



# LHCOPN lambda and fibre routing

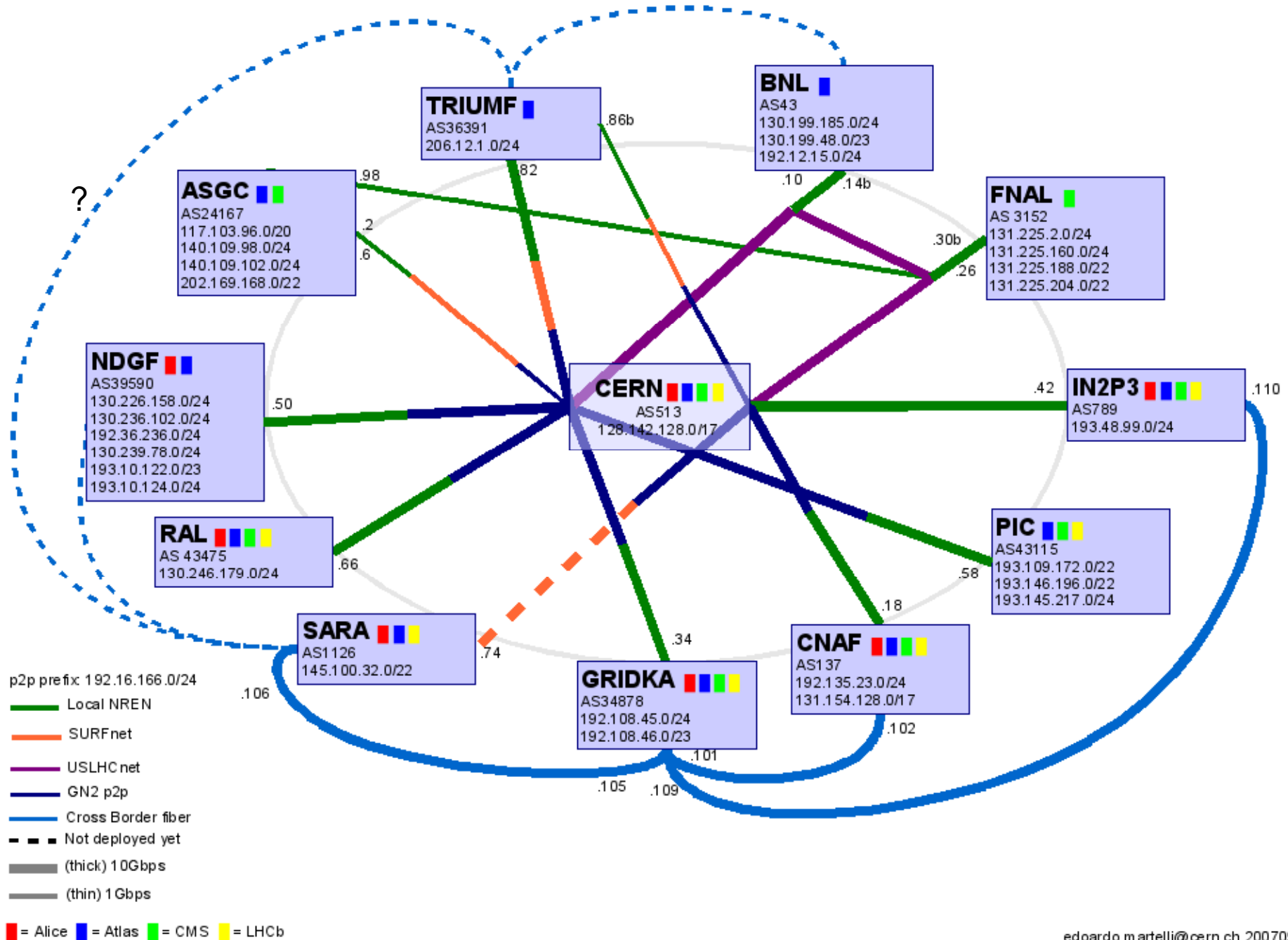
## Episode 4

(the path to resilience...)

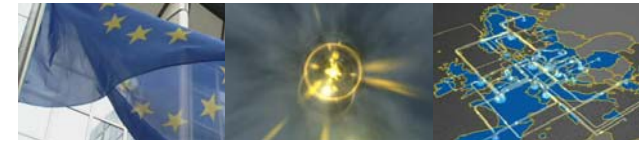
Michael Enrico  
Network Engineering & Planning Manager  
DANTE

LHC Meeting, Geneva, 06-07.11.2007

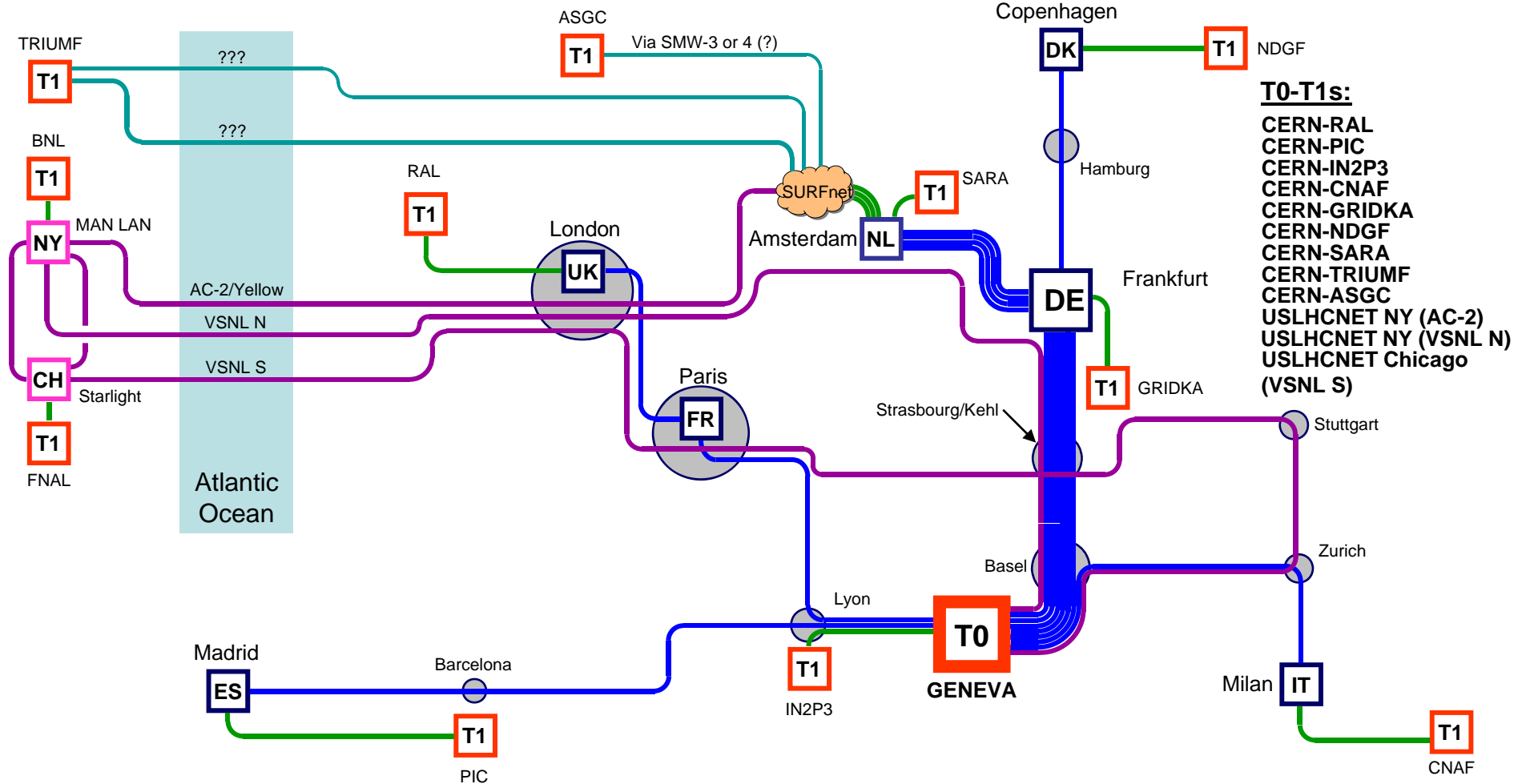
# LHCOPN – current status



# T0-T1 Lambda routing (schematic, previously)



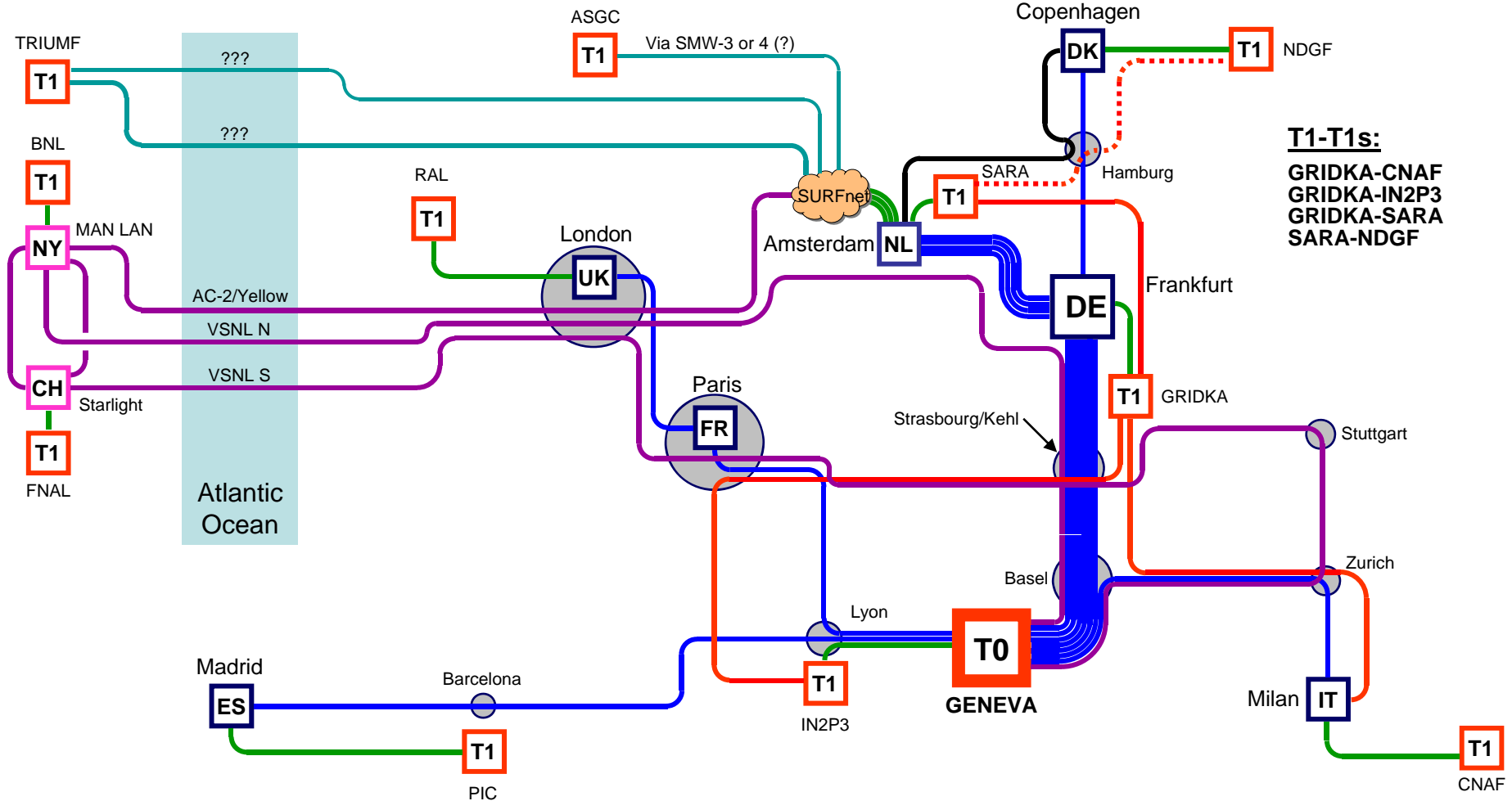
Connect. Communicate. Collaborate



# Add T1-T1 Lambda routing (schematic, previously)



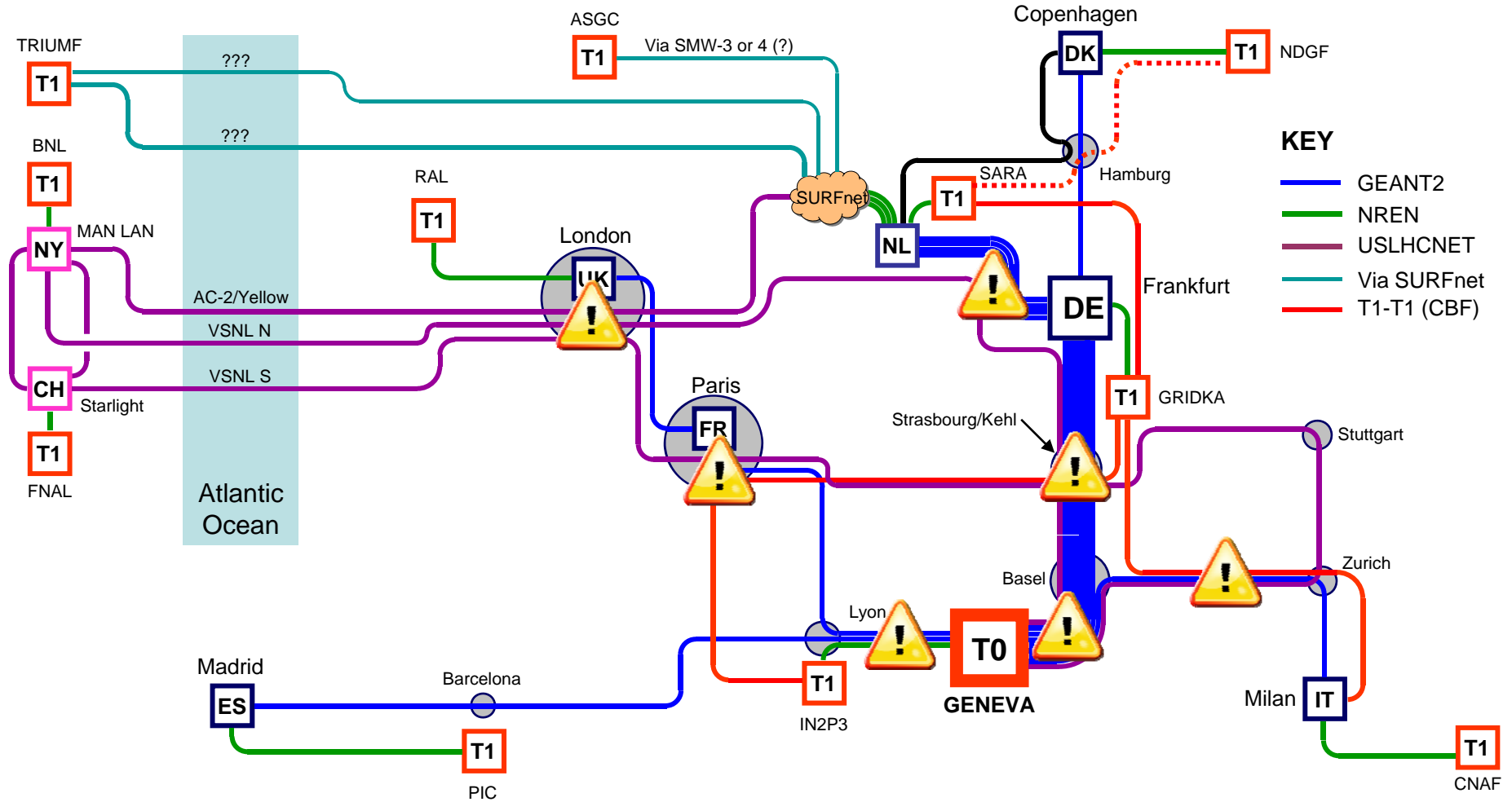
Connect. Communicate. Collaborate





# SRLG analysis

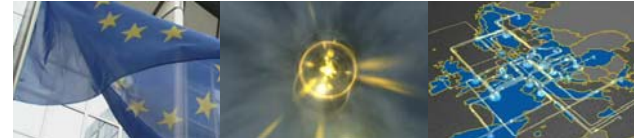
Connect. Communicate. Collaborate





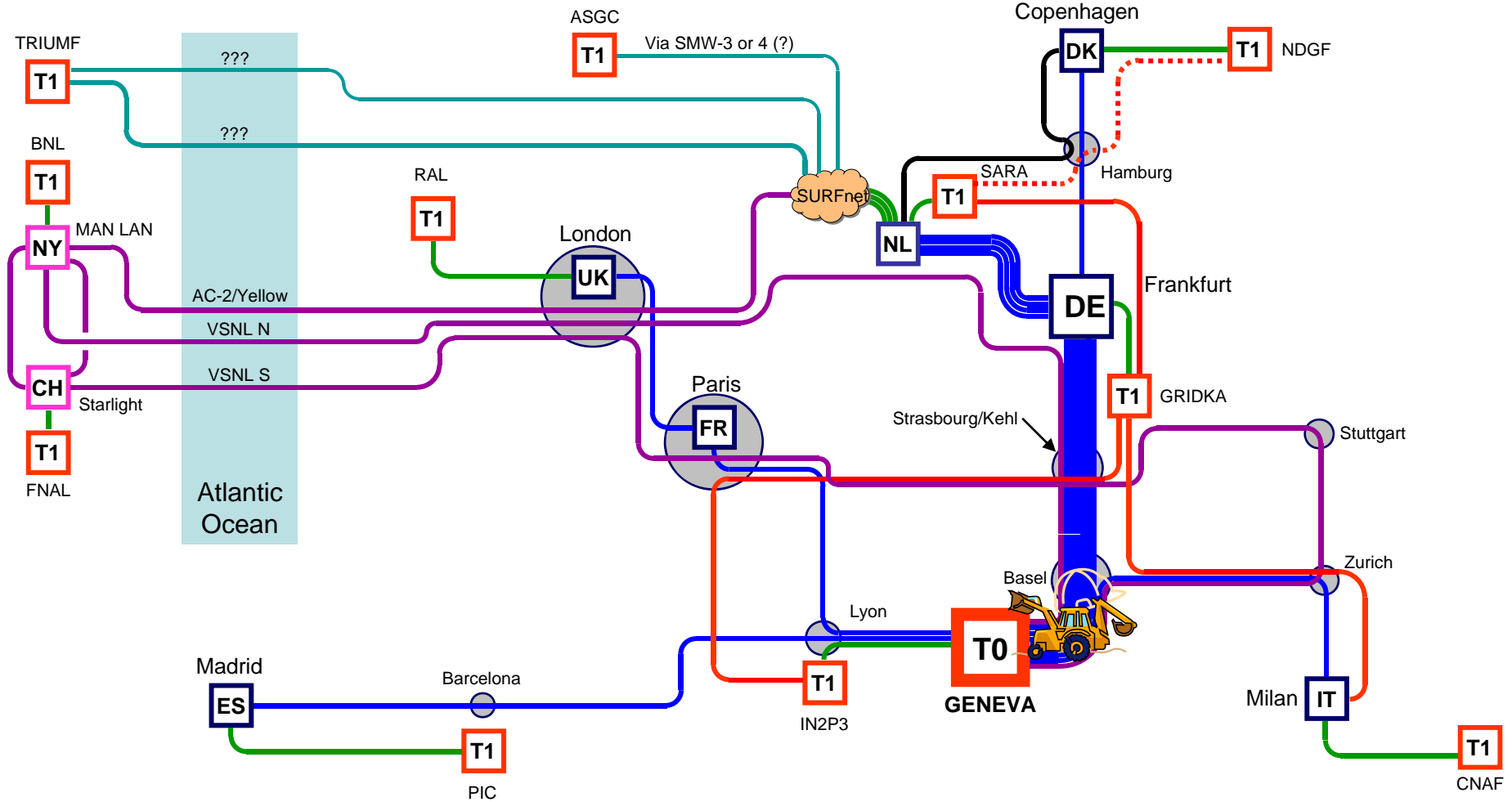
Connect. Communicate. Collaborate

# Failure scenarios (2 of them)



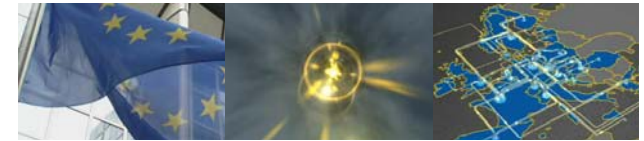
# e.g. Big fibre cut Basel-Geneva

Connect. Communicate. Collaborate

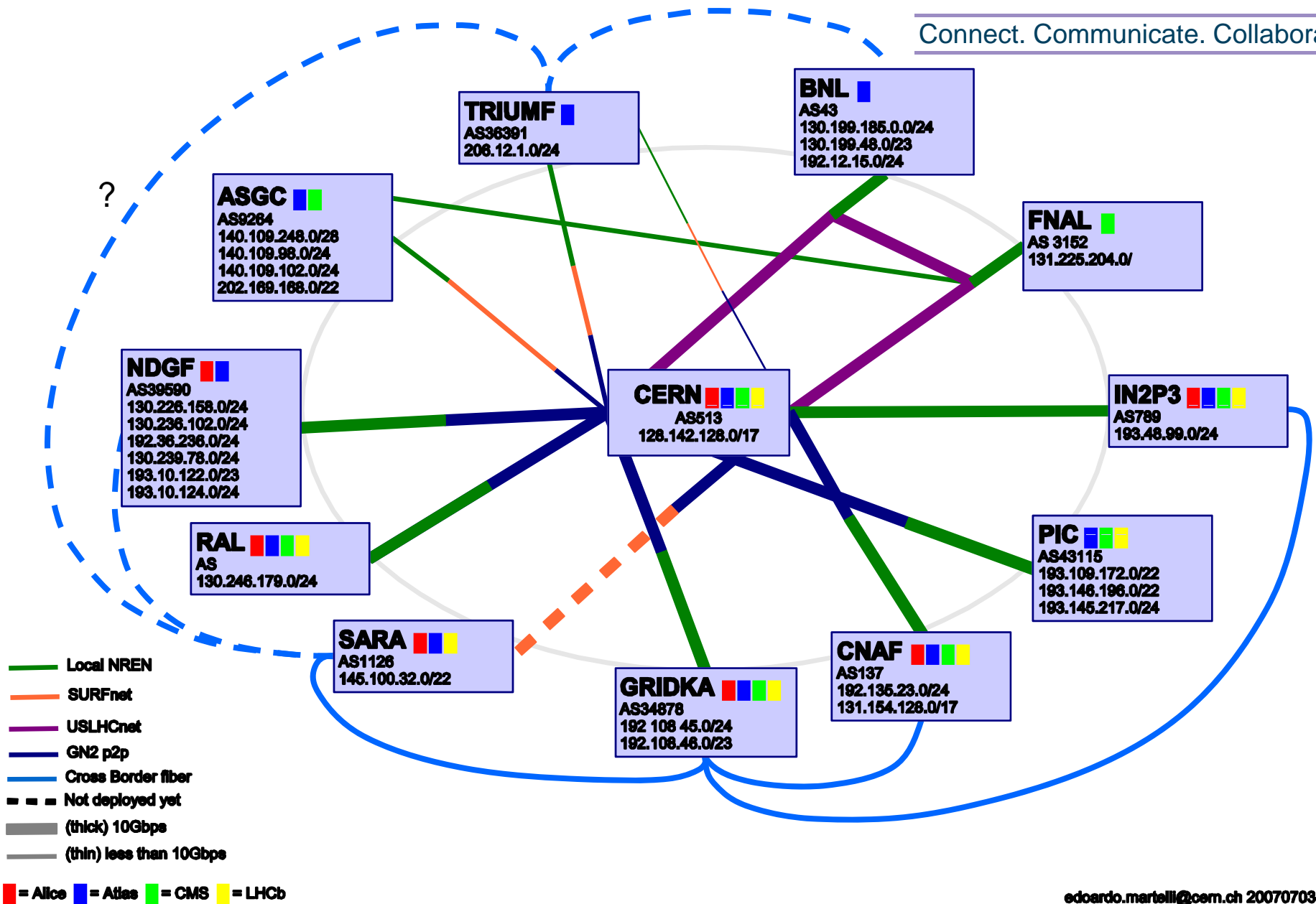


# e.g. Big fibre cut Basel-Geneva

(before animation)



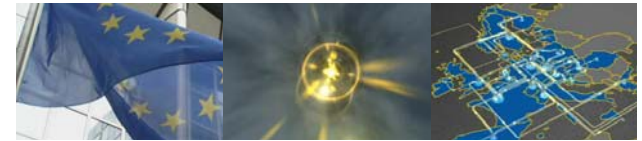
Connect. Communicate. Collaborate



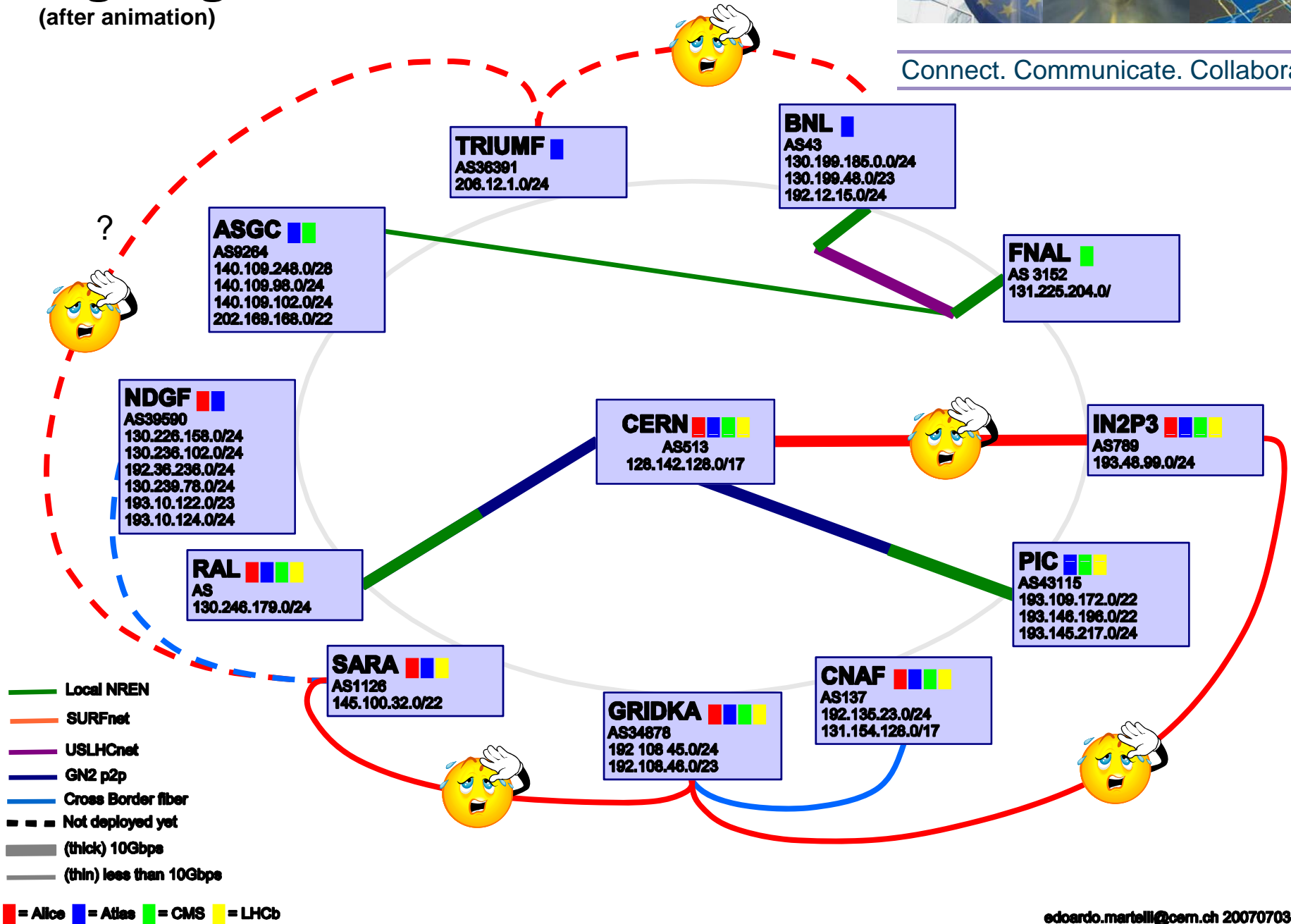


# e.g. Big fibre cut Basel-Geneva

(after animation)



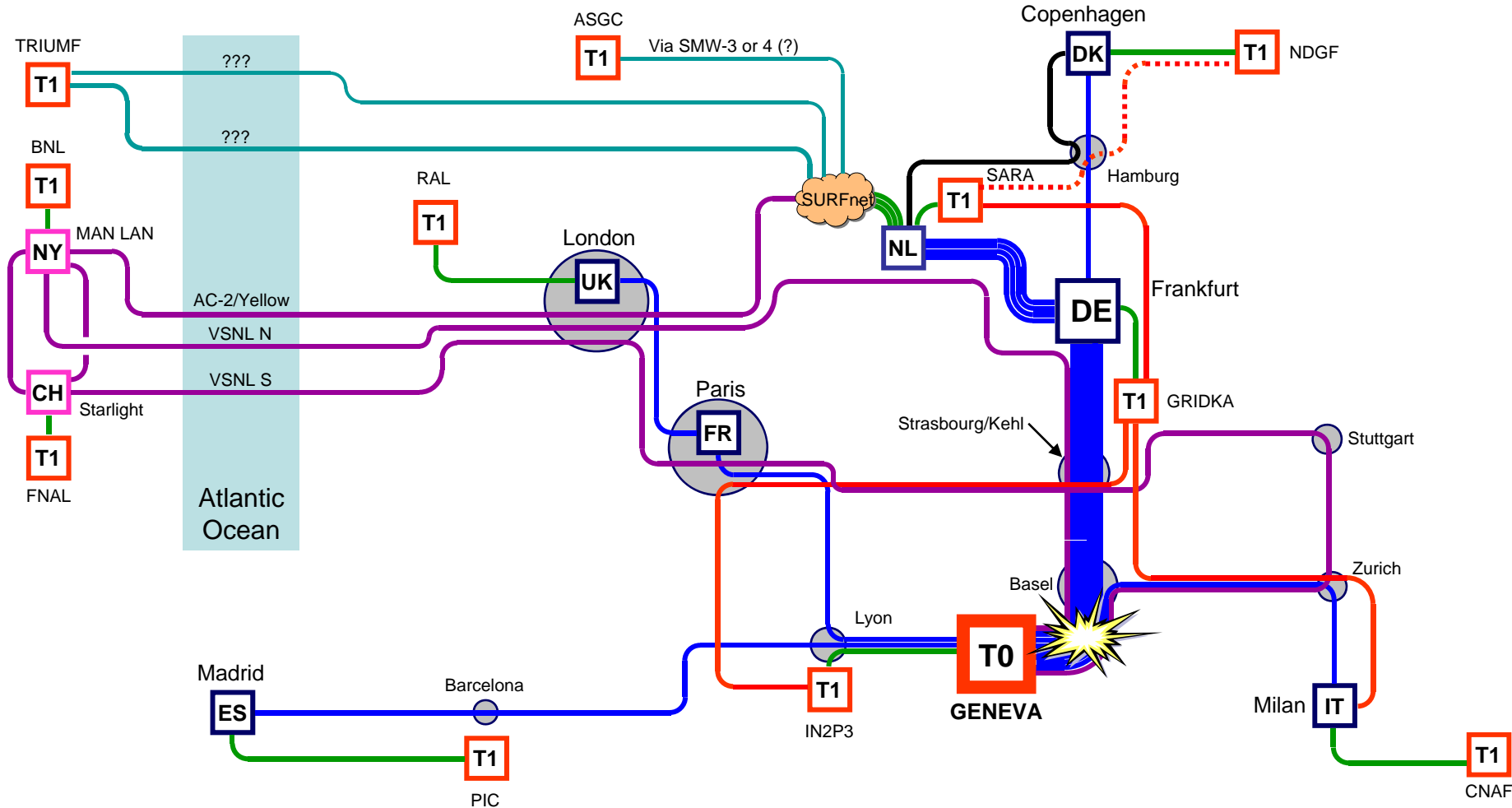
Connect. Communicate. Collaborate



# e.g. GÉANT2 Fra-Gen EDFA failure



Connect. Communicate. Collaborate

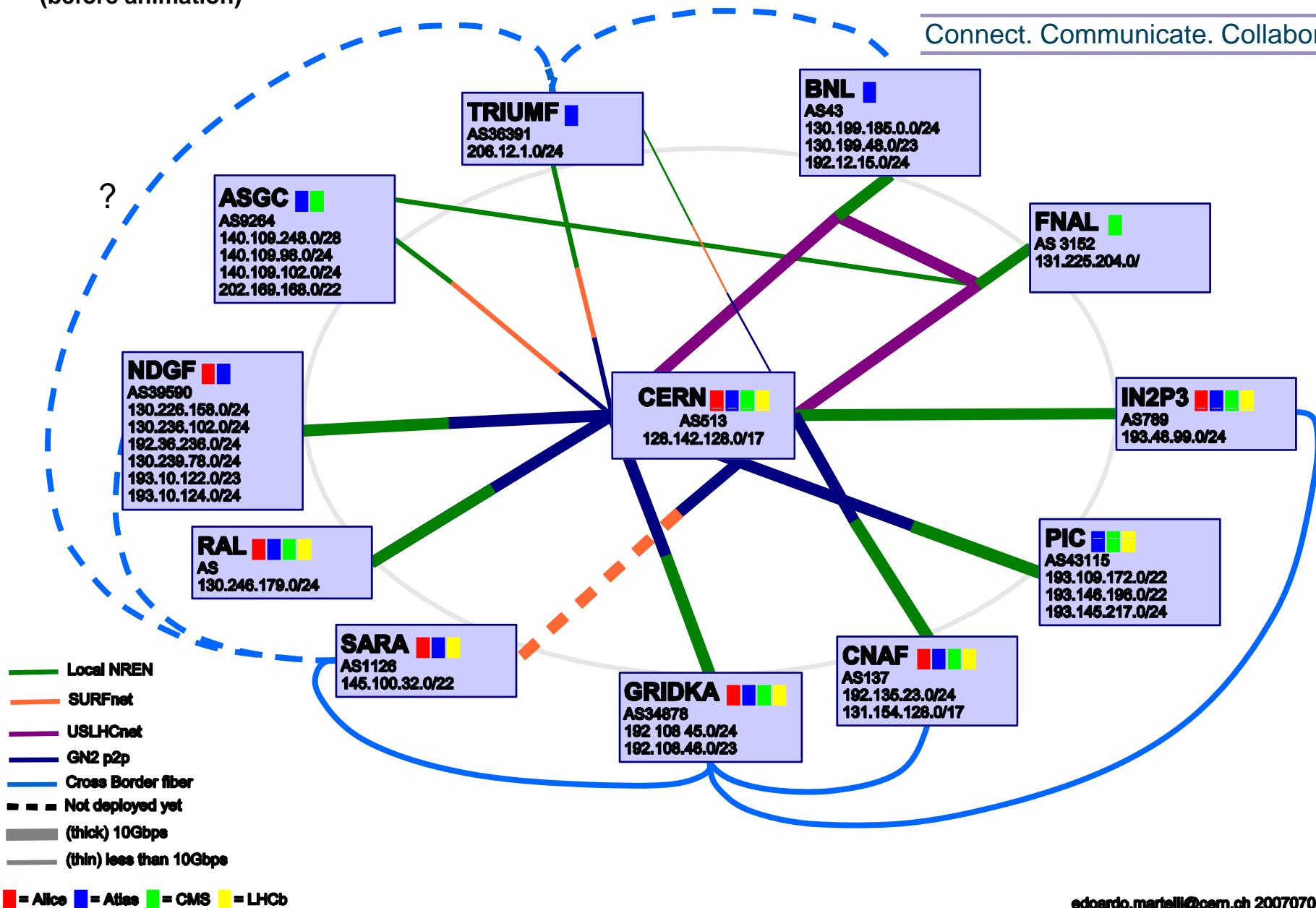


# e.g. GÉANT2 Fra-Gen EDFA failure

(before animation)



Connect. Communicate. Collaborate

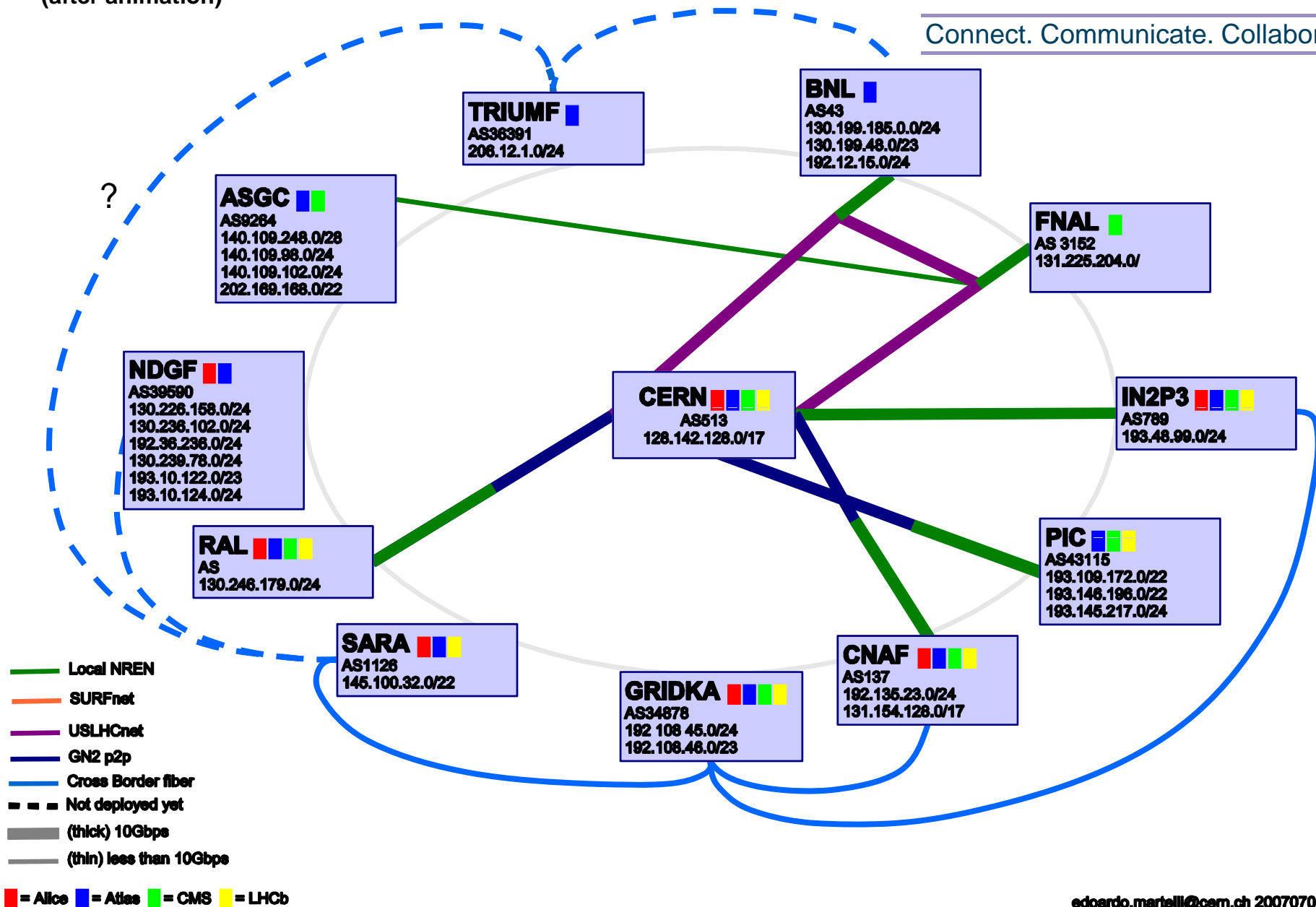


# e.g. GÉANT2 Fra-Gen EDFA failure

(after animation)



Connect. Communicate. Collaborate



# (Reminder of) Conclusions (from last time)



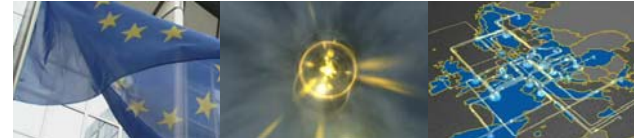
Connect. Communicate. Collaborate

- RAL & PIC need backups!!!
- CNAF needs a 3<sup>rd</sup> route into CERN
- SARA-NDGF should be routed on northern leg of NORDUnet's "Southern Cross" (for Cop-Ham part)
  - via Padborg, Kolding, Odense
- Reroute 2 Amsterdam-CERN lambdas via Lyon
- Reroute USLHCNET (FNAL-CERN) via Lyon
- Further investigations required in particular concerning:
  - Physical routing of GRIDKA-IN2P3 in Paris area
  - Leased lambdas passing through London



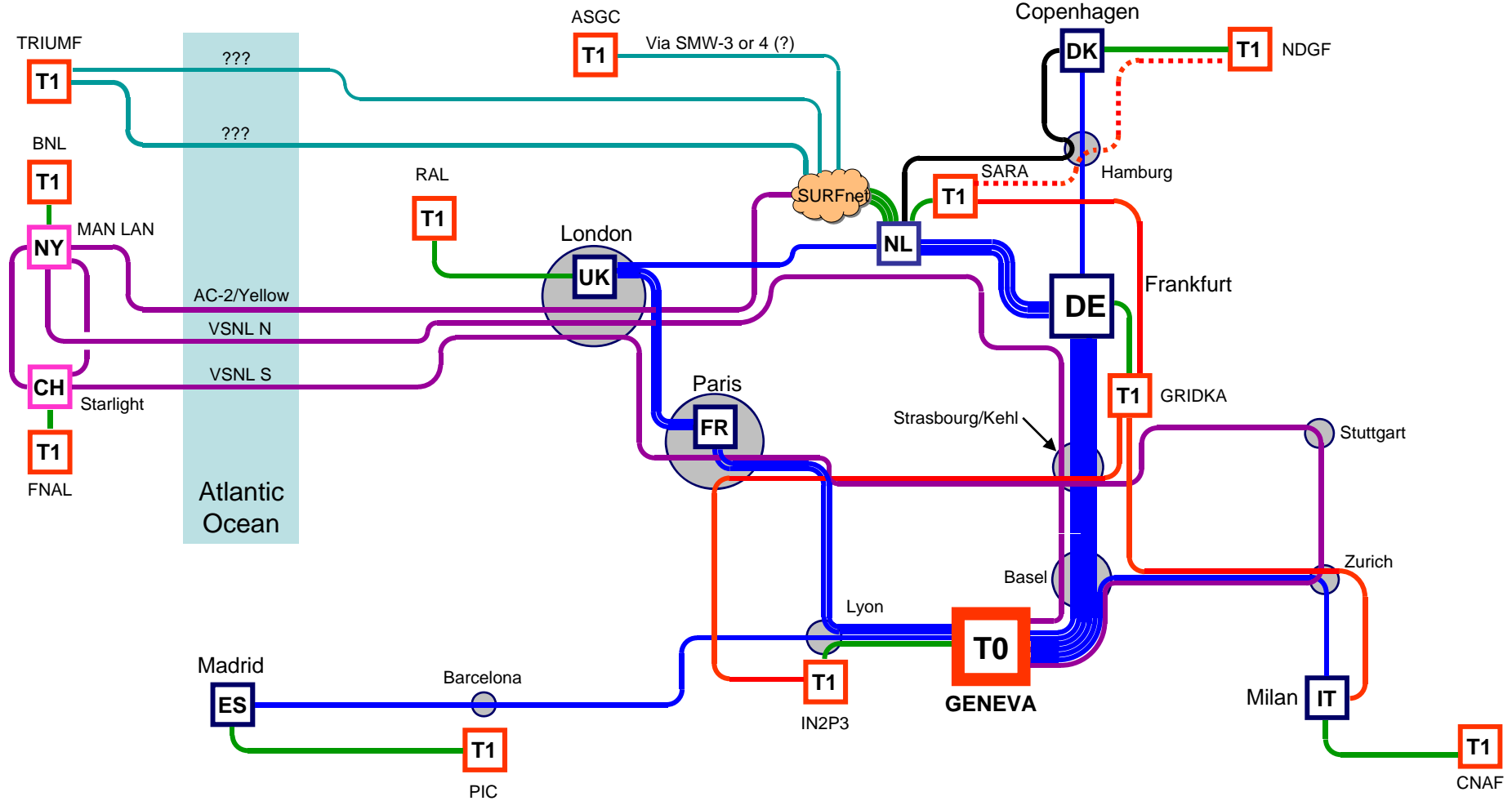
Connect. Communicate. Collaborate

# Mitigations (on the way)...



# Route SARA-CERN via Lyon

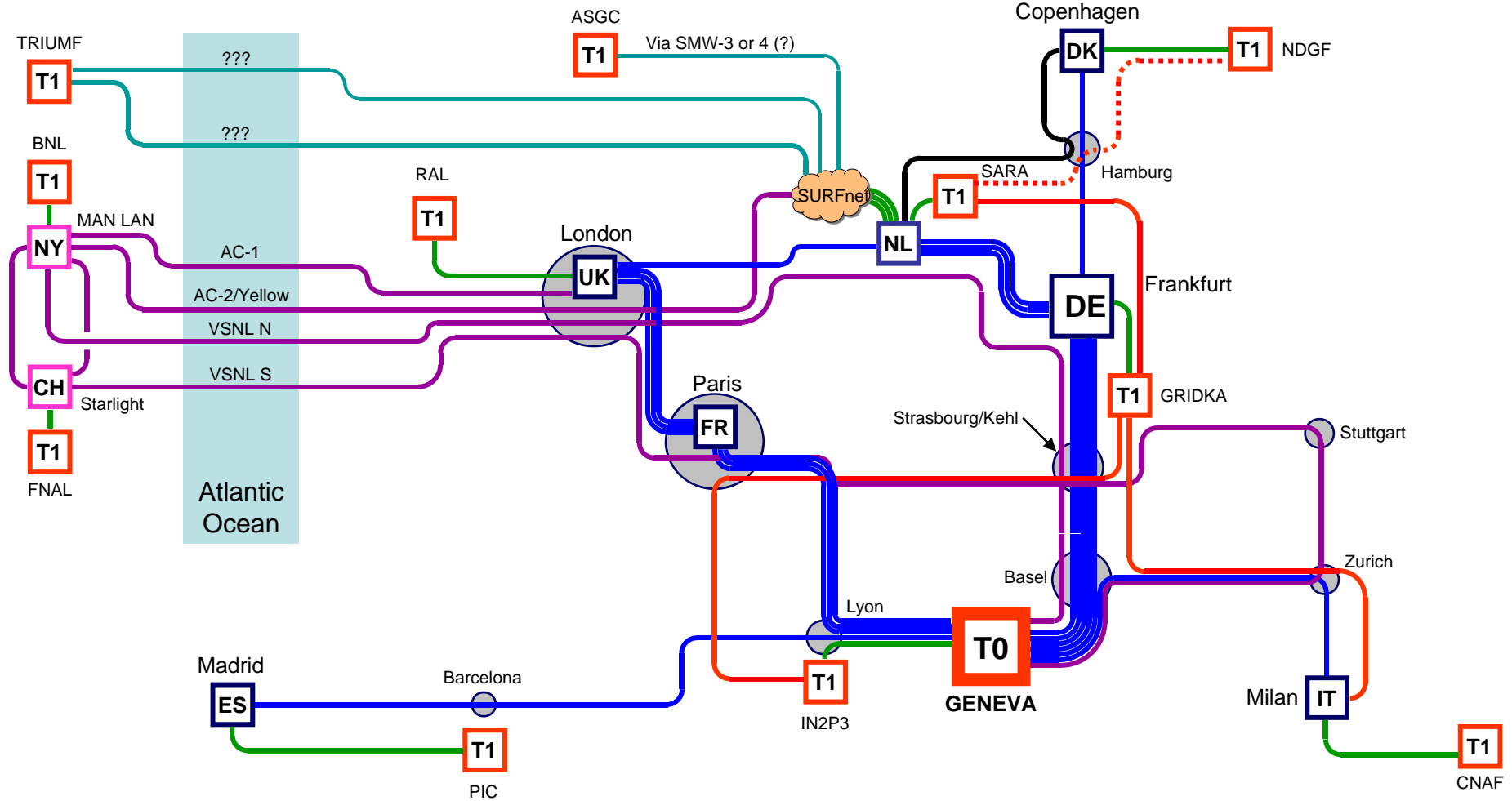
Connect. Communicate. Collaborate





# Add USLHCNET lambda #4

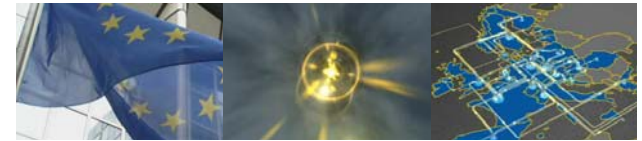
Connect. Communicate. Collaborate.



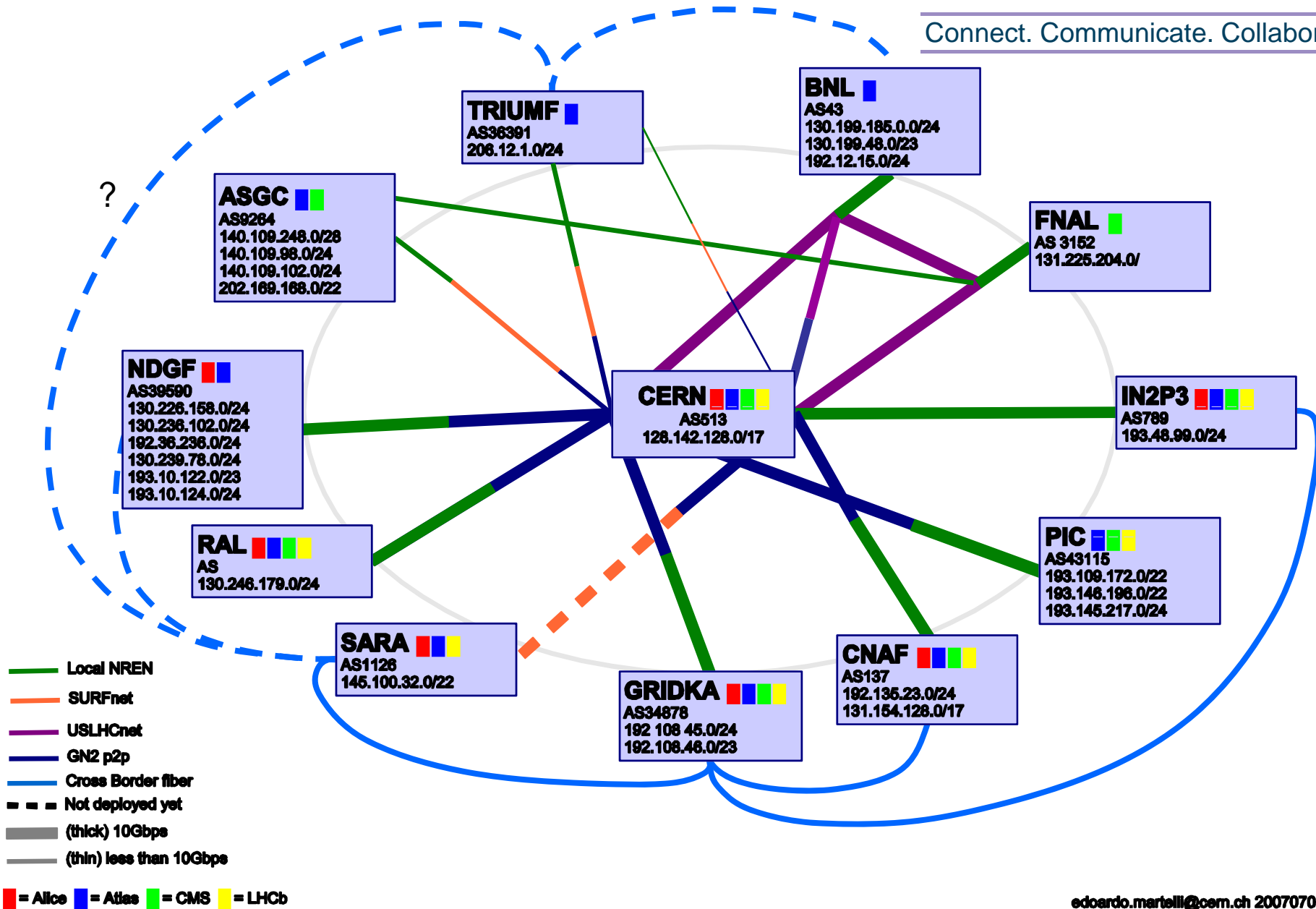


# Big fibre cut Basel-Geneva

(before animation)

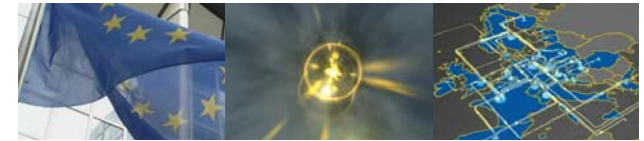


Connect. Communicate. Collaborate

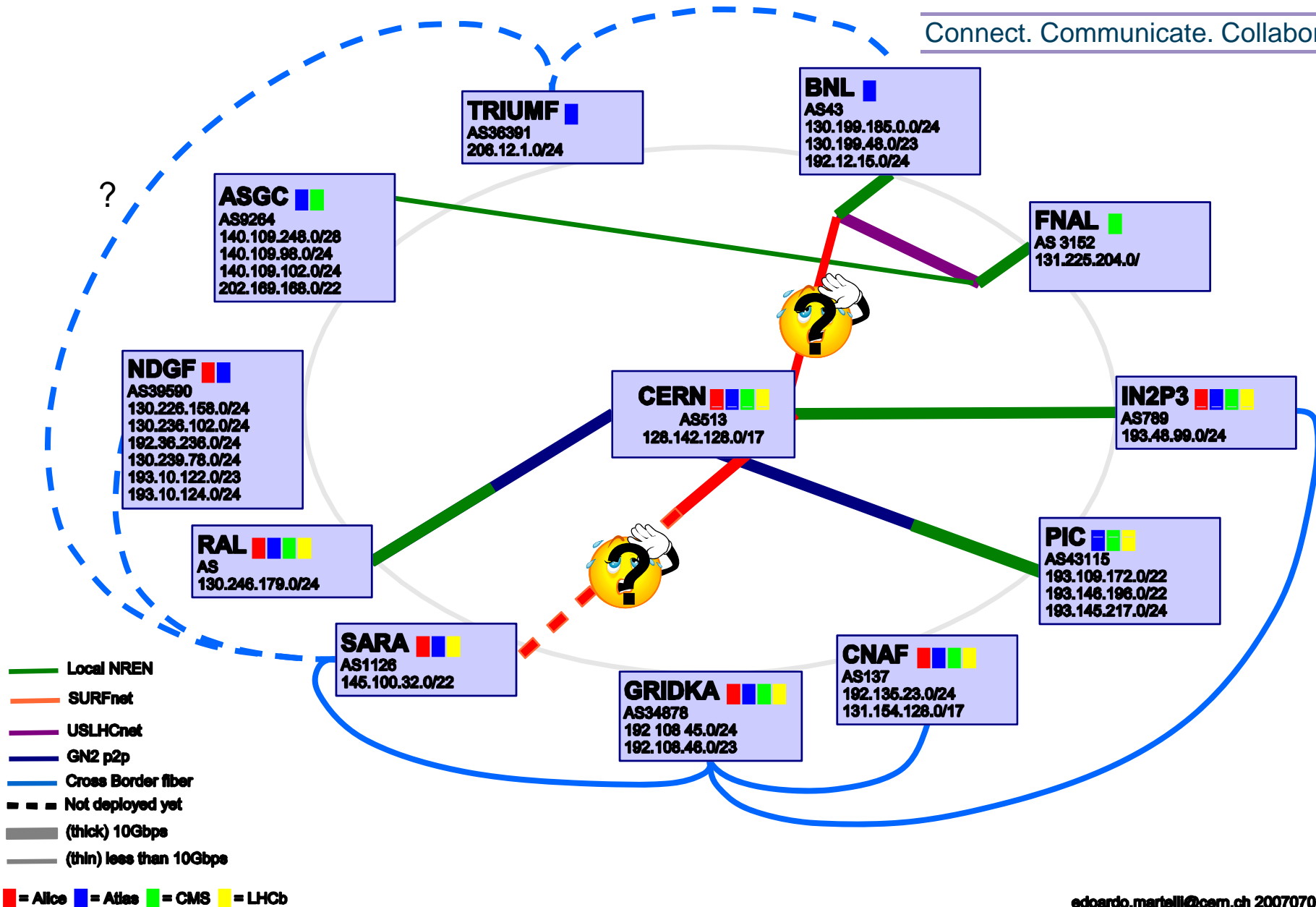


# Big fibre cut Basel-Geneva

(after animation)

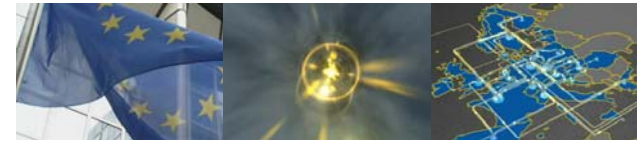


Connect. Communicate. Collaborate

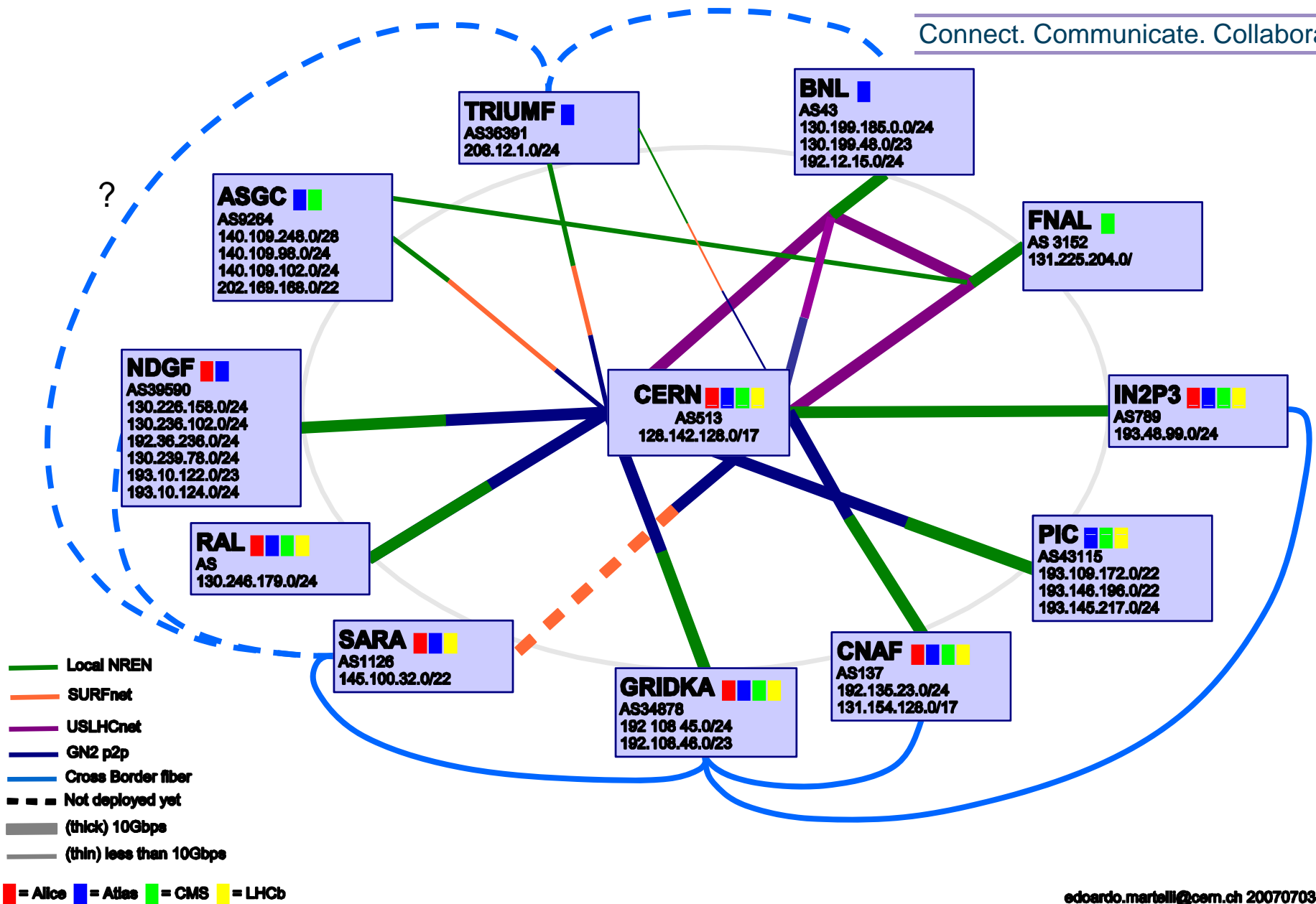


# Big fibre cut Lyon-Geneva

(before animation)



Connect. Communicate. Collaborate

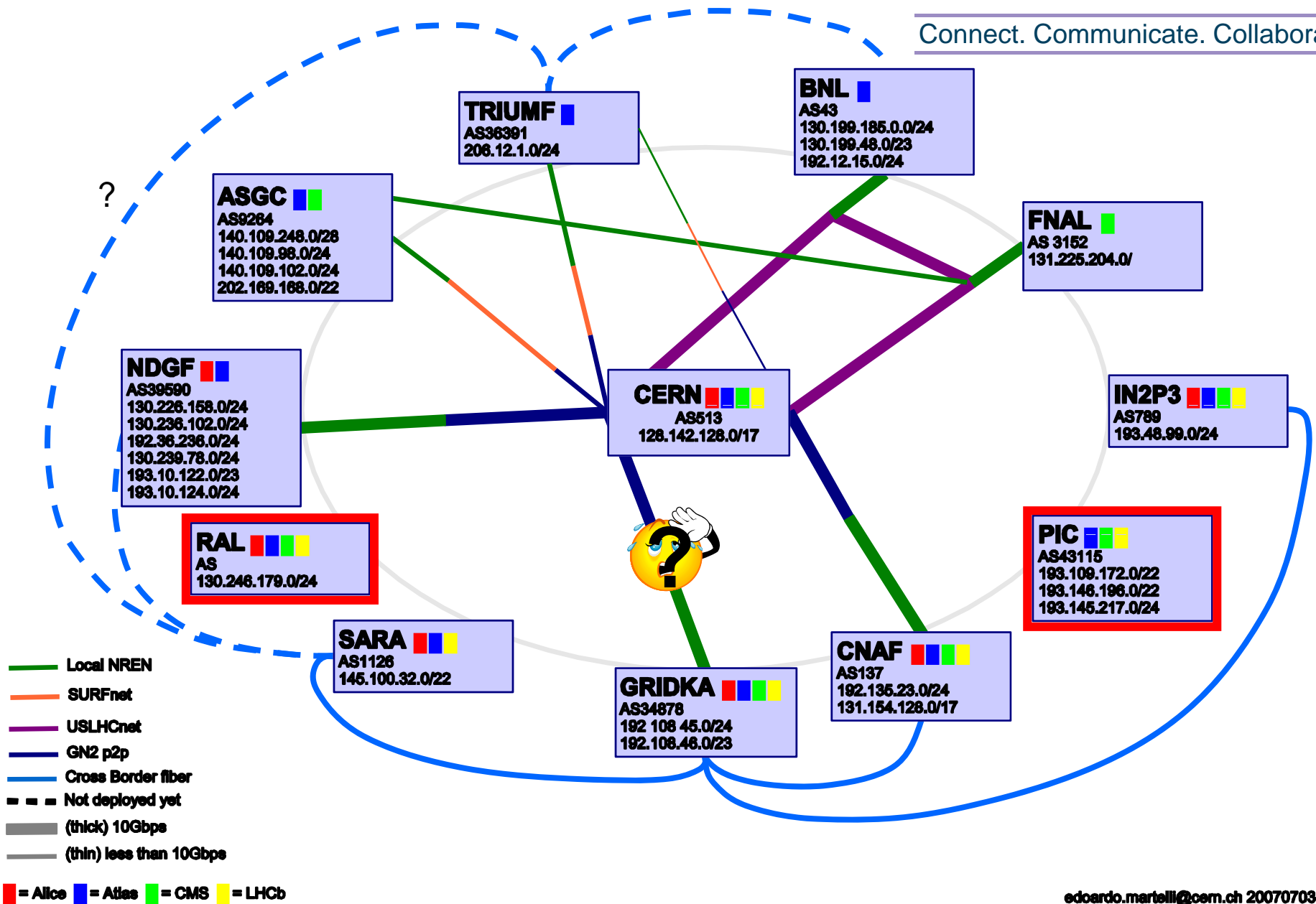


# Big fibre cut Lyon-Geneva

(after animation)

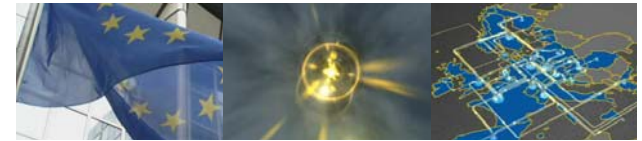


Connect. Communicate. Collaborate

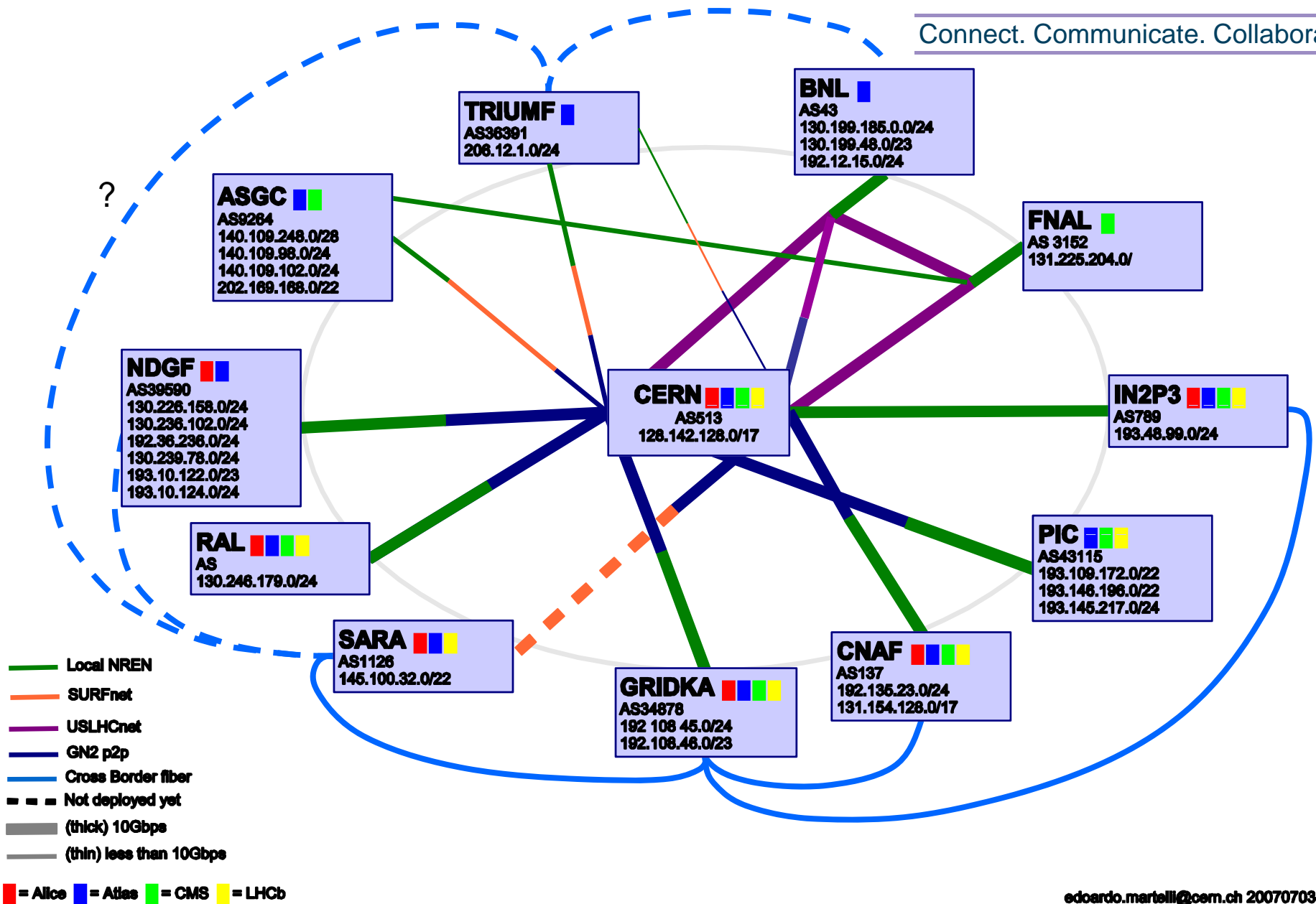


# Big fibre cut Zurich-Basel

(before animation)

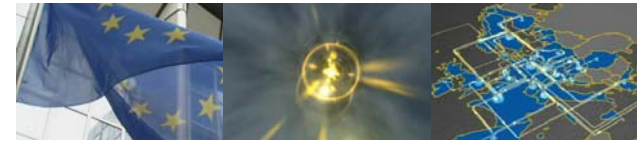


Connect. Communicate. Collaborate

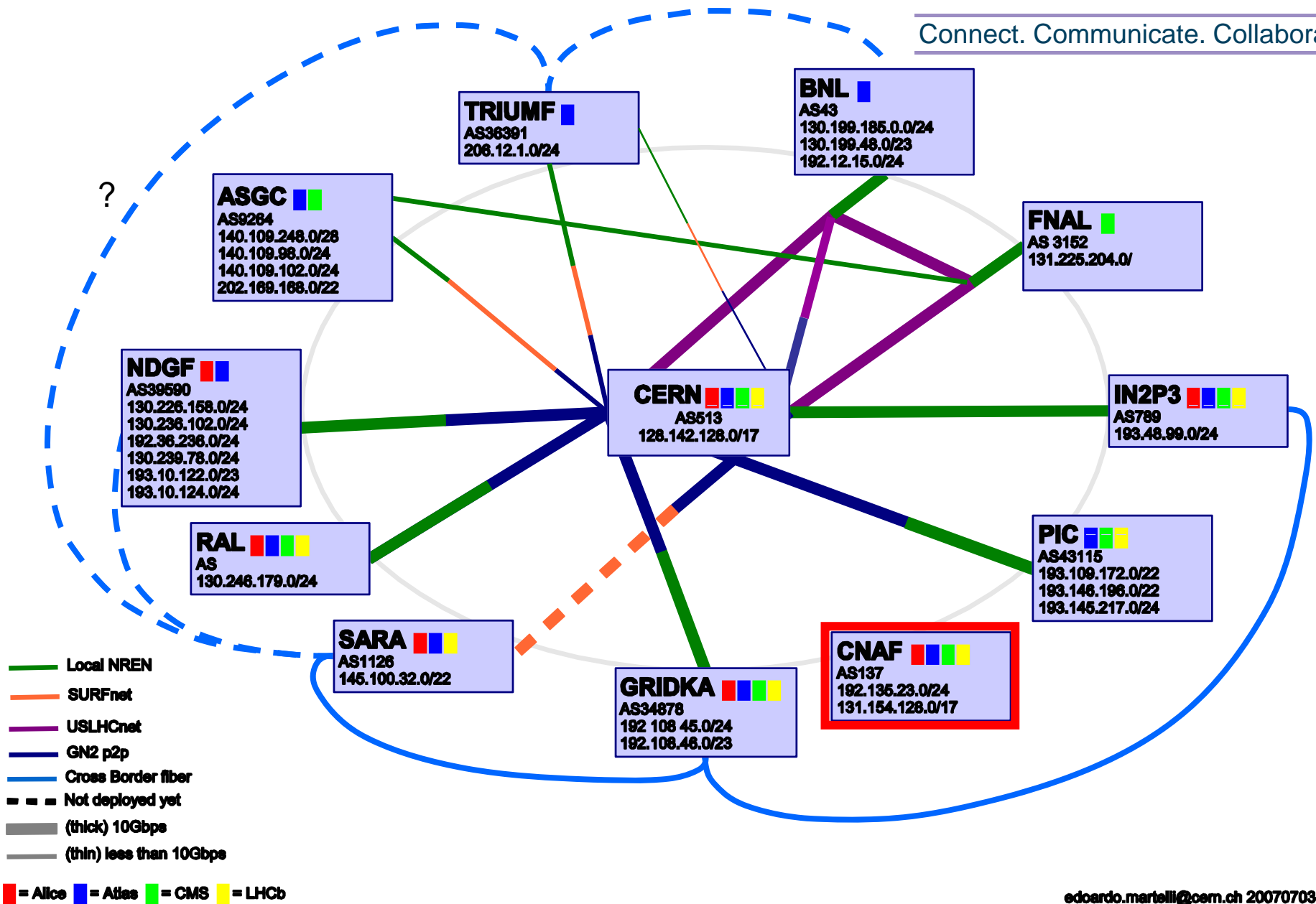


# Big fibre cut Zurich-Basel

(after animation)



Connect. Communicate. Collaborate





Connect. Communicate. Collaborate

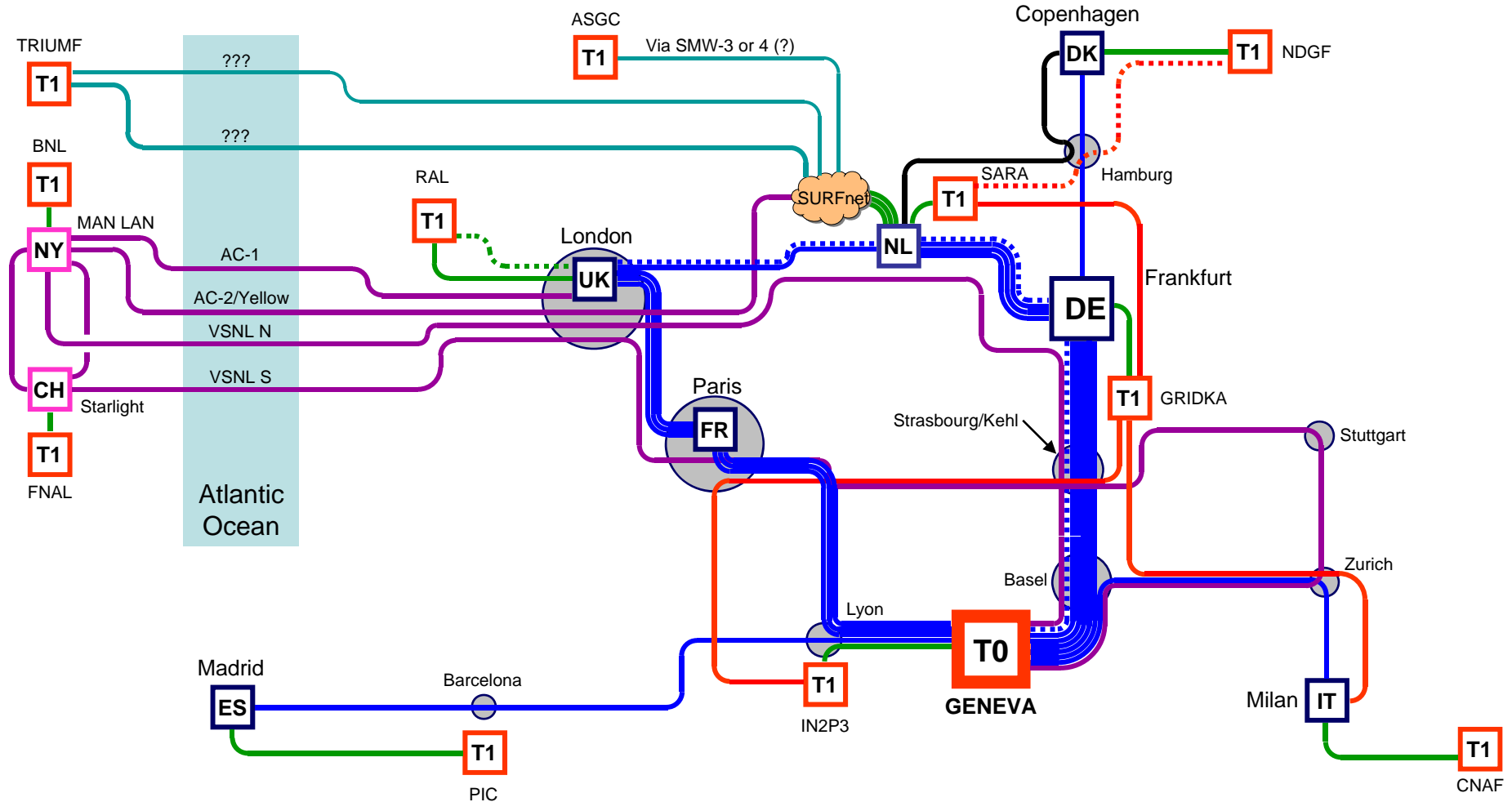
Still need to...



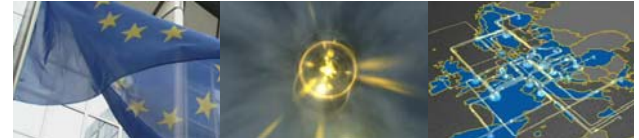


# Add RAL backup via Frankfurt

Connect. Communicate. Collaborate

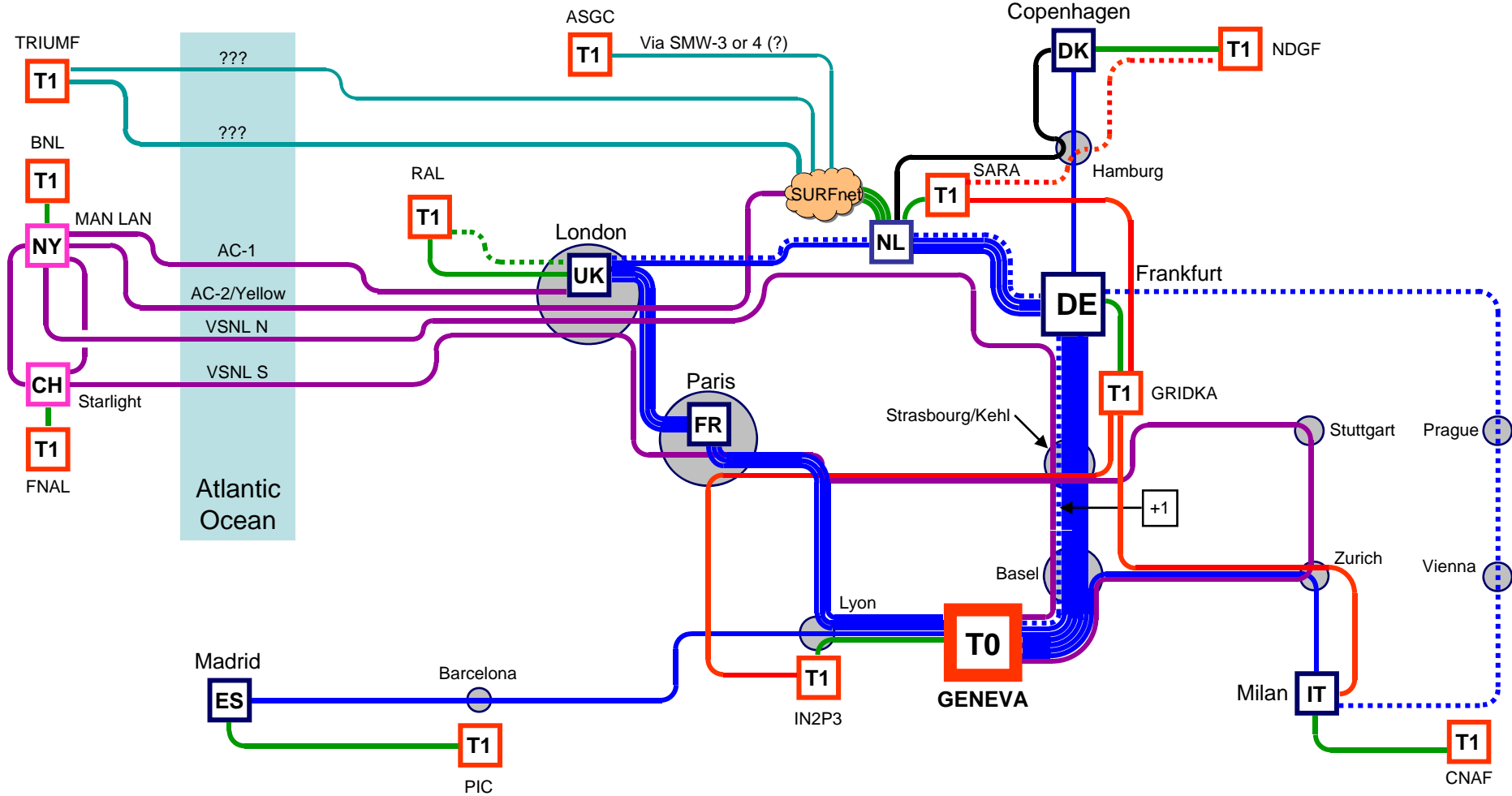






# Add CNAF backup via Vienna

Connect. Communicate. Collaborate



# And add PIC backup via Paris (or CBF arrangement)



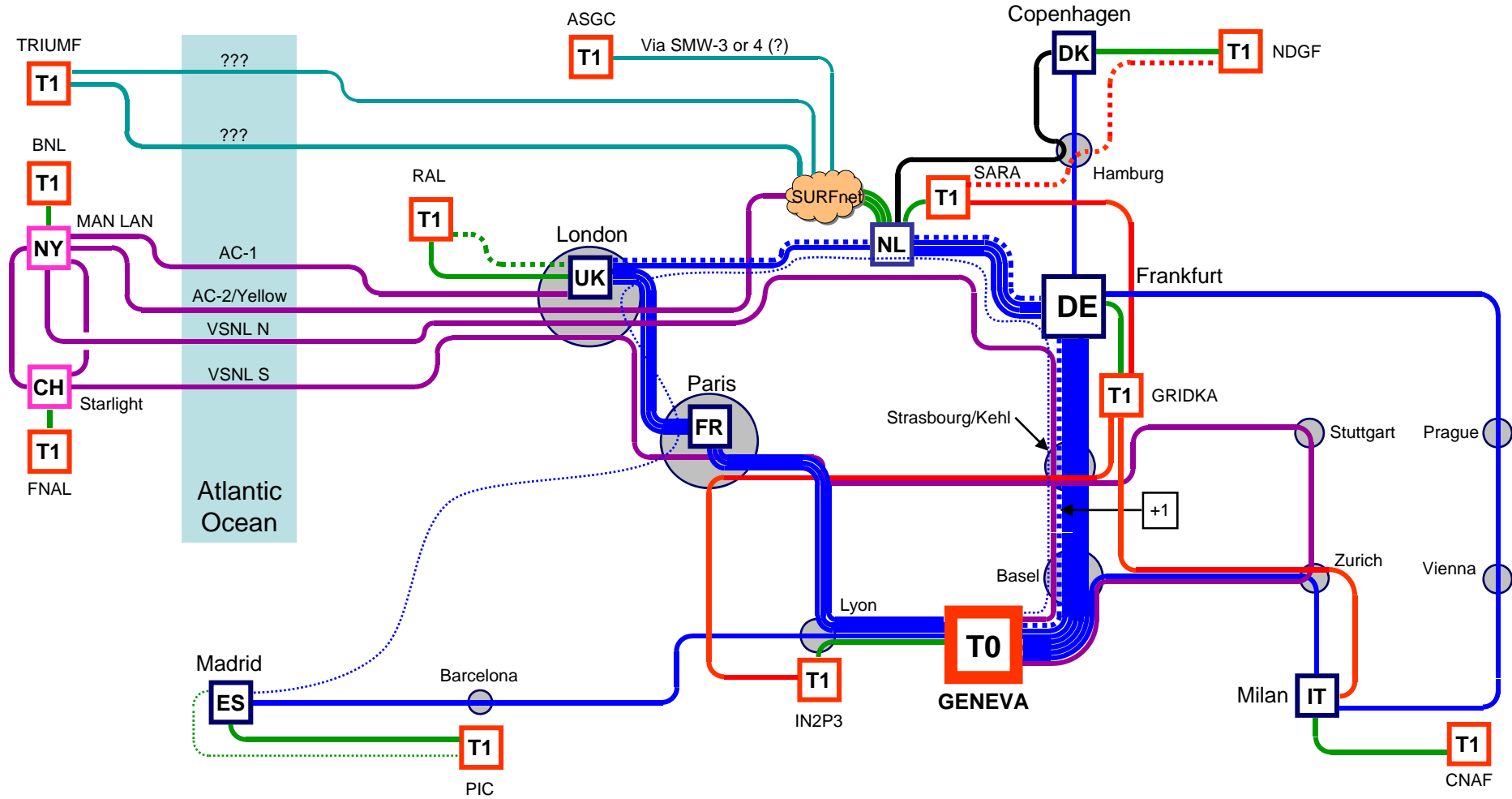
Connect. Communicate. Collaborate

- Can use GÉANT+ (for 1 or 2 Gbit/s circuit) temporarily
- Lease lambda Madrid-Paris
- Extend lambda via London-Amsterdam-FFM to CERN
  - Or maybe use CBF for Paris-Strasbourg/Kehl-GRIDKA?
- OR can extend lambda down to Geneva via Lyon
  - Via GÉANT2 fibre or RENATER fibre
- OR can use LCAS semi-protected 10GE service...
  
- CBF prospect (via Perpignan) has been mooted in the past but prospect not currently looking good...



# Add PIC backup (GÉANT+)

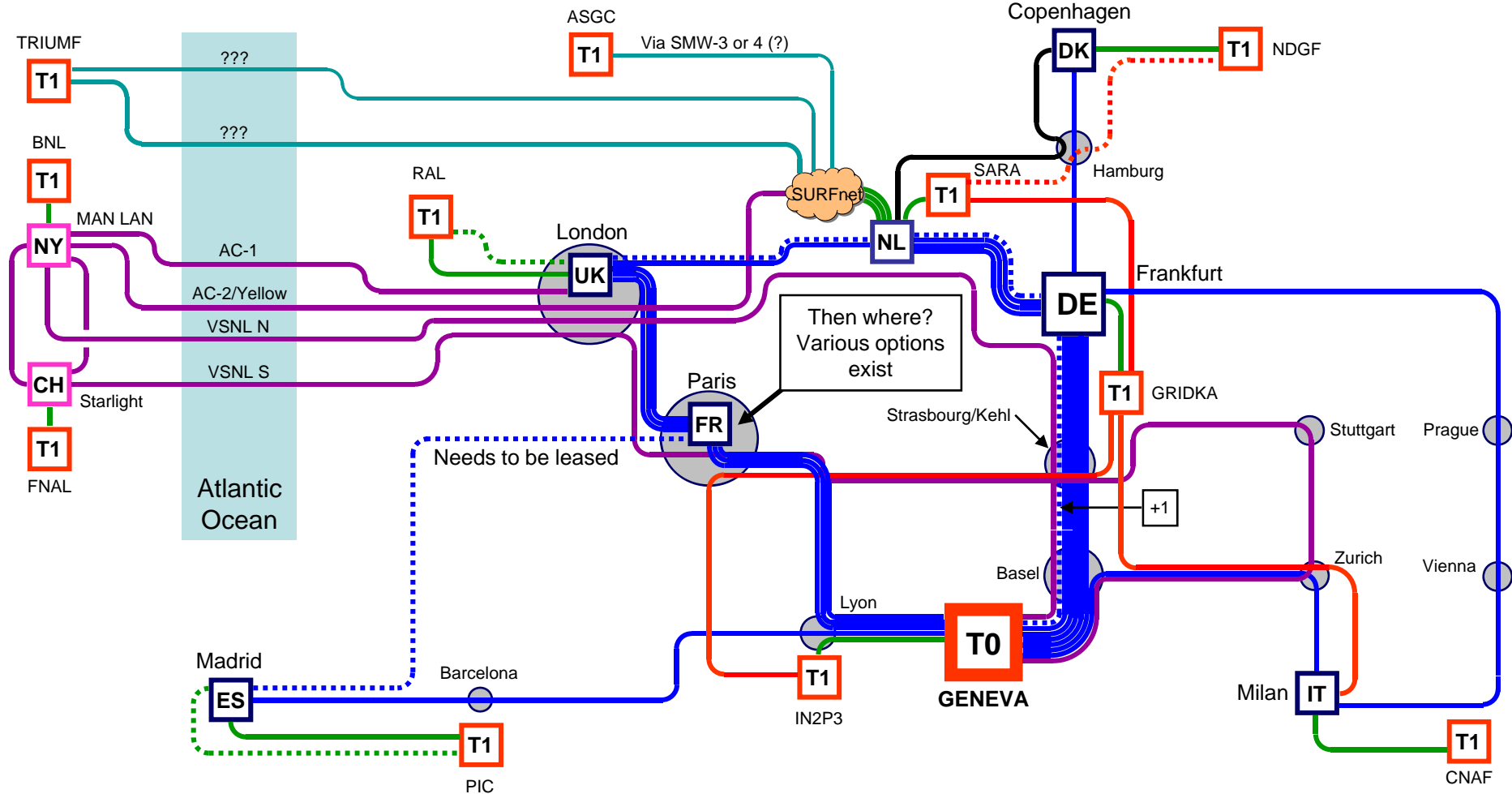
Connect. Communicate. Collaborate





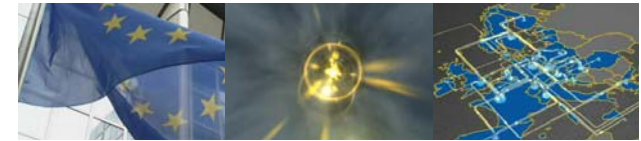
Connect. Communicate. Collaborate

# Add PIC backup (full lambda)

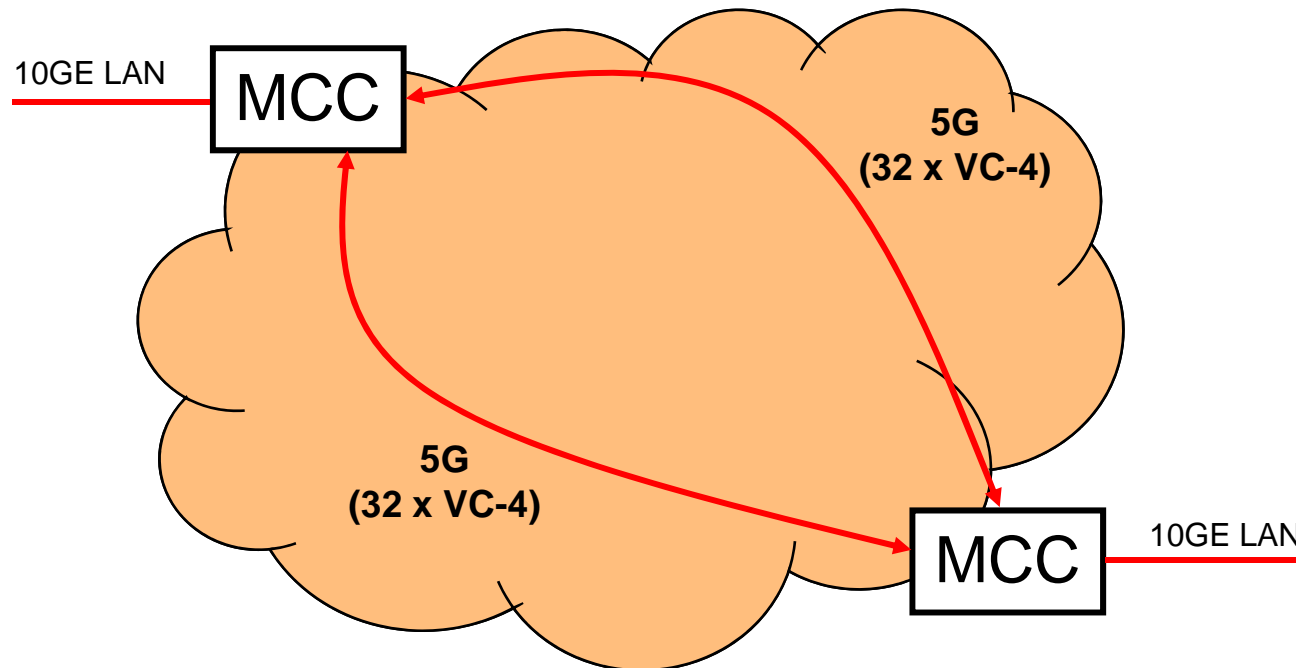


# LCAS semi-protected 10GE

(is technically possible)



Connect. Communicate. Collaborate



## Caveats:

- OWD is the longest of the two paths (~13ms for Amsterdam-Geneva)
- not quite full 10GE LAN PHY rate (~9.6Gbps)
- capacity reduced by 50% during single outage
- 10-20s of full outage following failure event (further testing under way)
- “protection” is only across GÉANT2
- only possible for Ethernet LAN-PHY services
- (more details at end)



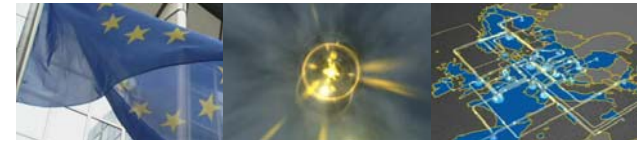
Connect. Communicate. Collaborate

# Updated “what-if” scenarios...

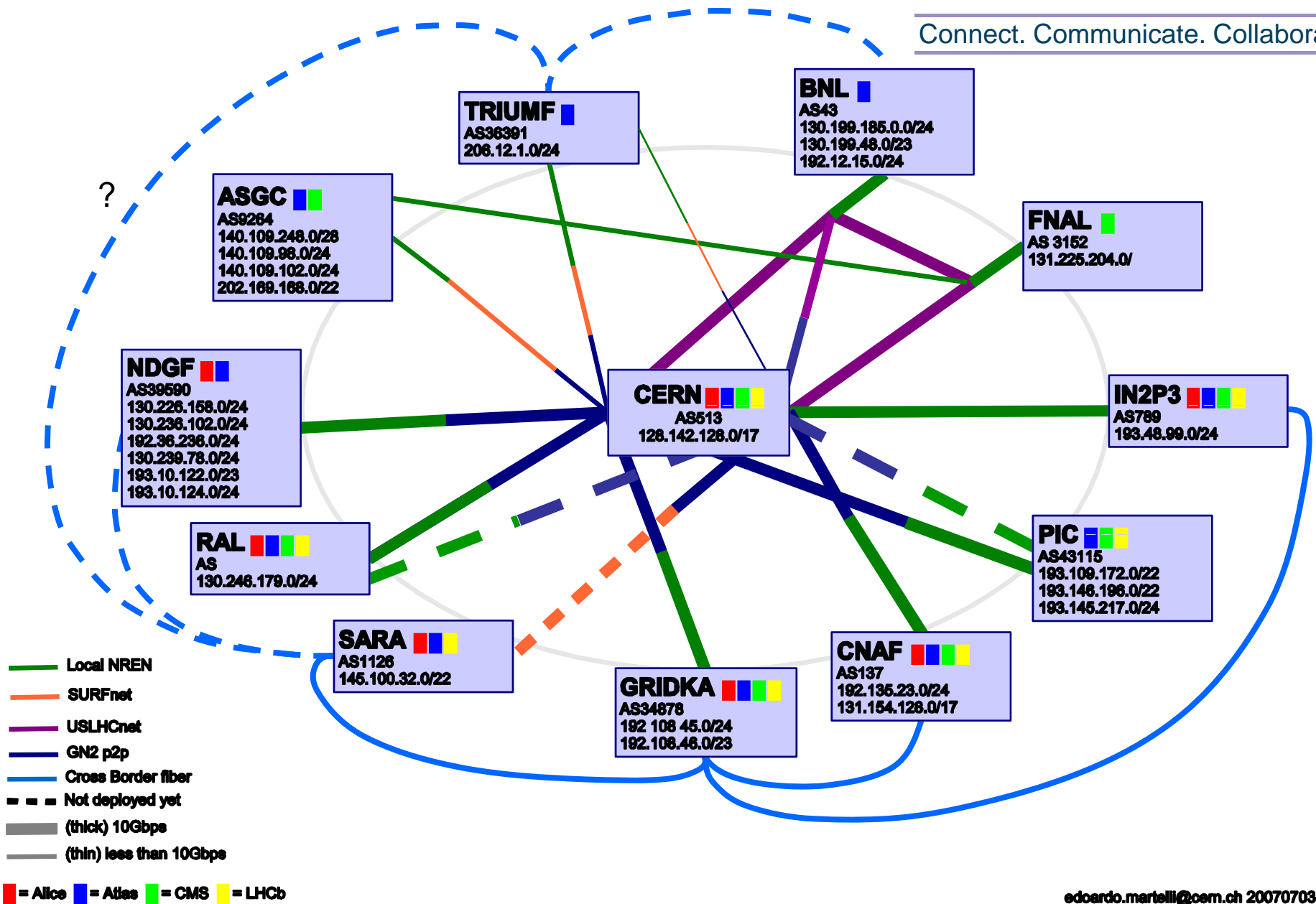


# Big fibre cut Basel-Geneva

(before animation)

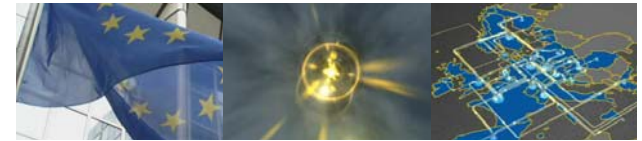


Connect. Communicate. Collaborate

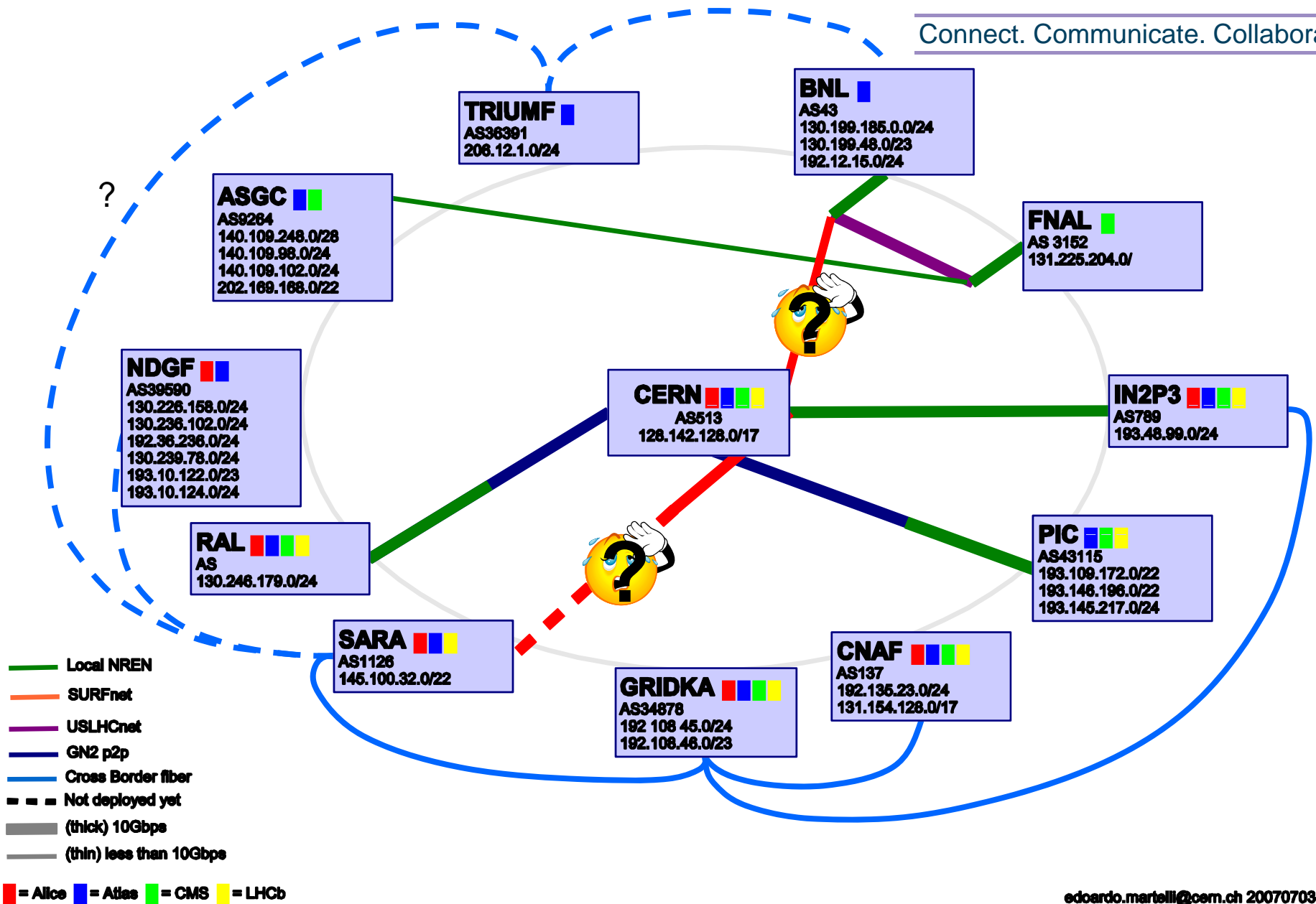


# Big fibre cut Basel-Geneva

(after animation)



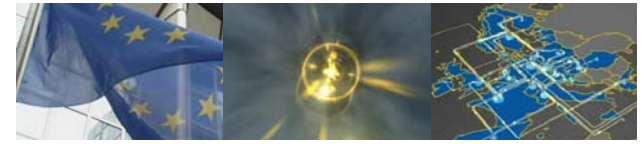
Connect. Communicate. Collaborate



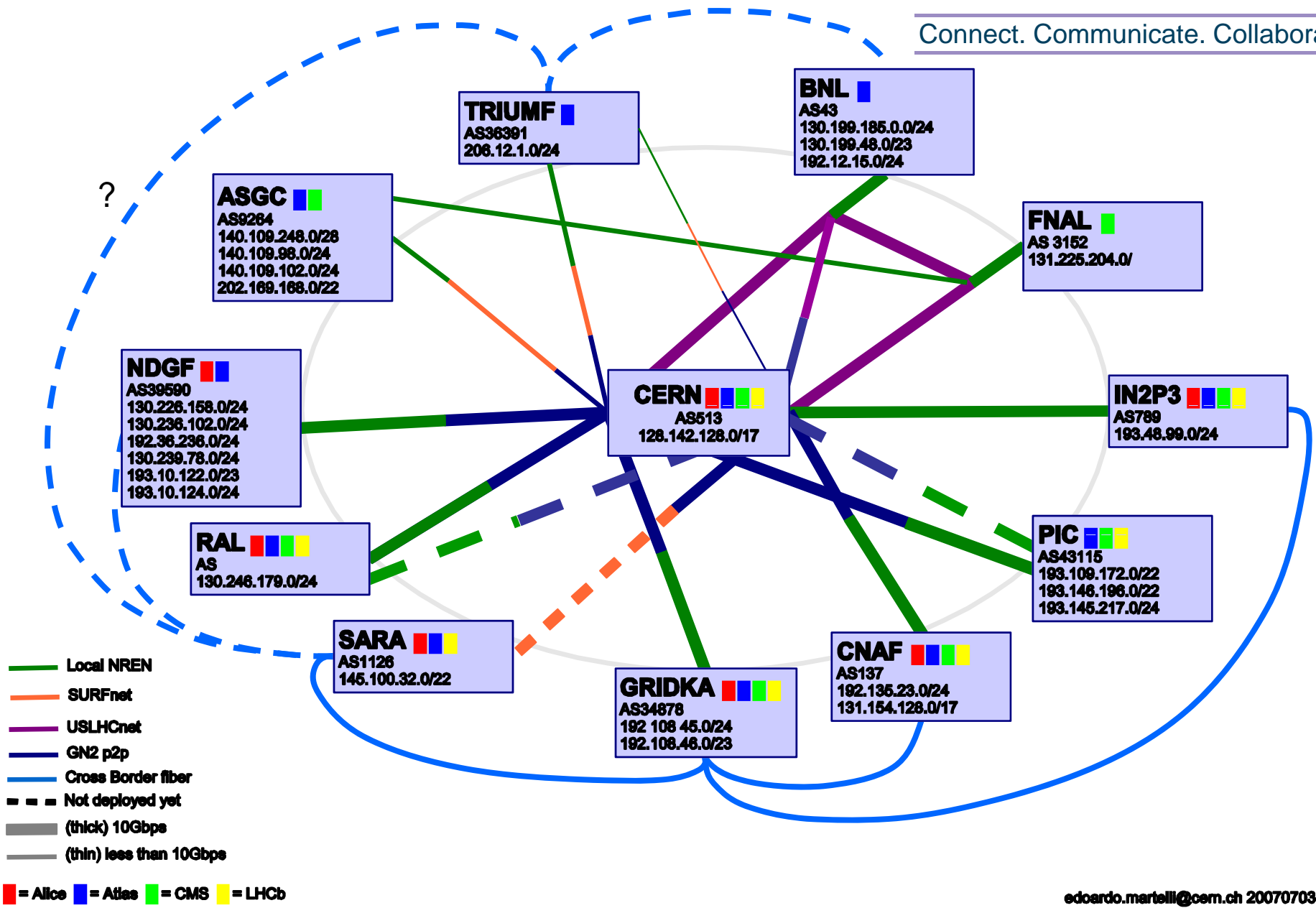


# Big fibre cut Lyon-Geneva

(before animation)



Connect. Communicate. Collaborate

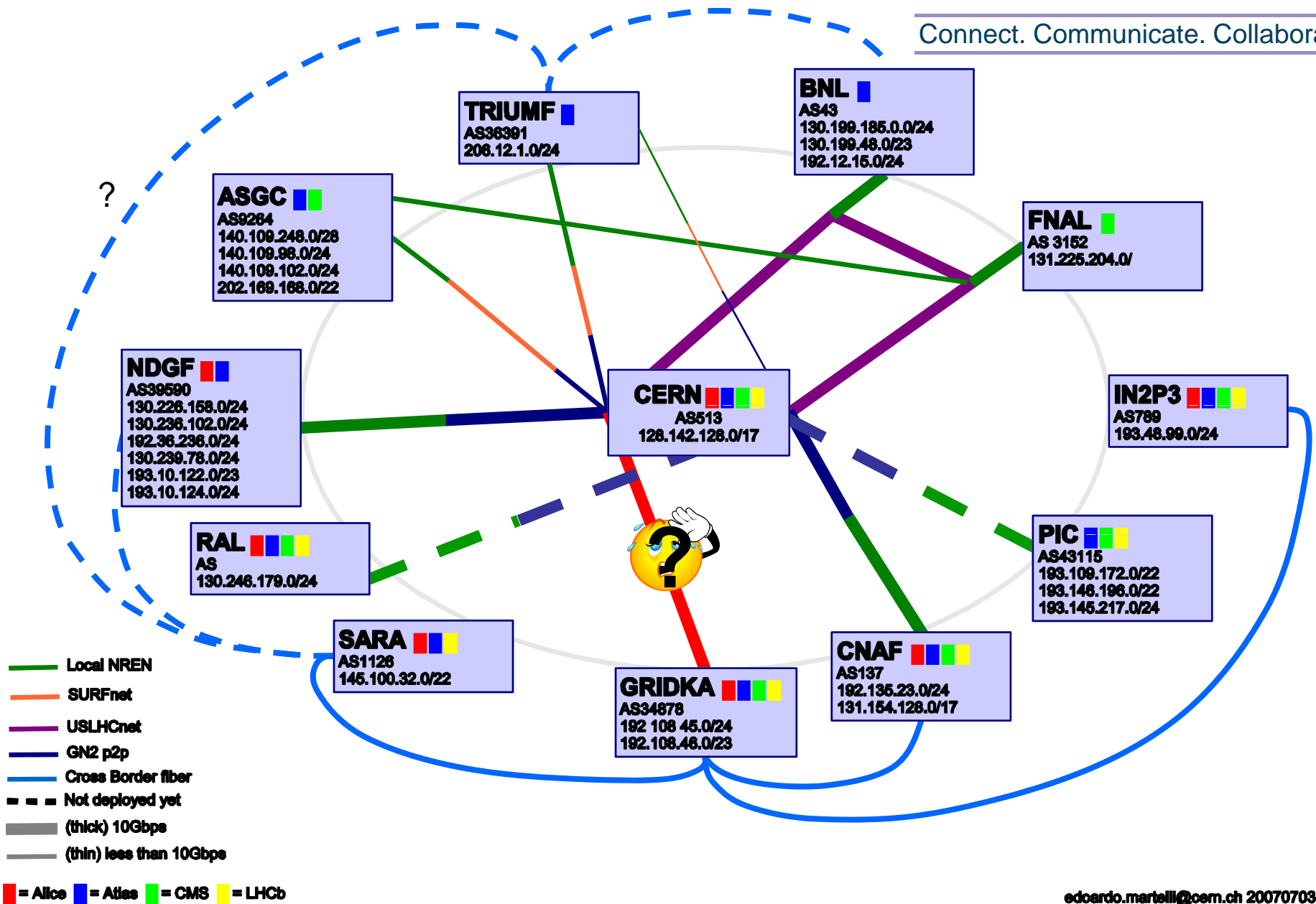


# Big fibre cut Lyon-Geneva

(after animation)

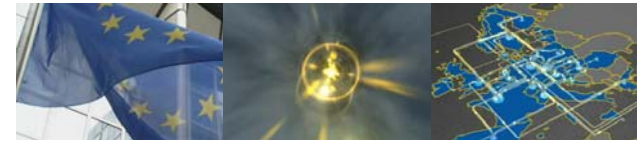


Connect. Communicate. Collaborate

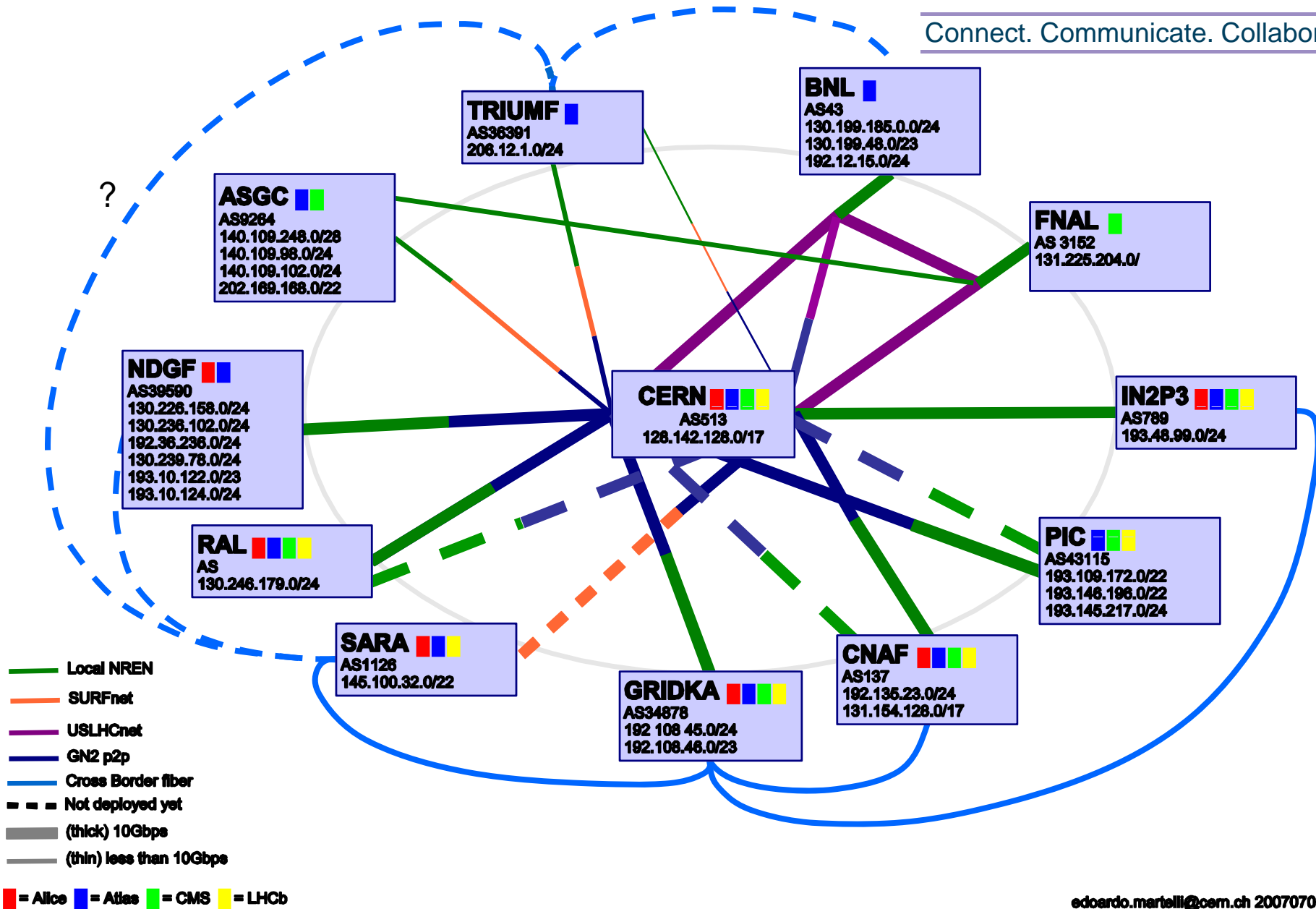


# Big fibre cut Zurich-Basel

(before animation)

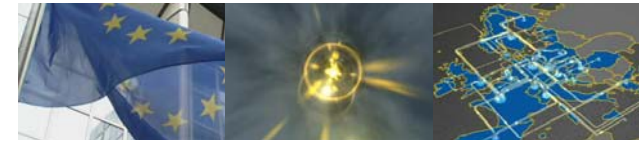


Connect. Communicate. Collaborate

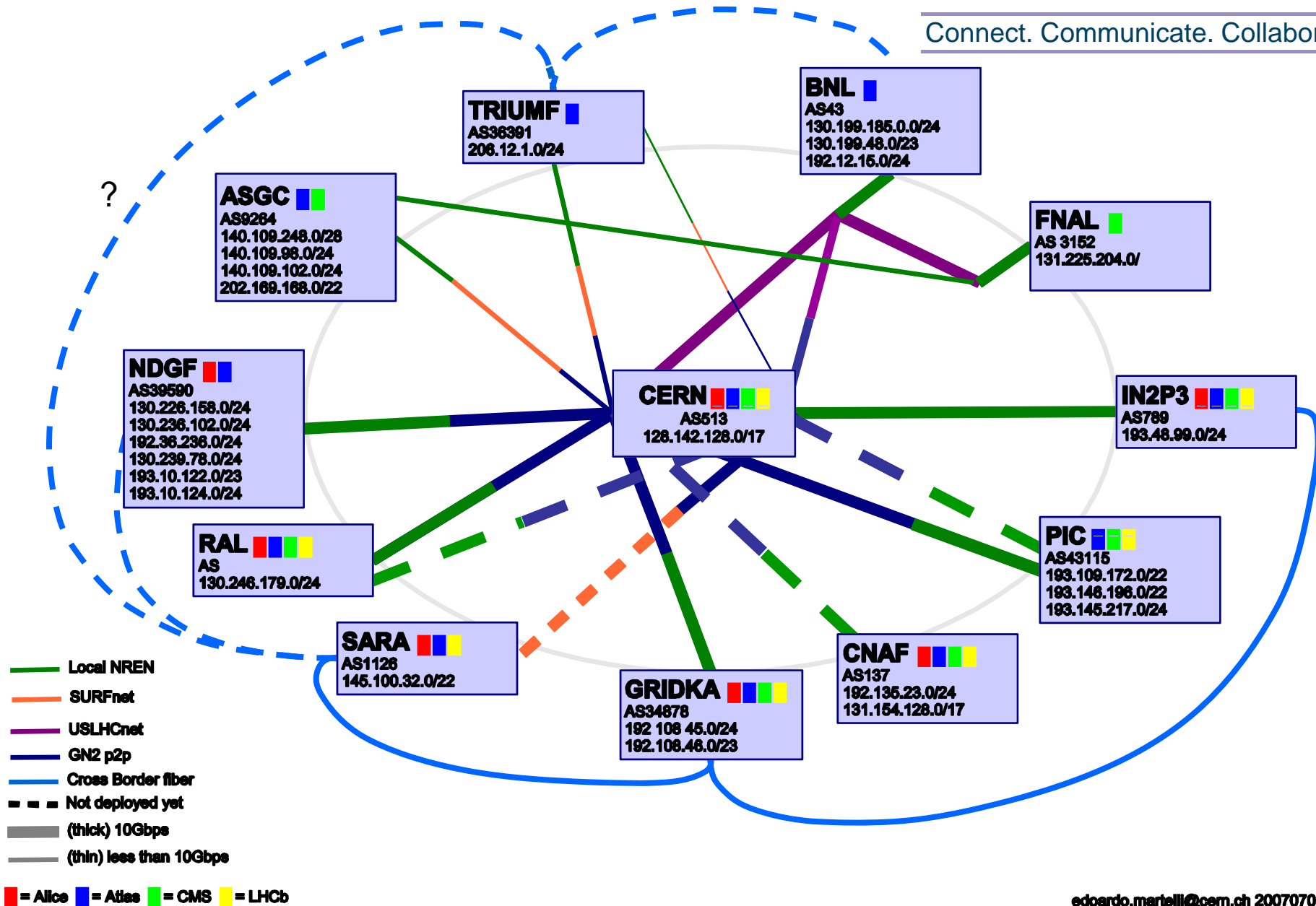


# Big fibre cut Zurich-Basel

(after animation)

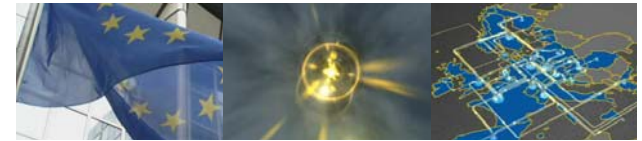


Connect. Communicate. Collaborate

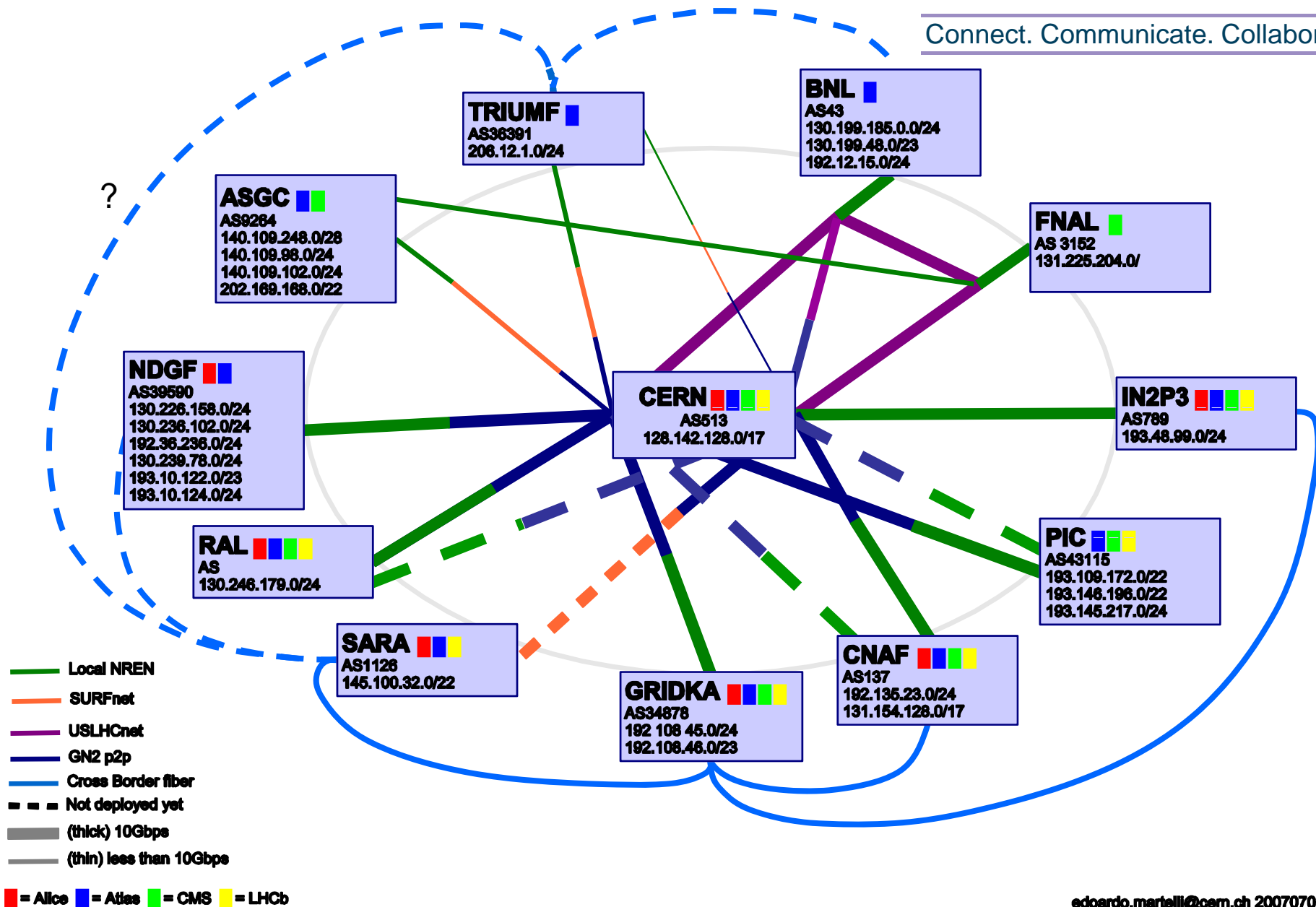


# Big fibre cut Strasbourg area

(before animation)

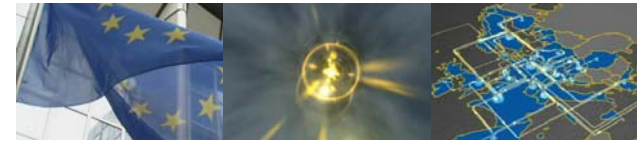


Connect. Communicate. Collaborate

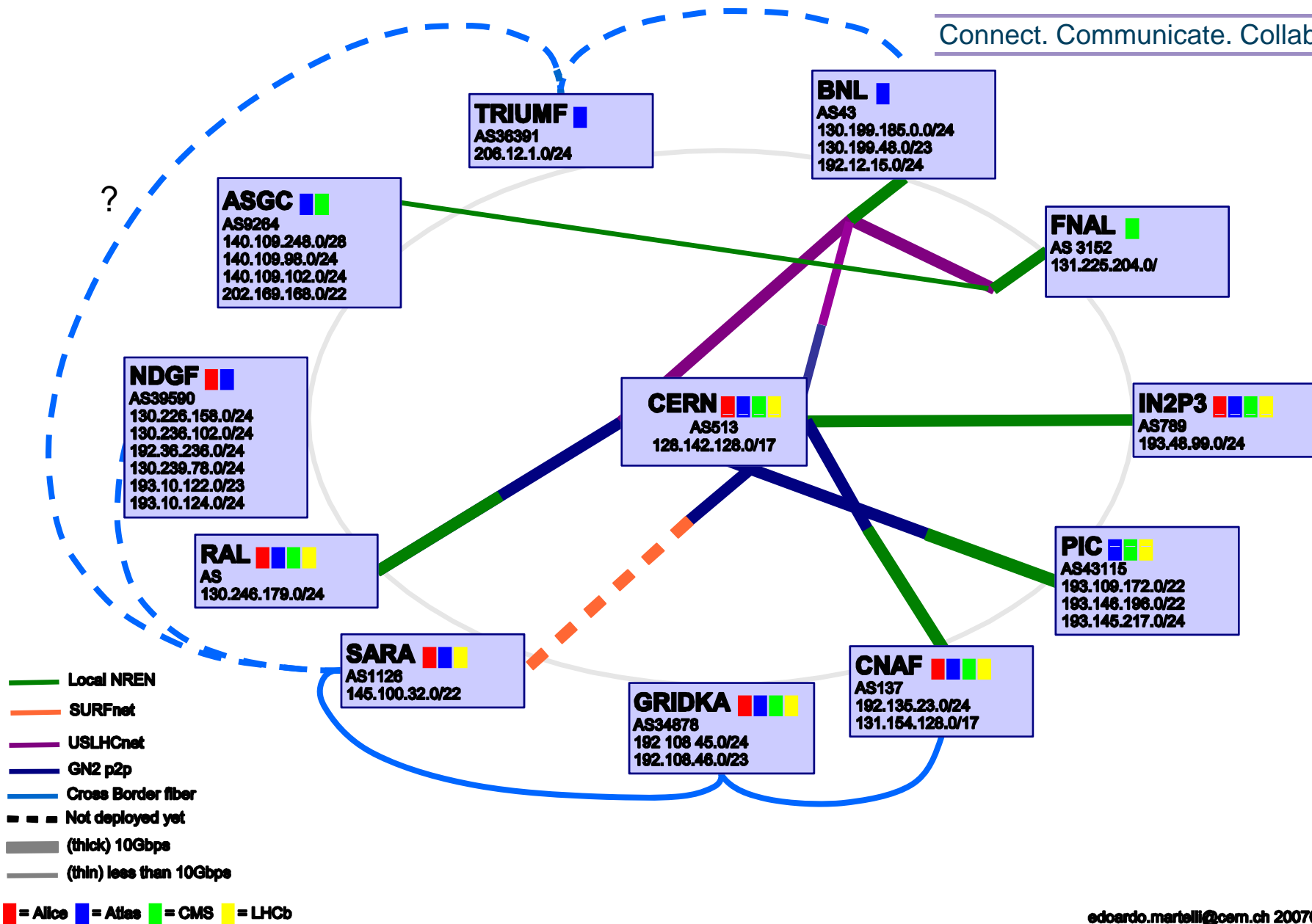


# Big fibre cut Strasbourg area

(before animation)



Connect. Communicate. Collaborate





Connect. Communicate. Collaborate

# Latest Conclusions

- SARA-CERN lambda has been rerouted (or soon will be)
- 4<sup>th</sup> diverse USLHCNET lambda will be added
- Can do “LCAS protected 10GE” for ASGC
- RAL & PIC still need backups!!!
  - LCAS “semi-protected” 10GE is technically possible but with caveats
- CNAF needs a 3<sup>rd</sup> route into CERN
  - Long route around “eastern ring” OR
  - New CBF solution(s)...
- Further investigations required in particular concerning:
  - Physical routing of GRIDKA-IN2P3 in Paris area
  - Leased lambdas passing through UK



Connect. Communicate. Collaborate

# Questions?







Connect. Communicate. Collaborate

# Additional slides





Connect. Communicate. Collaborate

# LCAS testing (10GE)



# LCAS

## Testbed Measurements



Connect. Communicate. Collaborate

- LCAS evaluation is performed on the DANTE testbed
- Iperf servers are connected directly to MCC 10GE ports
- Alcatel's 'diverse routing' option alternates VC-4 trails between two diverse paths
- VCG supports up to 32ms of path length difference –note that the net path latency is equal to the latency of the LONGEST path!

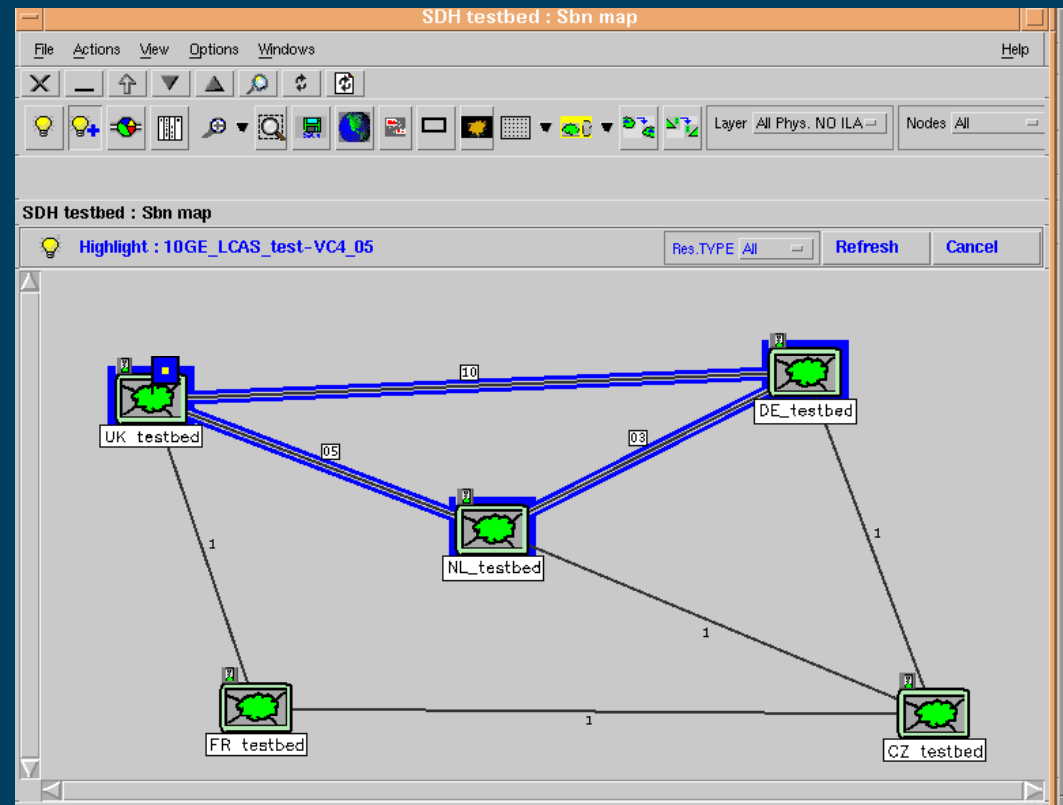
# LCAS Testbed Measurements



Connect. Communicate. Collaborate

First diverse path:

- London – Amsterdam – Frankfurt – London has a one way delay of 15.5ms



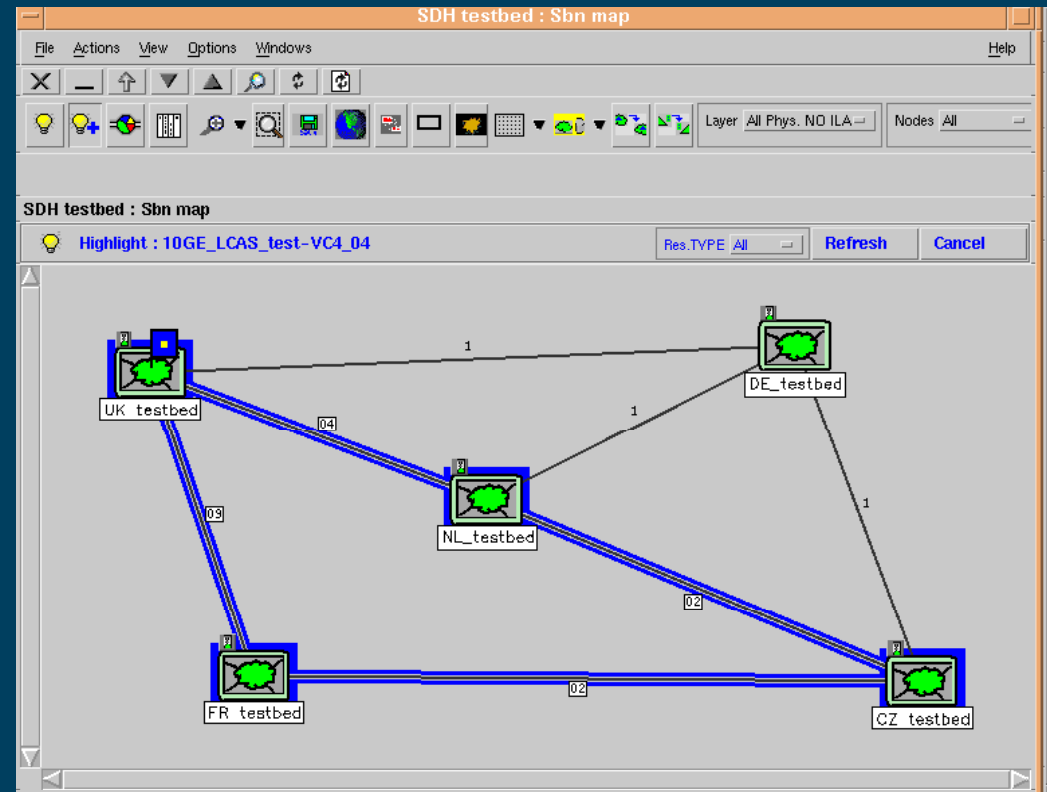
# LCAS Testbed Measurements



Connect. Communicate. Collaborate

## Second diverse path

- London – Amsterdam – Prague – Paris - London has a one way delay 27.7 ms
- Path latency difference is 12.2 ms



# LCAS

## Testbed Measurements



Connect. Communicate. Collaborate

- Throughput measurements are performed using Iperf on two servers with 10GE NICs in London
- TCP and UDP measurements
- 3 types of outages:
  - loss of optical signal on one leg
  - Remove cross-connects
  - Adjust bandwidth using LCAS

# TCP throughput: Fibre break



Connect. Communicate. Collaborate

