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Success story of implementing MPLS to the Backbone of GRNET

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Agenda

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- GRNET
- Topology
- Why MPLS
- Applications of MPLS
- Difficulties
- OAM in an MPLS Backbone

GRNET

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- NREN: Greek Research & Education Network

  General Secretariat of Research & Technology
  Ministry of Development
- Interconnects : 65 Institutions (Universities, Research Centers, Technological Institutions) with 190.000 Internet users
- Operates Athens Internet Exchange – AIX for all Greek commercial ISPs
- Strongly cooperates with the Research Institutions for its product- and pilot- services
- Currently upgrading its network with DWDM infrastructure

Topology of GRNET-1 @ 2001

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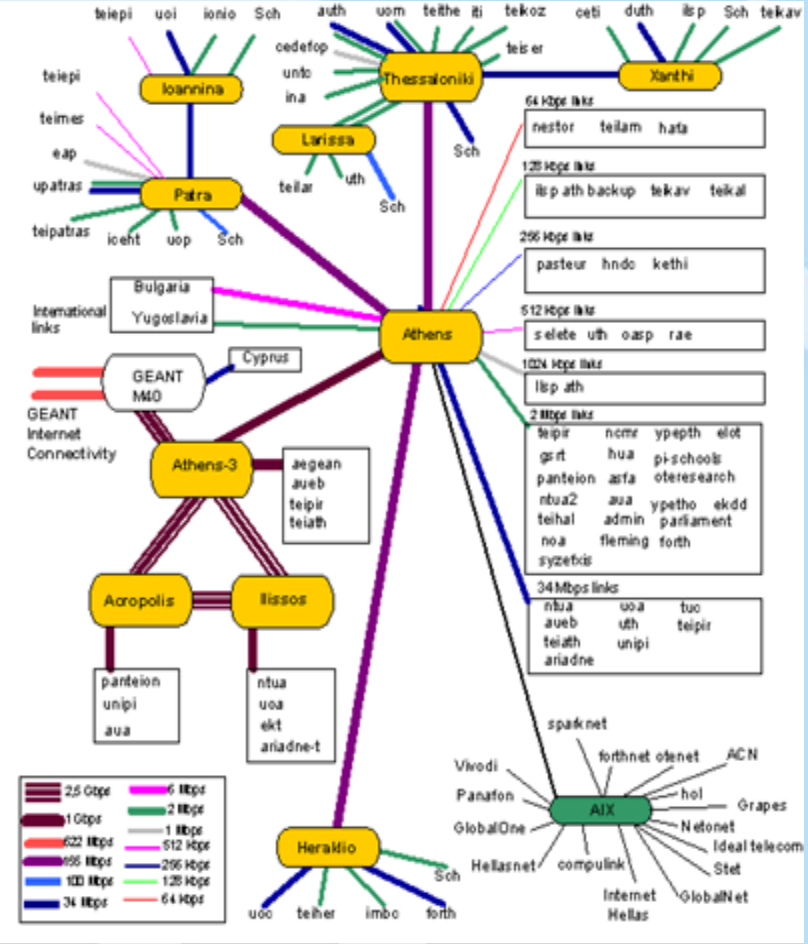
- Year 2001
- Core 34/155 Mbps
- Access 2/34 Mbps
- Services
  - Real-time services & VoD
  - Multicast
  - Security – GRNET-CERT
  - Managed Bandwidth Service (MBS)

  Monitoring tools
  - IPv6 support
  - Experimental support of MPLS



Topology of GRNET-3 @ 2008

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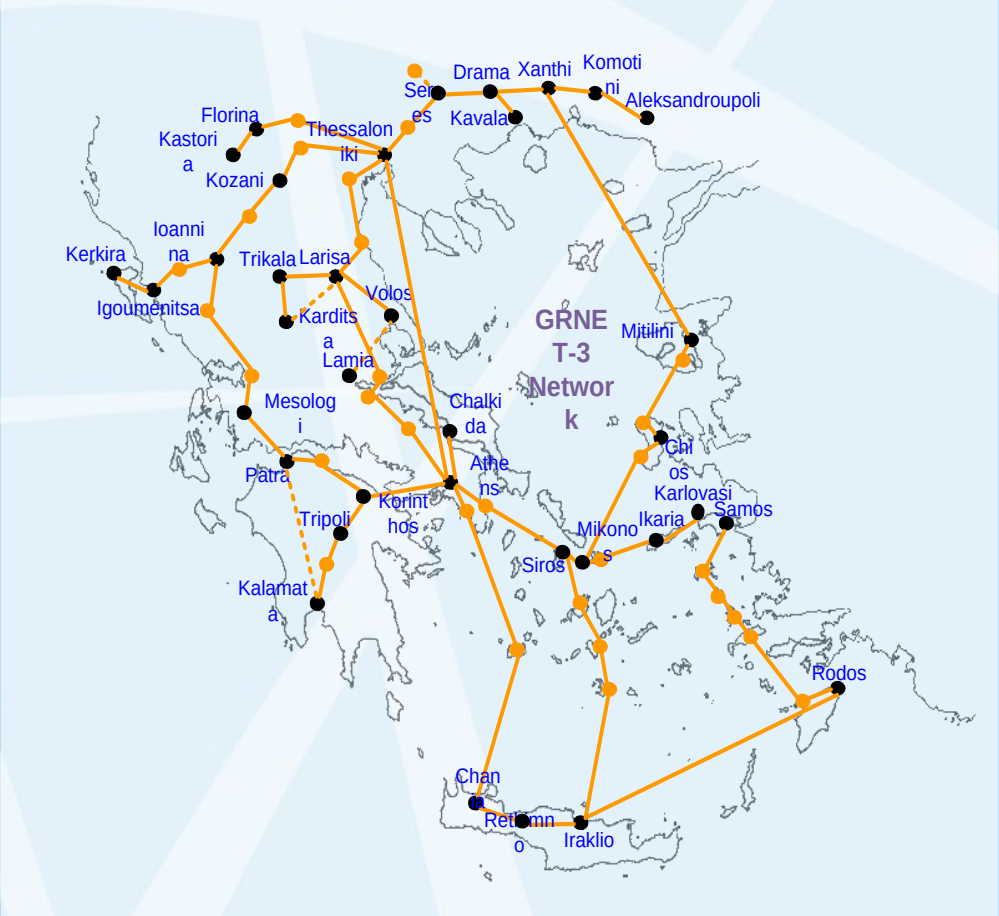
- Design principles:
  - Gigabit Speeds
  - IP over WDM (leased lambda)
  - Native IP QoS support
  - Native MPLS (VPN, TE)
  - Native IPv6 support
  - IP VPNs
- Implementation considerations:
  - GigE/PoS Ring-MAN, PoS/Partial Mesh-WAN
  - 2.5 Gbps speeds, GigaPoPs
  - SDH/DWDM international connections



Why MPLS

- MPLS readily available in GRnet routers (aka LSR)
- Initially as “experimentation” case
- A tunneling and switching technology
  - Between Layer 2 and Layer 3 (shim header)
    - (like ATM)
  - Typically **labels** are built automatically through application
  - Very rare case of static assignment
- Fundamental difference with ATM
- Labels change at every LSR
  - switching header changes at every routing node
  - Fundamental difference with IP routing (TTL, CRC)
- The trail of the packet defines a LSP (label switched path)

Applications of MPLS (1)

- How to build Labels
- Labels are built for FEC (Forwarding Equivalent Class) at every LSR
- IP routing
  - FEC for every IP routing entry
- Layer 3 VPNs
  - stack of Labels
    - 1 Label for IP routing
      - for normal Destination based routing selection
    - 1 Label for VPN

Applications of MPLS (2)

- Layer 2 VPNs
  - Could be a point to point connections between same or different technologies
  - stack of Labels
    - 1 Label for IP routing between nodes
      - for normal Destination based routing selection
    - 1 Label for port+ technology switching
- Extensively used in GRNET
- Layer3 VPNS and Layers 2 VPNS could be provisioned semi automatically via ANStool a GRNET tool

Applications of MPLS (3)

- MPLS Traffic Engineering (TE)
  - Policy based routing (source and/or destination based), **arbitrary selection of routing path**
  - on-demand routing based on constraints
    - Interface queue reservations with Diffserv semantics (DS-TE)
  - stack of Labels
    - 1 Label for on demand routing
    - 1 Label for normal routing through the rest of the network
- MPLS-TE (-DS) could be the underlying routing plane for other MPLS application
- MPLS-Layer-2 VPN on top of MPLS-TE
- A resiliency technique for Link or Node bypass if preallocation of resources (i.e. Labels) before a failure (MPLS-Fast Reroute – FRR)
- Useful in Big networks (tier-2)
- Unattractive for GRNET Case (due to small network diameter)

Applications (4)

- MPLS as a tunneling mechanism provided by one carrier to another
- Carrier Supporting Carrier
- Supporting carrier does not expose his IGP to other carrier
- Used by OTE-GLOBE PTT for supporting SEEREN deployment (in the Balkan area)

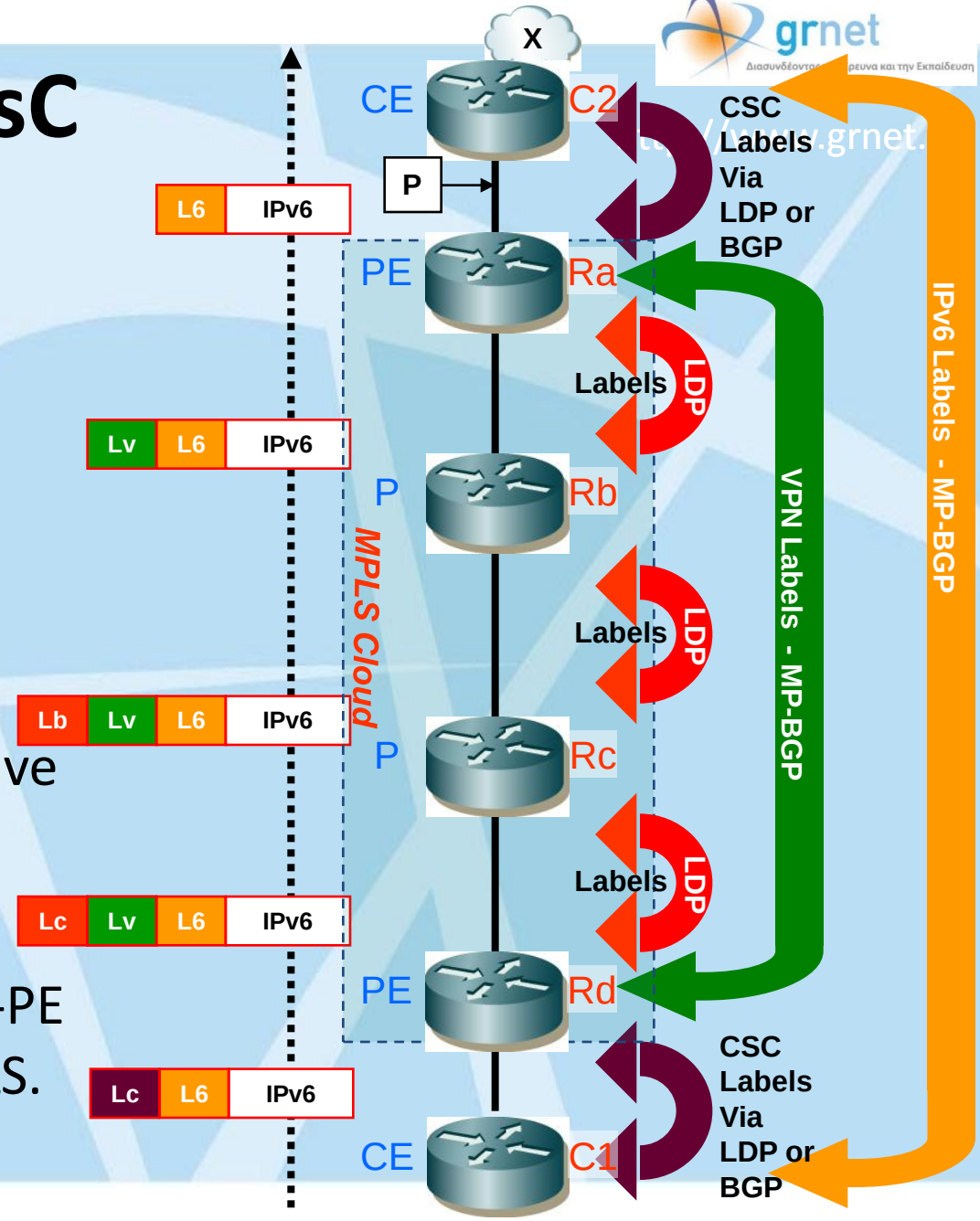
Applications (5)

- MPLS as a tunneling mechanism
  - Transition technique for IPv6 deployment only when MPLS is there
  - 6PE as a VPN on top of MPLS
  - Application for SEEREN network IPv6 deployment
  - Some links as a CsC (carrier supporting carrier) technology
  - Application of 6PE on top of CsC (see next slide)

6PE on top of CsC

Integration of two techniques:

- 6PE functionality is installed on the CEs instead of the PEs!
- 6PE peers belong to different administrative domains.
- Three Label Stack !!!
- Feasible, because CE-PE connection uses MPLS.



Difficulties

- MPLS as a tunnel and switching mechanism
  - Tunneling issues
    - Header increase
    - If MTU is not large enough packet could be dropped without notice
    - i.e Fast ethernet network (MTU 1500bytes)
  - Switching issues
    - Monitoring mechanisms are vendor specific so ask for specific ones.
    - What to monitor ?
    - (Labels ? They change at every hop)

OAM in an MPLS backbone

- All time winner of network troubleshooting tool
- Ping and traceroute
- PING and traceroute Label aware
  - Follow the Label stack change Hop by HOP
    - No IP header change
    - check the MPLS data plane integrity along the whole MPLS path towards the LSP egress
  - PREQ: HOPs support ICMP extensions for MPLS

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Questions

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