Network Convergence:
From Virtual Circuits to Pseudo-Wires.

Luca Martini, Technical Leader , Cisco Systems

Agenda

- **“Martini draft” Background and History.**
- **Network design principle.**
- **Network management design.**
- **Organization design.**

History:

- **Year 1998/99:**
  - **ATM has failed to deliver the multi-service networks, and is too slow/expensive**
  - **Huge bandwidth demand. (or at least we thought so)**
- **New network from the ground up:**
  - **All packet based services must run on one single packet network.**
  - **MPLS is an emerging technology with the best management/granularity compromise**
  - **Must create new telecom market competition to make network elements and services a commodity.**

Motivation of "draft-martini"

- **Next Generation SP design:**
  - **Classical frame/ATM is expensive and does not integrate well.**
  - **Multi-service Backbone.**
  - **Re-deployment or expand existing Hardware.**
- **Multiple vendor Implementation = market competition.**
- **New lower cost services with market acceptance.**

Protocol Design Criteria

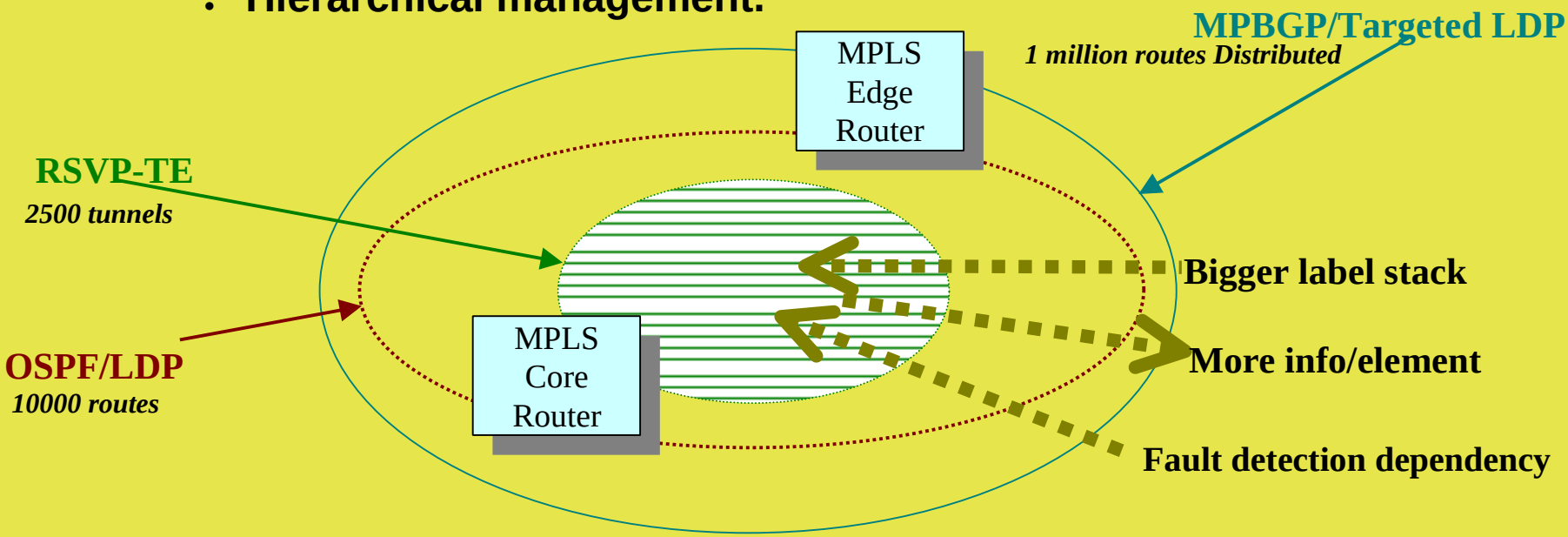
- **"Simple" protocol Implementation.**
- **Must use existing hardware when possible.**
- **Leverage MPLS, for multi-service Core network**
- **Support existing SP protocols, and existing CPE**
- **Similar operational model to standard SP services.**

Result:

- **11 vendors inter-operated when I stopped counting.**
- **Draft-martini is LDP based, a modern design.**
- **Point-to-point links - operationally similar to classical frame/atm.**
- **MPLS based Multi-service network.**
- **Service management granularity/scalability compromise**

Scaling MPLS to the Edge

- **Must take advantage of MPLS "stacking architecture" on all levels:**
  - **Routing information (RSVP, LDP/IGP)**
  - **FIB: customer specific information need not be in the core of the network**
  - **Hierarchical management.**



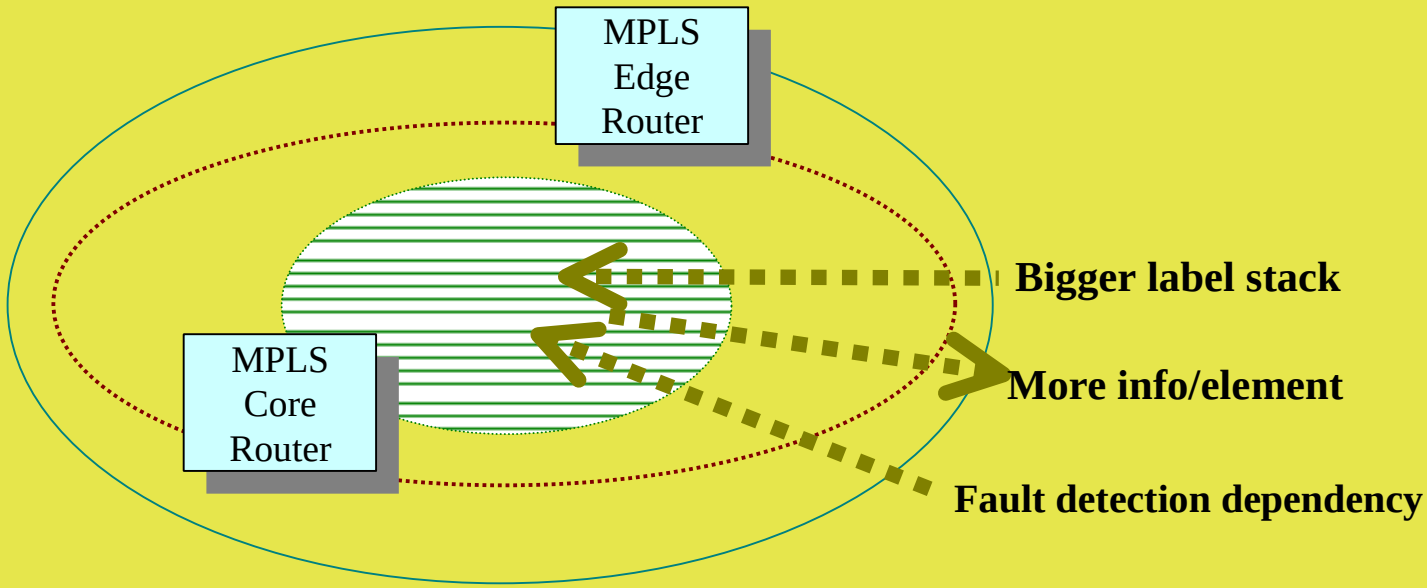
IP VS PW

- Success of IP is due to scaling properties
- Notion of longest prefix match -> aggregation of information.
- The network Egress point of an IP packet is not known at ingress to the network.
- Management of IP is performed on a network link by link basis
- No SP end user to end user management.
- Address Aggregation insures that a single user does not require specific information in the core network.

- PW success is due to network convergence potential
- No aggregation is possible.
- The network Egress point of a PW is static , and always known, when the packet enters the network.
- PW management: Each PW or Network only ?
- SP manages each PW.
- “Stacking” insures that a single user does not require specific information in the core network.

Learn the IP lesson

- **We must learn and use the architectural advantages of IP.**
- **Network state/information needs to be bounded.**
- **Aggregation of network information.**
- **SP monitoring of aggregate information only.**

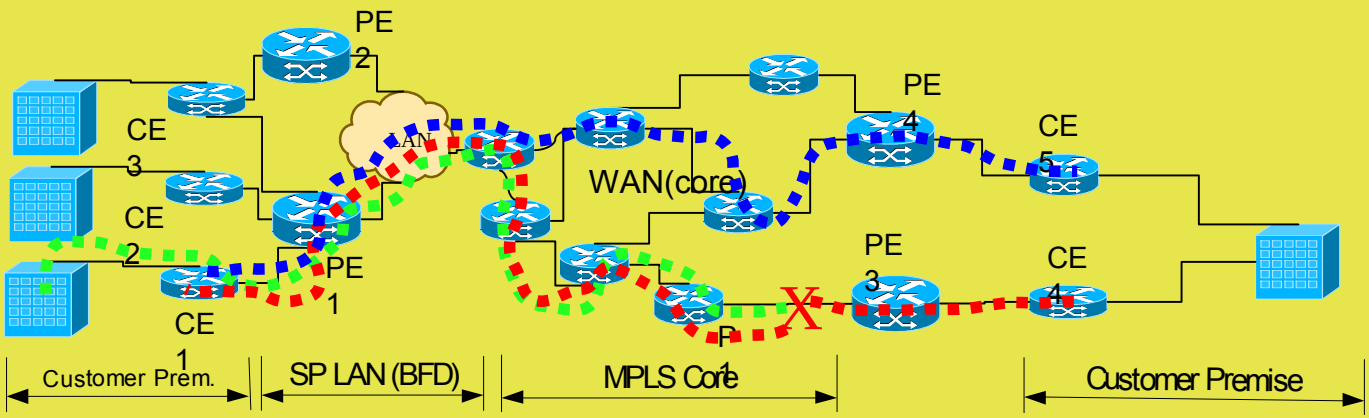


Stacking of Management layer.

- **Replicating a legacy network management will not scale !**
  - Example: ATM OAM Loop cells.
- **The MPLS network needs to be trusted to perform as specified.**
  - Monitoring each PW is not necessary, nor practical.
  - PE monitoring should be sufficient to detect 99% of the failures.
- **Core network status is propagated by IGP protocols.**
- **Monitor individual network link using BFD**

Hierarchical Network Fault Management.

- **Monitor Core Links (BFD)**
  - **.IGP notification of link failure.**
- **Repair: MPLS Fast-reroute/IGP fast convergence.**
- **Total failure ?**
  - **.Reachability information is withdrawn**
  - **.PE is notified of failure immediately.**
    - **.Customer link fault notification.**



The weak link.

- **The network's weak link : the Human.**
- **Example: Bypass LSP for Fast-reroute**
  - **.Manual Static network configuration routing:**
    - **.Is expensive.**
    - **.Is very prone to errors.**
  - **.Automatic routing (bypass LSP/RSVP-TE etc.)**
    - **.Is not as easy to understand.**
    - **.System can have Bugs. (but bugs eventually get fixed)**

New Organization Interactions.

- **Converged networks -> cost savings -> converged organization.**
- **Biggest hurdle to deployment of a multi service converged network.**
- **design/support organization structure must match new converged network design.**
- **IP/Frame/ATM network delineation is now blurred**
  - **.They all share the same core network.**
  - **.All existing organizations need to be re-trained.**

Organization design

- **Engineering <> operational support groups:**
  - **Operations groups “own” the network.**
  - **Engineering design groups “design” the new network.**
- **No "tossing over the wall" !**
- **For a successful converged network responsibility must be shared.**
- **Unfortunately more often then not, Network boundaries reflect internal organization boundaries.**
- **Support, and engineering organizations must be merged at least at head of department level.**

Conclusions

- A protocol designed for the market.
- Learn IP network architecture lesson.
- "Divide and conquer" strategy.
- Design the network properly, and trust it!