SDN in GARR and NREN/GÈANT

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GARR community

About 1000 connected sites belonging to several organisations

- 100 Universities
- 350 Research Institutes and Laboratories
- 60 Biomedical Research Institutes
- 65 Libraries, Museums and Cultural Institutions
- 500 schools (170 directly connected)

Institutions depending from several Ministries:

- Ministry of Education, University and Research
- Ministry of Health
- Ministry of Cultural Heritage
- Ministry of Economic Development
- Ministry of Agriculture
The GARR network

• More that 15,000 km of GARR owned fibers
  • ~9,000 Km of backbone
  • ~6,000 Km of access links
• About 1000 user sites interconnected
• > 1 Tbps aggregated access capacity
• > 2 Tbps total backbone capacity
• 2x100 Gbps IP capacity to GÉANT
• Cross border fibers with ARNES (Slovenia), SWITCH (Switzerland).
• > 100 Gbps to General Internet and Internet Exchanges in Italy
• NOC and engineering are in-house, in Rome.
GARR and GÉANT
The European NREN ecosystem

CAMPUS
National Research and Education Networks (NREN)

Core Backbone  
GÉANT

GÉANT: optics + switching  
Multidomain services: IPv4, IPv6, multicast,  
Federated identities (EDUgain, EDUroam),  
Testbed as a service, ...

Expenditures’ ratio:  
1000 (users) : 100 (NRENs) : 1 (GÉANT) !
I collegamenti mondiali di GÉANT

At the Heart of Global Research and Education Networking

GÉANT and partner networks enabling user collaboration across the globe

September 2014
Why changing?

• Focus on enabling end-user to access and use services (often outside the local domain), making the network "invisible"

• Users' requirement for exa-scale and empowerment

• Scaling (number of sites, equipment, users, capacity, ...)

• CAPEX and OPEX cannot follow traditional expensive paradigms (single vendor, one box->one service e.g.) and medium to long depreciation schema
GÉANT Network – Platforms

- Transmission layer based on Infinera DTNx Platform
- IP/MPLS layer based on Juniper MX series Platform
- Single vendor solution
- High backplane capacity
- High space and power requirements
- No data-plane programmability
Traffic on the GARR Network

GARR X Progress Project in operation (100 Gbps South of Italy)
GÉANT: research traffic is **symmetric and bursty**
Traffic Forecast

Over 60% year on year growth on IP MPLS means 140 times in 10 years

In Q2 2017 GÉANT received about 4.6 Petabytes of traffic per day, that is 4.6 millions of Gigabytes.

Between 2015 and 2016 the IP/MPLS traffic on the GÉANT network grew by 64%. This has reduced to~50% in the last 4 quarters.

LHC and the high energy physics community has been one of the major drivers for growth.
GARR and SDN

GARR started in 2012 researching on OpenFlow with internal grants. It continued with an EC project on Carrier Grade OpenFlow/SDN technologies (DREAMER), resulting in components adopted later by ONOS.

At the end of 2016 initiated a project (ELISA - Evolved Layered network Infrastructure with Software/services Architecture) to collect users' requirements, use cases and consider the next generation of the GARR network. A white paper summarizes the considerations (see references)

Extensives testing of optics (ADVA, INFINERA, Juniper...) and software (Controllers, orchestrators, analytics,...) is planned in the next months, using a geographically distributed platform.
Starting in GN4-1 (mid 2016) SDN the objective of an official activity of the project. The effort is continuing in the active project GN4-2.

The project is validating the use of a network operating system (ONOS e.g) for a production environment, including control of "white boxes" (CORSA e.g).

The NRENs are planning the next generation of the project (GN4-3) which has to evolve the current infrastructure.

Optical Open line systems, disaggregation and software will play a key role.
GARR and SDN – a model

From traditional stack

L7

L3

L0

Through Layered Network

L0-L2

L3-L7

APP Services
NAT/FW/DNS
IP/MPLS

PACKET
OTN
WDM

To overlays

OVERLAY

APPs
Services
Orchestrator
SDN Controllers

UNDERLAY

Packet
Flex-Grid
Open Line Systems
Flex-Modulation

Computing
Storage

Optical equipment and topology have a core role as founding infrastructure
Lessons learned and Comments

(-) OpenFlow has various issues in WAN (see Internet2 roll-back to IP/MPLS)

(-) Speed of Light is still a constant
A physically distributed set of resources cannot be centrally managed in real time unless the distance is ~ zero.
The WAN case is quite different from datacenter

(-) Debugging (i.e. operations) is much more complex. The software layer is much thicker and complex.

(+) Software is getting mature and networks function can be "easily" added

(-)(+) New expertise is needed
Operation, CyberSecurity, SLAs, new expertise may actually imply that the devil is in the details
[Operational EXpenses >> CAPital Expenses]

Terabit capacities will create new challenges for monitoring, control. New merchant silicon may make the difference and change the management model (P4....)

Protocols like QUIC may render network packet management difficult or not feasible

Overall testing needs to be performed in real world scenarios and having in mind a production environment. Need for
- security by design
- monitoring and analytics at Terabit speeds
- strong automation
- clear maintanance/support paths
References

Consortium GARR: https://www.garr.it

GÉANT: https://www.geant.org

Progetti Ricerca DREAMER:
https://www.garr.it/it/ricerca-e-formazione/ricerca/networking-e-tecnologie

White Paper "Considering the Next Generation of the GARR Network":