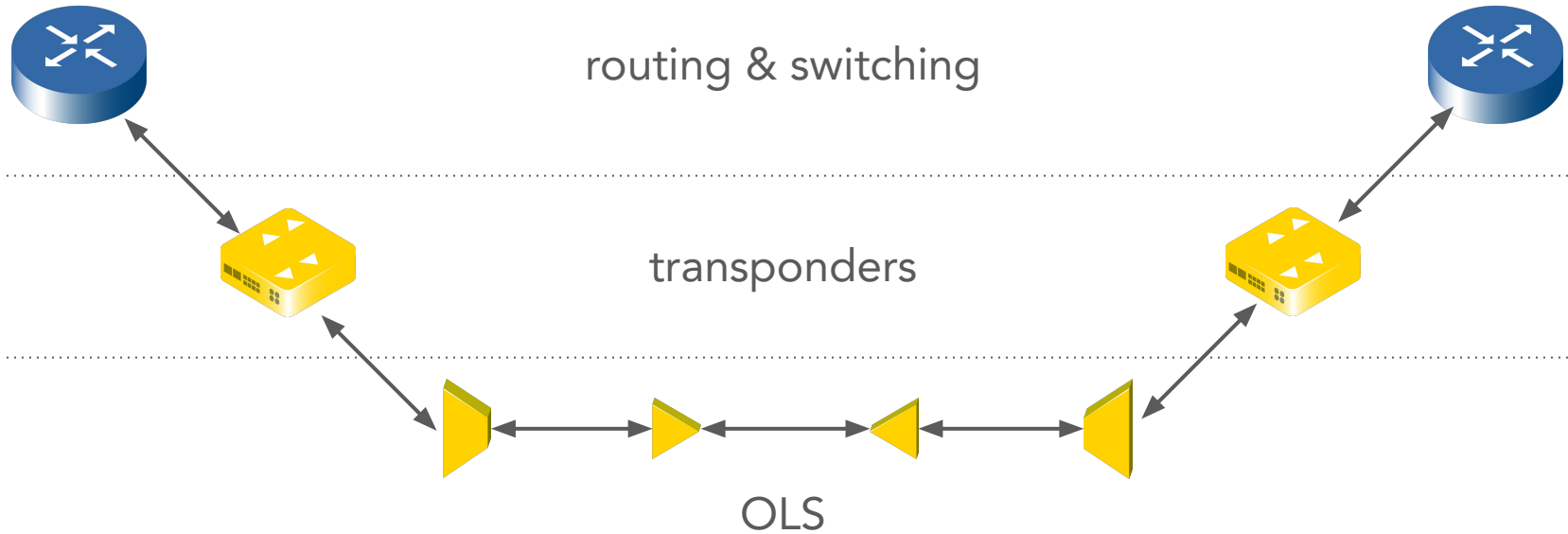
# Open Optical Line Systems at CESNET

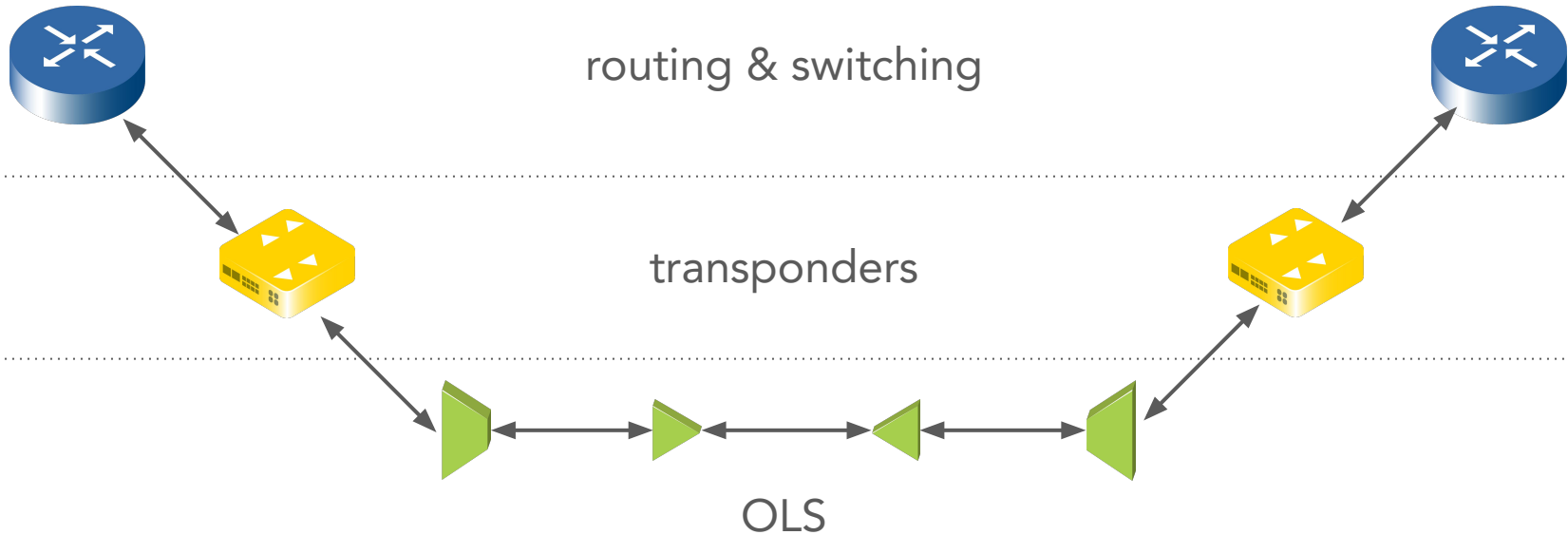
Jan Kandrát



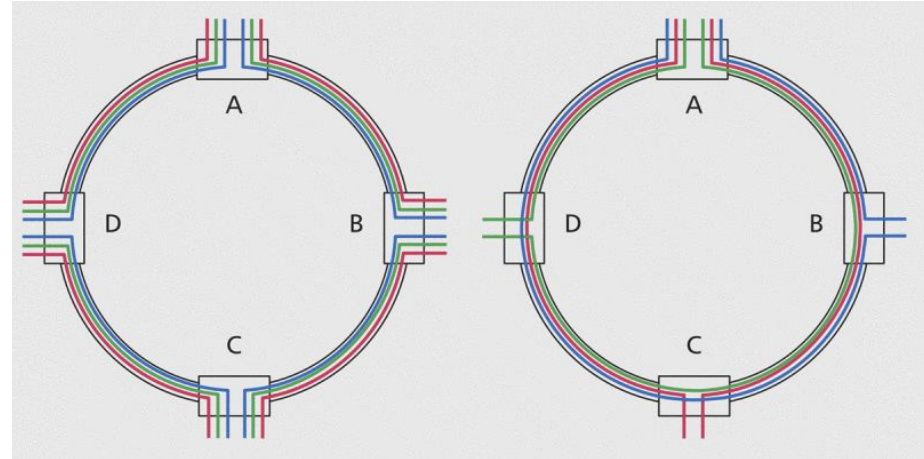
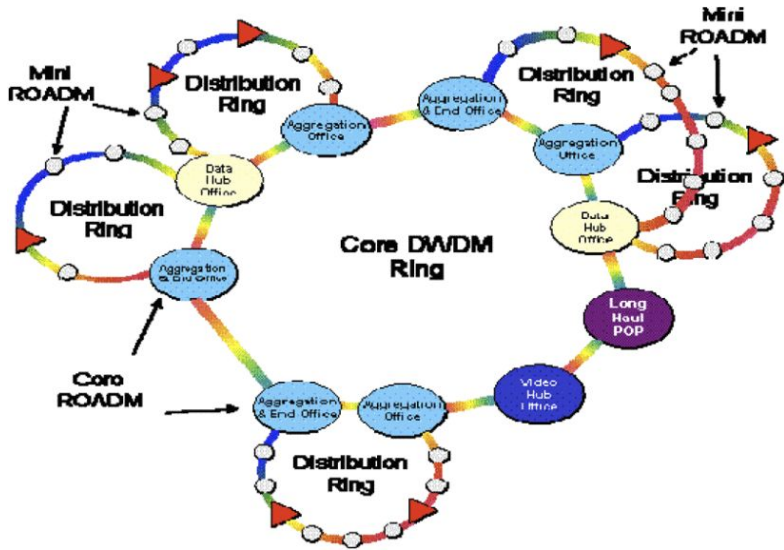








# Reconfigurable Optical Add/Drop Multiplexer (ROADM) Networks



Flexgrid. Colorless, Directionless, Contentionless. Broadcast & Select, Route & Select. Booster & Preamp. Express vs. Add/Drop impairments. Add/Drop filtering. Passband narrowing.



Image source: DARPA CORONET Program on Dynamic Multi-Terabit Core Optical Networks



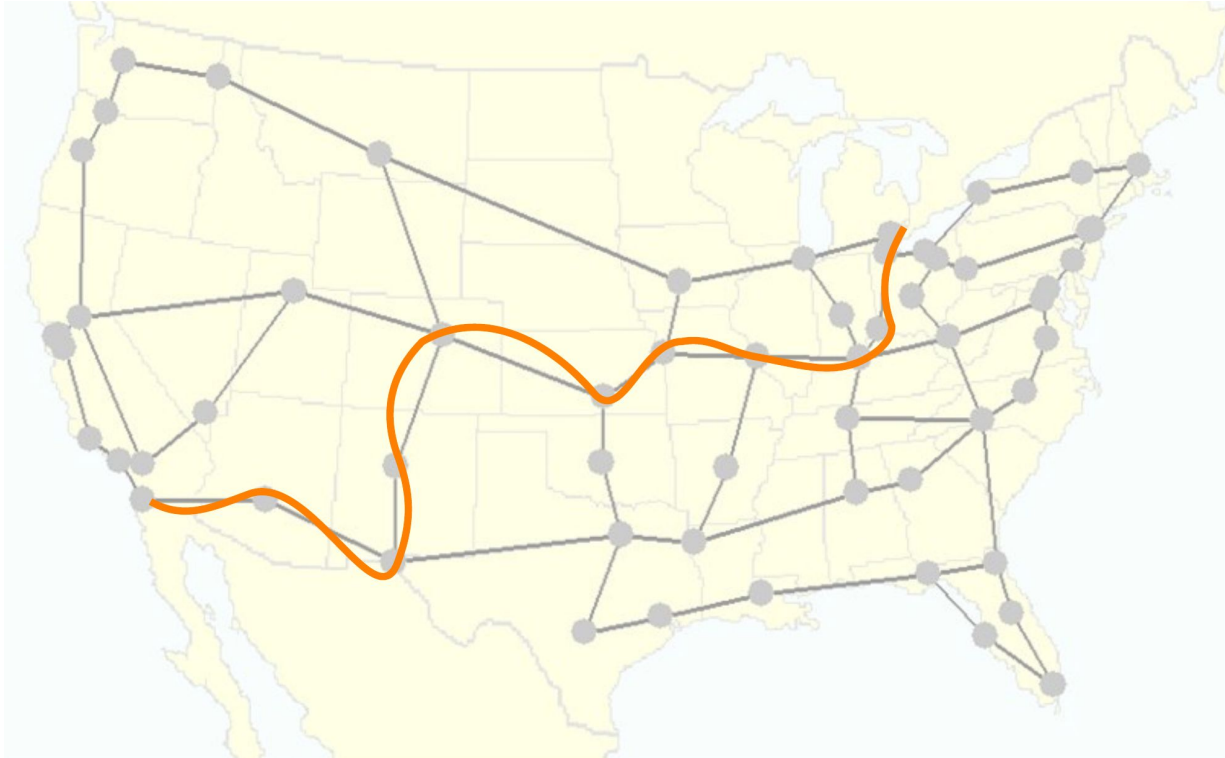
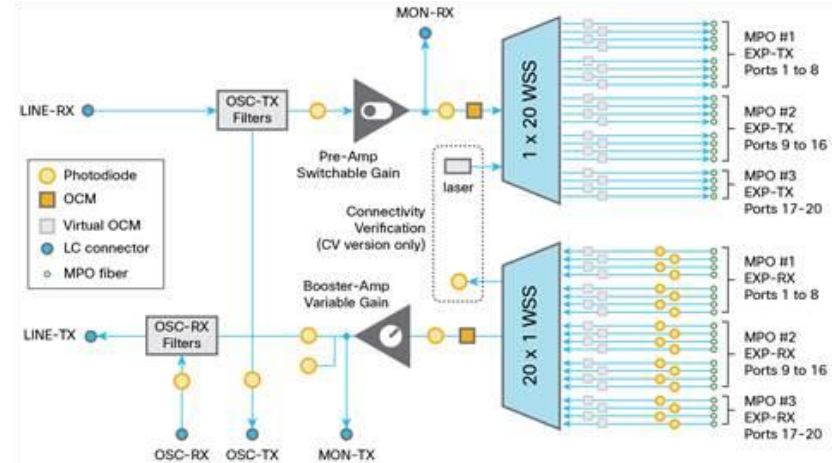


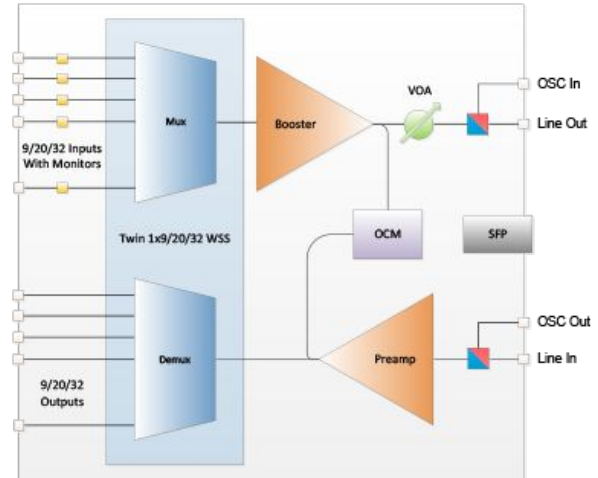
Image source: DARPA CORONET Program on Dynamic Multi-Terabit Core Optical Networks



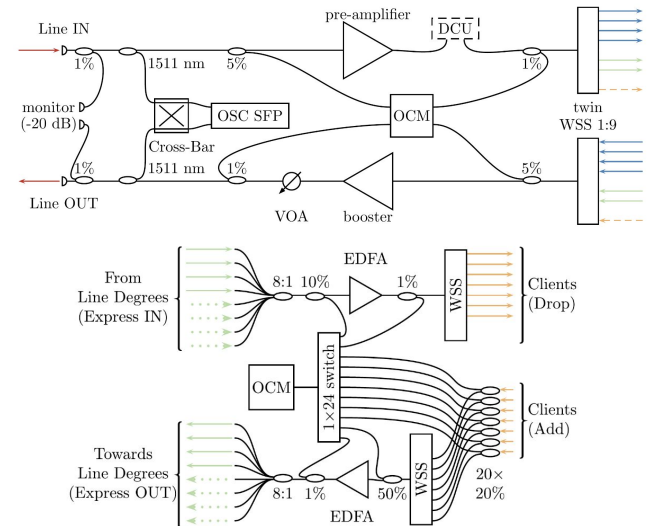
- Everything is remotely configurable
  - ...via "some API"
- Spectrum routing
  - From where, to where, how much light
- Monitoring
  - Optical power
  - Streaming telemetry



- Everything is remotely configurable
  - ...via "some API"
- Spectrum routing
  - From where, to where, how much light
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  - Optical power
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- Everything is remotely configurable
  - ...via "some API"
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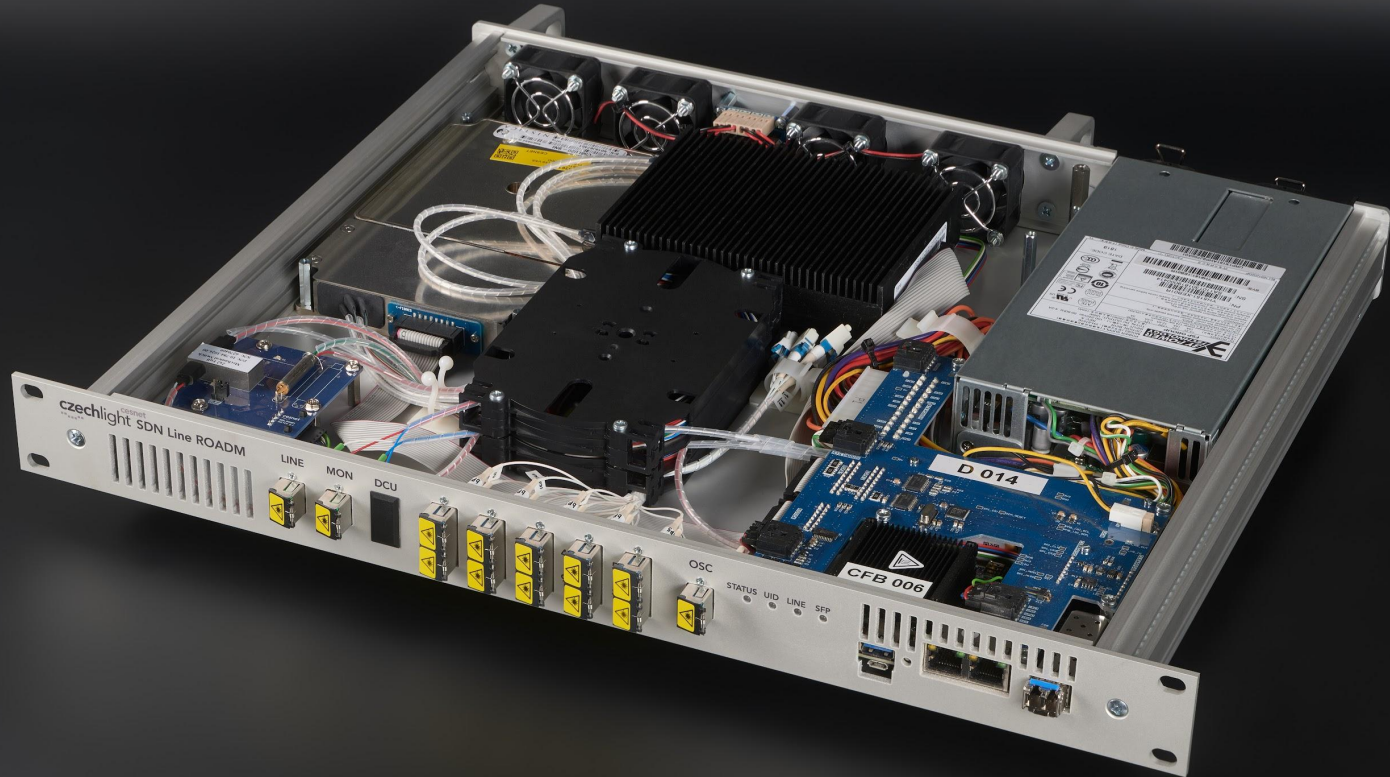


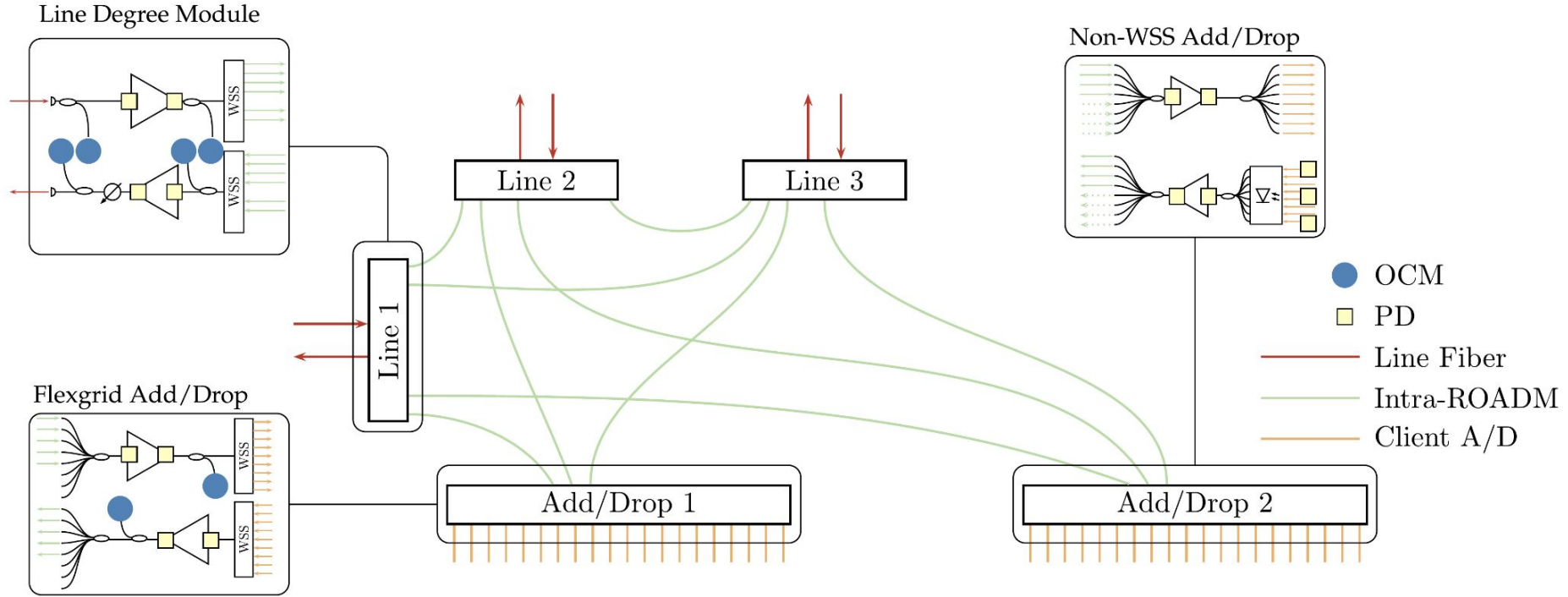
# Czech Light™ SDN ROADM

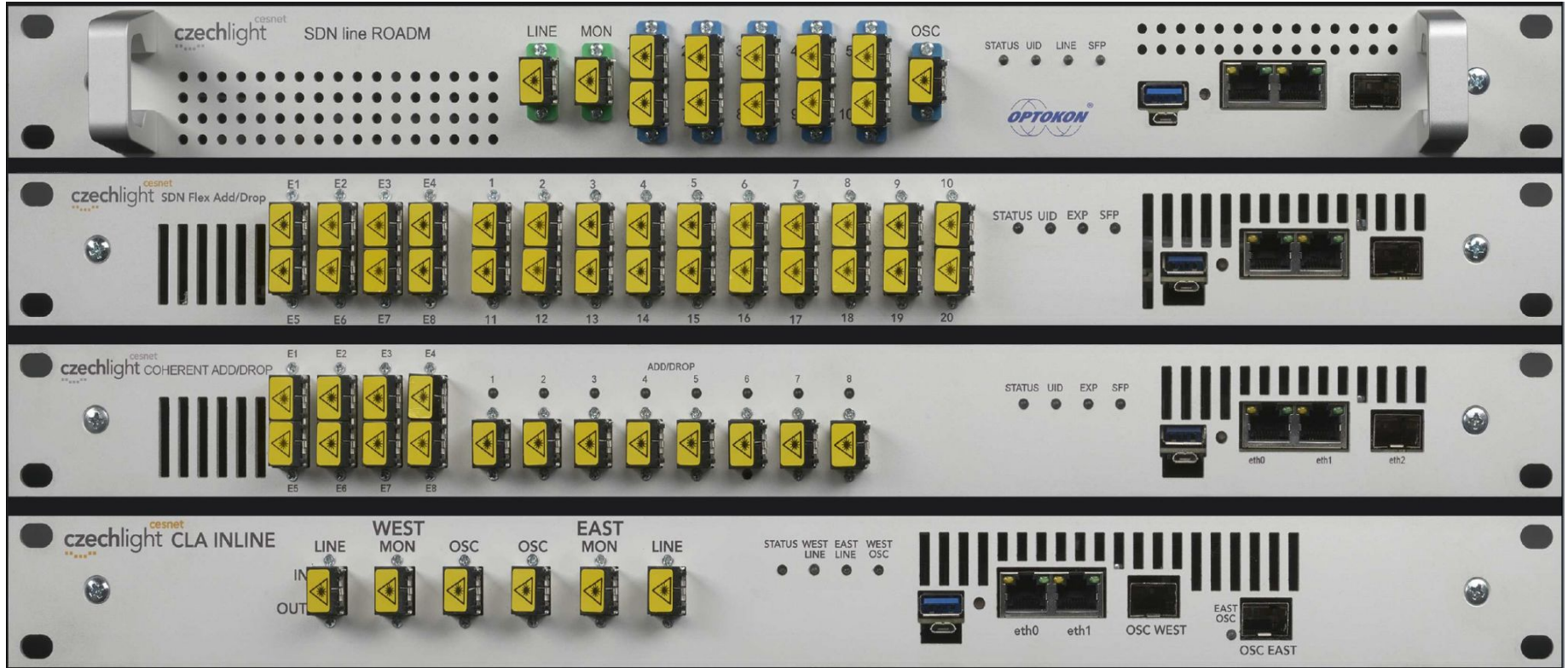
1U Pizza Boxes,  
up to 8-degree

Flexgrid,  
Colorless,  
Directionless,  
Contentionless

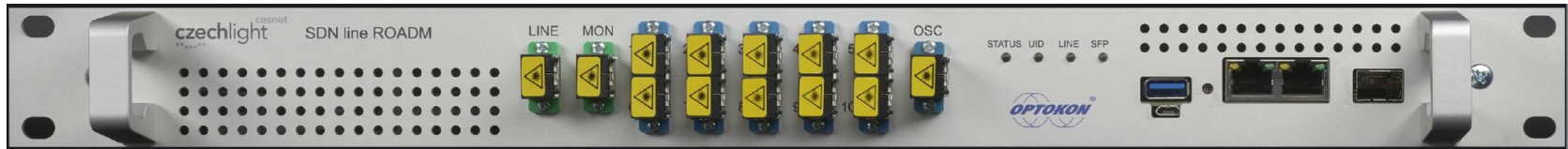
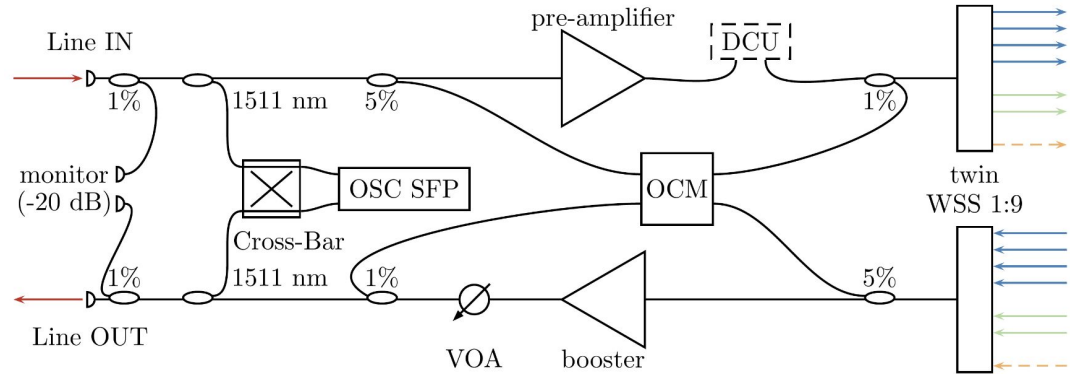
SDN Spectrum  
Control and  
Monitoring



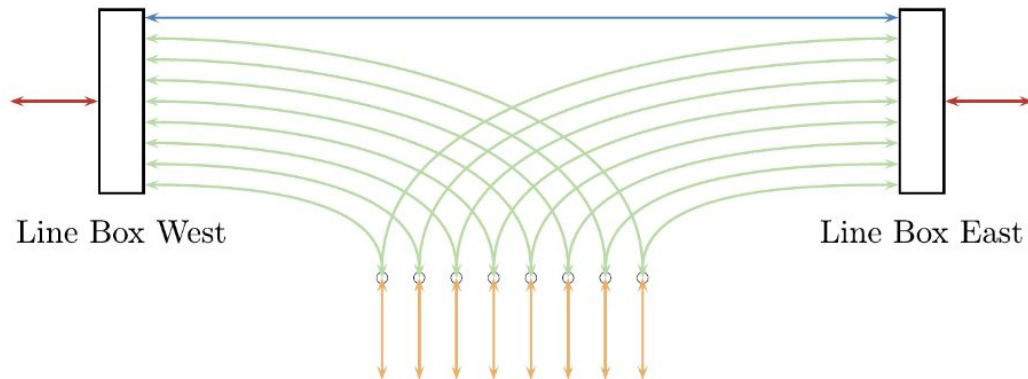




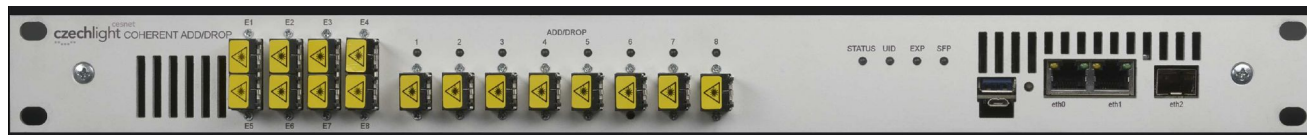
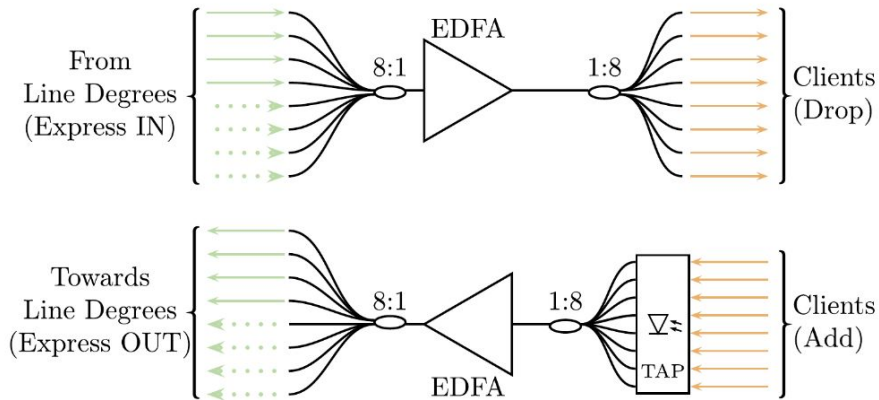
- 1-8 degrees
- Long-haul connection
  - Internal amplification, up to 25 dB spans
- Integrated OSC
  - OTDR option
- SDN spectrum control
  - Routing & monitoring



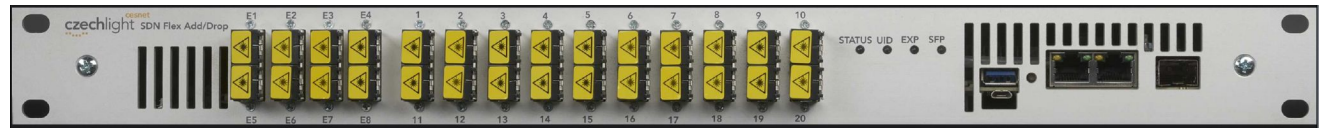
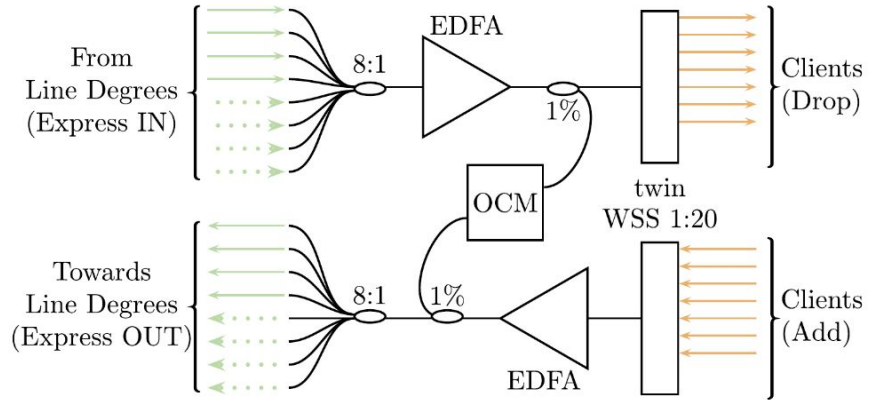
- **Passive**
  - 2-deg
- Coherent Signals
  - 8ch/1U
- WSS-based
  - 20ch/1U
- Hi-resolution
  - 20ch/1U



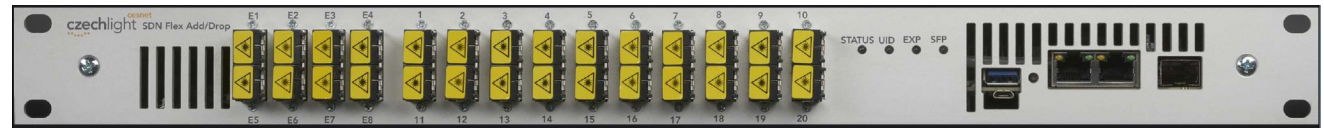
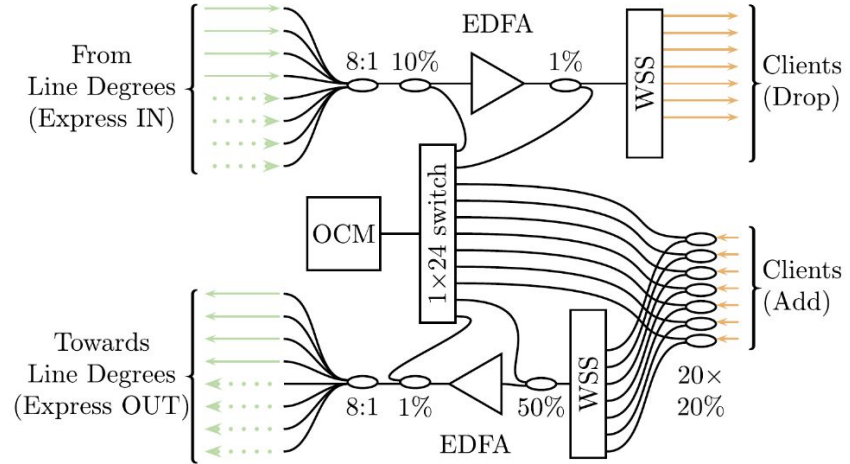
- Passive
  - 2-deg
- Coherent Signals
  - 8ch/1U
- WSS-based
  - 20ch/1U
- Hi-resolution
  - 20ch/1U



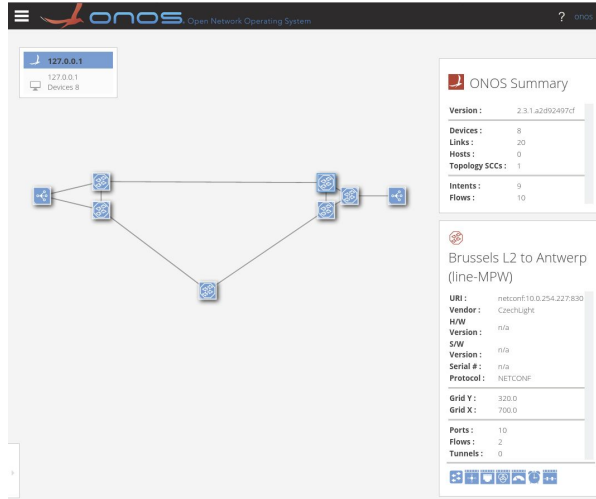
- Passive
  - 2-deg
- Coherent Signals
  - 8ch/1U
- **WSS-based**
  - 20ch/1U
- Hi-resolution
  - 20ch/1U



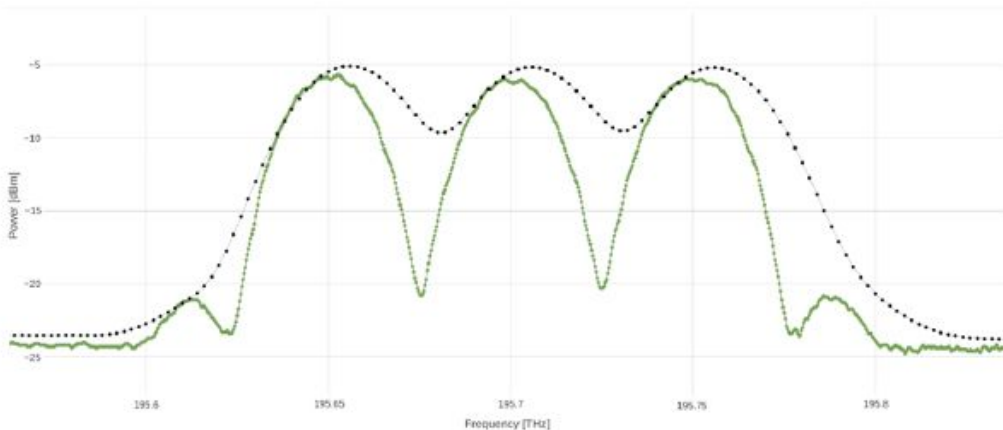
- Passive
  - 2-deg
- Coherent Signals
  - 8ch/1U
- WSS-based
  - 20ch/1U
- Hi-resolution
  - 20ch/1U



- Everything is remotely configurable
  - NETCONF
  - RESTCONF
  - YANG-push
  - Local console
- Optics (DWDM)
  - Spectrum routing and monitoring
- System management



- Streaming Telemetry
  - All the metrics
  - Sub-second latencies
- I/O Formats
  - IETF YANG-push
  - OpenMetrics (Prometheus)
  - Grafana



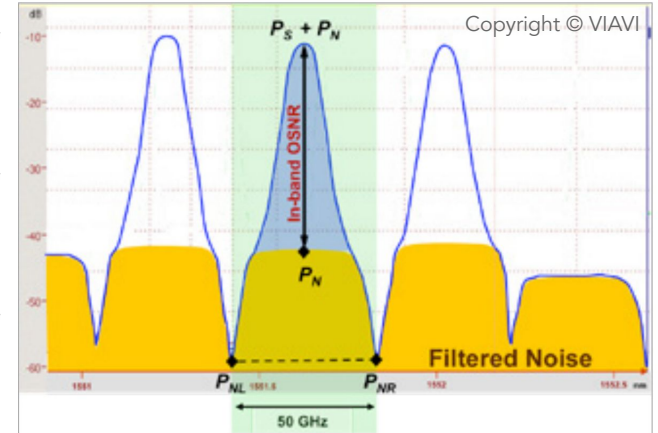
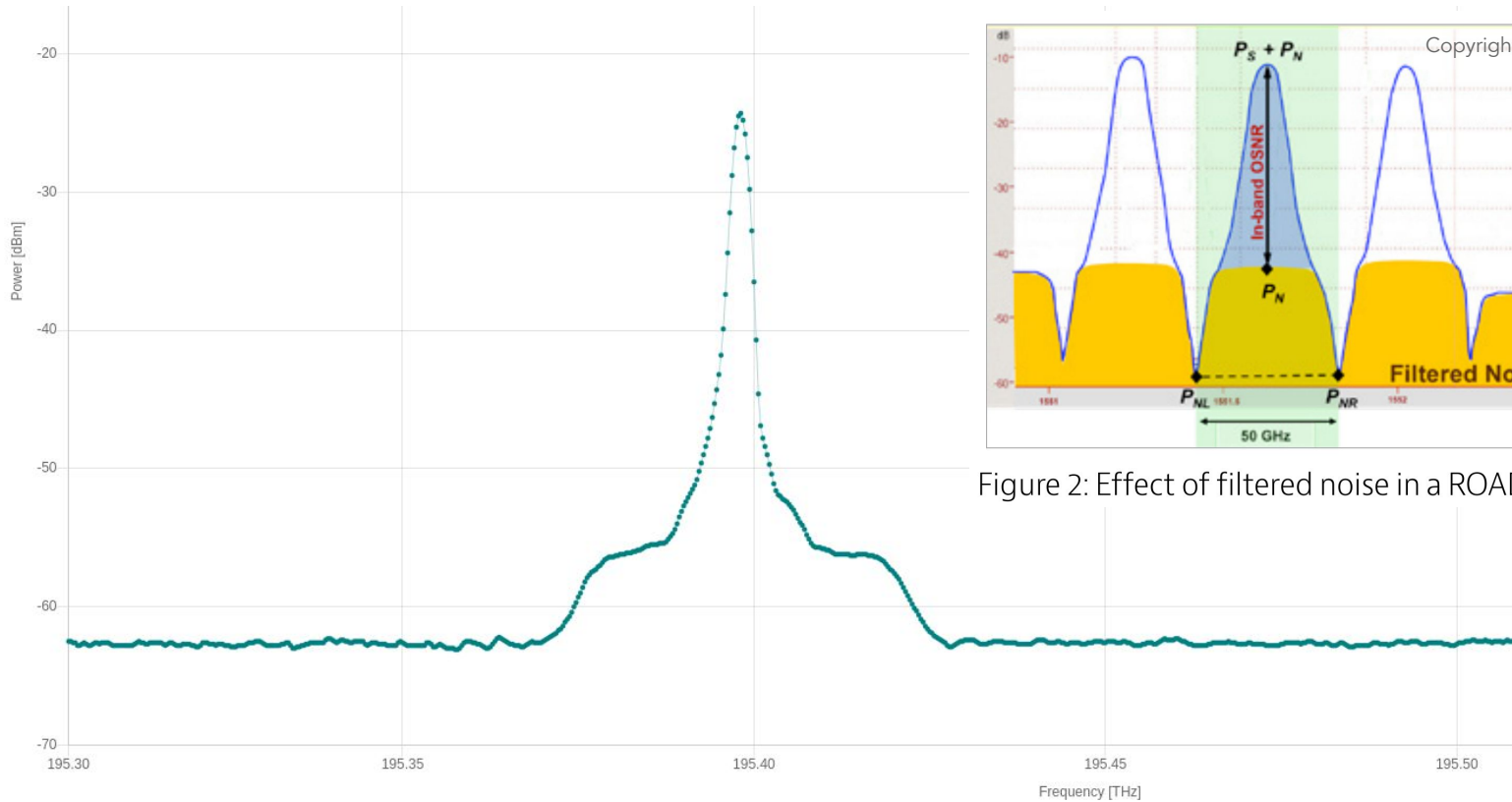
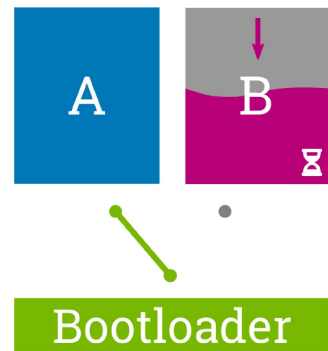
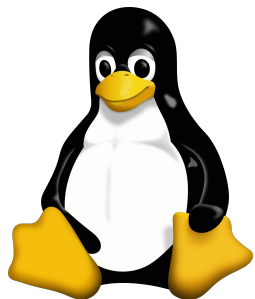
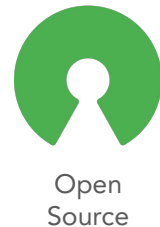


Figure 2: Effect of filtered noise in a ROADMs system

- Read-only Linux rootfs via **buildroot**
  - Stateless system
    - Except the YANG database (and some bits for early boot)
- Userland based on **systemd**
- A/B software slots via **rauc**
  - Integrated with HW watchdog
  - Atomic system updates



■ **sysrepo, libyang and Netopeer2**

- YANG software stack
- Configuration DB + ops data
- NETCONF server

■ **netconf-cli**

- Interactive console
- 100% generic
- Context-sensitive completion

■ **cla-sysrepo**

- Drivers for optical modules
- ROADM logic

■ **velia: system management**

- Health tracking
- System management
  - User accounts
  - SW updates
  - ...
- Firewall
- Hardware
- Network (L2/L3)



Open Source


■ **rousette**

- RESTCONF-ish server
- Telemetry

## ■ Current status

- Well-described hardware, with peer-reviewed design
- 100% control over source code
- SDN control with detailed telemetry
- Integrates well into 3rd-party controllers

## ■ Work in progress

- Standalone optical domain controller
  - Transponder management & monitoring
- 
- A decorative horizontal bar at the bottom of the slide, composed of a series of small blue squares of varying heights and positions, creating a pixelated or mosaic-like effect.



Thank you

[jan.kundrat@cesnet.cz](mailto:jan.kundrat@cesnet.cz)

