

Lambda Networking Research

www.science.uva.nl/~delaat/optical

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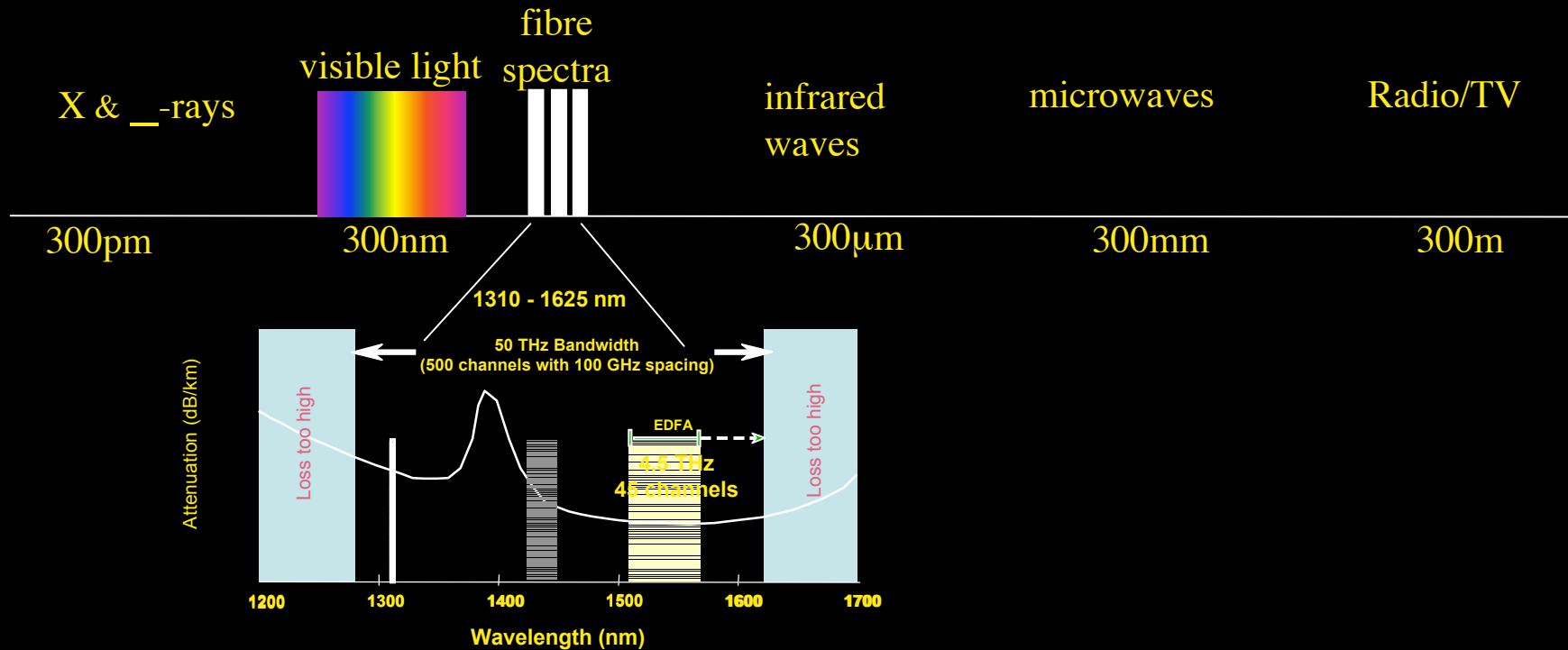


Contents of this talk

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What is a Wave?

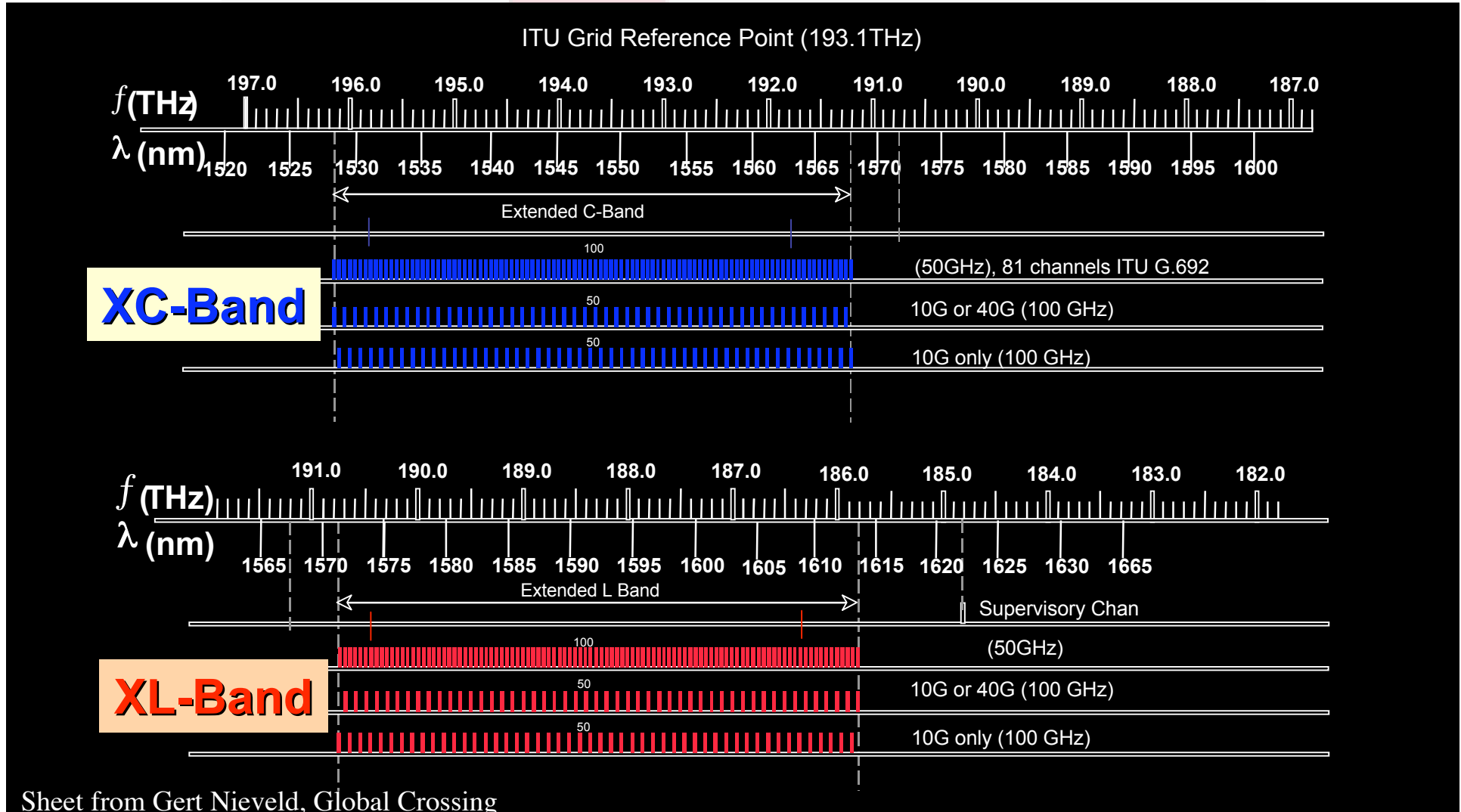


Sheet from Gert Nieveld, Global Crossing

*) S-Band is planned for the 1440 nm + range



C and L-band λ overview (terrestrial applications)



So, what's up doc

Suppose:

- **Optical components get cheaper and cheaper**
- **Dark (well, dark?) fibers abundant**
- **Number of available λ /user $\rightarrow \infty$**
- **Speeds of 10, 100, 1000 Gbit/s make electrical domain packet handling physically difficult**

Then:

- **λ provisioning for grid applications becomes feasible**

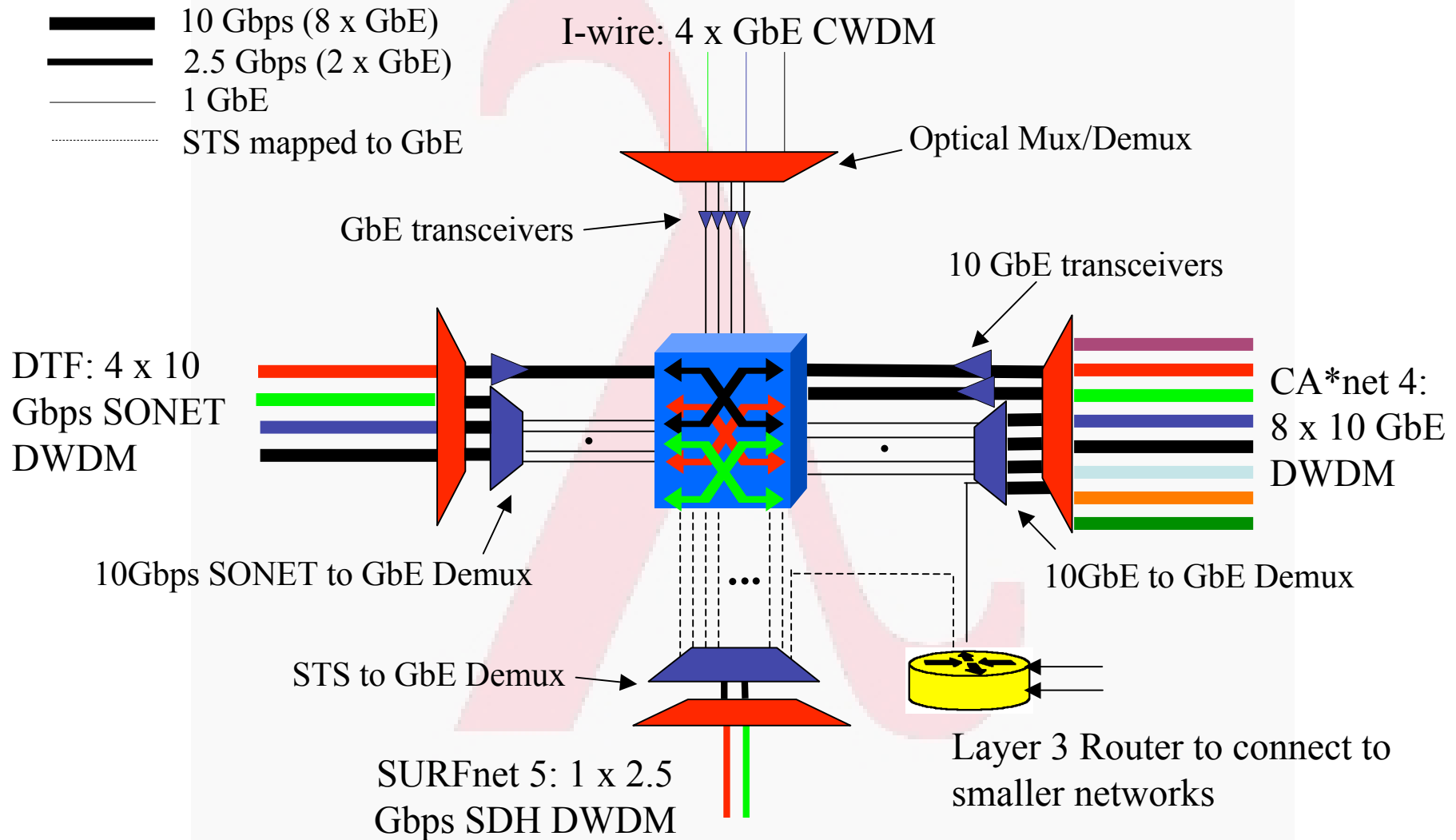


Current technology + (re)definition

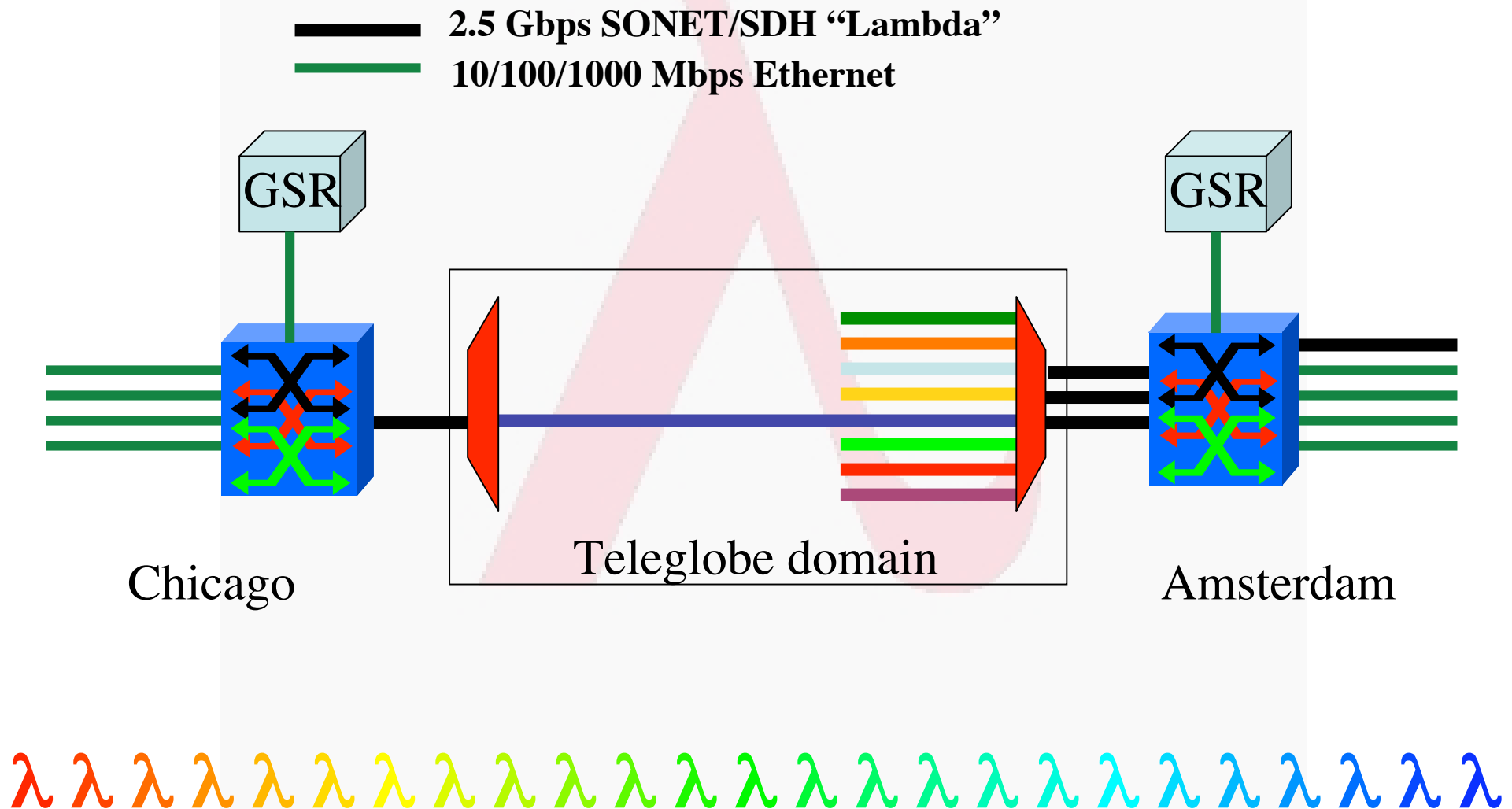
- Current (to me) available technology are SONET/SDH switches
- Starlight uses for the time being VLAN's on ethernet switches to connect exactly two ports
- So redefine a λ as:
“a λ is a pipe where you can inspect packets as they enter and when they exit, but principally not when in transit. In transit one only deals with the parameters of the pipe: number, color, bandwidth”



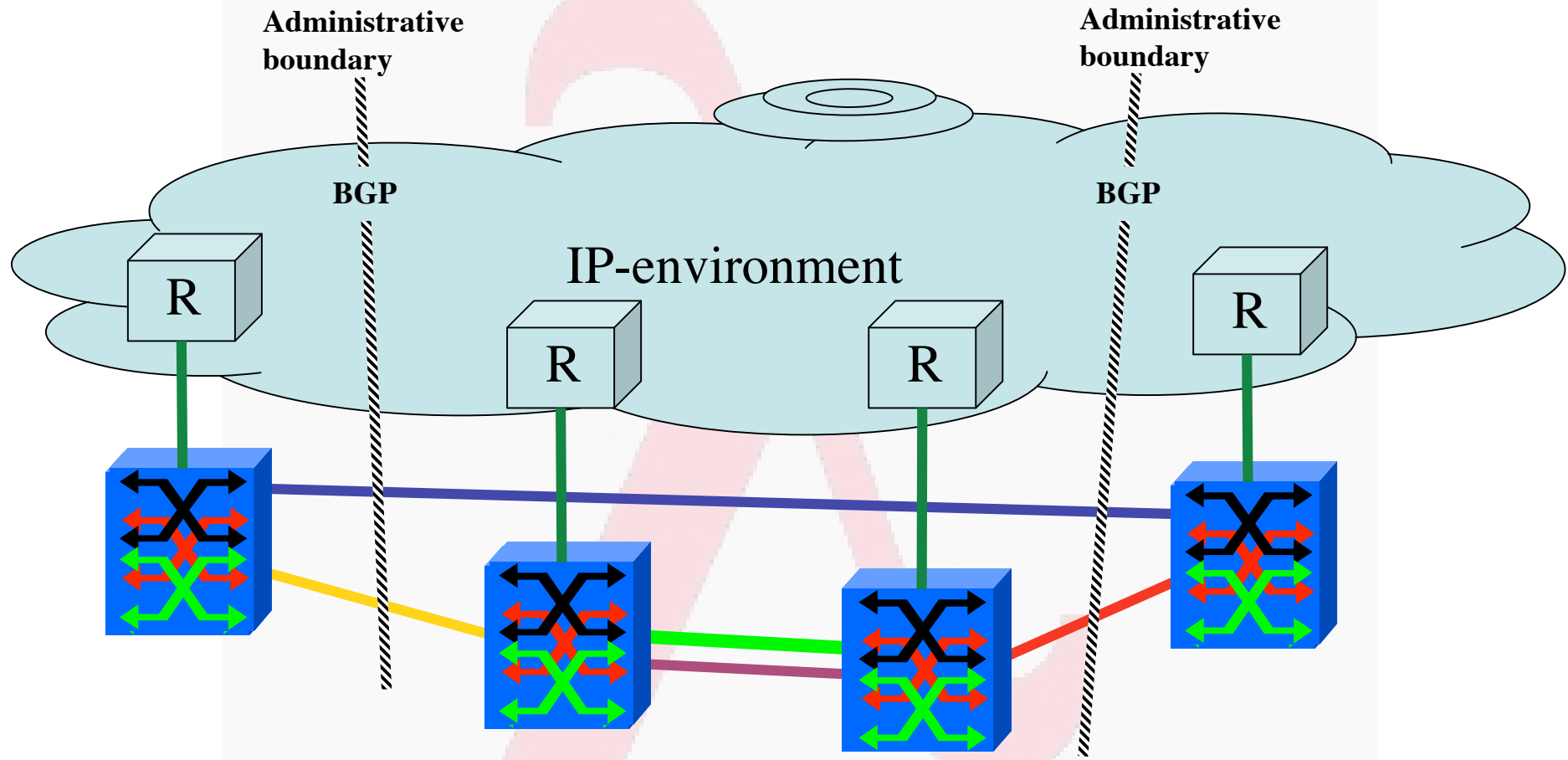
Possible STAR LIGHT configuration



Technology in the first phase



Multi domain IP controlled



λ research

- how to get traffic in and out of lambdas
- how to map load on the network to a map of lambdas
- how to deal with lambdas at peering points
- how to deal with provisioning when more administrative domains are involved
- how to do fine grain near real time grid application level lambda provisioning

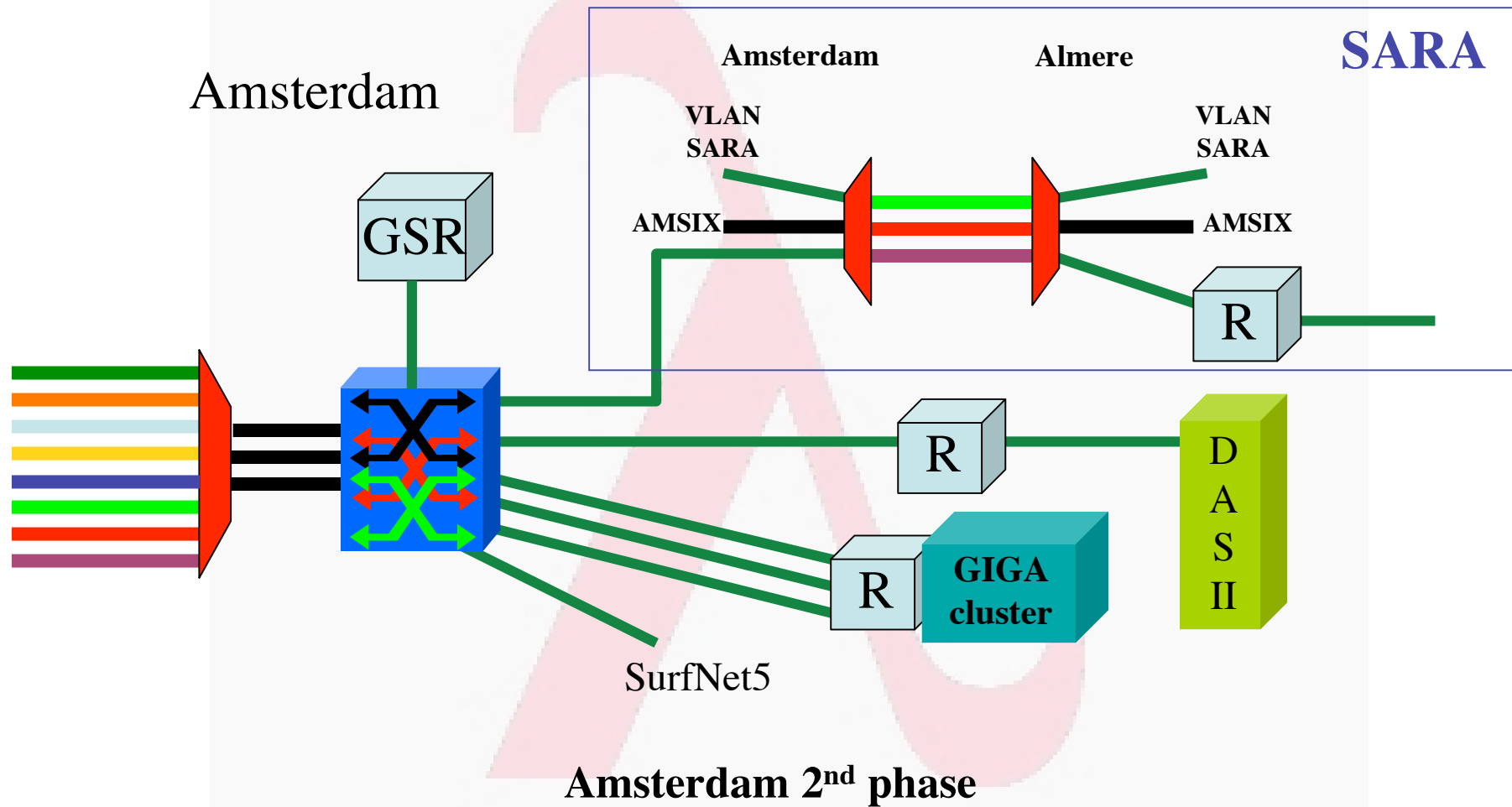


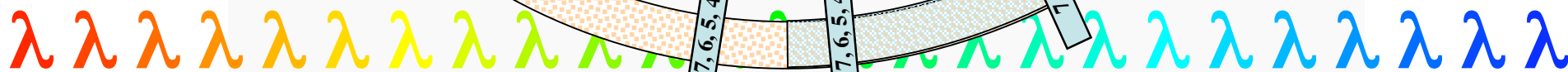
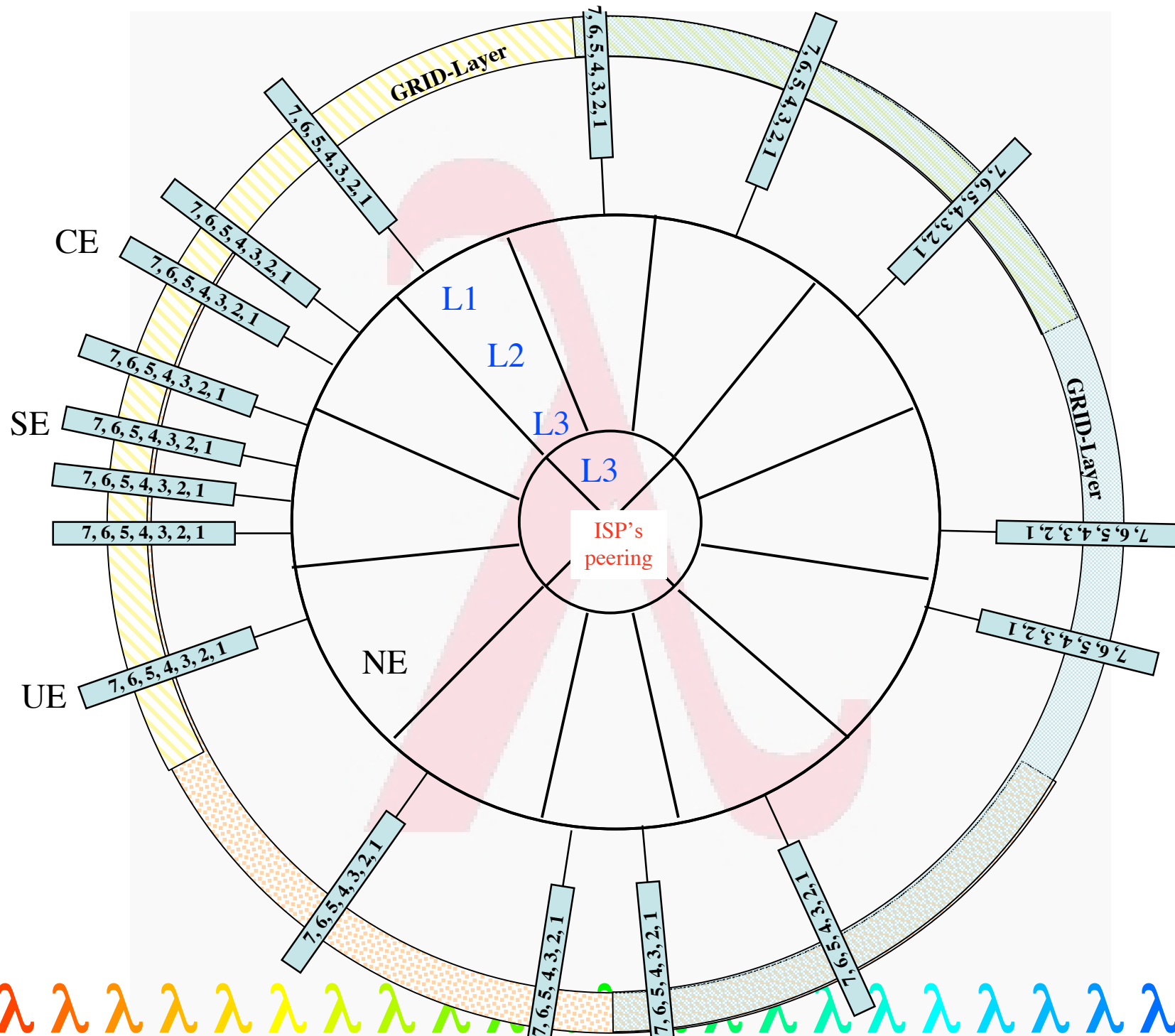
Optical networking, 3 scenarios

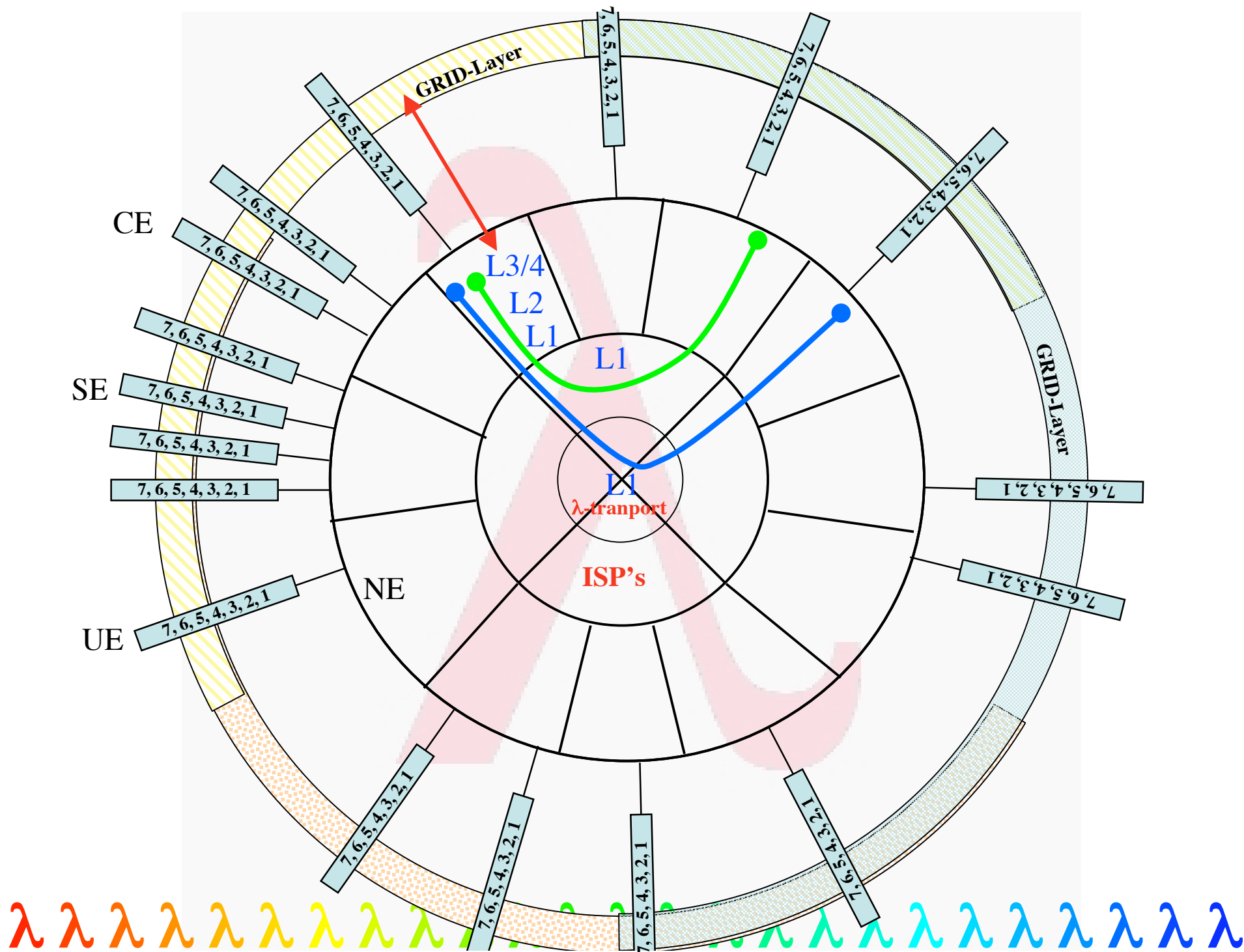
- **Lambdas for internal ISP bandwidth provisioning**
 - An ISP uses a lambda switching network to make better use of its (suppliers) dark fibers and to provision to the POP's. In this case the optical network is just within one domain and as such is a relatively simple case.
- **Lambda switching as peering point technology**
 - In this use case a layer 1 Internet exchange is build. ISP's peer by instantiating lambdas to each other. Is a $N*(N-1)$ and multi domain management problem.
- **Lambda switching as grid application bandwidth provisioning**
 - This is by far the most difficult since it needs UNI and NNI protocols to provision the optical paths through different domains.



- 2.5 Gbps SONET/SDH “Lambda”
- 10/100/1000 Mbps Ethernet







CE

SE

NE

UE

GRID-Layer

GRID-Layer

λ-transport

ISP's

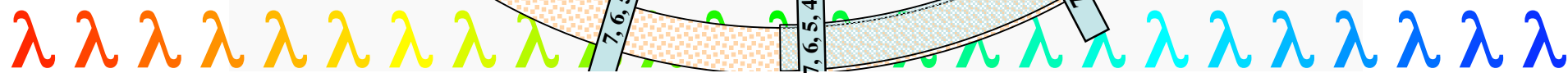
L3/4

L2

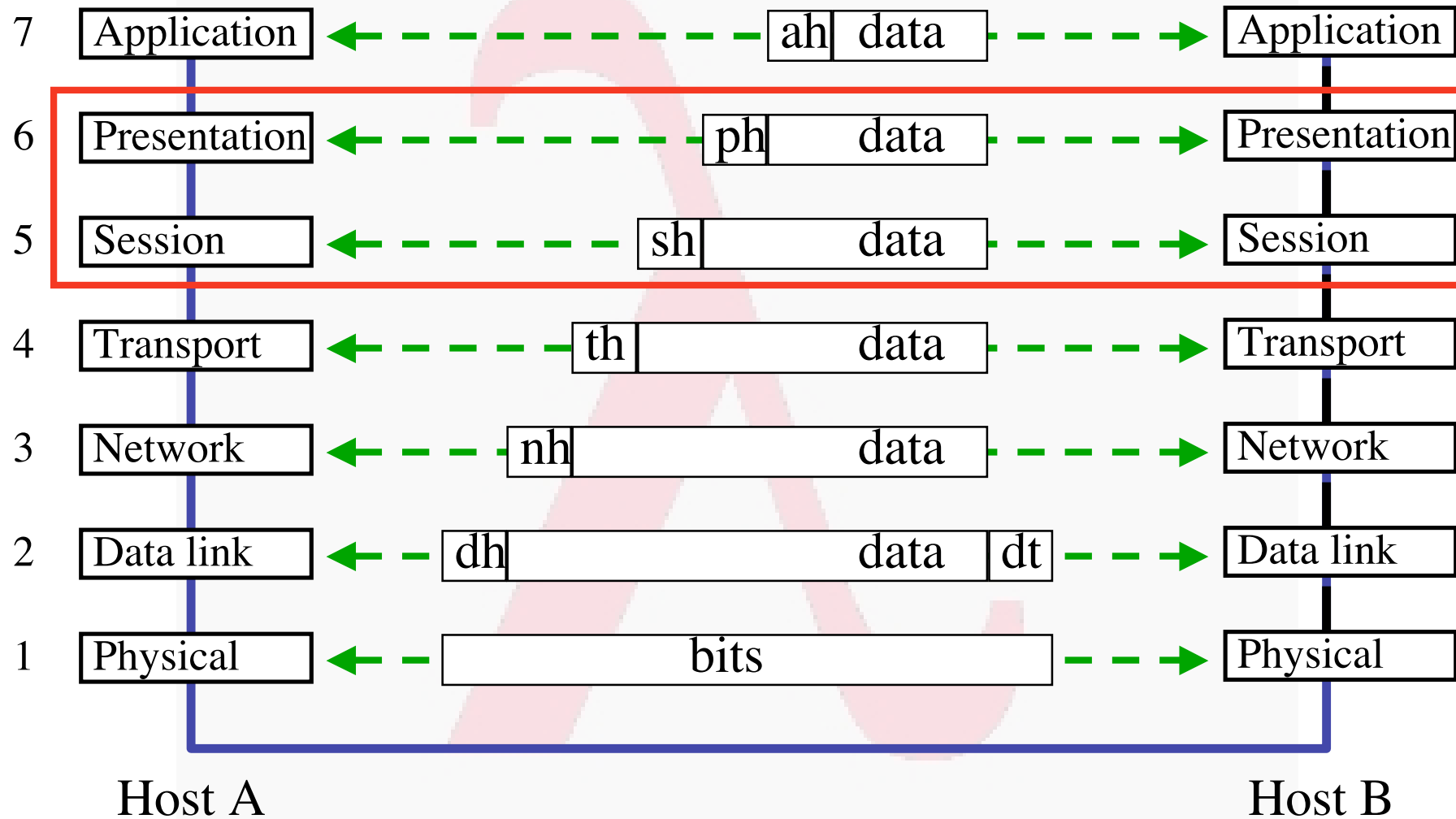
L1

L1

L1



The OSI Reference Model



— = data path
← → = protocol path



Revisiting the truck of tapes

Consider one fiber

- **Current technology allows for 160 λ in one of the frequency bands**
- **Each λ has a bandwidth of 40 Gbit/s**
- **Transport: $160 * 40 * 10^9 / 8 = 800$ GByte/sec**
- **Take a 10 metric ton truck**
- **One DLT contains 50 Gbyte, weights 200 gr**
- **Truck contains (10000 / 0.2) * 50 Gbyte = 2.5 PByte**
- **Truck / fiber = $2500000 / 800 = 3125$ s \approx one hour**
- **For distances further away than a truck drives in one hour (50 km) minus loading and handling 50000 tapes **the fiber wins!!!****

