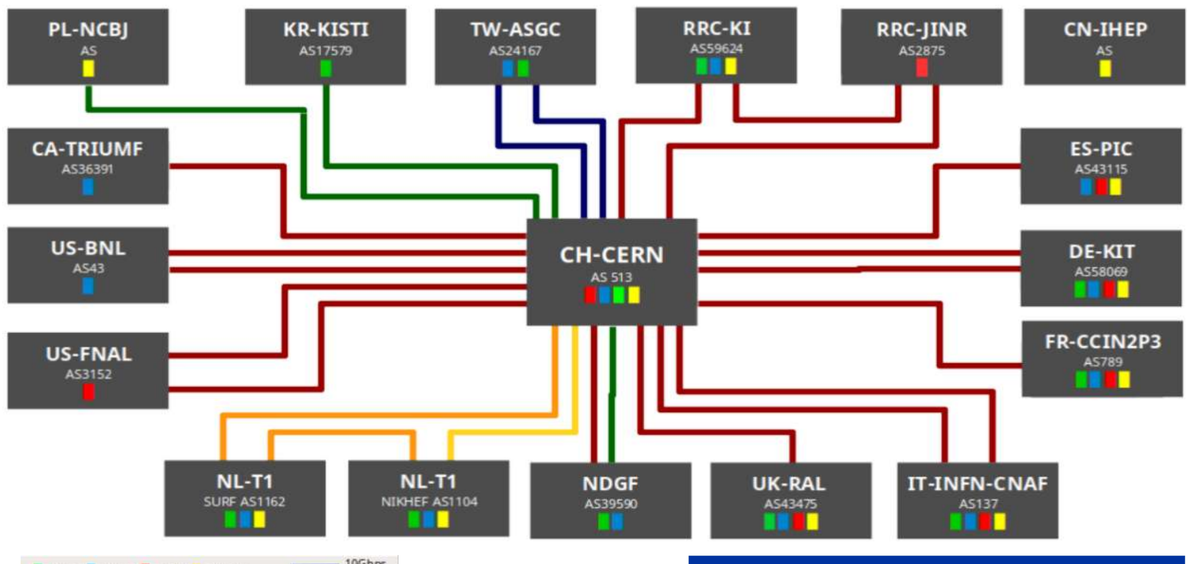
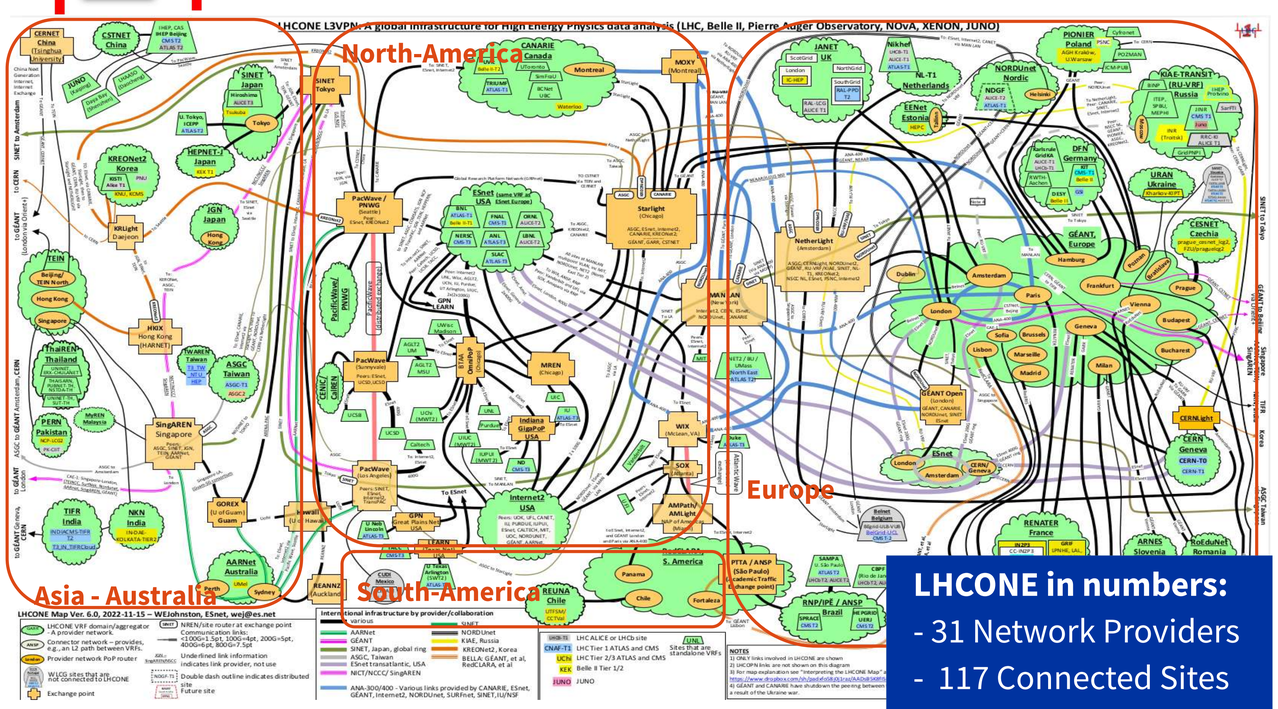
LHCOPN and LHCONE networks evolve to support HL-LHC computing

LHCOPN Tier0-Tier1s network



LHCOPN in numbers:
- 15 Tier1s + 1 Tier0
- 13 countries in 3 continents
- 2.1 Tbps to the Tier0

Tier1s-Tier2s network



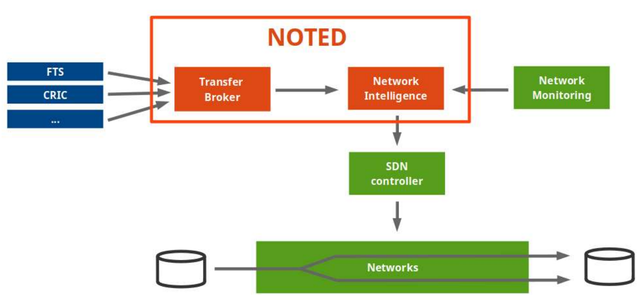
LHCONE in numbers:
- 31 Network Providers
- 117 Connected Sites
- 5 Continents

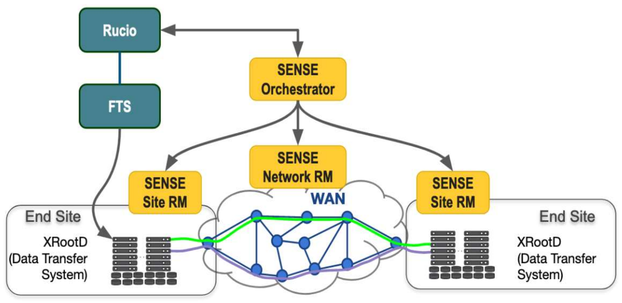
LHCOPN and LHCONE are the networks that serve the LHC data distribution. **LHCOPN** has a star topology with CERN in the centre and it connects the Tier0 to all Tier1s. **LHCONE** is a multi domain L3VPN (routed Virtual Private Network) provided by Research and Education Networks (RENs) on all continents. LHCOPN and LHCONE are also used by other HEP collaborations: BelleII, Pierre Auger observatory, JUNO, NovA, XENON, DUNE.
LHCOPN and LHCONE are planning bandwidth upgrades to support the large HL-LHC transfer capacity demands

Technology R&D

SDN: NOTED, SENSE-Rucio

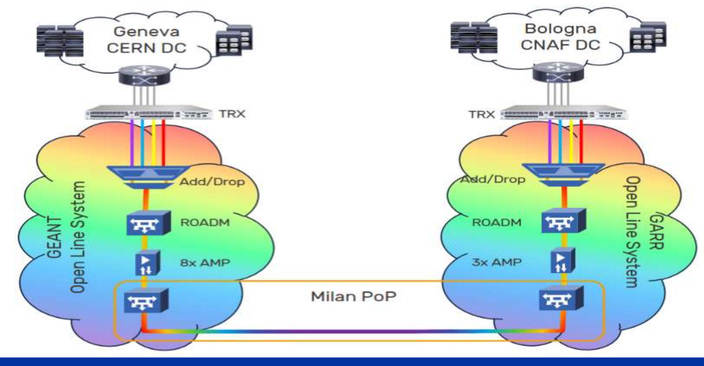
NOTED: a framework designated and developed at CERN that can detect when large FTS data transfers start and, consequently, triggers actions in the network to increase the available bandwidth.
SENSE-RUCIO Science Workflow: provides mechanisms for domain science workflows and middleware (Rucio) to identify "priority" data flows and implement wide area traffic engineering.
These SDN tools can help to meet transfer deadlines in overloaded networks





DWDM: CERN-CNAF DCI

INFN-CNAF, GARR, GEANT and CERN have setup a **Data Centre Interconnect** service between CNAF and CERN. The service is implemented using long distance transmission devices injecting multiple 400Gbps wavelenghts on the dark fibres of GEANT and GARR.
This DCI can easily grow to 1.6Tbps, more than the T0-T1 bandwidth required by HL-LHC



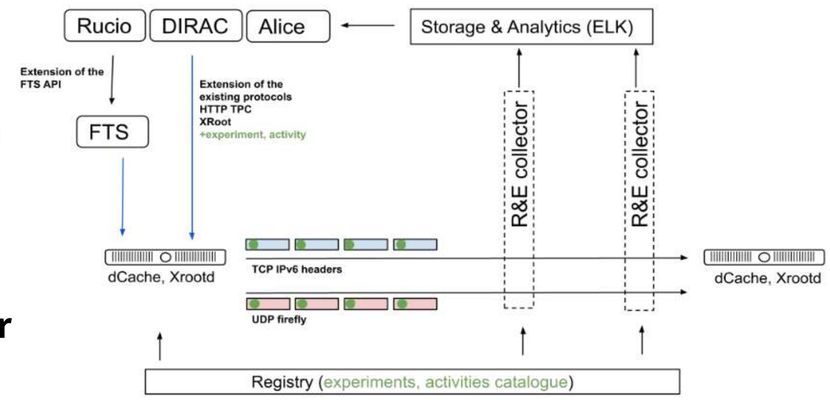
1.6 Tbps
4 carriers
- DP-16QAM
- 27% SD-FEC
- 69 Gbaud

Monitoring and Accounting evolution

SciTags

Scientific network tags (scitags, https://www.scitags.org/) is an initiative promoting identification of science domains and their high-level activities at the network level. Two methods are proposed:
- **Flow marking** with **UDP fireflies**: issuing a specific UDP packet in a separate channel.
- **Packet marking**: adding a 14 bits code in the **IPv6 flowlabel** field.

Scitags will improve the understanding of the network utilization, the monitoring of the transfer applications and may allow advanced traffic engineering techniques



Large Science co-existence

MultiONE

MultiONE is an activity aiming to offer the advantages of LHCONE to other large science projects (SKAO, ITER, Rubin Observatory) that will start operating at the same time as HL-LHC.
MultiONE can provide a secure network environment for sites serving multiple large-science collaborations without compromising the securityof LHCONE sites