SUNET

SunetC -> SunetCD

Magnus Bergroth
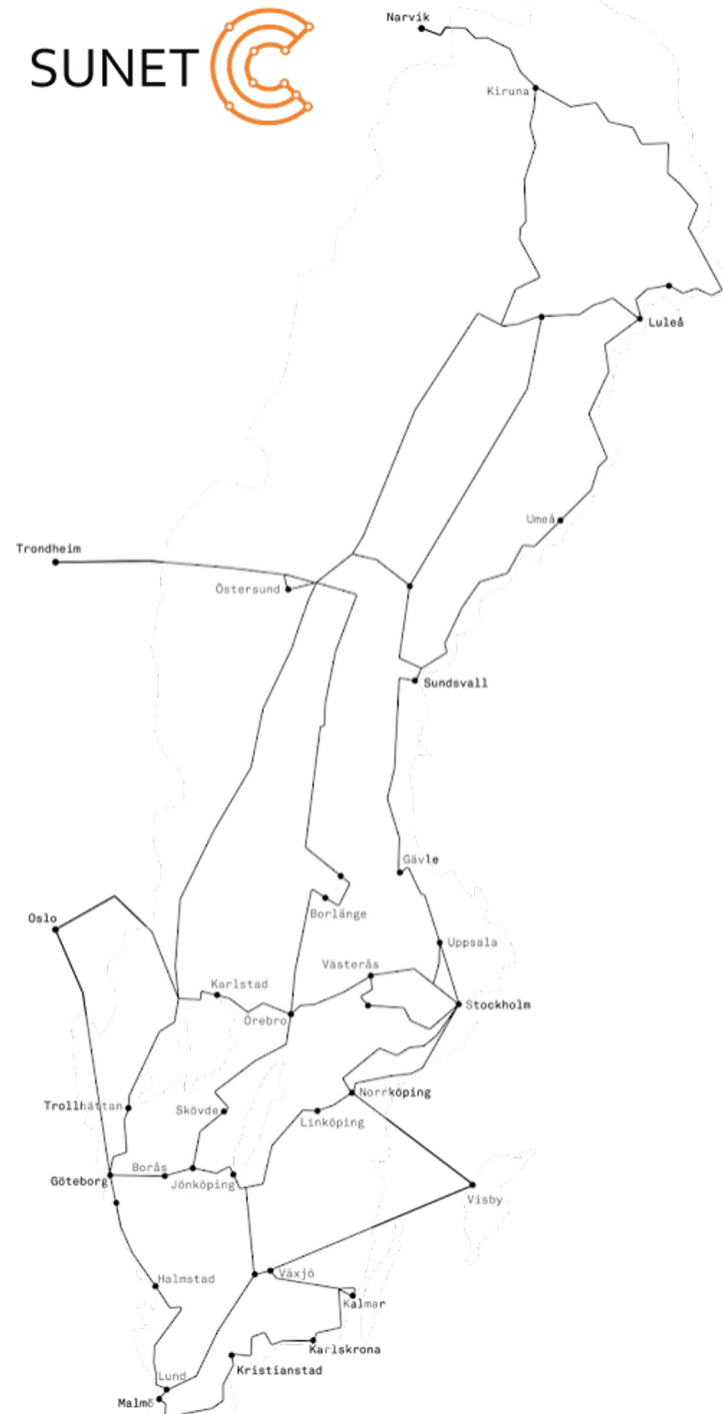**SUNET**

206,856,796 m/s

|					
1	I	11	XI	50	L
2	II	12	XII	100	C
3	III	13	XIII	500	D
4	IV	14	XIV	1000	M
5	V	15	XV		
6	VI	16	XVI		
7	VII	17	XVIII		
8	VIII	18	XVIII		
9	IX	19	XIX		
10	X	20	XX		

SUNET

SunetC

IP/MPLS network
flexgrid DWDM network
9200km optical fiber (leased, IRU)

- ~ 115 connected organisation
- ~ 750 000 end users
- ~ 55 Point of Present
- ~ 100 routers

- **Network services:**
  - Internet, ip forwarding
  - IP VPN
  - L2 VPN
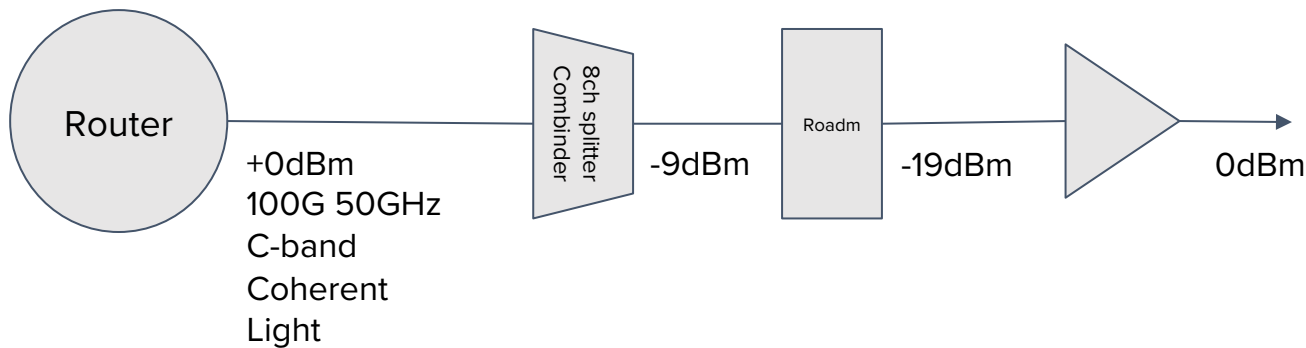 - P2P ethernet(transponder)
  - Alien waves

SunetC

100 Gbps IP over DWDM directly into Adva Roadm
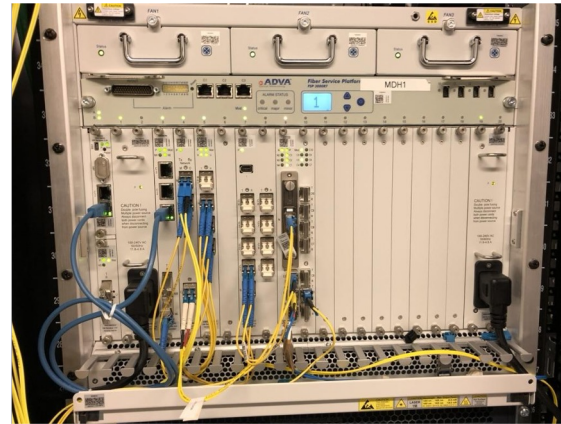
- 47 Universities, MX480
- 25 PoP, MX960
- 4 PoP, MX2010
- 1 PoP, MX2020
- 5 x MX10003
- 10 x MX204
- 15 x MX80

MX480   MX960   MX2010   MX2020

Router
+0dBm
100G 50GHz
C-band
Coherent
Light

8ch splitter Combinder   -9dBm   Roadm   -19dBm   0dBm

SUNET

SunetC design

- Telco facility
  - University independence

- One City router(PoP)
  - DWDM link to closest Cities

- Two University routers
  - Grey 100GLR4 to city Router
  - DWDM link to next City
    - Pop blows splice fiber and be up and running in 1-4 hours.
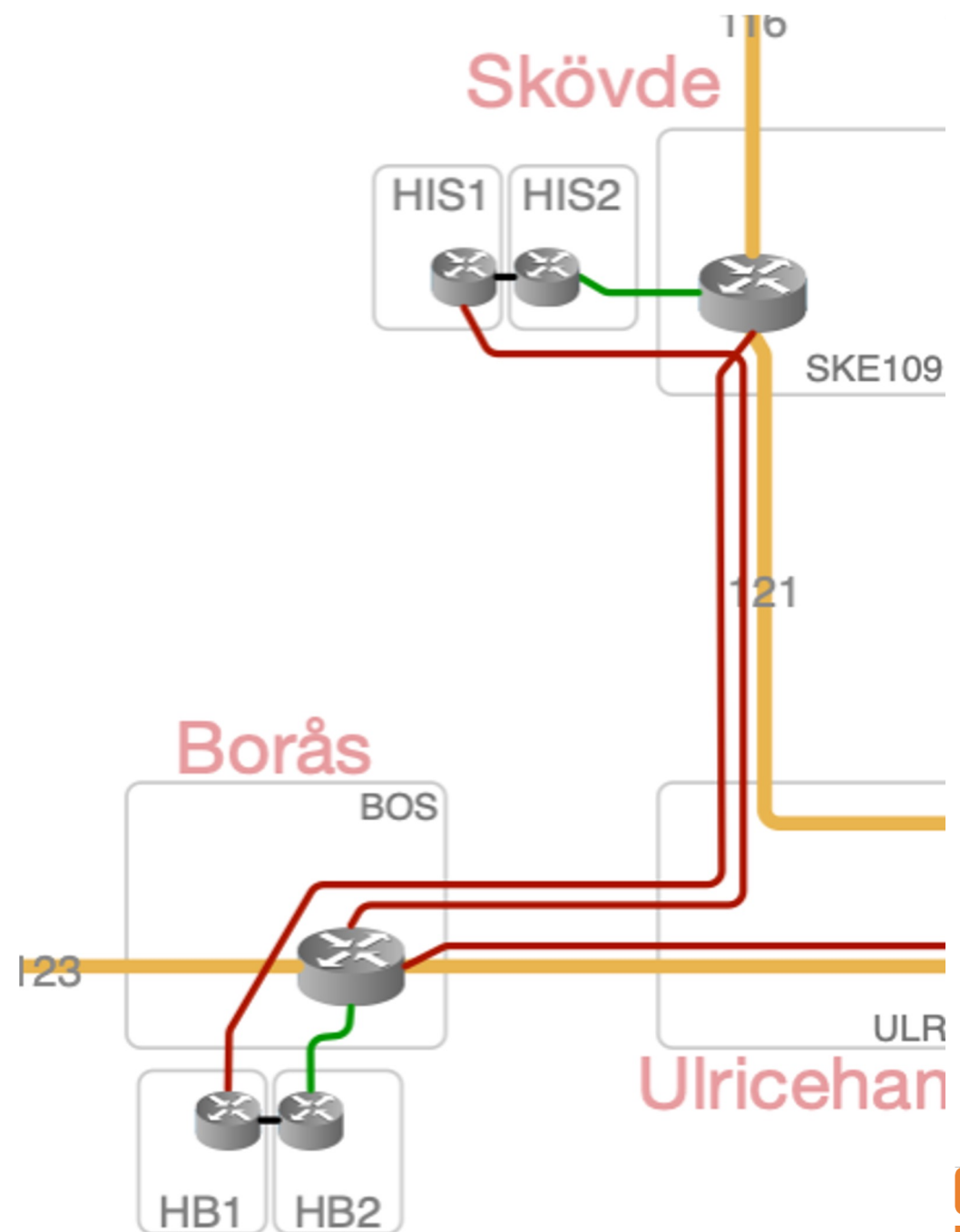
SunetC -> CD

Testing 400GZR+

- pre production samples
- multiple vendors
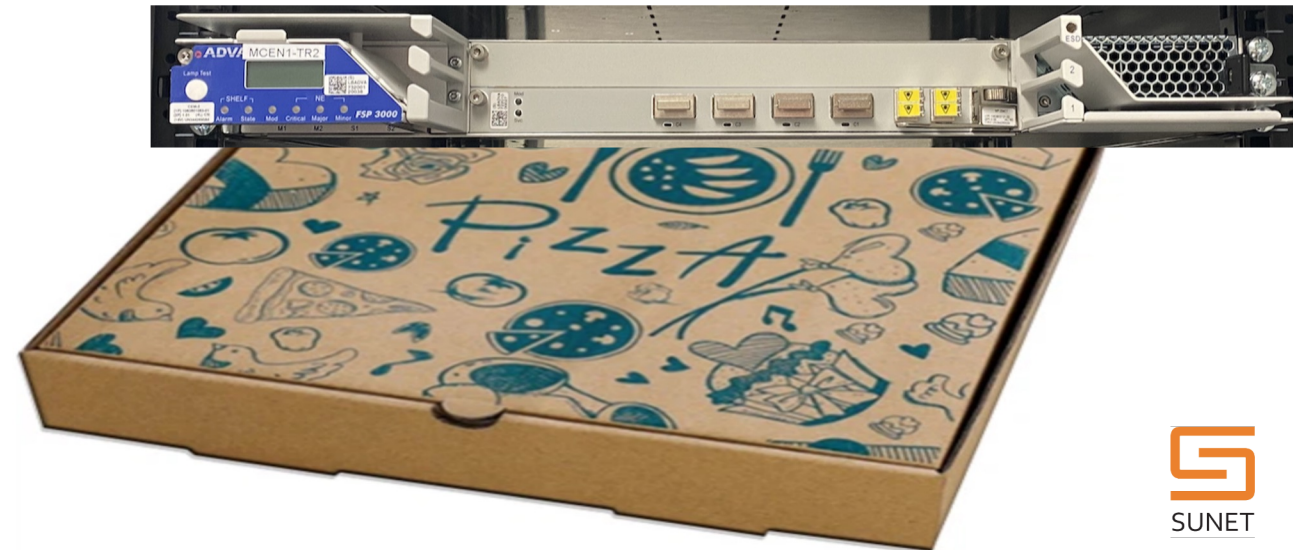- -10dBm and 0dBm

Conclusion

Optics 400G ZR+ and capable Router

It is cheaper than

DCI / Transponder and cheaper Router

Tender

- 400GZR+
  - 0dBm (-10dBm dwdm rebuild)

- Pizza box Router (fewer spare parts)
  - MacSec

SUNET

SunetCD

Resulted in

- 154 units of Juniper (branded) 400GZR+ 0dBm
- 92 units of Juniper PTX10001-36MR

SunetC -> CD

Routers

- PTX10001-36MR36 network ports

36 network ports
1U
(Juniper 2010 (34U) MX960 (16U) MX 480 (8U))

24 double density quad small-form factor pluggable (QSFP56-DD) 10-Gbps, 25-Gbps, 40-Gbps, 100-Gbps, and 400-Gbps.

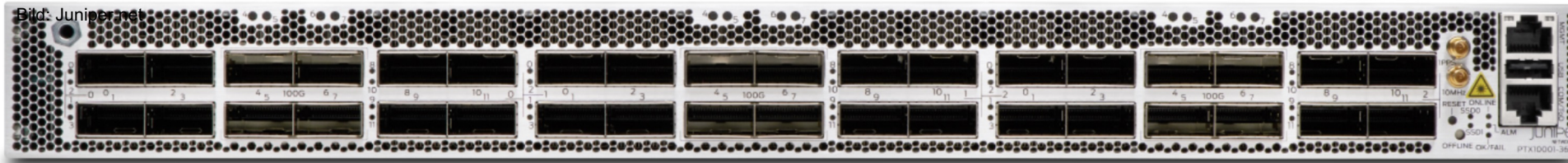12 quad small form-factor pluggable (QSFP28) ports that support data rates of 10-Gbps, 25-Gbps, 40-Gbps, and 100-Gbps.

Bild: Juniper.net

Bild: Juniper.net

SunetC -> CD

SunetCD Rollout

- No changes to the DWDM network.

- Add new routers without removing the old

  - Possible by having our own DWDM network

- Move customers before the new network is completed.

- Build on multiple places at the same time

SunetC -> CD

Protocols and functions

Logical system (LS) SunetC

- OptoSunet was built of Junipers feature Logical routers later Logical System

- Universities was given the opportunity to use the CPEs as internal routers in their own as.

- New platform does not have that support, Some universities needed to change their internal infrastructure to support BGP directly with Sunet.

  - Cisco Catalyst/Nexus BGP, Extreme BGP, Firewall BGP,Arista BGP (Campus Network As A Service)
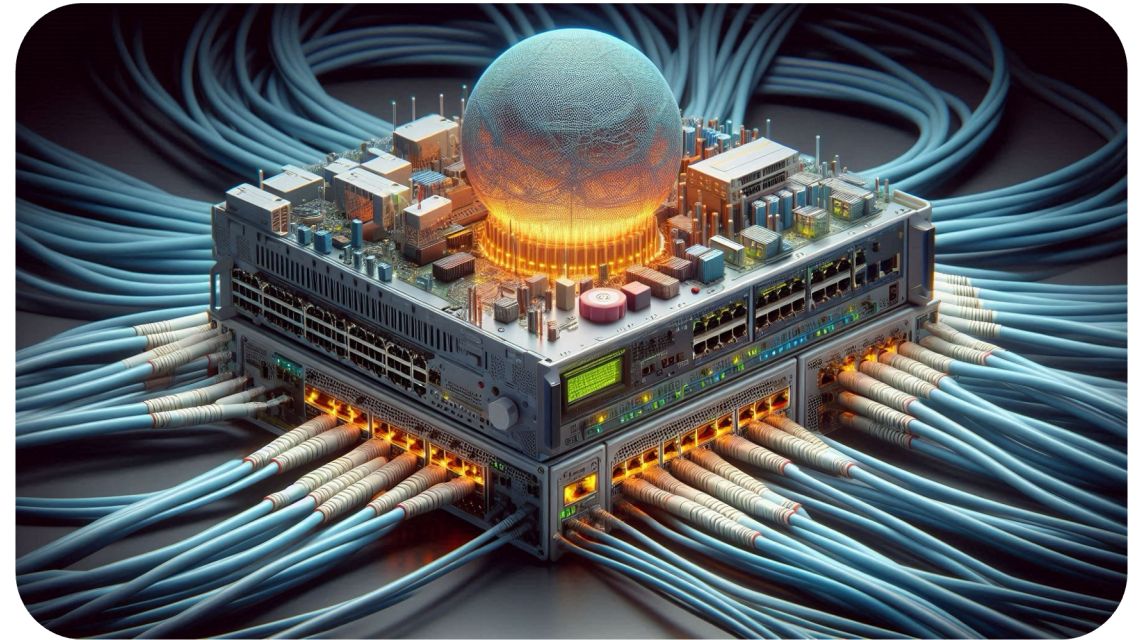
SunetC -> CD Nordunet

- **Narvik, Luleå**
  - Nordunet running AS2603 in Logical System.
  - Replaced with Juniper MX204
    - Luleå -> Kalix
- **Stockholm, Malmö**
  - TUG - 400G LR4
  - STHB - 400G LR4
  - Lund - Ballerup 400G ZR+
  - *Malmö - Örestad 400G ZR+*

SunetC -> CD

Protocols and functions

MACsec IEEE 802.1AE

Built in on the PTX forwarding chip

License of course

- MACsec between all Sunet devices.

  - Juniper did not have a wirespeed device for 10GE/100GE that supported MAC-SEC.

    - A few MX80/MX204 waiting for replacement.

SunetC -> CD

Protocols and functions

- **LDP (label distribution protocol) replaced with Segement Routing L-ISIS**

  - During migration LDP is running in both networks

- **BGP replace OSPF**

  - OSPF used in logical system for connected organisations.

- **Reduced support for multicast only SSM where asked for it.**

  - RP and MSDP are removed

SUNET

SunetC -> CD

Protocols and functions

Tidy up the link ip-space

- Better ACL of traffic going from "Internet" to our infrastructure(routers and servers) running SunetCD.

  - Customer facing ip-space also gets standard ACL.

 - Troubleshooting traffic like ping, tranceroute are allowed but ratelimited.

SunetC -> CD

Protocol and features

1Gbps Ethernet

- New 400G platform does not support 1GE.

- Solution: Upgrade free of charge to 10GE.

- Where not possible install simple switch with SFP+/SFP ports.

- Platform does not support per VLAN shaper.

    - Shape 10GE port to 1GE speed.

   - physical ports 400GE port -> 4x10GE -> 1GE.
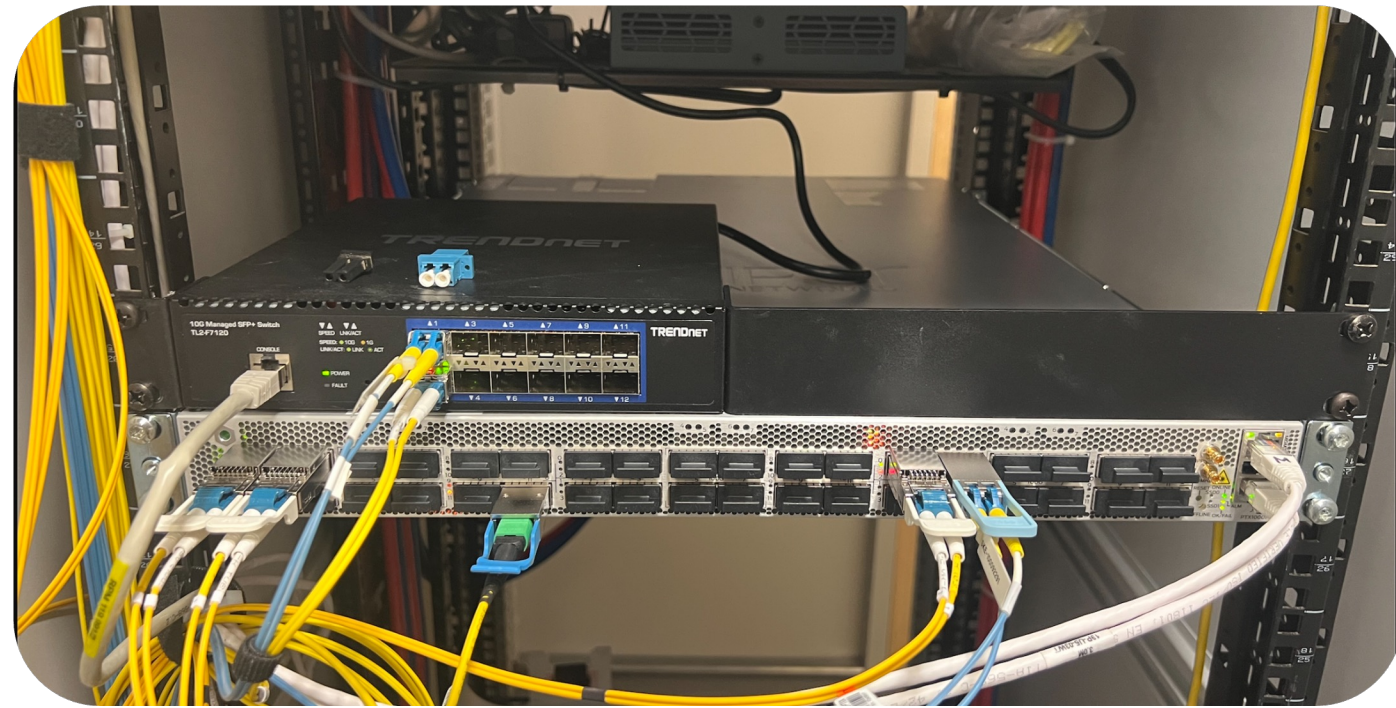
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SunetC -> CD

Router	gbg7-r12
City	Goteborg
Type	PTX10001-36MR
ipv4	86.104.200.6
ipv4_nh	86.104.201.6
ipv6	2001:6b0:2000::6
ipv6_nh	2001:6b0:2001::6

Basis for ordering and configuration

- **SunetCD - JSON plus Python and bash**

    SunetC isis databas + Changes defined in python code

    -> JSON data (visualisering)

    Iteration until it felt okay.

- **Generate optic BOM:**

    4x10GE LR, 100GE LR4, 400GE LR4, 400G ZR+

    almost All optics from router vendor.

- **Create DWDM Alien-waves**

    Python script talks SNMP(write) with DWDM nods

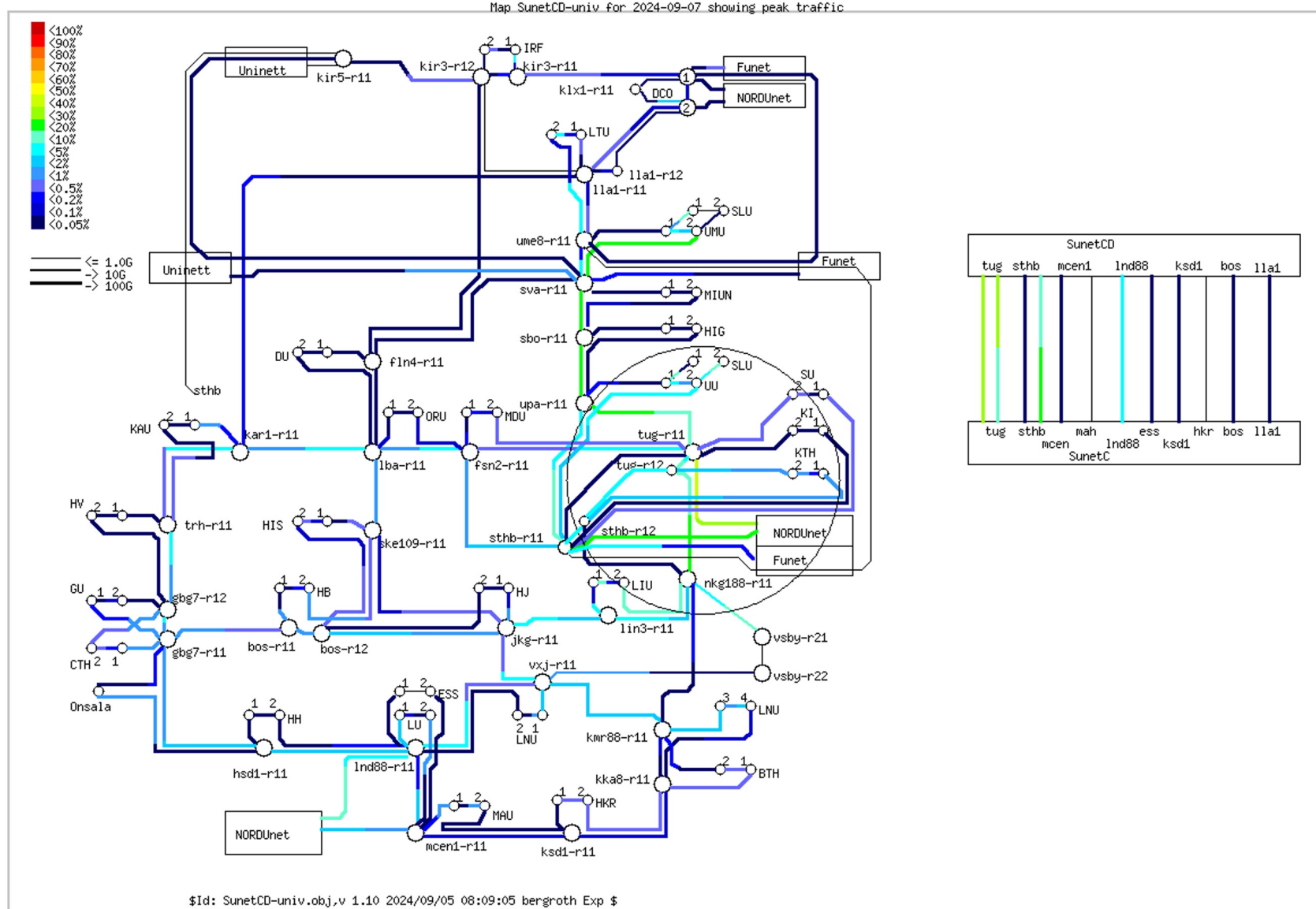- **Input/variables for router templates (SNC Network Controller)**
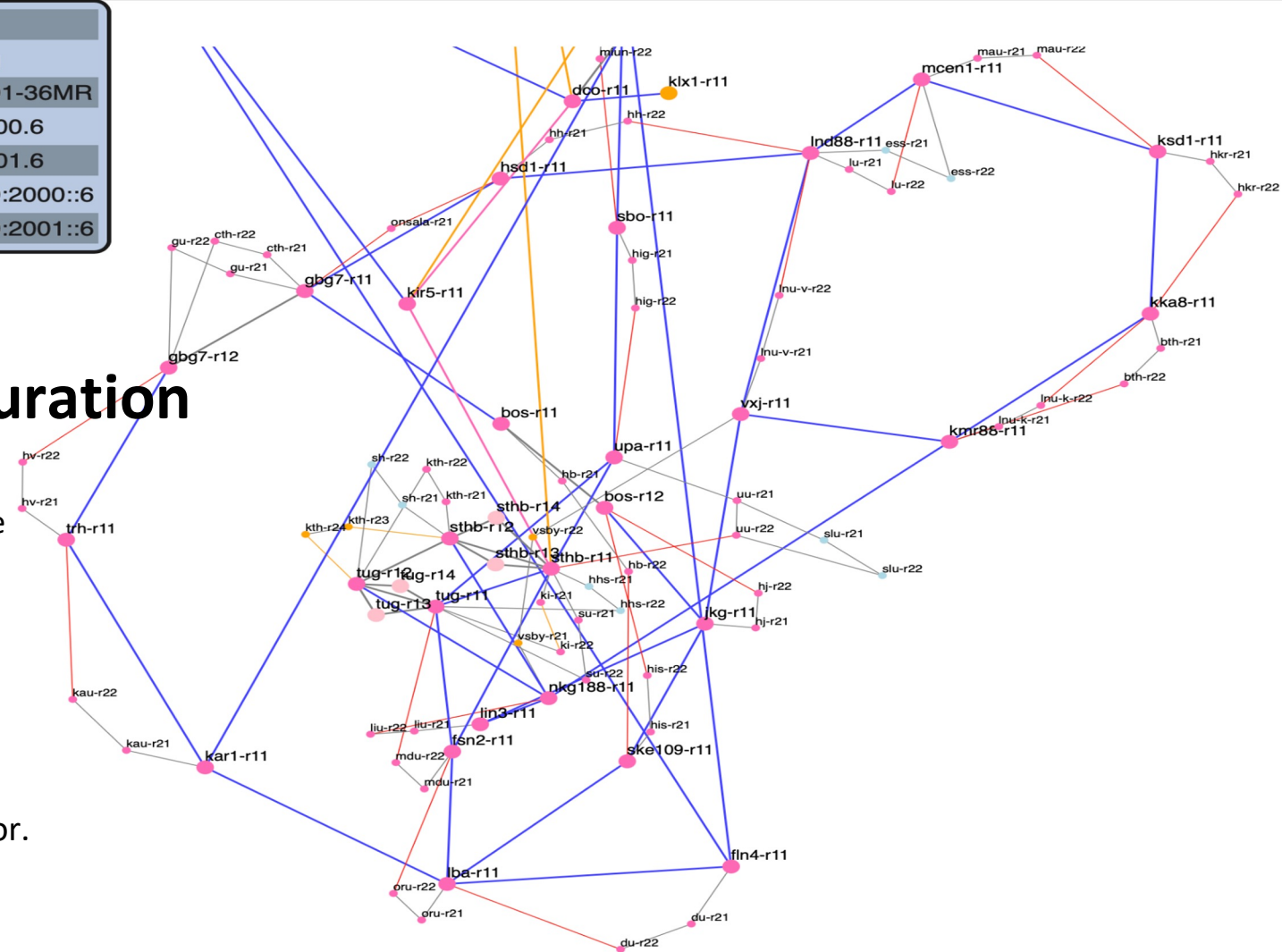
SUNET

SunetC -> CD

Order

Order 2023-01 delivery 2023-12

- 92 PTX10001-36MR
- 142 400G-ZR+HP
- 120 400G-LR4
- 60 100G-LR4
- 85 QSFP+ 4x10GE

Additional order 2024

- 2 PTX10001-36MR
- 46 100G-LR4
- 11 400G-LR4
- 12 QSFP+ 4x10GE
- 12 400G-ZR+HP

Map SunetCD-univ for 2024-09-07 showing peak traffic

$Id: SunetCD-univ.obj,v 1.10 2024/09/05 08:09:05 bergroth Exp $

SunetC -> CD

Junos verification and configuration base

- POC test at Juniper Amsterdam

- Five PTX in our own lab in Stockholm and one IXIA network tester.

- Building Configuration templates for the routers to be used with SNC.

  - Doing the documentation at the same time.

SunetC -> CD

SNC Network Controller (SNC)
Netconf - Yang

- **Used for provisioning of router (global configuration and protokoll BGP/ISIS)**
    - Templates for global configuration (system, policys, interfaces etc)
    - Database for variables (node-names, adresser, metrics m m)
    - On deploy-script for config, initially via OOB (4G mgmt:0)
    - When ip-connectivity is established it's changed to inband management (IP loopback). Manuelt verification of protocol ((L-)ISIS/BGP/PIM/LDP)

Juniper is not RFC compliant without a configuration knob

SUNET

SunetC -> CD

Deploy exempel

```
usage: deploy_cd.py [-h] [-f FILENAME] [-l] [-a] [-d] [-v] [-n] [-i]
                    [-c {all,firewall,interface,templates}]
                    [router]

Read routers from json and them to SNC network controller

positional arguments:
  router                router name

options:
  -h, --help            show this help message and exit
  -f FILENAME, --filename FILENAME
                        json file with router data, defaults to
                        SunetCD_routers.json
  -l, --list            list available routers
  -a, --add             add device to SNC
  -d, --deploy          deploy templates
  -v, --verbosity       increase output verbosity
  -n, --nothing         do nothing just print
  -i, --interface       only apply interfaces
  -c {all,firewall,interface,templates}, --clear {all,firewall,interface,templates}
                        delete existing config to be applied with templates
```

```
dennis@snc:~$ deploy_cd.py -d uu-r21
###########################################

 Using file /usr/local/bin/SunetCD_routers.json


###########################################

output: <!-- uu-r21: -->
<devices xmlns="http://clicon.org/controller">
    <device>
        <name>uu-r21</name>
        <addr>uu-r21.sunet.se</addr>
    </device>
</devices>


pull config / sync device
OK
output:

-- Applying all generic templates for uu-r21 --

applying deploy-security                        31/31  [###################################]  100%

-- Done applying generic templates for uu-r21 --


-- Applying device specific templates for uu-r21 --
```

SUNET

Deployment Plan

- 26 Universities
  - 3 - Stockholm
  - 23 Places to visit outside Stockholm
    - Start week 3,
    - End week 13 (last of March)
    - **14 week -> two peer week**

- 34 Core routers
  - 4 - Stockholm
  - 2 - DCO
  - 1 - FSN2
    - 22 Core sites (Dual on pop in Luleå, Göteborg, Borås, Kiruna)
      - **Complete day before going to Univ**

- Last to migrate (reuse of C routers, in CD as new role)
  - Museums, ~80 in Stockholm
  - Services In Stockholm

SUNET

SunetC -> CD

1 620kg

Delivery - Tulegatan Stockholm

Dec 2023

Special Transport direct from Amsterdam
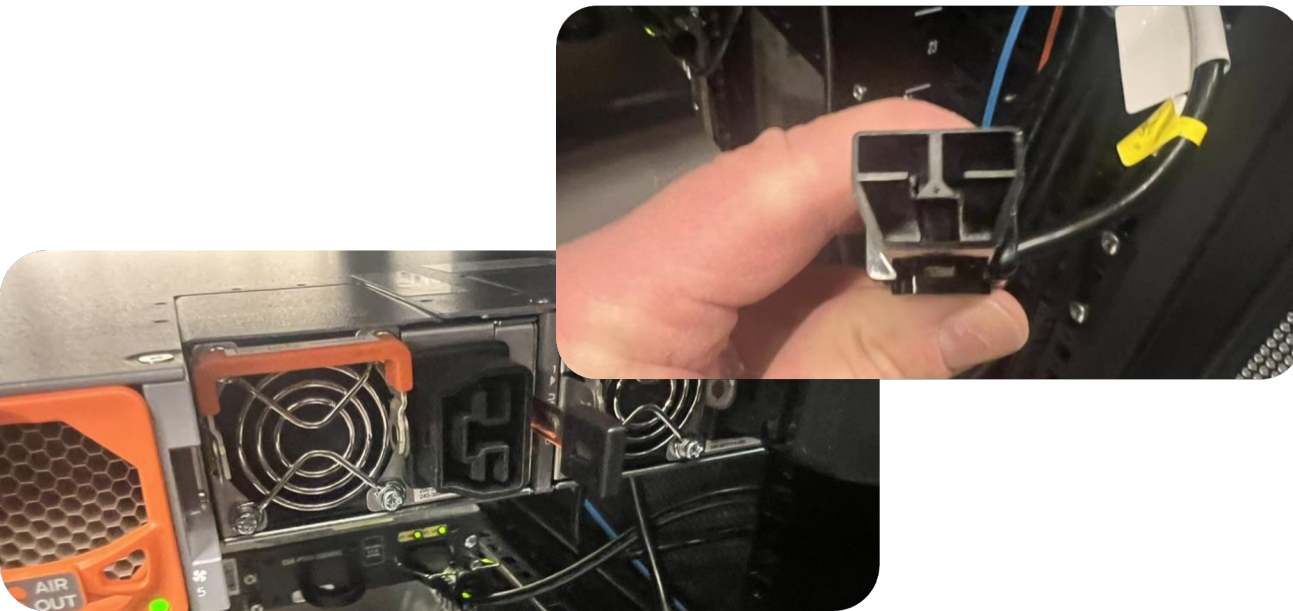

SUNET

Stockholm Office sweatshop

Mr Anderson

- PTX uses AC/HVDC power supplies.

- High Voltage DC need a special power plug
  (Made by AndersonPower and is called "Saf-D-Grid")
  Spec: 600V 30A AC/DC

- Our order was with schuko and 5m cable.
  - Most universities wanted C13 or C19 and 1-2meter cable

    - All staff at the office helped.

Perpering 25mm2 DC Cabels for the PoPs

- 120meter BITFLEX RÖD/BLÅ 2X25.
  (Not all hands and feets has crimptols for american cable shoes)
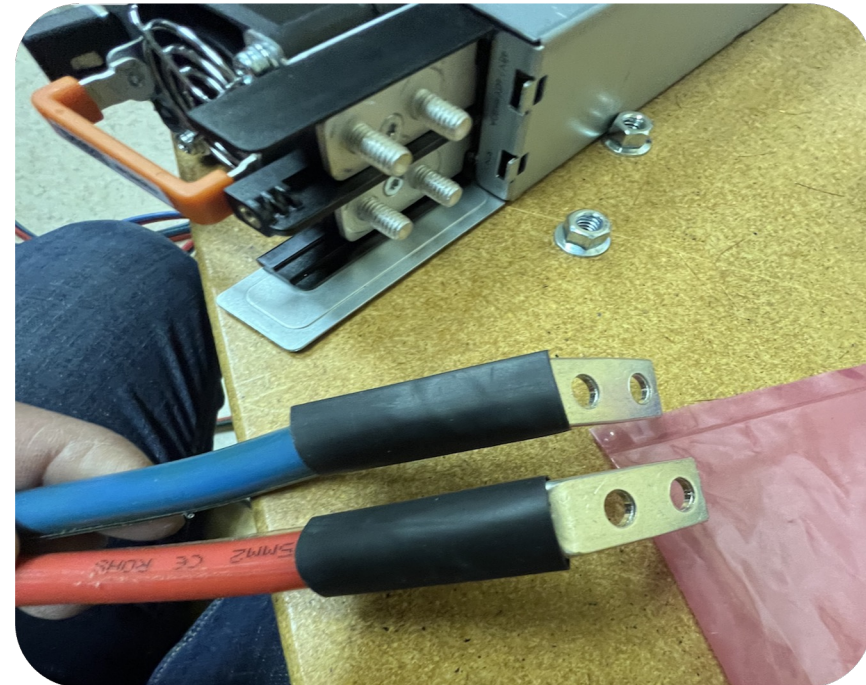
Shipping labels

- Universities - Directly
- PoPs - Hands and feet contractor.

Only four was sent to the wrong place

SunetC -> CD

Physical installation at PoP and Universities
First time the box is opened

- **Universities**
  - Two routers
  - Two OOB 4G router Teltonika RUTX09

- **Hands and Feets at PoPs**
  - Installation
  - OOB connection
  - DC Power
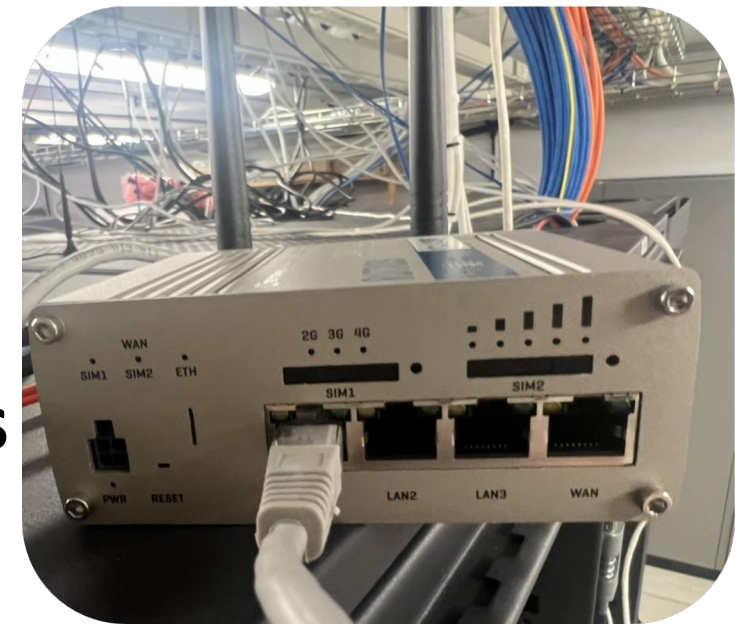
Installation

Eltel Did installation at PoP

Two power feeds borrowed from the MX960. (you need to take the correct or half the router dies)
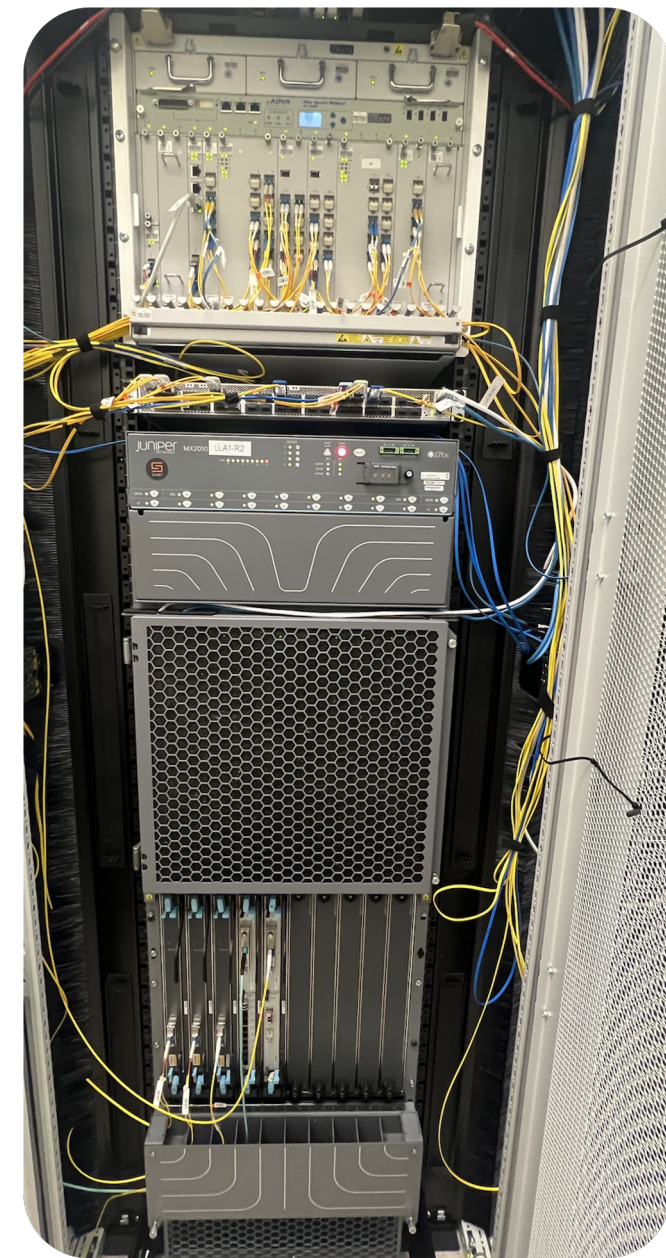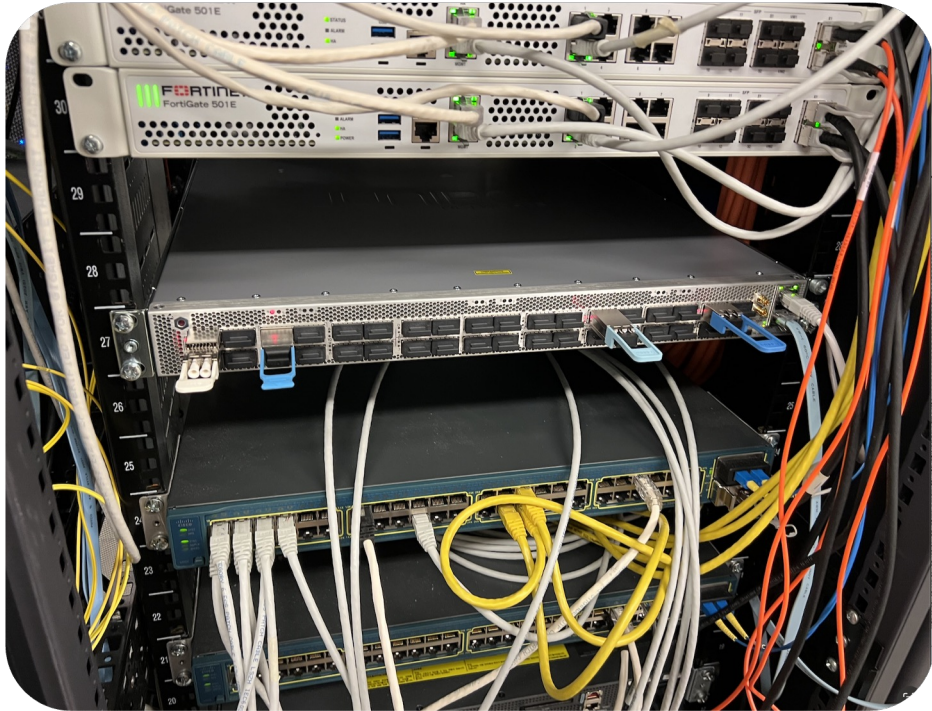
OOB opengear (from RE1)

GUNILLA WOLDE

Totte
Installs
Router

SunetC -> CD

Examples
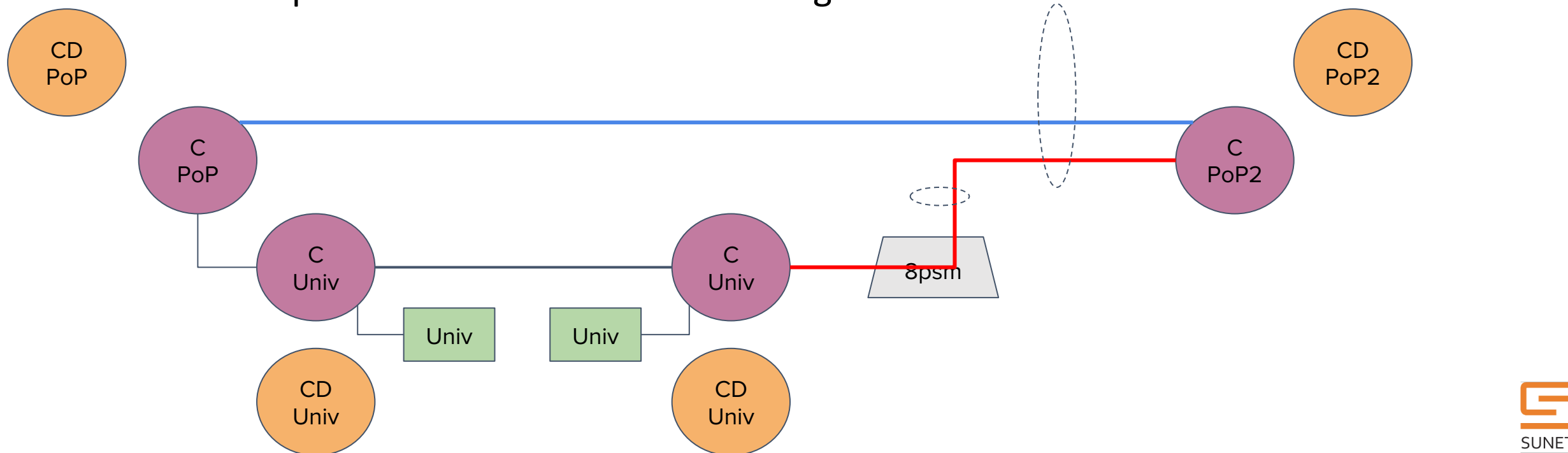
January

First CD Production: MDH/MDU

Next: KTH, SU, KI

SunetC -> CD

Migration (6 Sunet staff out in the field)

- Redundant connections, move to CD can be done during office hours

- SNC Preps the router and the BGP configuration.

Start here

SunetC -> CD
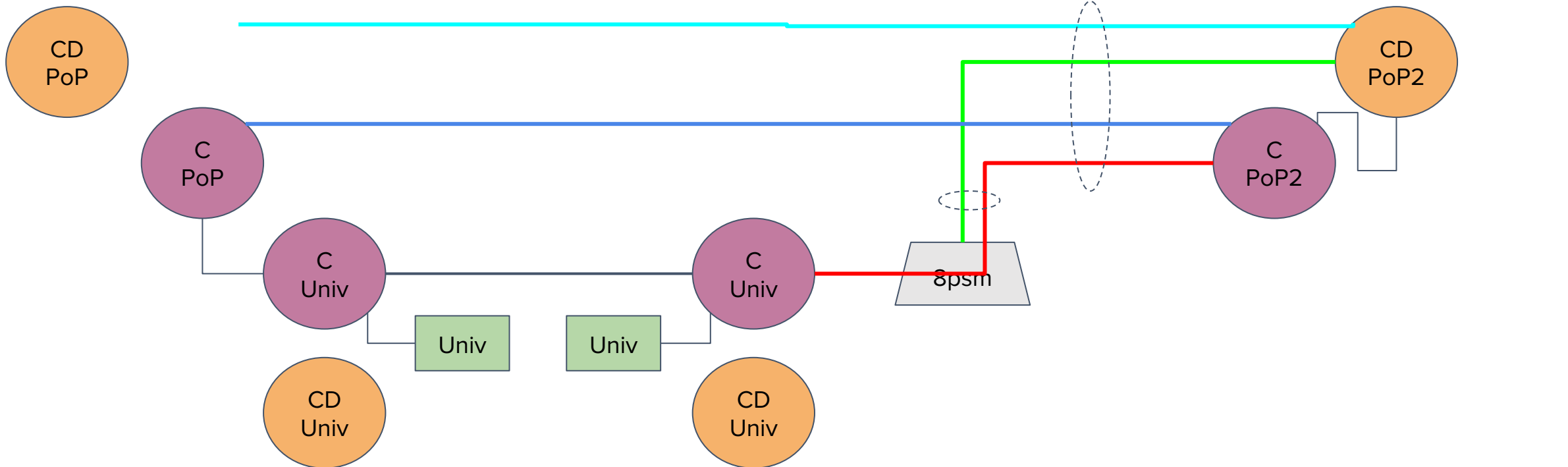
Migration

Install optics

Clean fibers

Tell SNC to push config

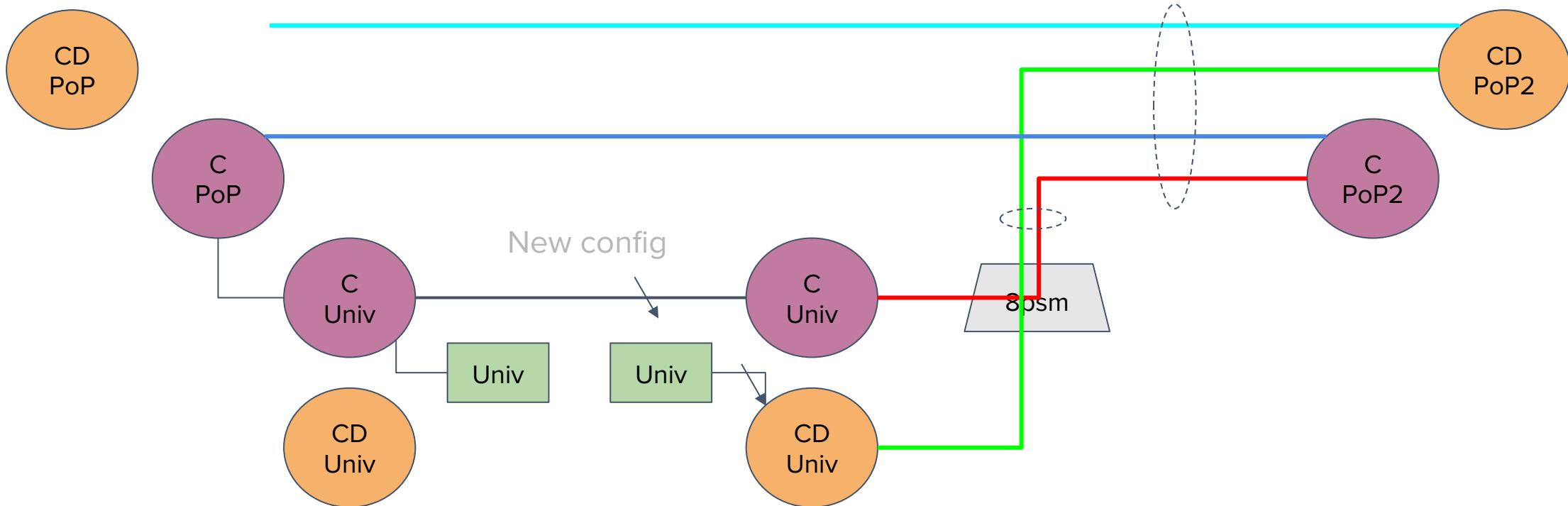Turn up wavelengths

Tell SNC to create full mesh iBGP sessions.

Install optics

SunetC -> CD

Migration

- Bring Fika
- Migrate one university device
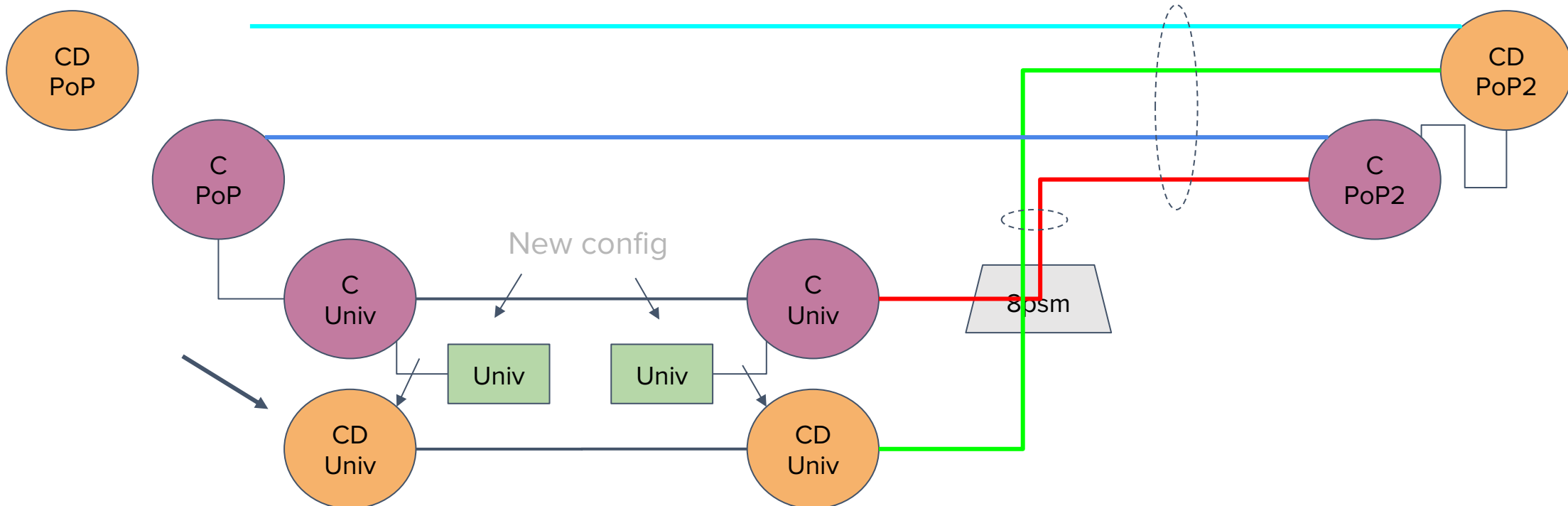- Help with University BGP configuration
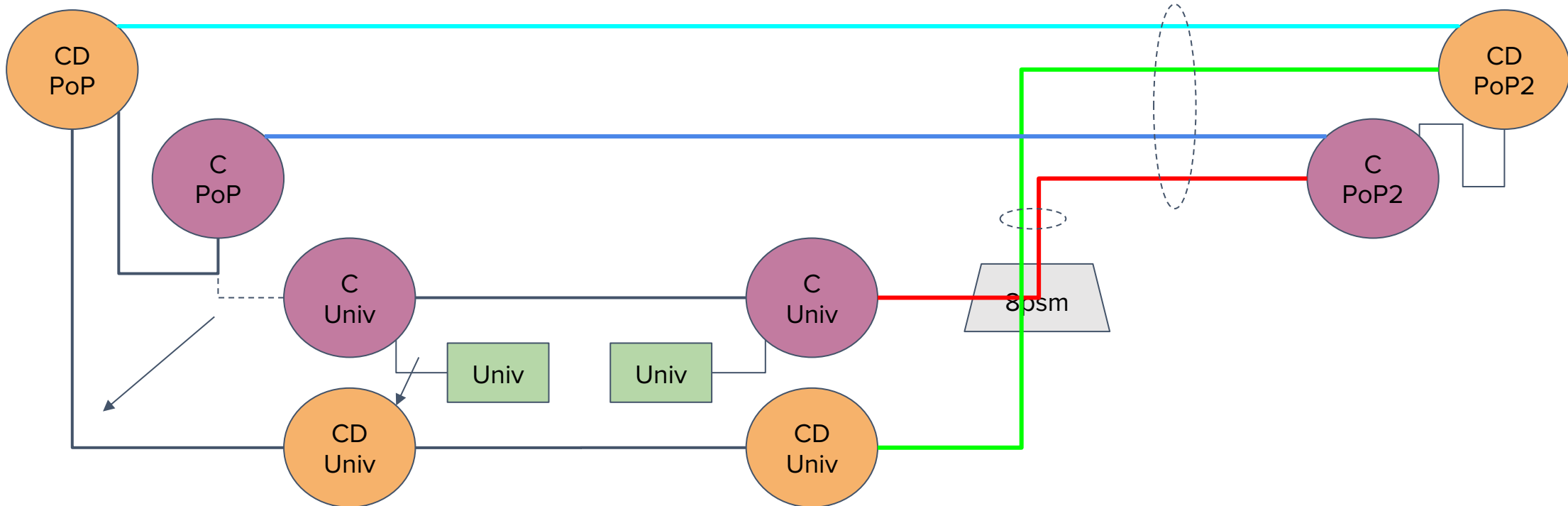
SunetC -> CD

Migration

• Second device after lunch

SunetC -> CD

Migration

- On Telco Site, Install optics and get waves up.
- Move gray access fiber to CD
- Interconnect old and new network

SunetC -> CD

Unforeseen problem

Access fiber becomes longer, MDU

- Fiber was 6km when SunetC started, It is now 20km :)

- Apparently can you run 100GE LR4 10km on 20km fiber.

- 400GE LR4 10km can NOT, MDU

So we switch and are running 400GZR+, Three Universities needed this fix

SUNET

SunetC -> CD 400G LR4

So... how long can you run 400GE LR4 10km?

25km fiber spool -> OK

Tests max attenuation:
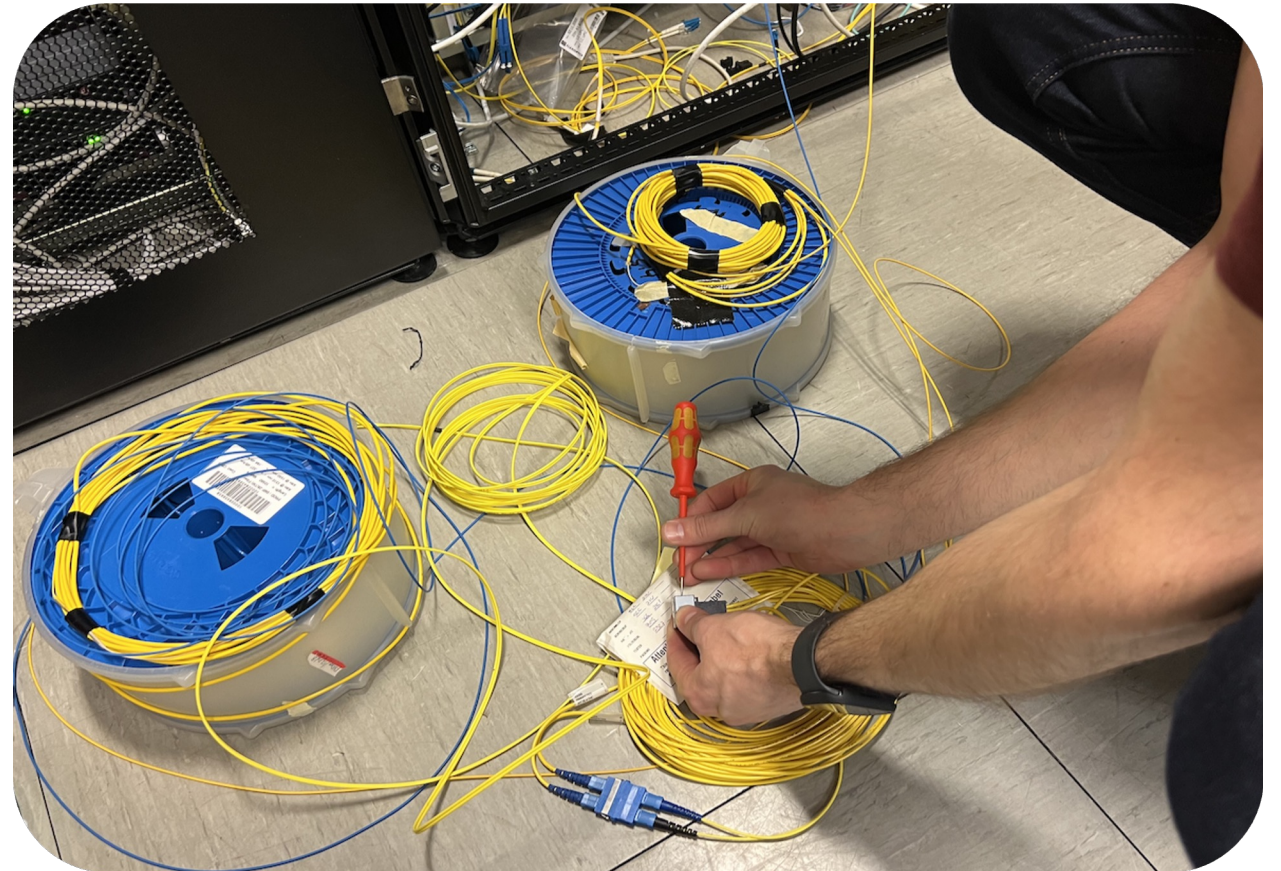15km spool + tunable pads

Increased attenuation

Link Up -> Down
tx: +2.3dBm
rx: -8.5dBm (10,8dB)

Minskade dämping

Link Down -> Up
tx: +2.3dBm
rx: -8.0dBm (10,3dB)

10,3dB Measurement
6.3dB Datasheet

SunetC -> CD

More Issues

100GE-LR4 <-> 400G-LR4

- If one by mistake install a 100GE LR4 where it should be a 400GE LR4
- You can't figure out why you don't get link up, as you have some light.
- You clean the connectors until your are crazy mad.
- The wavelengths are different. 400G see lights on only two lanes

QSFP-100G-LR4-T2

Wavelengths (range)
1294.53 nm through 1296.59 nm
1299.02 nm through 1301.09 nm
1303.54 nm through 1305.63 nm
1308.09 nm through 1310.19 nm

QDD-400G-LR4-10

Wavelengths (range)
1264.5 nm to 1277.5 nm
1284.5 nm to 1297.5 nm
1304.5 nm to 1317.5 nm
1324.5 nm to 1337.5 nm

SUNET

SunetC -> CD

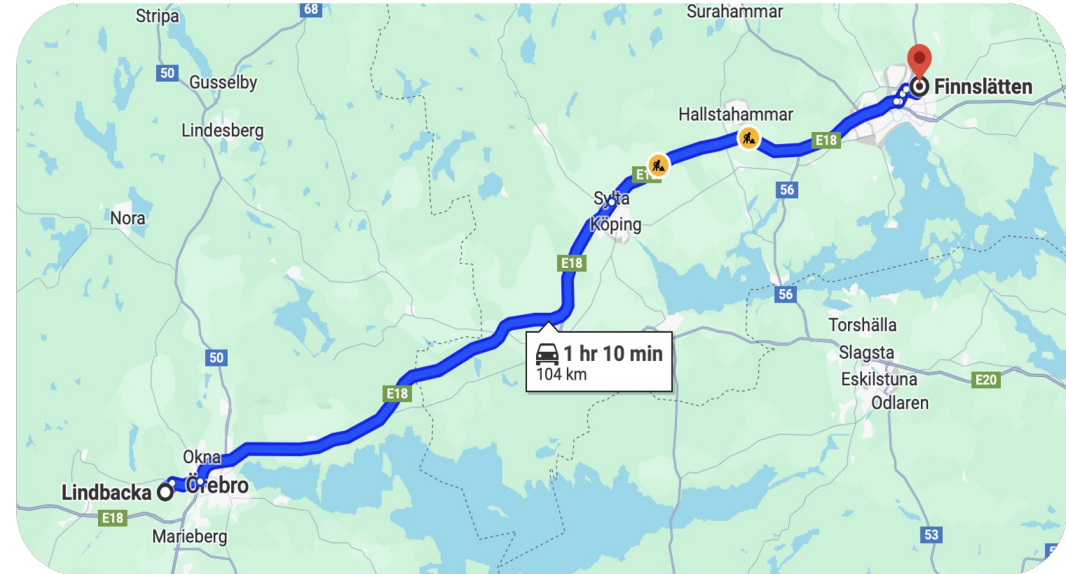# More issues

400G ZR+ bug

If you install optics before you have put any configuration on the router, the plug goes into unknown state when you add the configuration.

The plug transmit the configured light but the router does not know about it.

You need to do a janitor reset on it.

Finnslätten -> Örebro ->Finnslätten -> Örebro

Link UP!! (400km)

We later got the information on how to use hidden commands to simulate a janitor reset

SunetC -> CD

Other Issues

10GE

Plug and pray?
Customer equipment moved to PTX will not come up. Some equipment like Microtik had to change SFP+.

10GE fixed DWDM from "third parties" showed PCS error, moved to mx204 worked perfectly

10GE tunable DWDM, set wavelength some times. Reboot the router and it needed another janitor reset.

100GE DAC

100GE DAC, Didn't work swapped to LR4.

Third party optics that worked in MX10003 and MX204. Did not work in PTX

Two: University got new 100GE optics that was broken in their equipment

SunetC -> CD

DOA

During staging at pop and universities we had DOA.

- 1x PTX Rebooted after 1-2 mins uptime (over and over again)
- 3x PTX Crash - "Chassis error could not find stuff like fans" rebooted
- 1x PTX Deviered with config, other root password and nightly-build Junos
- 1x PTX Reporting plenty of chassis alarms
- 1x PTX and an DC power supply without amp selection switch

Router Crash

- Process PICD (linux process)
  - Handling the optics
  - 1GB of memory and all available swap
  - Memory leak when asking optics for values. like Tx Power
  - 400GZR+ has many operational values.
  - 6 months then swap and memory full and linux monitoring decides to kill the process.
  - RPD does not die just all the interfaces.
  - ISIS attracts transit traffic that goes nowhere.

- Have to preemptive restart other routers.
  - Software fix is now available

SUNET

SunetC -> CD Remaining

- **Stockholm Universities**
- **Stockholm Museums**
  - Mx10003(vlan shaper) with QFX breakout.
    - SNC service on its way
- **Nordunet - Sunet Stockholm**
  - New routers from Nordunet
- **Decommission**
  - Turn off and get it out and of our hands
- **Documentation, Inventory**