GÉANT update

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10th Dec. 2009

LHCOPN meeting

Agenda

1. GÉANT network architecture WS

2. GÉANT network capacity questionnaire results

3. Future requirements of GÉANT services

4. High level plans for GÉANT network equipment RFI

5. GÉANT 40G pilot

6. Multi-domain services: cNIS and autoBAHN pilot

1. GÉANT Network Architecture WS

- The main goal of the GÉANT Architecture WS is to produce a development roadmap for the GÉANT network

- Four work-shops so far, centred around:
  - GÉANT service uptake and 4 year forecast
  - GÉANT services features and future plans
  - Networking technology review
  - Reuse of NREN resources in a federated environment:
    - *Connectivity*
    - *Operations*
  - Cost sharing and digital divide
  - Global connectivity

2. GÉANT network capacity questionnaire results

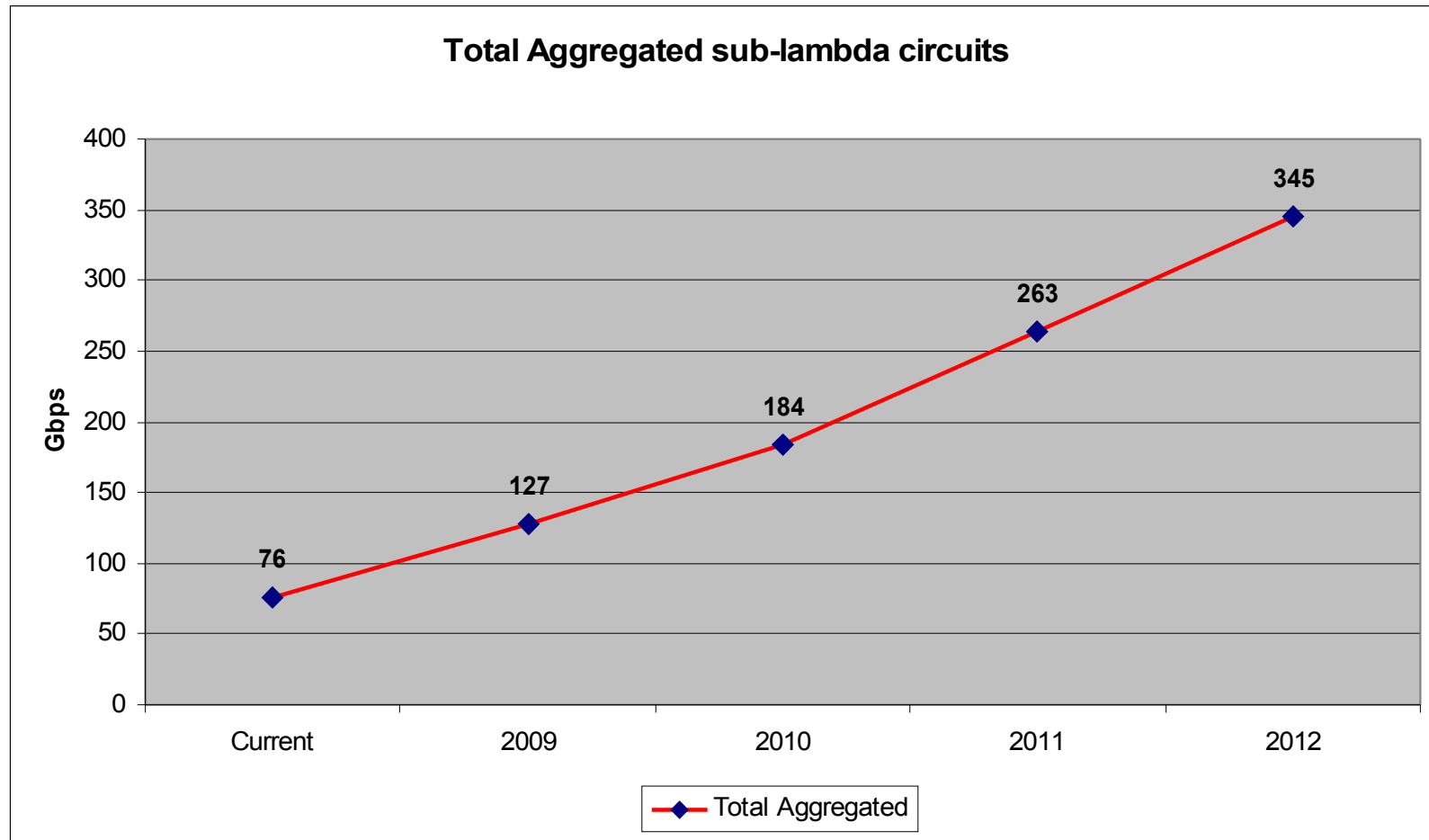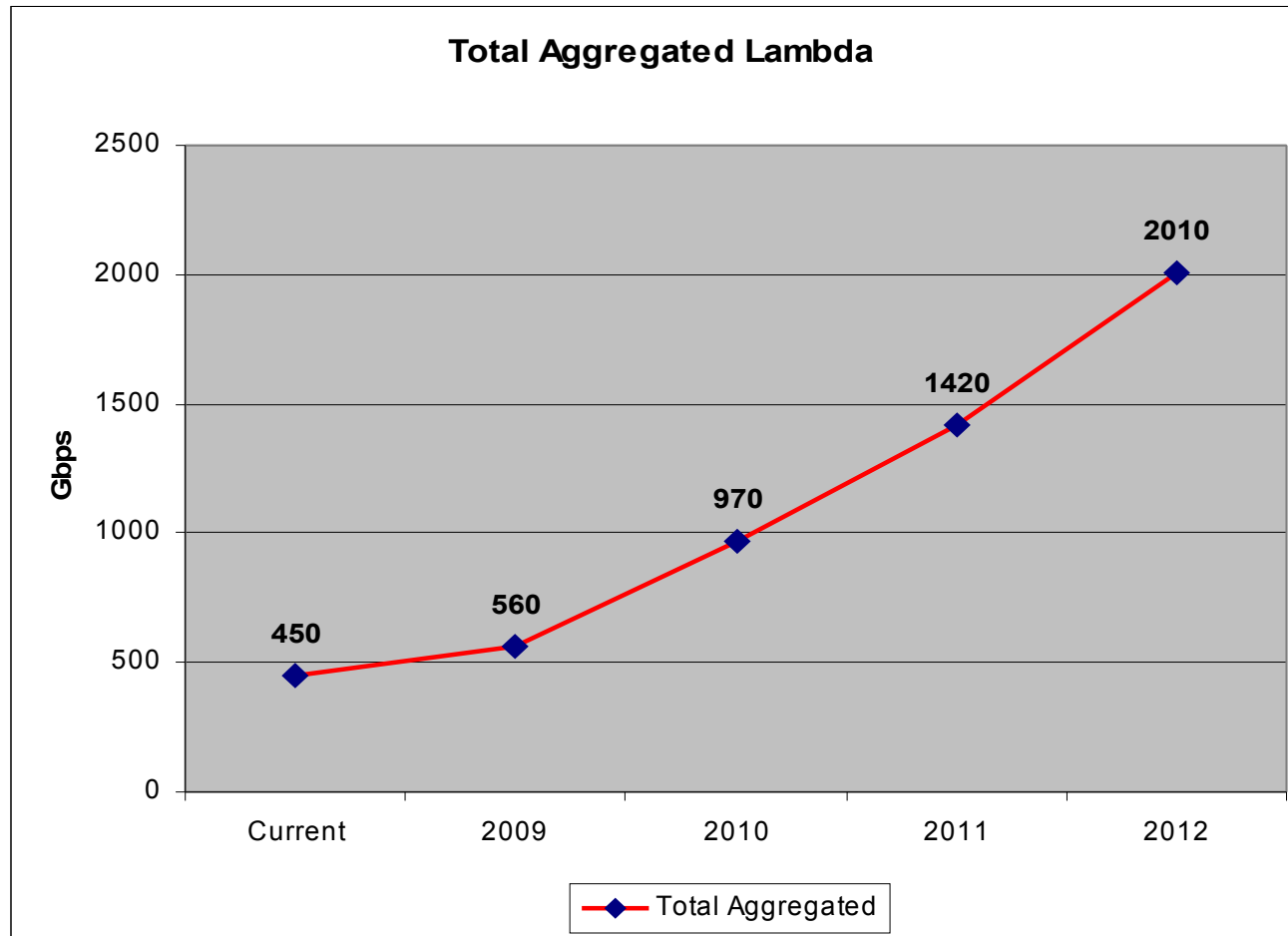# Aggregated IP access R&D and DWS / year

Aggregate IP R&D and DWS
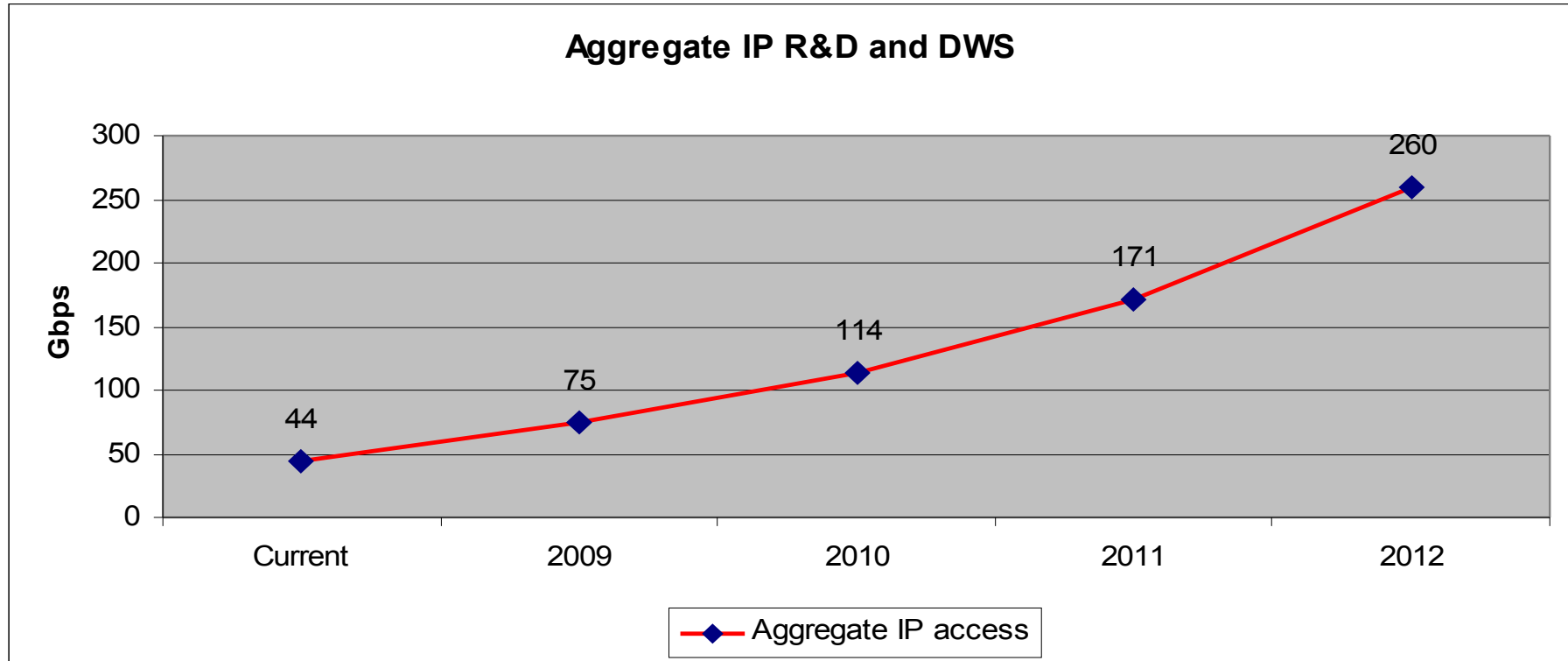
Possible 40 and 100G upgrades to GÉANT IP core

Link	2010		2011		2012	
	trunk	Gbps	trunk	Gbps	trunk	Gbps
Lon-Ams	40	6.8	40	10.3	100	15.2
Ams-Cop	40	5.6	40	8.4	40	12.3
Cop-Tal	10	3.2	20	4.8	40	7.1
Ams-Fra	40	7.3	40	11.0	100	16.1
Cop-Fra	20	4.2	20	6.3	40	9.3
Lon-Par	20	5.1	40	7.7	100	11.4
Par-Mad	20	1.4	20	2.1	40	3.1
Par-Gen	40	7.0	40	10.7	100	15.7
Mad-Gen	40	8.1	40	12.3	100	18.0
Mad-Mil	20	0.0	20	0.0	40	0.0
Mil-Gen	40	6.6	40	10.0	100	14.7
Fra-Gen	40	12.0	100	18.1	100	26.6
Fra-Poz	20	4.1	40	6.1	40	9.0
Fra-Pra	20	3.2	20	4.8	40	7.1
Mil-Vie	20	3.6	40	5.5	40	8.1
Vie-Bud	20	5.6	40	8.4	40	12.3
Vie-Ath	20	4.9	40	7.4	40	10.9
Ath-Sof	20	6.0	40	9.0	100	13.3
Sof-Bud	20	6.2	40	9.4	100	13.8

Total sub-lambda (GÉANT Plus) capacity / year

Total Aggregated sub-lambda circuits

- 76 — Current
- 127 — 2009
- 184 — 2010
- 263 — 2011
- 345 — 2012

Gbps

Legend: Total Aggregated

GÉANT Lambda aggregated capacity / year

Total Aggregated Lambda

connect • communicate • collaborate

3. Future requirements of GÉANT services

Overview of current GÉANT network connectivity services

- **GÉANT IP**
  - *Up to 20G access and up to 20G backup*
  - *Native IPv4, IPv6, multicast v4/v6*
  - *Global access*

- **GÉANT Plus**
  - *sub-wavelength point-to-point circuits 155Mbps-10G*
    - *diversity in routing can be offered.*
  - *pre provisioned NREN interface capacity – 10G*
  - *connectivity to European NRENs and trans-Atlantic end point*

- **GÉANT Lambda**
  - *10 Gbps wavelength connection between two GÉANT NRENs*
    - *diversity in routing can be offered*

Health warning …

… <u>ALL</u> features shown in the next slide are under the <u>proposal</u> status and they will be investigated as part of the development of the new GÉANT architecture.

*There are no commitments, currently, on **if, how** and **when,** any of these service features will enter operations!*

Services enhancements proposed for investigation

- **GÉANT IP**
  - *resilient IP backup access*
  - *Internet eXchange access*
  - *High capacity access interfaces: 40-100G*

- **GÉANT Plus**
  - *High capacity interfaces: 40-100G*
  - *Protection for the p2p circuits*
  - *Rapid on-demand provisioning*

- **GÉANT Lambda**
  - *40G lambda*
  - *100G lambda*
  - *Rapid provisioning of lambda*
  - *Recovery: protection and restoration at the lambda level*

4. High level plans for GÉANT network equipment RFI

- *Transmission*
- *Switching*

Current situation

IP/MPLS	GÉANT IP
SDH	GÉANT Plus
DWDM	GÉANT Lambda

Convergence option I

GÉANT

| IP/MPLS | GÉANT IP |

| DWDM | GÉANT Plus |
| | GÉANT Lambda |

Convergence option - III

GÉANT

IP/MPLS → GÉANT IP

??? ← GÉANT Plus

DWDM → GÉANT Lambda
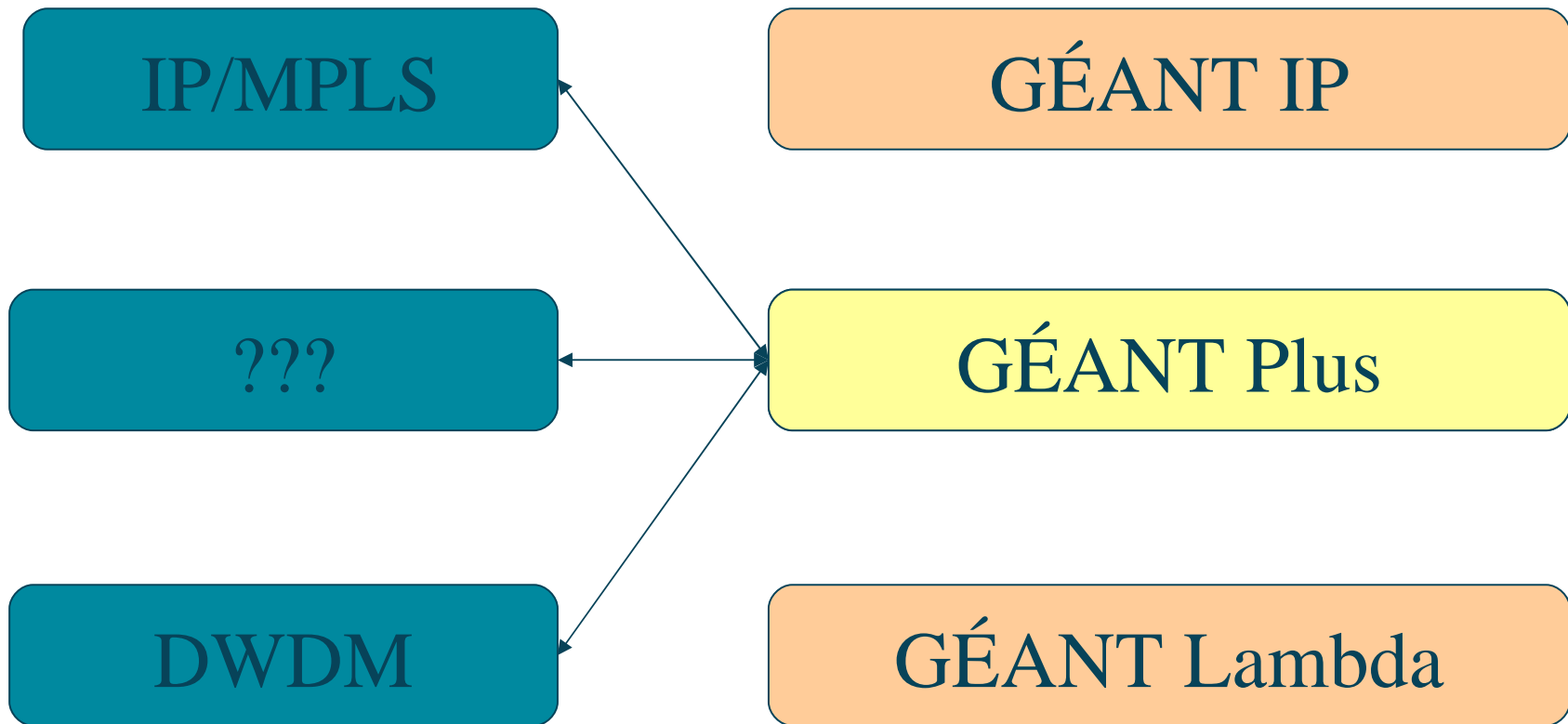
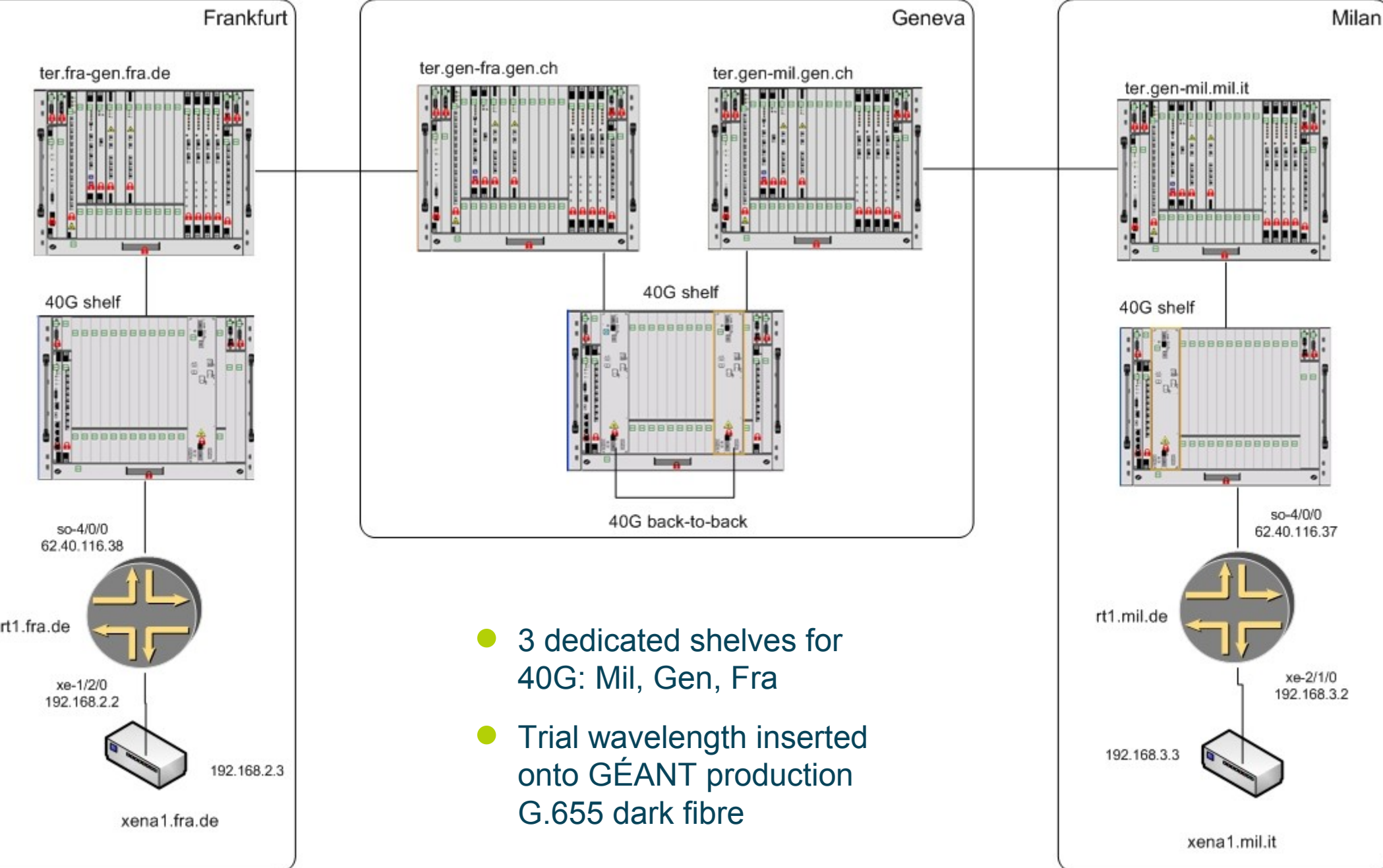# 5. 40G trial

40G trial

Goals of 40G trial

- To demonstrate that existing GÉANT dark fibre routes are able carry 40Gbps lambdas without modification

- To confirm that 40G will not interfere with existing 10G lambdas

- To understand the operational and planning implications of 40G

Current status

- 2 wavelengths have been successfully installed – Geneva to Milan and Geneva to Frankfurt

- These wavelengths are now connected back-to-back to create a 40G 1400km lambda from Milan to Frankfurt.

- This wavelength is now connected to the Milan and Frankfurt routers with Juniper 40G PICs

40G trial - current setup

Frankfurt

ter.fra-gen.fra.de

40G shelf

so-4/0/0
62.40.116.38

rt1.fra.de

xe-1/2/0
192.168.2.2

192.168.2.3

xena1.fra.de

Geneva

ter.gen-fra.gen.ch

ter.gen-mil.gen.ch

40G shelf

40G back-to-back

Milan

ter.gen-mil.mil.it

40G shelf

so-4/0/0
62.40.116.37

rt1.mil.de

xe-2/1/0
192.168.3.2

192.168.3.3

xena1.mil.it

- 3 dedicated shelves for 40G: Mil, Gen, Fra

- Trial wavelength inserted onto GÉANT production G.655 dark fibre
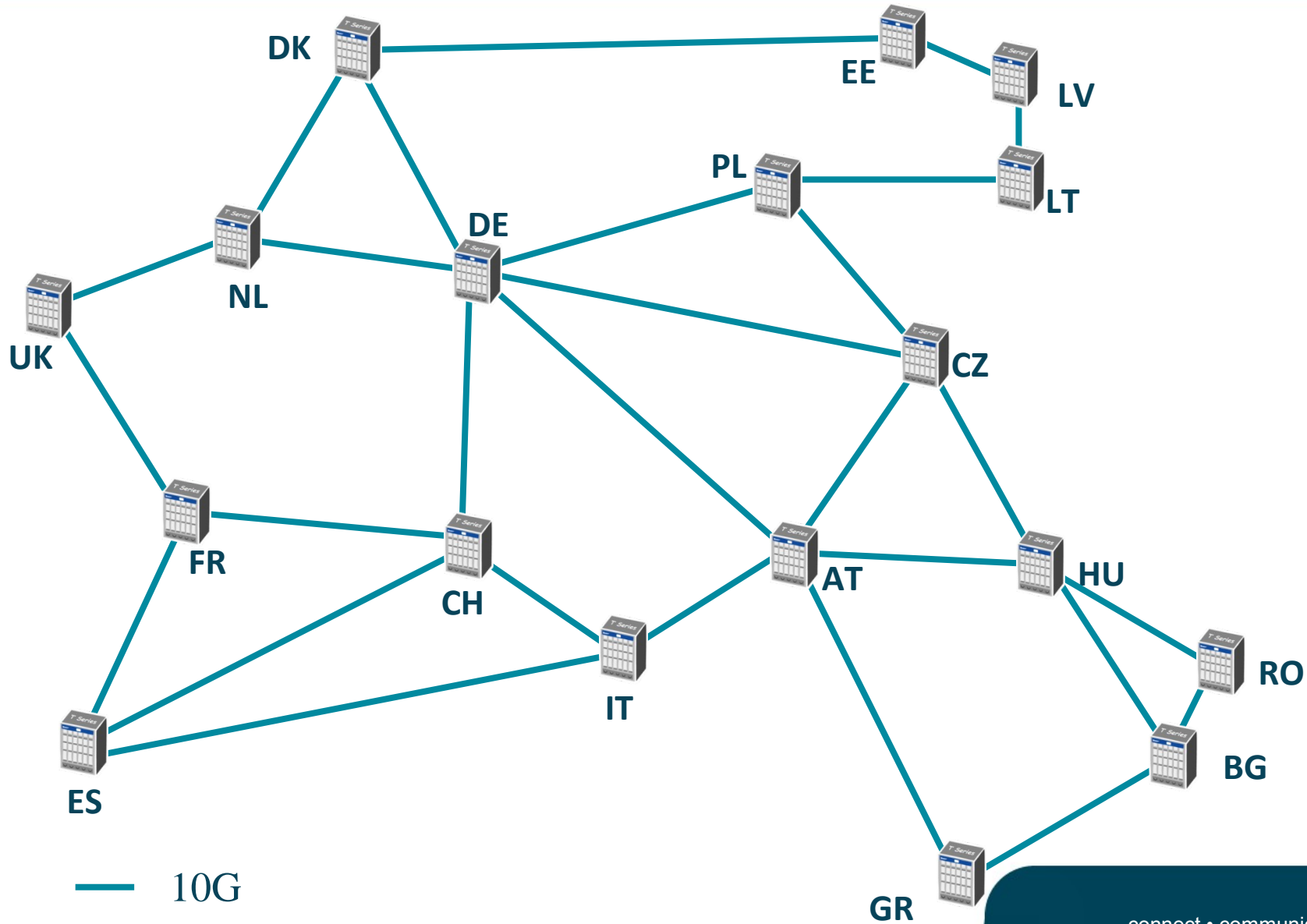
40Gbps trial results

Photonic layer test results

- Error free operation with FEC – receive margin of better than 5 dB on all wavelengths

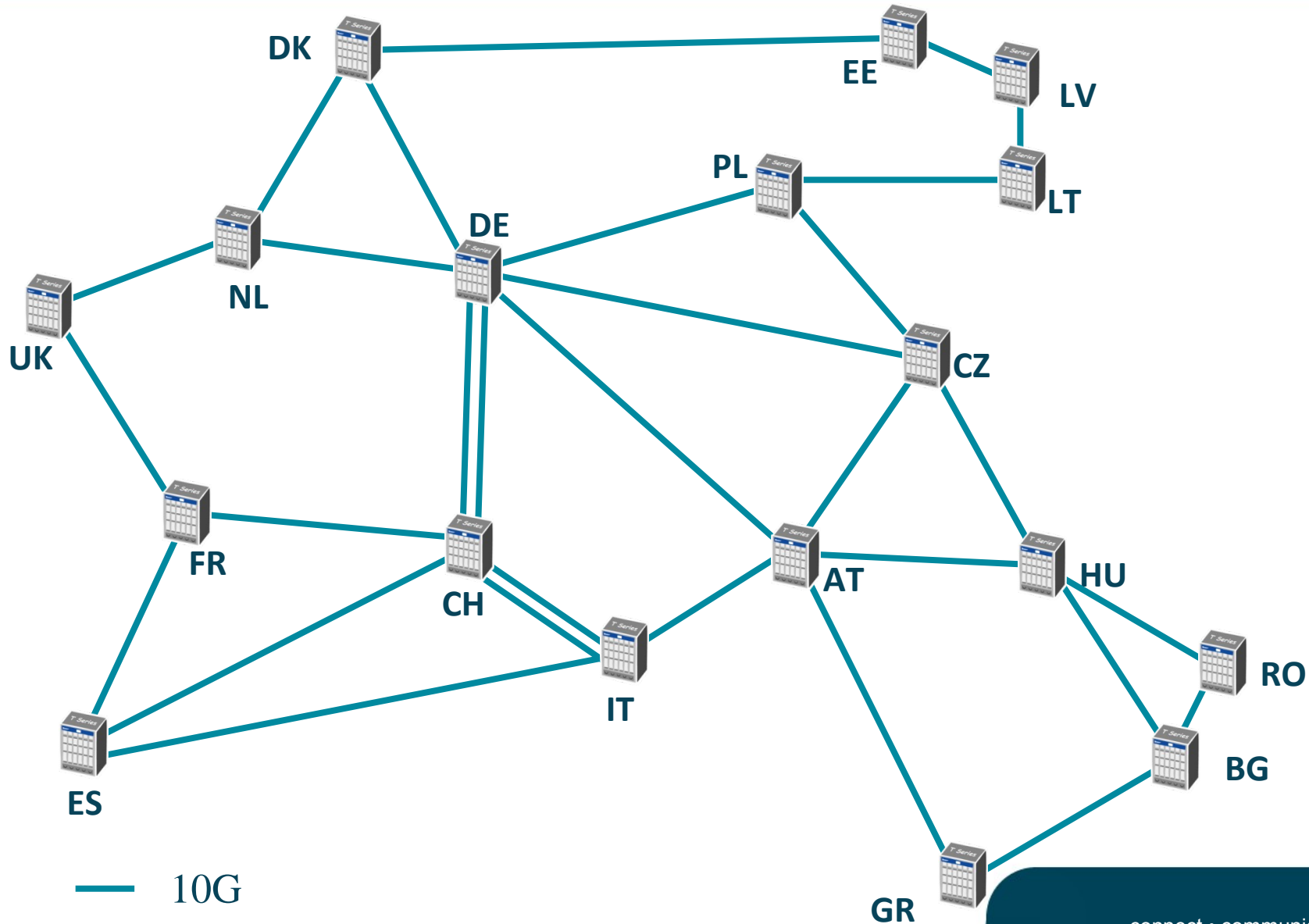- No measurable interference with existing 10Gbps wavelengths

Layer 3 test results

- Xena Networks testers are used to traffic load this route

- Tests show 1×10^{11} packets sent in 48 hours without losing a single packet
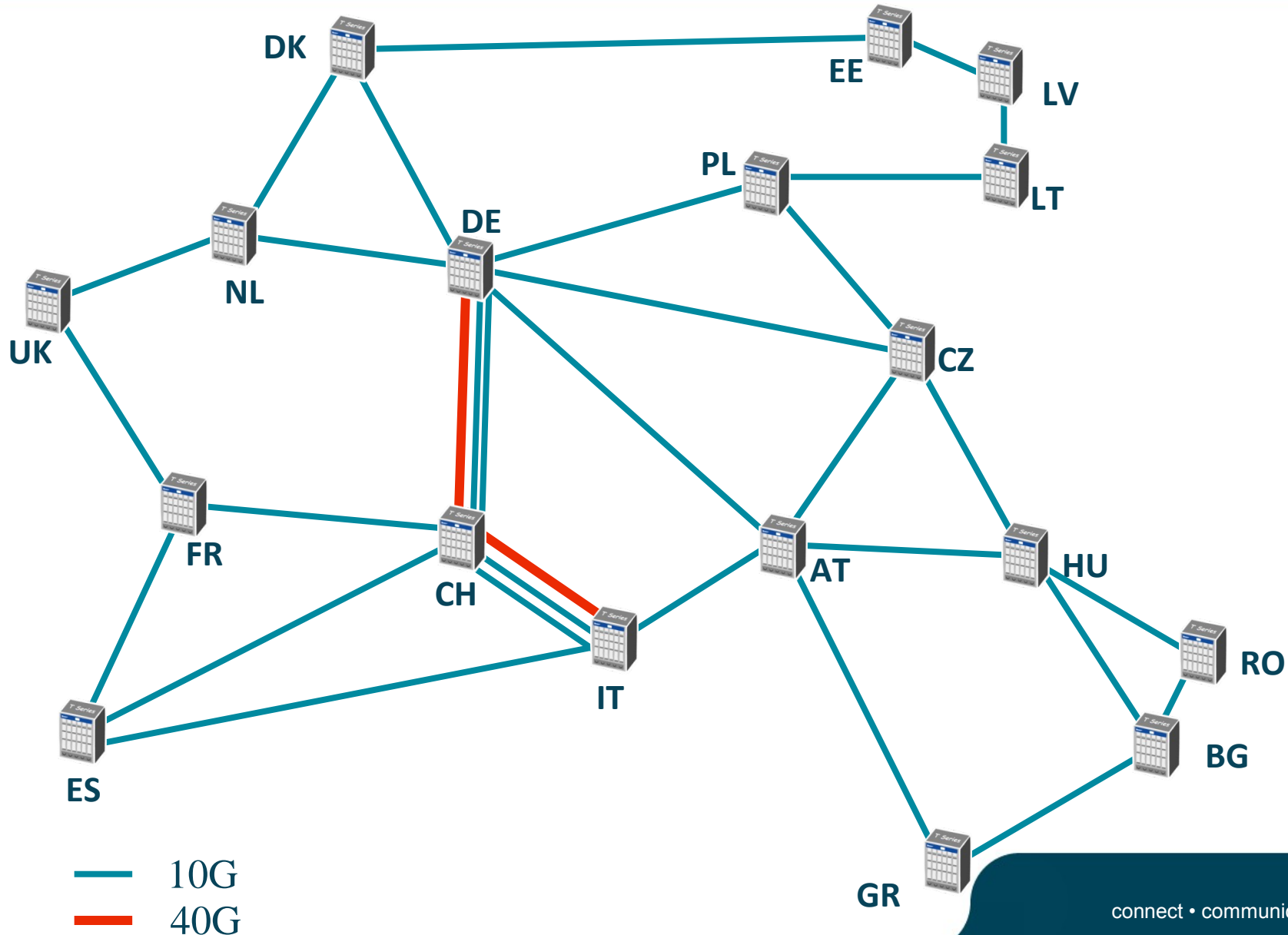
  - Implies a bit error rate of better than 1×10^{-15}

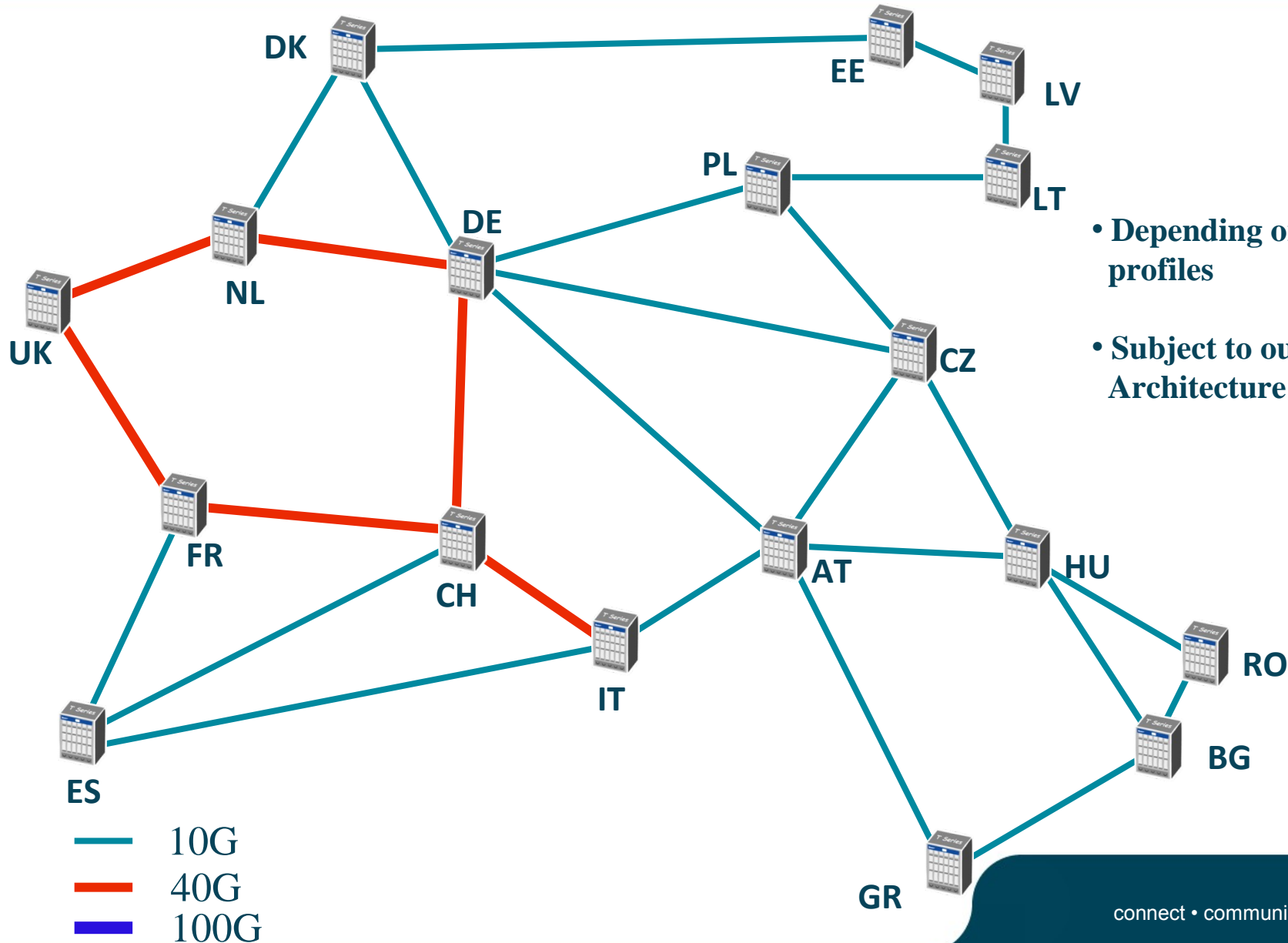GÉANT IP/MPLS network 2008 – 1H

10G

GÉANT IP/MPLS network 2009/2010

connect • communicate • collaborate

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GÉANT IP/MPLS network – 201x

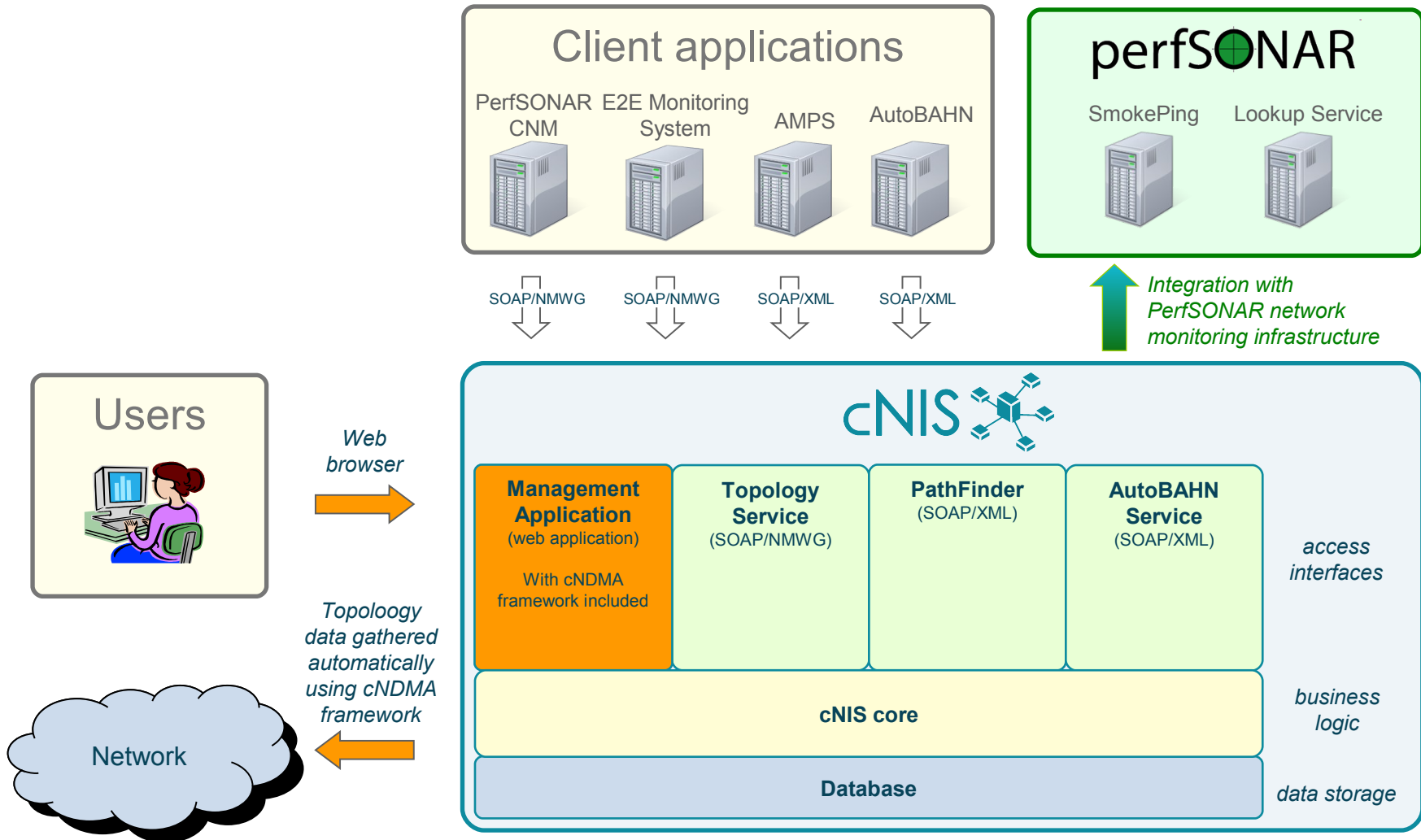- Depending on future traffic profiles

- Subject to outcome of GÉANT Architecture WS and RFI

Legend:
— 10G
— 40G
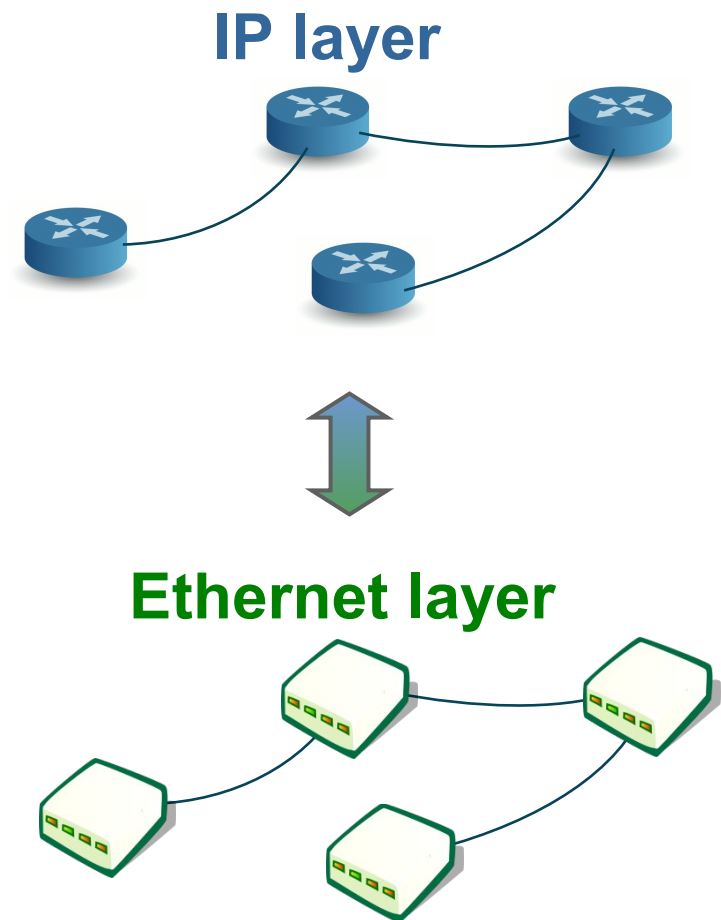— 100G

5. Multi-domain services:

- **cNIS - Common Network Interface Service**
- **autoBAHN pilot**

cNIS overview

Client applications

PerfSONAR CNM E2E Monitoring System AMPS AutoBAHN

SOAP/NMWG   SOAP/NMWG   SOAP/XML   SOAP/XML

perfSONAR

SmokePing   Lookup Service

Integration with PerfSONAR network monitoring infrastructure

Users

Web browser

Topoloogy data gathered automatically using cNDMA framework

Network

cNIS

| Management Application (web application) With cNDMA framework included | Topology Service (SOAP/NMWG) | PathFinder (SOAP/XML) | AutoBAHN Service (SOAP/XML) | *access interfaces* |

cNIS core — *business logic*
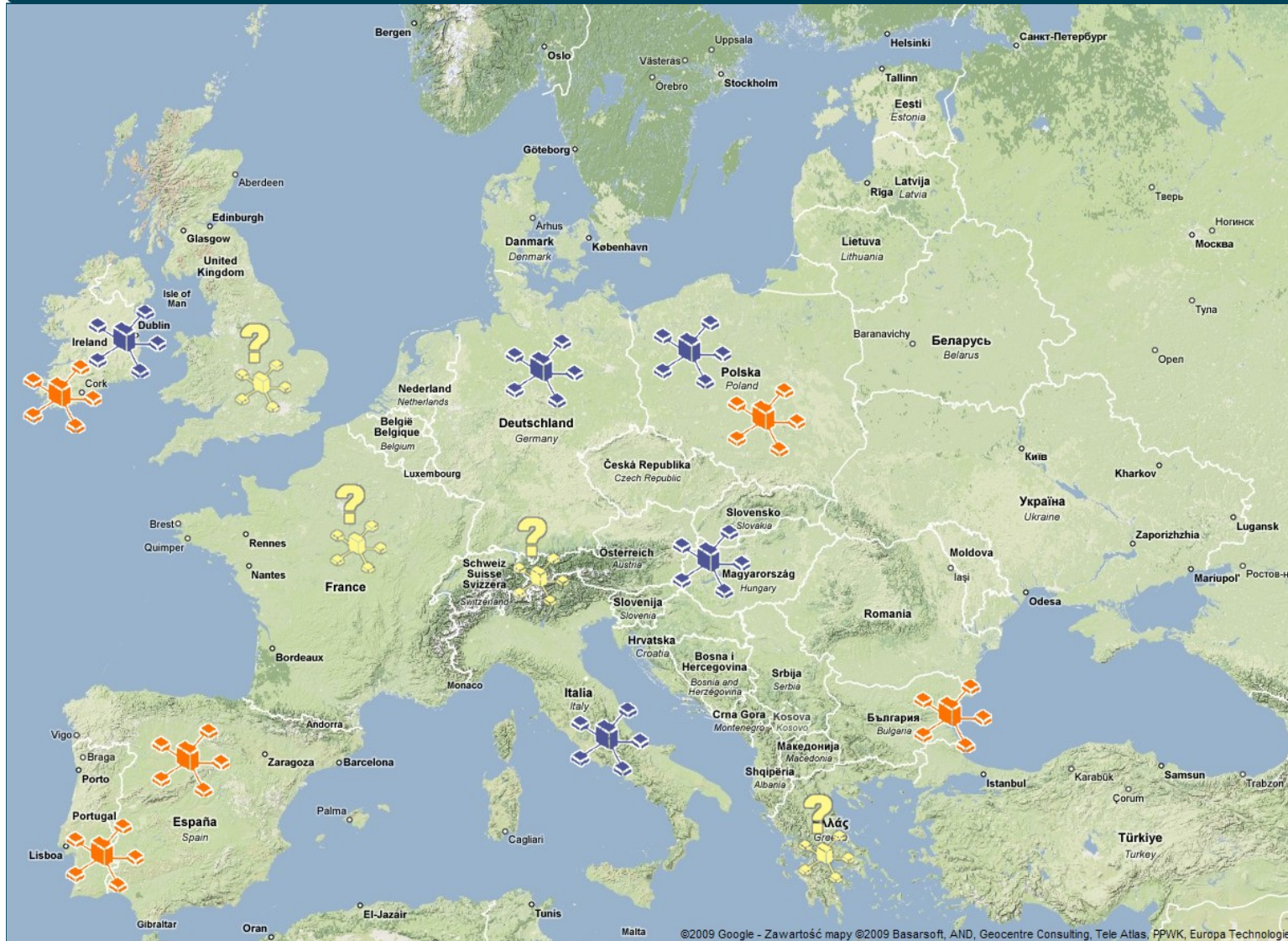
Database — *data storage*

cNIS Interlayer data management

- cNIS supports different network technologies (layers): IP, Ethernet and SDH.
- Layers may relate to each other (stack of layers).
- Relations between layers can be automatically matched.
- Automatic matching requires interlayer meta-data to be available.
- Interlayer meta-data need to be discovered and provided by the cNDMA framework.

IP layer

Ethernet layer

Deployments

http://cnis.psnc.pl

Operational AutoBAHN pilot

- **Goals of the pilot**
  - Identify network operational expectations with regards to:
    - *Installing*
    - *Operating*
    - *Maintaining*
    - *Provisioning*
    - *Monitoring*

- **Output of the pilot**

  - Procedures and FAQ for operational deployment and management of AutoBAHN

Operational AutoBAHN pilot - II

- Pilot timelines
  - 5 NRENs
  - Pilot starts 1H 2010
  - Expected to last 2 months
  - Results 2H 2010

- Users:
  - Several users have expressed interest in participating in autoBAHN tests
  - Currently under consideration to include them in the operational pilot or launch a separate pilot.

Conclusion

- Significant growth expected on all current services (>50% per year).

- User input is welcomed in support of new services or added value functions for current services.
  - Your, LHCOPN operator, input critical so please come forward if you have specific requirements.

- Equipment and network architecture refresh expected; subject to RFI and user requirements analysis.

- Multi-domain services are starting to move into operation and pilot phases.