

Lambda Networking Research

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Contents of this talk

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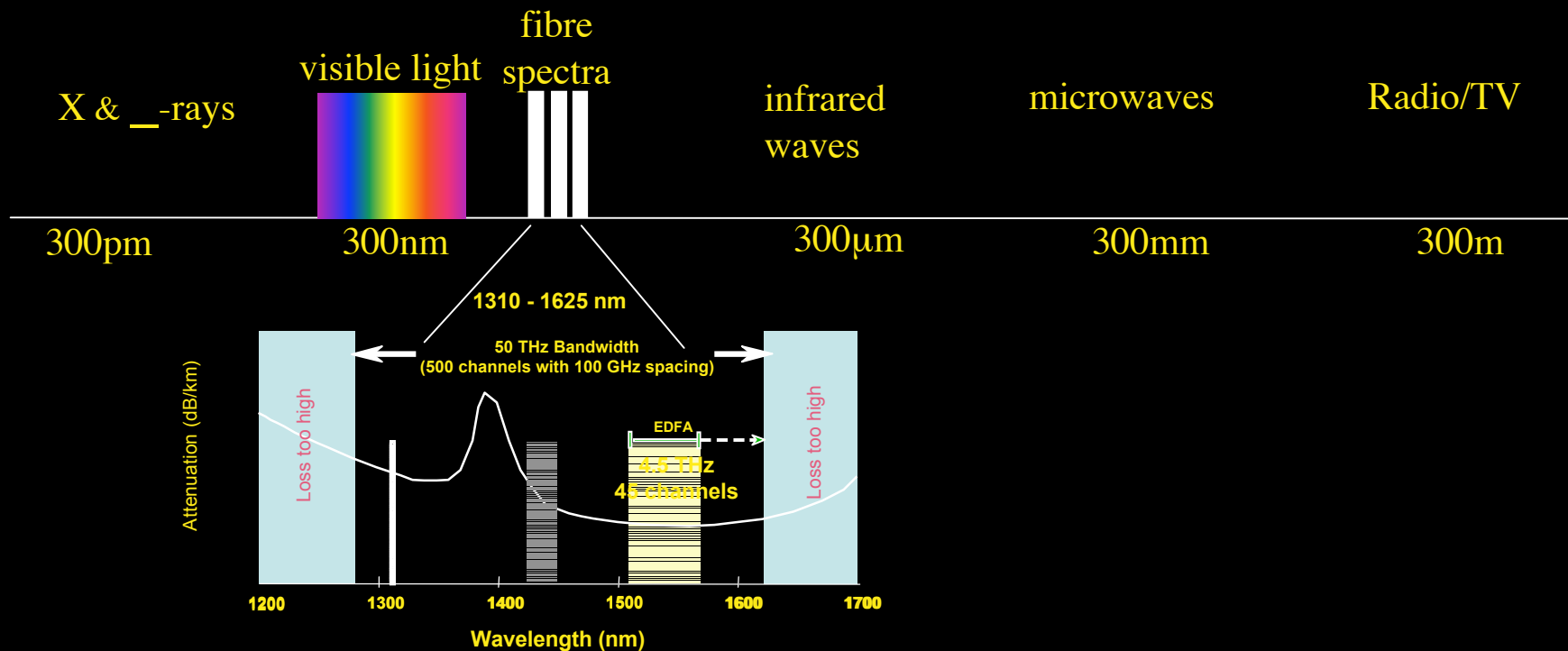


Purpose of this talk

- You can do:
 - Research on Lambda's
 - Research with Lambda's
 - Research because of Lambda's
- This talk is about the first two points



What is a Wave?

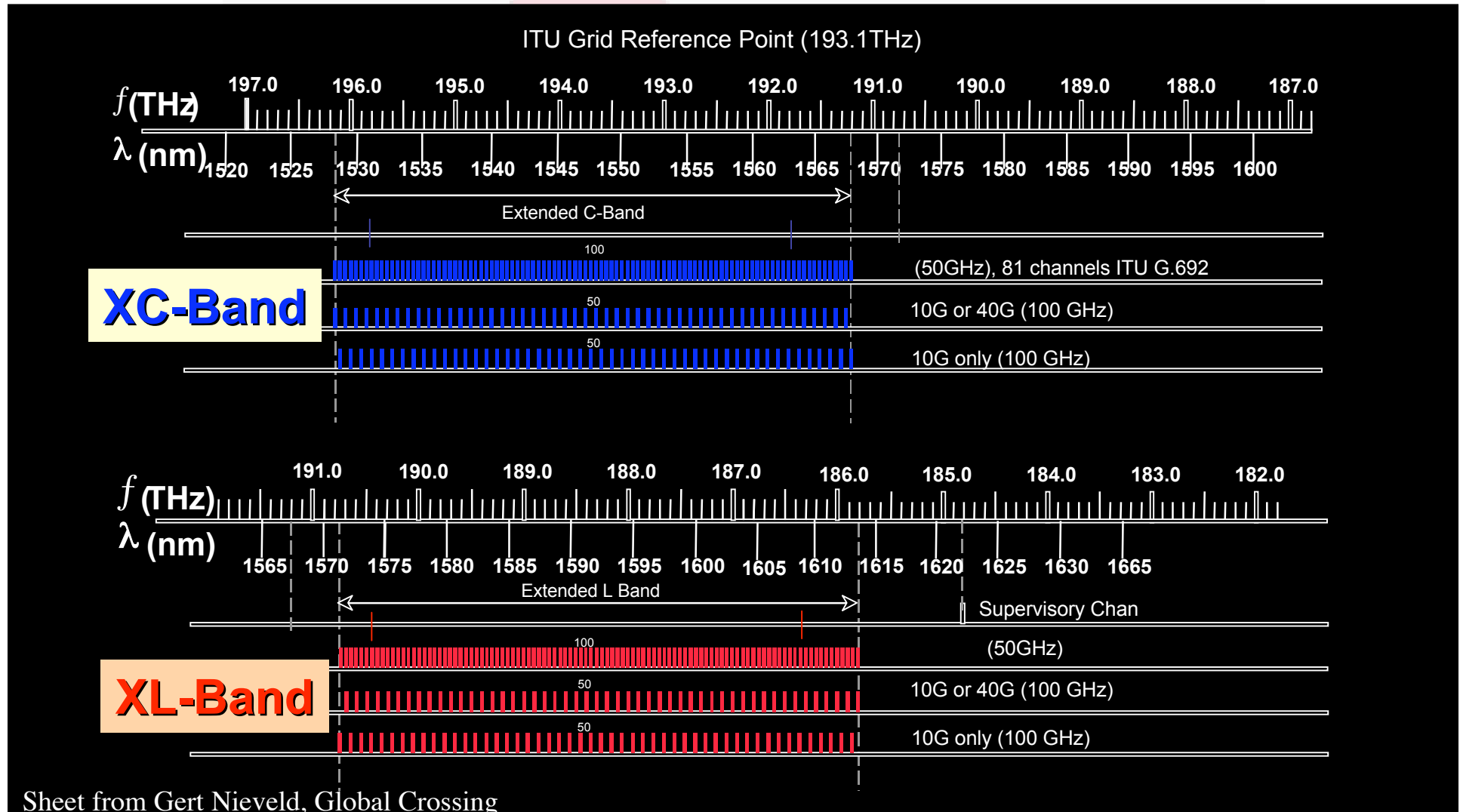


Sheet from Gert Nieveld, Global Crossing

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



C and L-band λ overview (terrestrial applications)



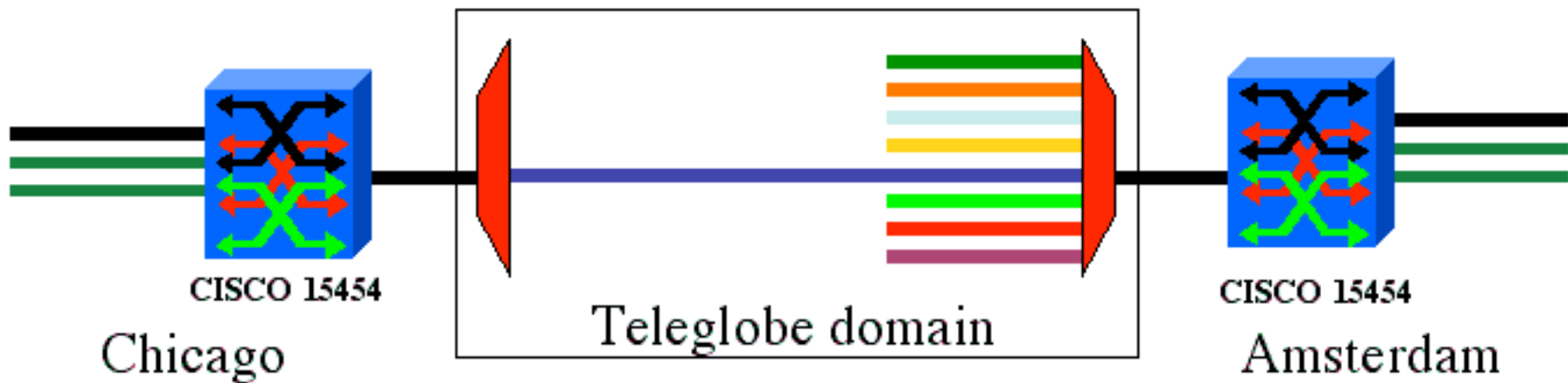
Current technology + (re)definition

- Current (to me) available technology consists of SONET/SDH switches
- DWDM+switching coming up
- 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”



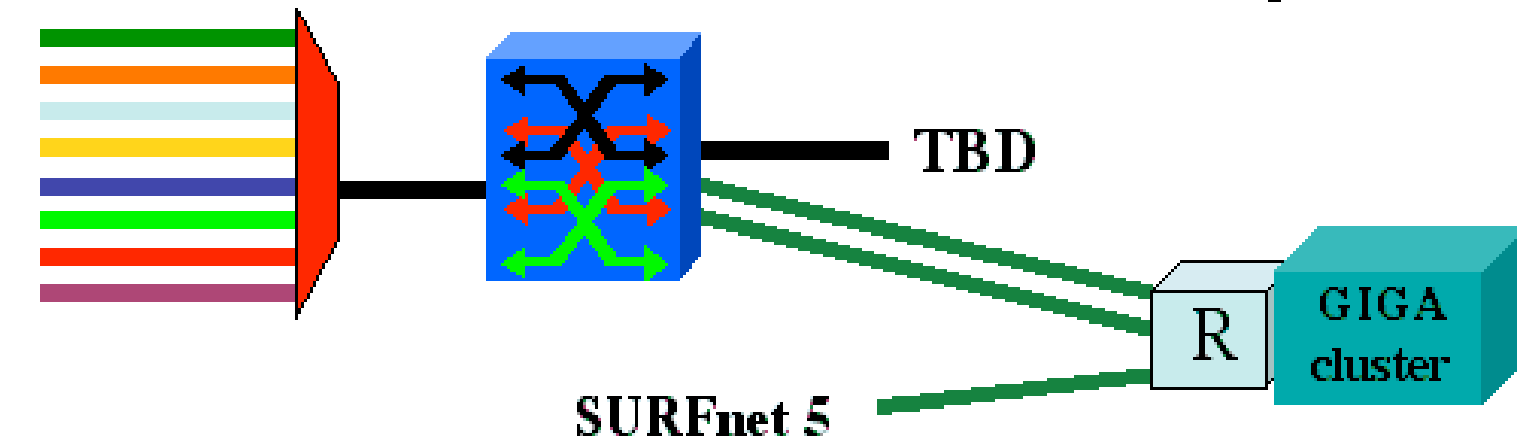
Basic phase 1

- 2.5 Gbps SONET/SDH “Lambda”
- 1 Gbps Ethernet

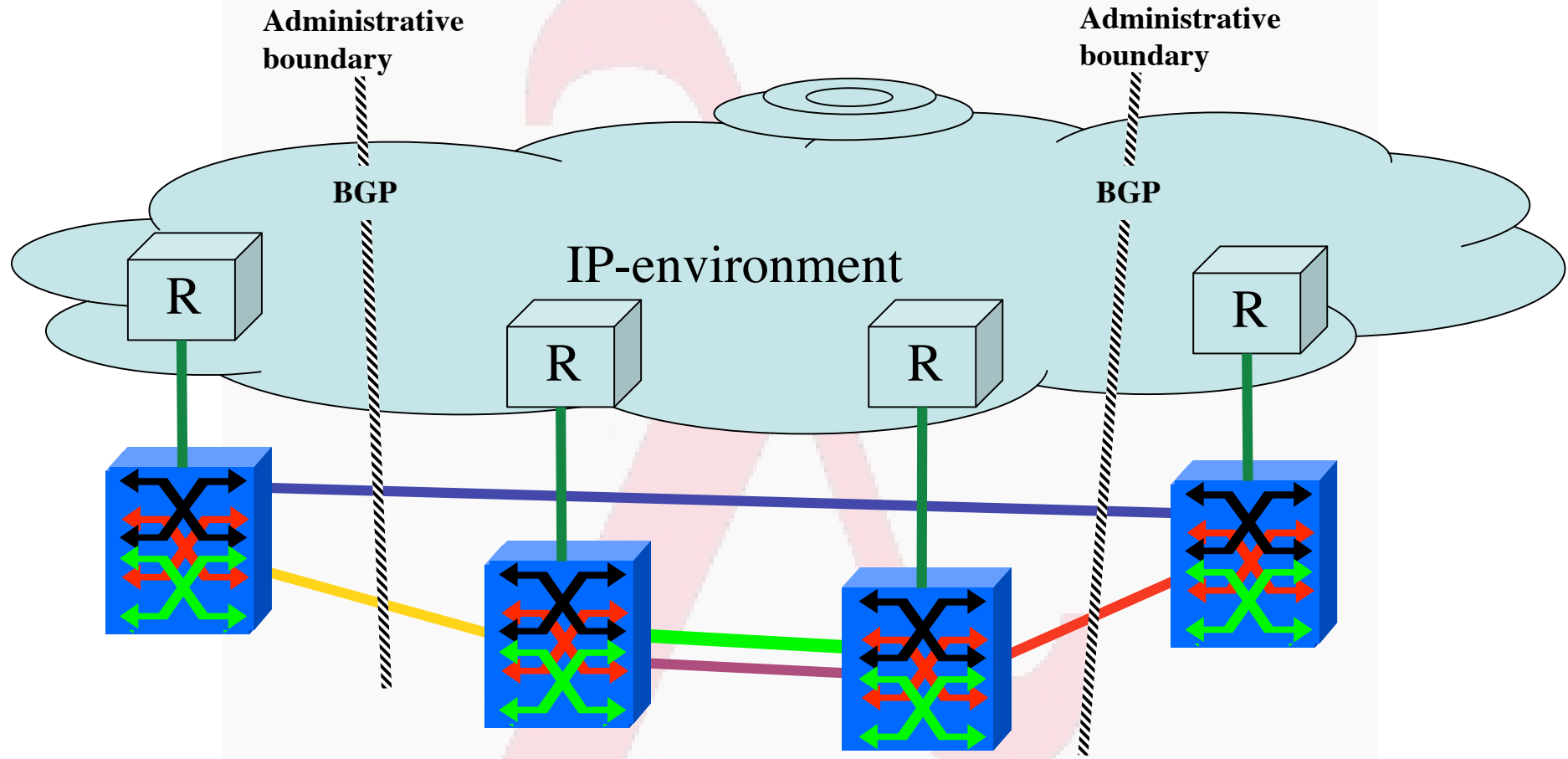


Amsterdam 1st phase

— 2.5 Gbps SONET/SDH "Lambda"
— 1 Gbps Ethernet



Multi domain IP controlled

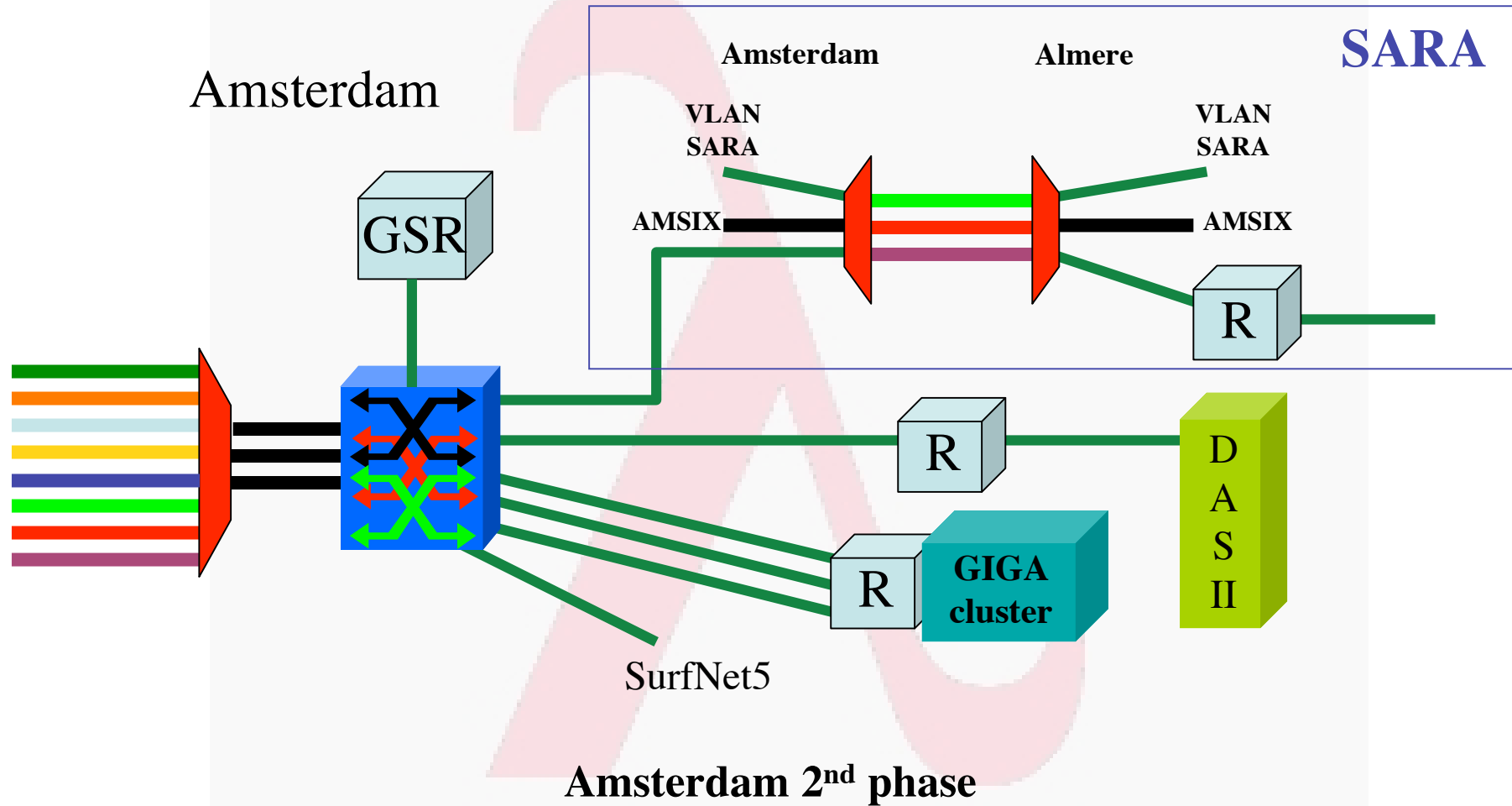


Optical networking, 3 scenarios

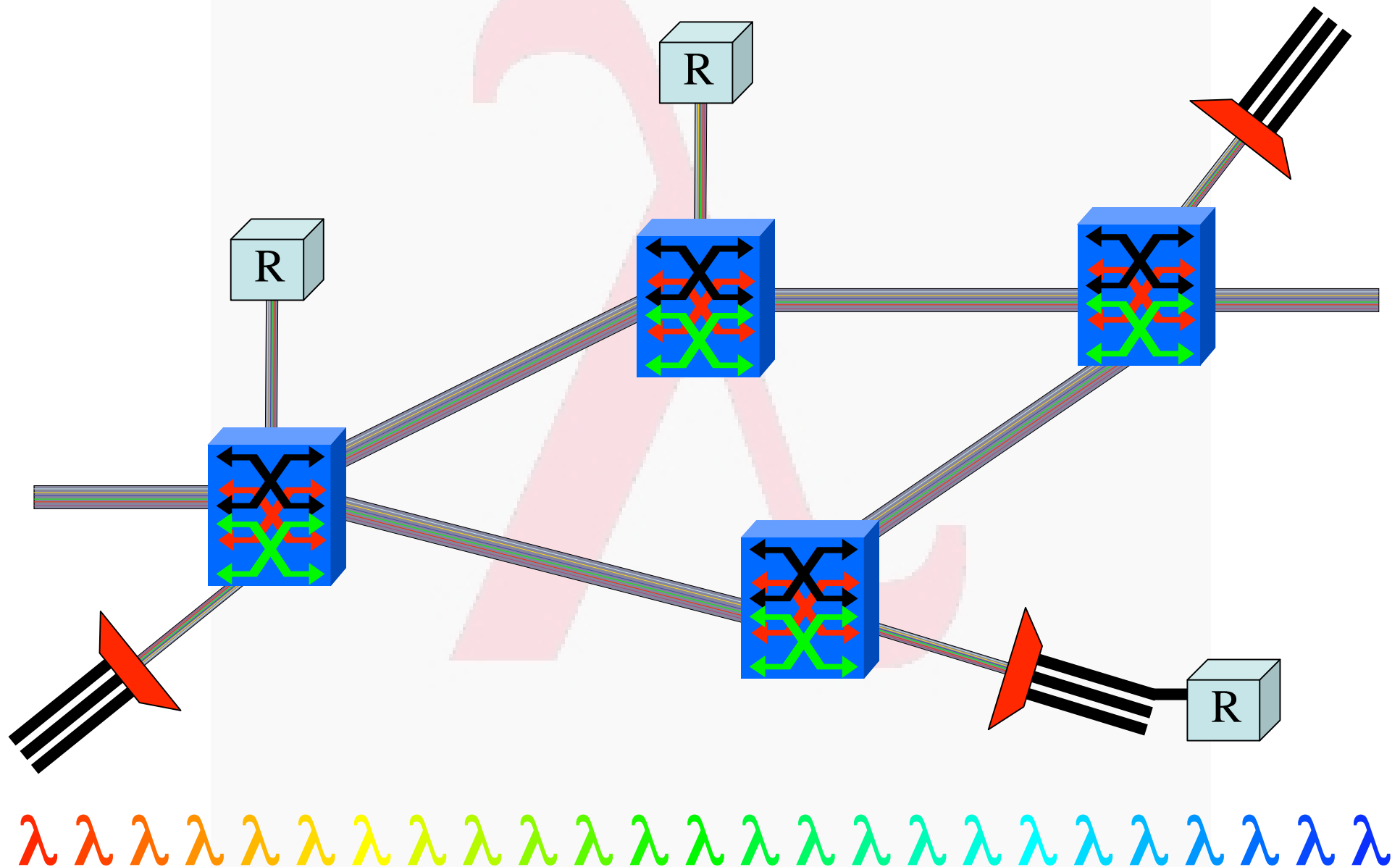
- **Lambdas for internal ISP bandwidth provisioning**
 - An ISP uses a lambda switching network to make better use of its (suppliers) dark fibers and to provision to the POP's. In this case the optical network is just within one domain and as such is a relatively simple case.
- **Lambda switching as 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.



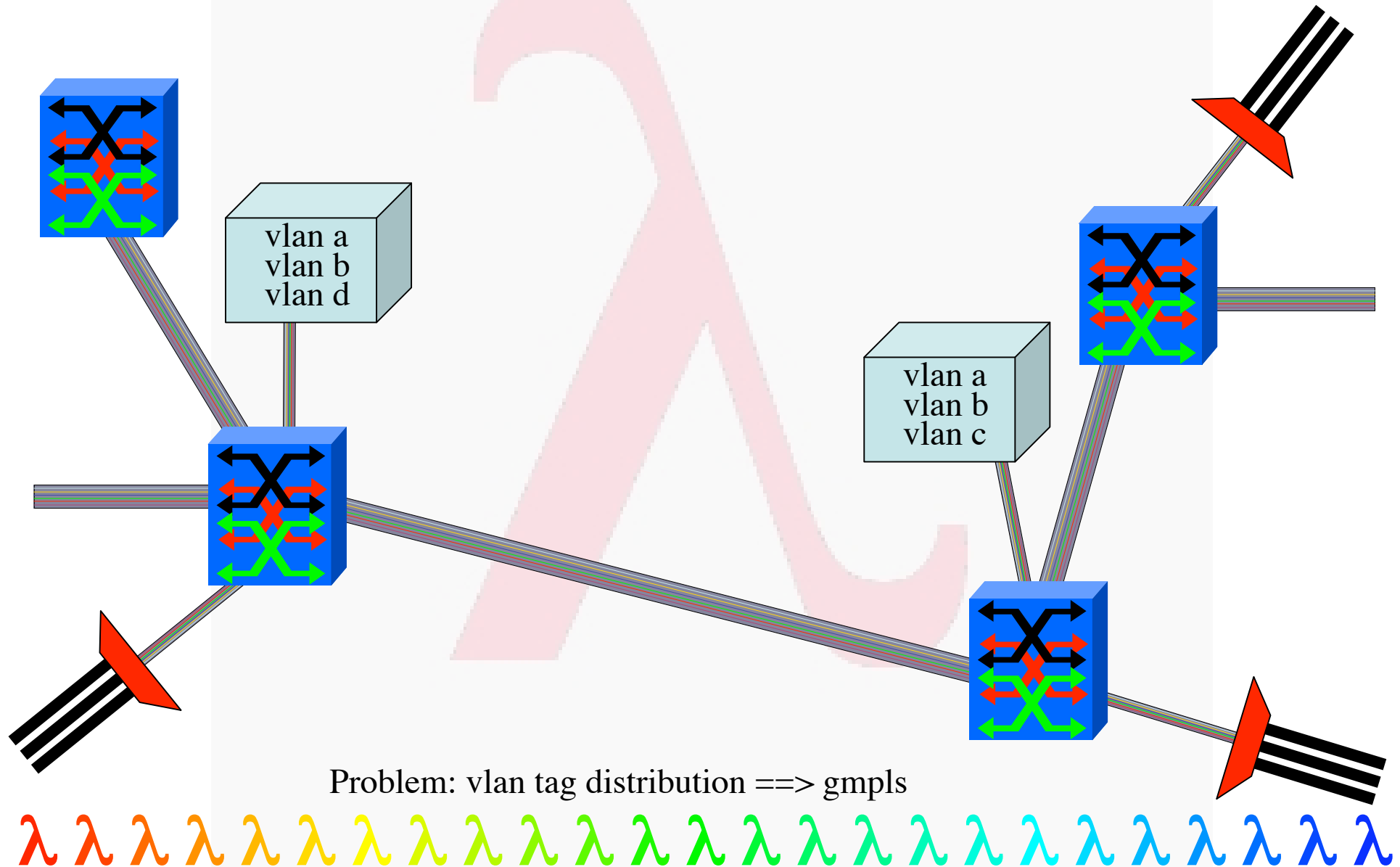
- 2.5 Gbps SONET/SDH "Lambda"**
- 10/100/1000 Mbps Ethernet**



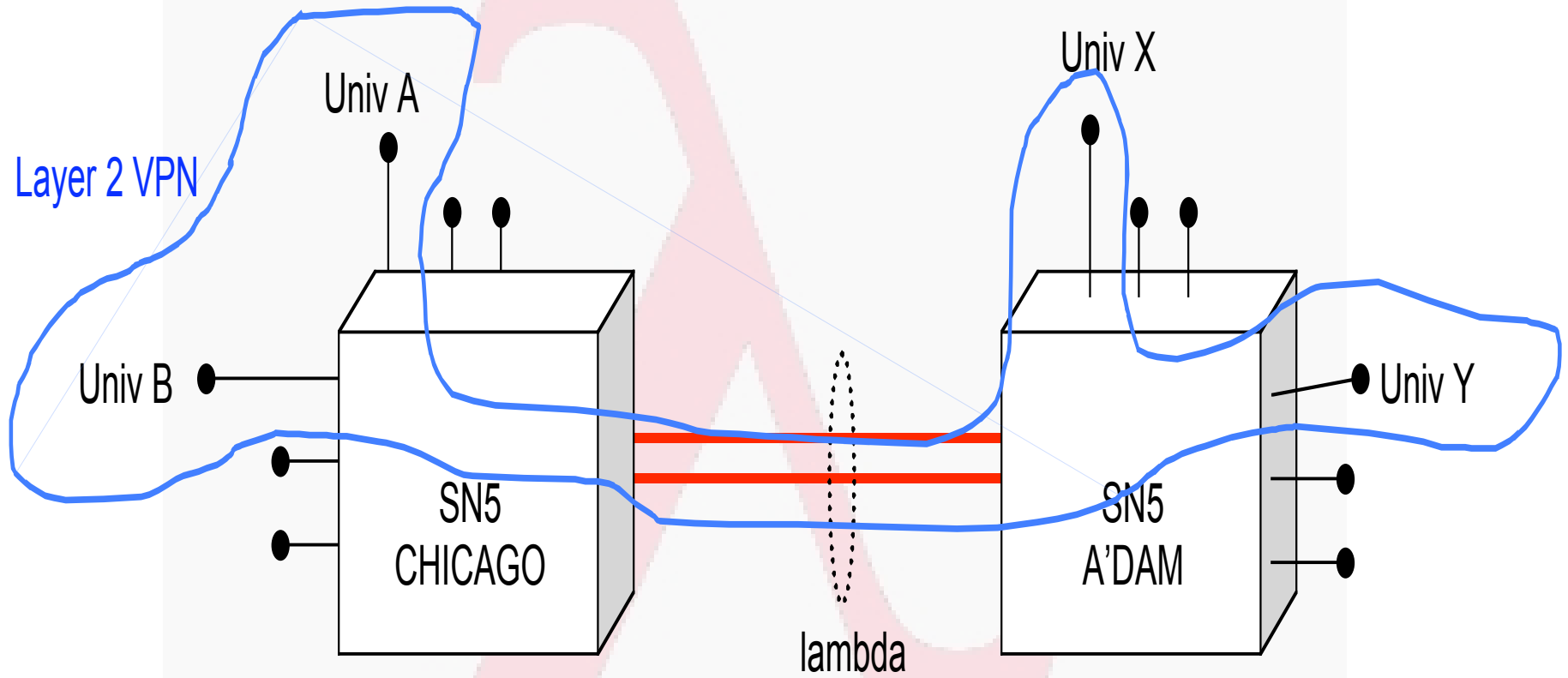
Other architectures - L1 - 3



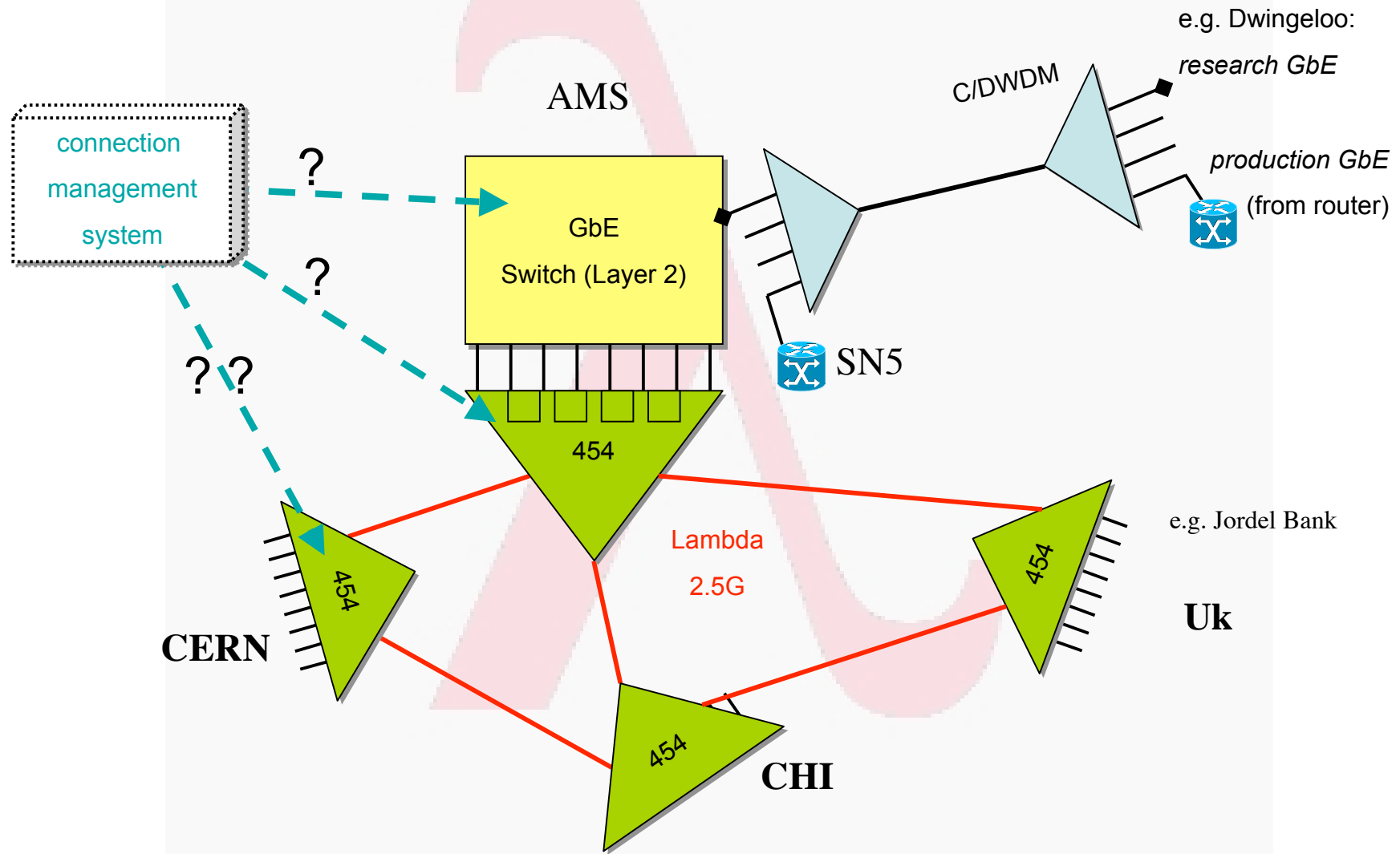
Other architectures - Distributed virtual IEX'es



Distributed L2



Lambda/GbE exchange



research on λ 's

- 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

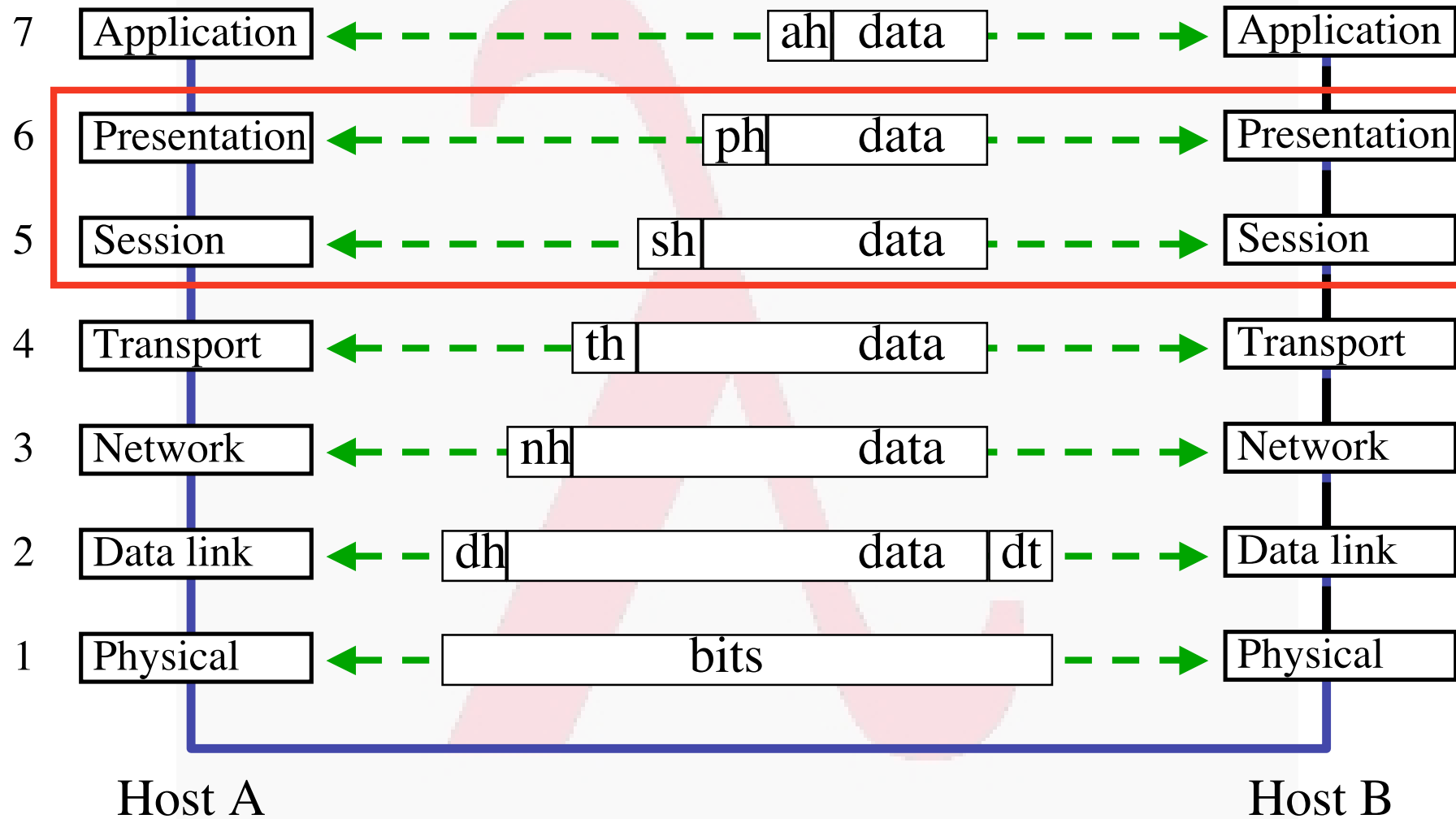


Research with λ 's

- High speed TCP (high rtt and BW)
- Routing stability
- Routing responsibility
- Extremely multihomed Networks
- Roles, organizational issues
- SLA's
- Models (Connection less versus oriented)
- Discreet versus continuous in time



The OSI Reference Model



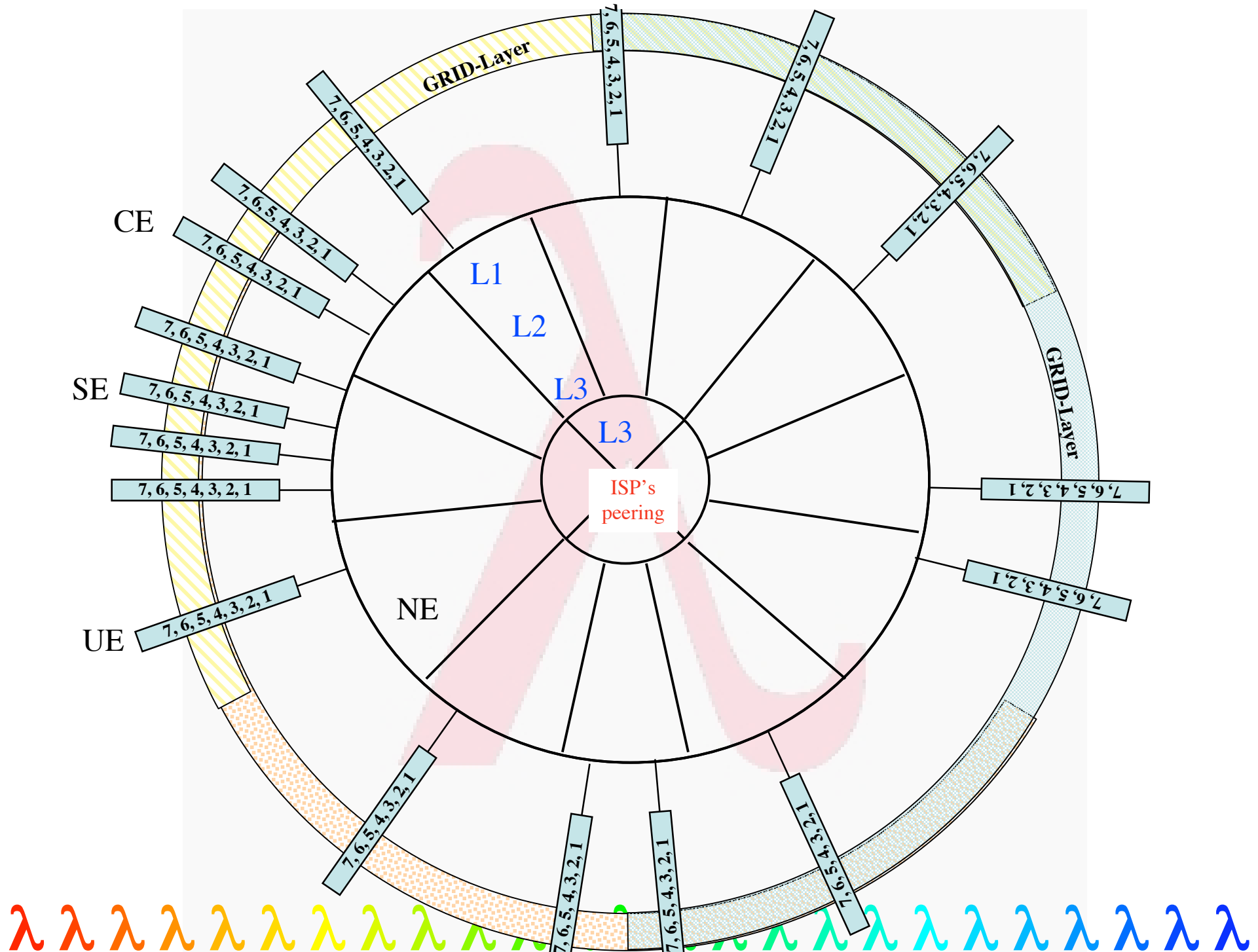
Host A

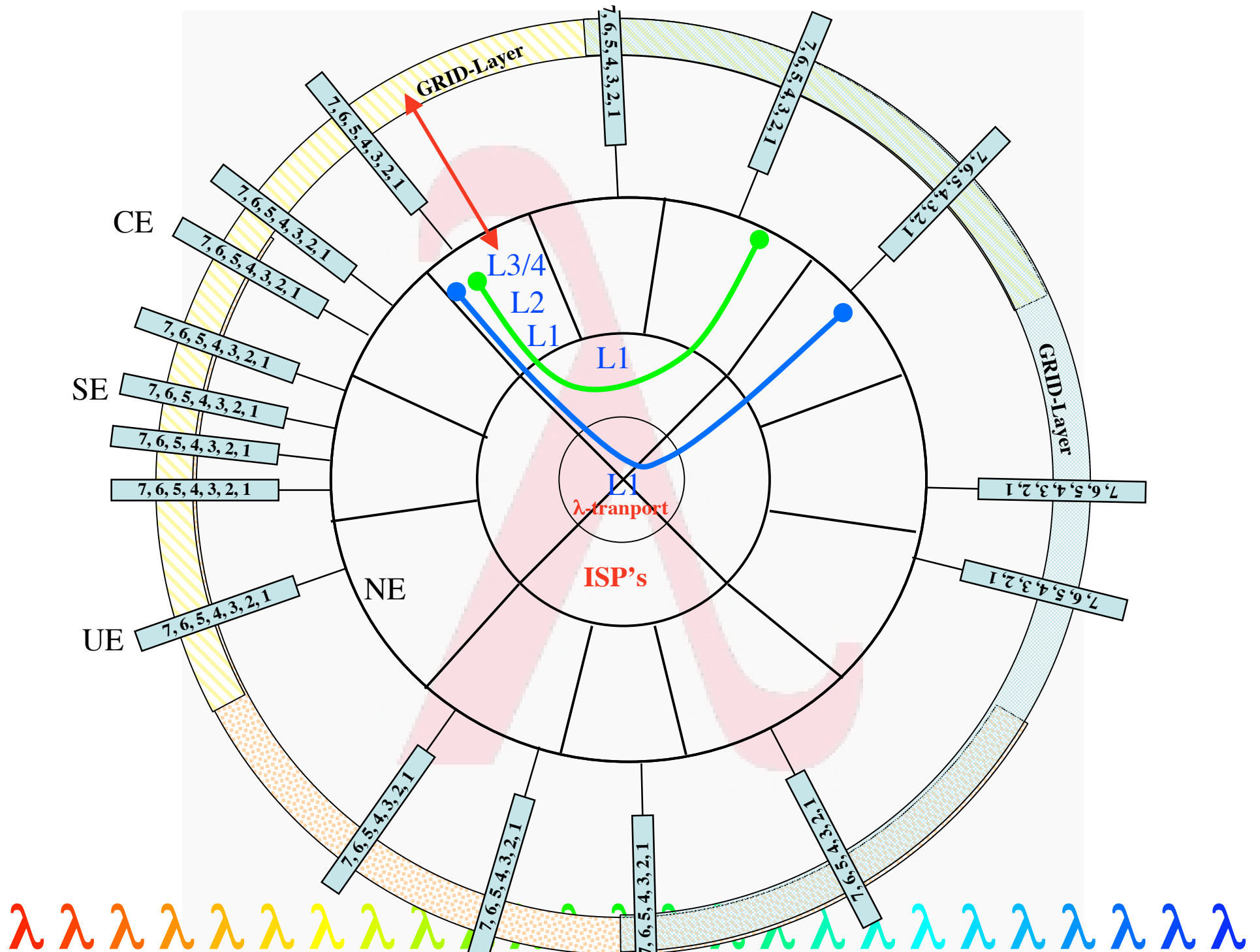
Host B

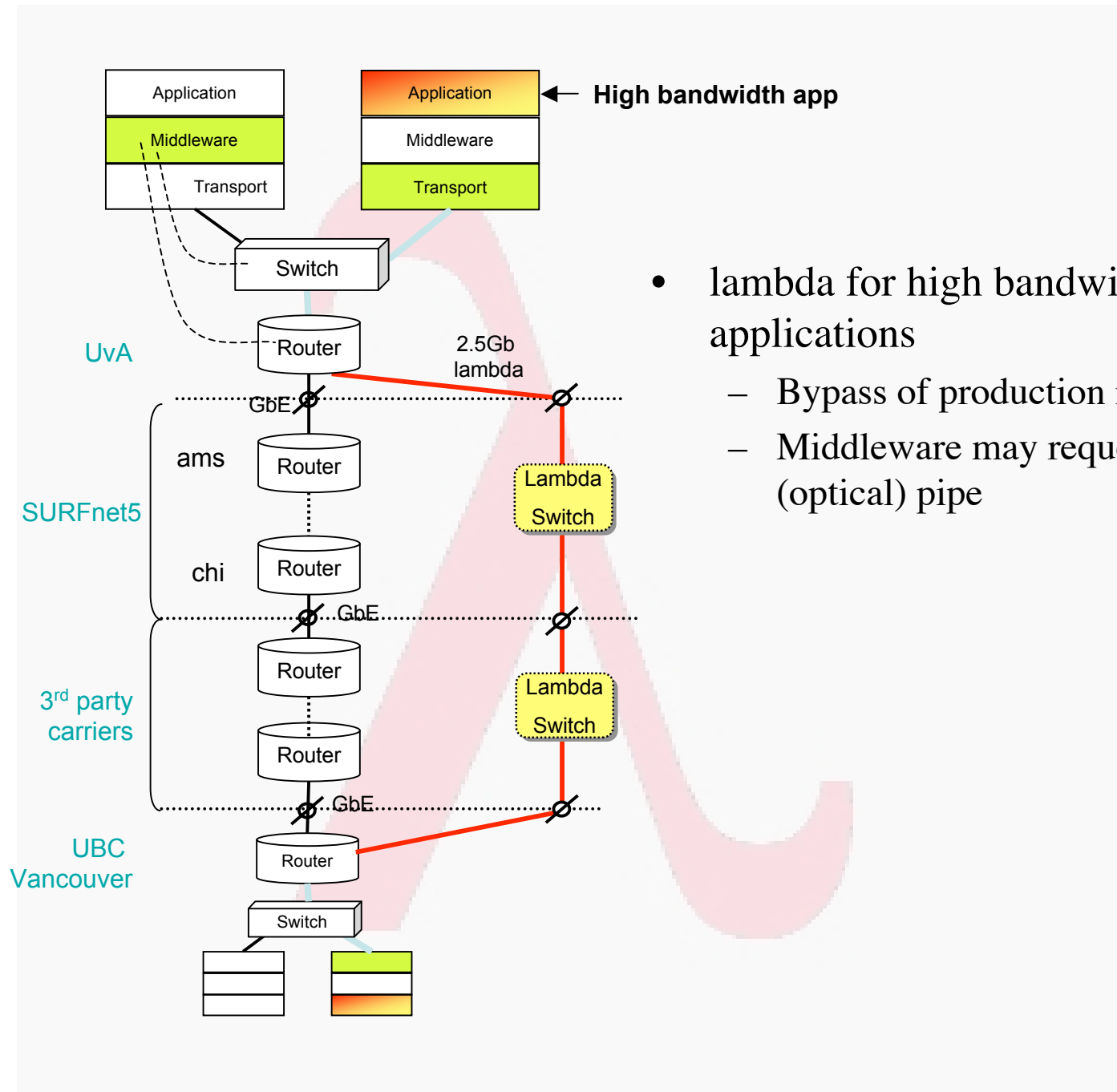
— = data path

← → = protocol path









- lambda for high bandwidth applications
 - Bypass of production network
 - Middleware may request (optical) pipe



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!!!****

