

Network Futures

Lars Fischer

CTO, NORDUnet

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Agenda

- The drivers
- End-to-end services
- Bandwidth on Demand
- Transmission technologies
- Control planes
- GRID implications



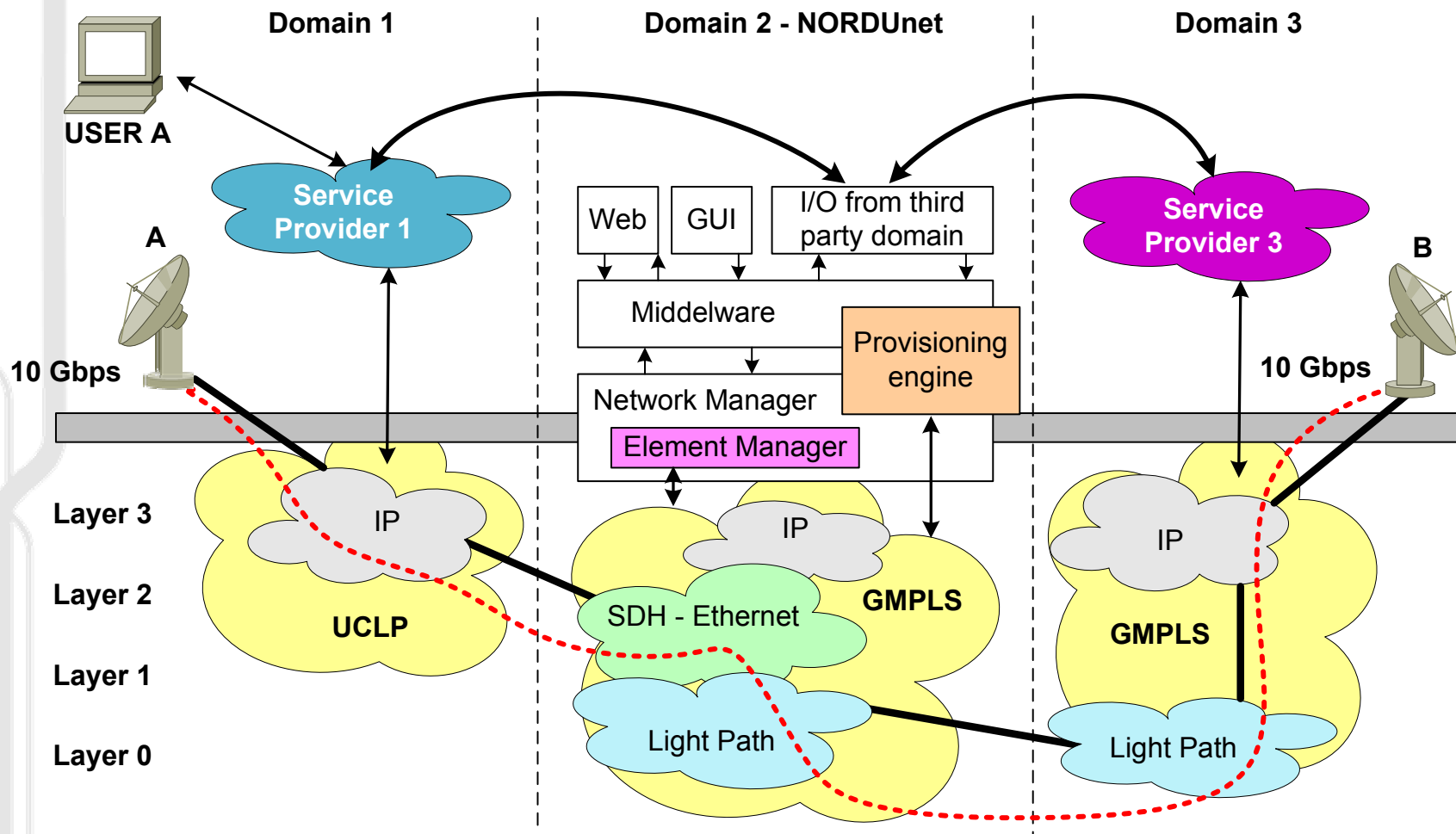
Bandwith, Bandwidth, Bandwidth

- The growth will continue for many years to come
 - Transmission technologies are evolving
 - The growth in need has just begun
 - Growth stimulated by realization that previously impossible problems can now be tackled
- Predictions that current networks cannot grow to cope with new uses



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End-to-End Services



User control of Network Elements

- In the simplest case, a user will be granted a number of network components (circuits), and will be allowed to control the topology on the fly
- Requires user access to management platforms
- Requires network partitioning through middleware
- Working systems exist
 - UCLP
 - DRAGON
- Multi-domain systems a have been deployed



Bandwidth on Demand (BoD)

- (Semi)Automated processes for ensuring availability of sufficient end-to-end capacity for an application
- Issues
 - Granularity
 - Time
 - Bandwidth units
 - Controlling entity
- Crossing multiple domains?



Application-driven BoD

- Several projects
 - GEANT2 and Internet2
- Systems have been built for both shared (IP) networks and for circuit switching
- Some limited demonstrations
- Single-domain only
- Two methods
 - Bandwidth Reservation
 - Bandwidth Allocation on Demand



Bandwidth Reservation

- Capacity reserved in advance
- Service can be guaranteed
- Allows approval process
- Allows for fairly long set-up times
- Requires complete picture of network
- Capacity must be used during reserved time – planning required
- Granularity will be large



Bandwidth Allocation on demand

- Allows applications to ask for capacity when they need it
- Requires application access to management systems / control plane
- Requires previously granted user rights
- Allows low granularity
- Allows less planning
- Require fast set-up times
- Multi-domain will be very complex



Network-driven BoD

- In this model, the network owns a pool of capacity resources and can choose to apply them where they are needed, based on usage
- The network monitors application behaviour and network usage
- Complex in shared networks, simpler in circuit switched networks
- Simpler than application-driven BoD



Bandwidth Scaling on Demand

- Scaling bandwidth of existing circuits up and down with usage
- Example: Static topology, dynamic bandwidth
- Automating VCAT / LCAS capabilities
 - Fast enough to prevent packet loss?
 - Multidomain should be possible
- Allows very fine granularity
- Works without full network picture
- Cienna demonstration
 - Using buffer fill rate
 - Multi-domain not demonstrated



Transmission issues for BoD

- Application control
 - Speed of setup – like 50ms restoration times?
 - This is not at all like the way SDH / SONET is being used today
 - Speed of authentication and control plane interaction
- Bandwidth Scaling
 - Speed of VCAT / LCAS?
 - Speed of propagation of control plane decision
 - Has been demonstrated to work



Control Plane

- Taking the management system out of the NOC
- Who can access the control plane?
- How are allocation decisions made and bandwidth granted?
- Do applications or users need privileges?
- Does the control plane service the network, the applications, or the users?
- How do multiple control plane systems interact in multi-domain scenarios



Control Plane Technologies

- Network element abstraction (i.e., GMPLS)
- Network partitioning and control
 - UCLP, DRAGON
- Network abstraction
 - Middleware
 - Similar to Grid abstraction of compute resources
- Network Information and repositories
 - Network Description Language
 - XML description of Network resources
 - Being sponsored by Global Grid Forum
- Control planes using these layers of abstraction



Transmission Technologies

- SDH / SONET
 - Dominates today
 - Many advantages in restoration, quick setup
 - Very long haul / maritime support
- Ethernet – as the presentation
 - Ethernet presentation of a multitude of framings and transmission capabilities
 - Is Ethernet a universal presentation?
 - Ethernet over optical / DWDM (no SDH / SONET)



Optical Switching

- All optical?
 - The role of photonic switching?
 - All-Optical systems?
- Non-digital optical transmission?
 - Analog systems

Capacity?

- 40G SONET / SDH is (nearly) here today
- 100G Ethernet coming soon
- Switches with 200+Gbps/port have been demonstrated
- 1000+ waves/fiber has been demonstrated



Future of Packet Switching

- Packet switching still incredibly versatile
 - Most uses will depend on packet switching
 - Routing still essential for majority of uses
- Many, not one, packet networks
 - Will we still run IP on our circuit-switched networks?
 - TCP for end-to-end transmission control
 - Ethernet for (small-scale) many-to-many
 - No routing?
- Solving packet switching problems
 - Cost of routing, cost of making decisions
 - Power consumption



GRIDs and Future Networks

- Duality of Views
 - We can regard the Network as just another resource in the grid
 - We can regard the grid as just more services in the network
- Similarities of Grid middleware and network abstraction middleware
 - NDL (Network Description Language) is now a Global Grid Forum project
- Classic computing ideas
 - Resource Scheduling – a classical computing problem
 - Control plane issues - a scheduling problem



EARNEST Study

- TERENA is organizing study of future network technologies
- Participation of European experts
- Vendors interviews, technologies investigated
- Report due this summer



Future Network

- More bandwidth
- More user control
- More dynamic networks
- Multiple, parallel networks
- Advanced controlplanes
- User control vs. Network (system) control
- Convergence of Grid and Network



Questions?

<lars@nordu.net>

