



Next Generation NREN Architectures

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Agenda

Requirements

A look over the fence

IP approach

Transport approach

Conclusions



Requirements



Research & Education Network Tiers

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LEADERS

NETWORK TYPE

CAPABILITIES/USERS

Web100
NLR

Research

Experimental environments for
network researchers

Teragrid
WIDE
CALREN
NLR

Experimental
Networks

Next generation architecture
and applications
for research
community

I2-Abilene,
Renater-3
SJ4

Advanced Education Networks

Advanced services
for education

ISPs

Commodity Internet

General Use

Interesting characteristics of NLR

- **Three types of networks, over a single fiber plant**
- **1. “Production” L3, IP network**
- **2. L2 cross-connect**
 - For non-IP methods/experiments- (10)GigE, VLANs, etc.
- **3. Optical cross-connect**
 - Allowing for “extreme experiments”
- **A practical example of developing a single infrastructure that supports both production (e.g. applications research on a stable/production network), test **and** research networks**

Requirements for NRENs

- **Strong and scalable, high available IP base service**
 - GE, 10GE as customer facing interfaces**
 - nx 10 Gb/s core, Ethernet or POS**
 - Unicast & Multicast**
 - Dual-stacked IPv4 & IPv6, feature parity**
- **Production, Test and Research on Networks**
- **Point to Point bandwidth with fixed SLAs, typically for limited time**
 - Signaling from applications**
 - Today Unicast, some requirements for Multicast**
 - Ethernet-framed vs. transparent**
 - Virtualization of the Network Infrastructure**
- **Interfacing to the Campus**

- **What's a LightPath ?**

All Optical Lambda Service between sites

All Optical Lambda Service End to End

Ethernet framed Pt2Pt (GE/10GE)

SONET/SDH

L2 Pt2Pt via IP or MPLS (Ethernet via L2TPv3/Martini)

L2 VPN over IP or MPLS

L3 VPN

LightPaths - Open Questions

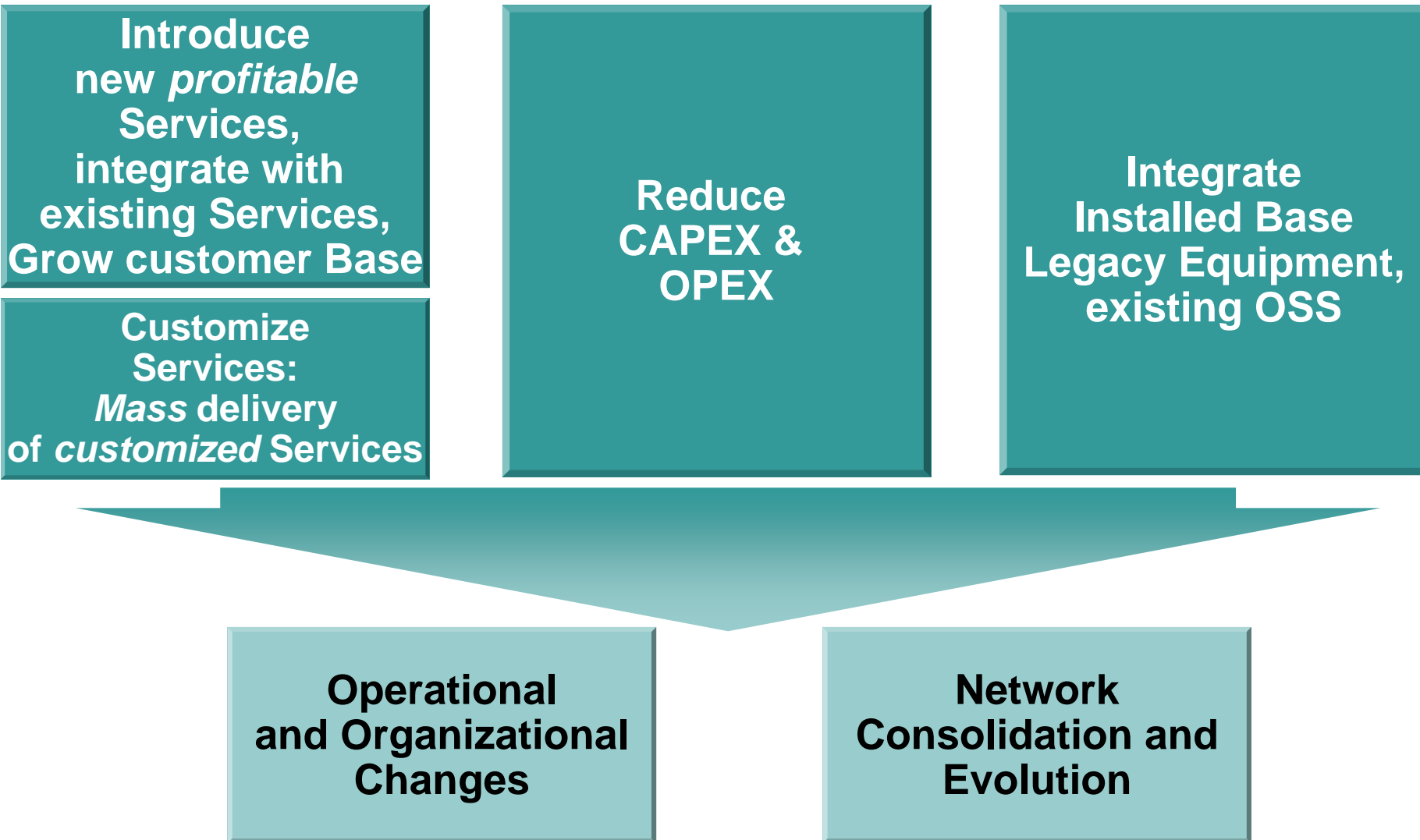
- **How many NREN customers will buy LightPath services**
- **How many interfaces per customer**
- **Detailed SLA specs**
- **High Availability for LightPaths vs. Fallback to base IP service ?**

- **Delivery via IP or Transport based service**

A look over the fence



SPs today: *Business Drivers* rather than *Technology Trends* rule...



Customize Services:
Mass delivery of customized Services

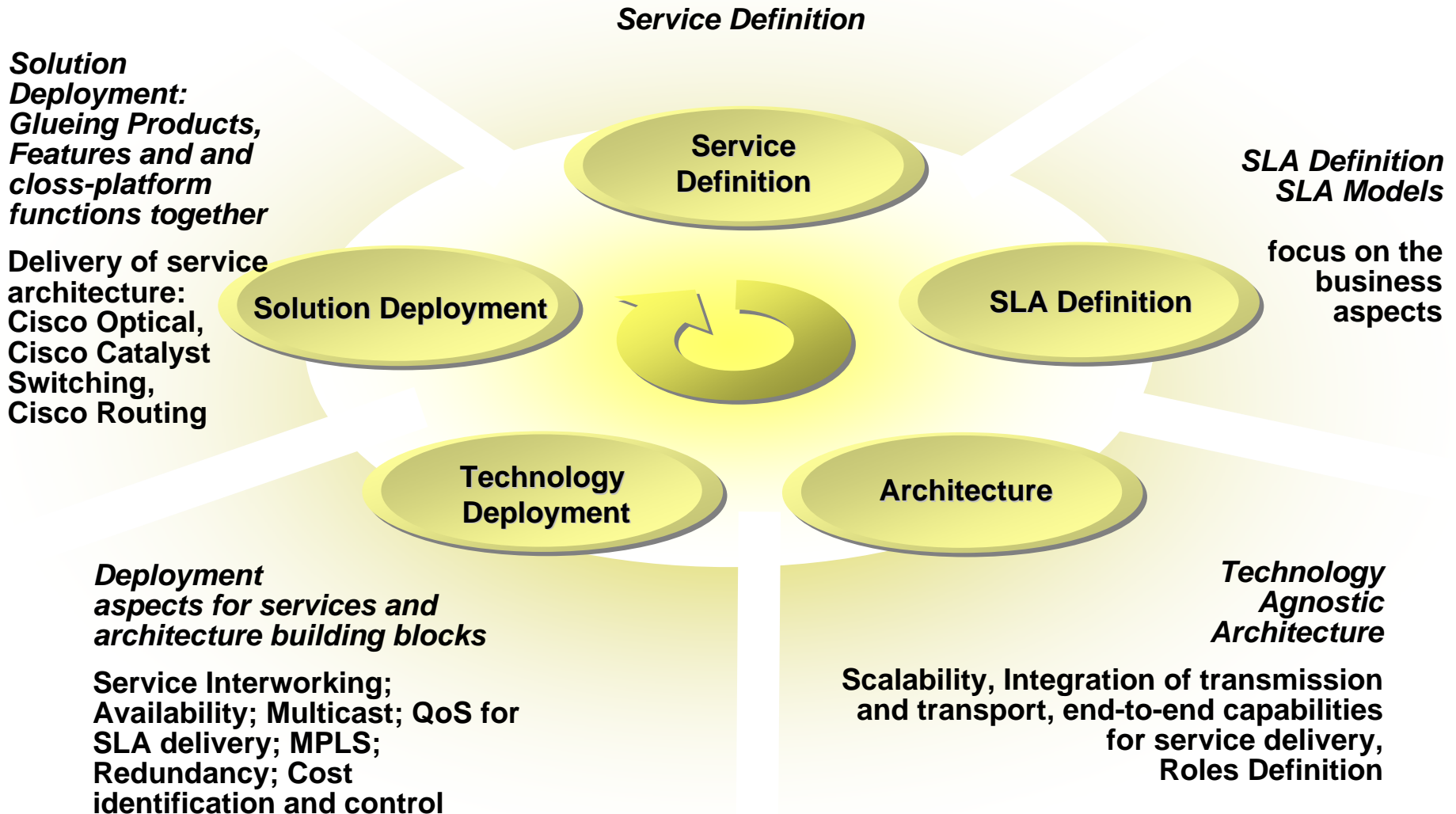
Operational and Organizational Changes

Network Consolidation and Evolution

Towards a Service Driven Network

Start with Services.... Not with the Architecture or Technology

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Common Understanding with SPs Today...

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Network Paradigm Shift

„Services drives Transport“ – rather than
„Build Transport, Services follow“

Service Shift

„Mass Production“ to „Mass Customization“

Organizational Transition & Transformation

From a vertical to a horizontal business model. Removing operational silos, limit internal overlap & competition, expand service portfolio

Some rules remain valid

The concept of layering remains valid. Put into perspective: Leverage all 3 layers for service delivery and scalability – rather than a single one. We'll continue to see L1, L2 and L3 functions and equipment in the network

SP IP Network

- **THE vehicle for service delivery**
- **Typically, MPLS based (RFC2547 VPN, AToM, L2 VPN, few TE, fewer FRR)**
- **Design for Tight-SLAs***
 - Fast Convergence**
 - Diffserv vs. Overprovisioning in the Core**
- **Bandwidth depending on requirements: OC-48c..OC192c..nx
OC192c..OC-768c in 2005**
 - POS is dominant in WAN core**

*John Evans, Clarence Filsfils, "Deploying Diffserv at the Network Edge for Tight SLAs", IEEE Network Computing, 2 part series: Part 1, Volume 8 Issue 1, pp. 61-65, Jan 2004; Part 2, Volume 8 Issue 2, Mar 2004
Clarence Filsfils, John Evans, Engineering a multiservice IP backbone to support tight SLAs, Computer Networks: The International Journal of Computer and Telecommunications Networking, v.40 n.1, p.131-148, 16 September 2002

IP Approach



IP Approach

- **Use L2TPv3 or AToM technology to deliver P2P circuits**
- **Use L2VPNs technologies like VPLS to deliver P2MP solutions**
- **Over-provisioning facing special flows**
 - Use Diffserv**
 - Engineering IP Backbones for Tight SLAs**
 - KISS ?**
- **Nx 10Gb/s .. 40 Gb/s .. 100 Gb/s ?**

- **Advantages**

 - (Overprovisioned) IP Network is there anyhow**

 - Best use of spare capacity**

- **Disadvantages**

 - Impact of “special” communication patterns on over-provisioned backbones**

 - QoS adds complexity & OpEx**

 - CapEx**

 - Pure IP network makes it difficult to provide test/research networks**

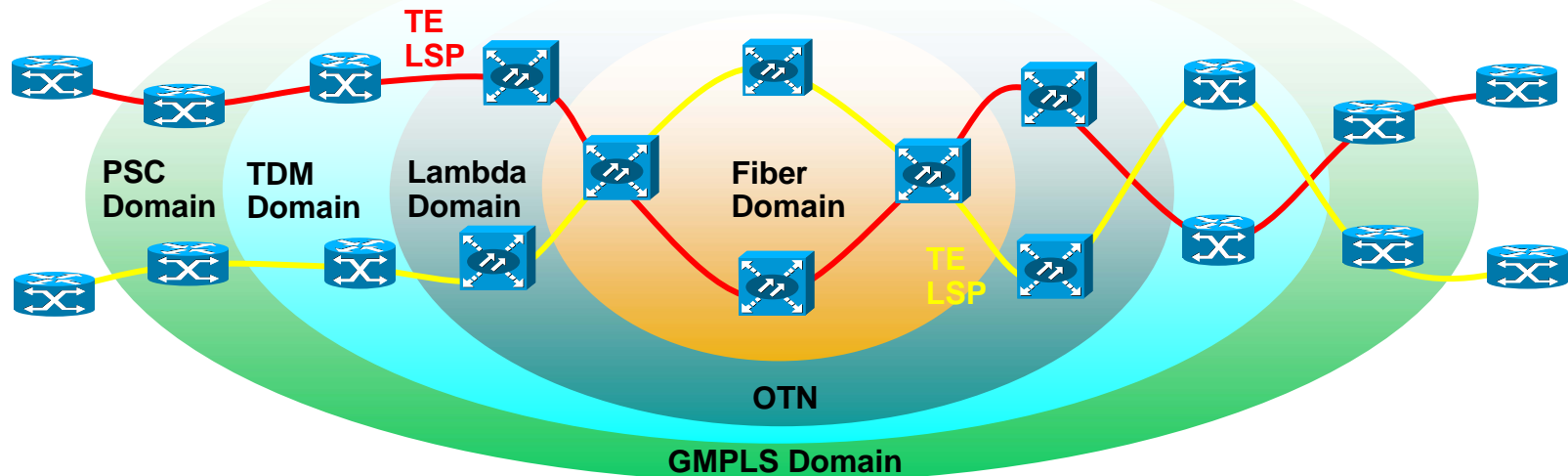
Transport based



Transport Approach

- **What's a Lightpath ?**
- **Is the Next Gen NREN a Next Gen Phone Network ?**
- **Operating**
Ethernet via SONET/SDH, Ethernet via CWDM/DWDM
- **Coming**
GMPLS based control plane
Standards still in an early state
Proxy based vs. native approach
Do we want to share the IGP between optical and IP ?

GMPLS Signaling



- Extended label semantics for Fiber, Waveband, Lambda, TDM and PSC LSP setup
- Extend RSVP-TE/CR-LDP for opaquely carrying new label objects over explicit path
- Suggested Label - conveyed by upstream LSR to downstream LSR to speed up configuration (on upstream)
- Label Set - limits choice of labels that downstream LSR can choose from
 - If no wavelength conversion available then same lambdas must be used
- Bidirectional LSP setup

Transport Pro & Con

- **Advantages**

 - Fixed SLAs**

 - Simple, well established technology**

 - Easy to provision test/research networks**

 - For NRENs with Dark Fibre: combination of CWDM, DWDM & TDM**

- **Disadvantages**

 - Provisioning**

 - Control Plane proprietary - GMPLS just coming to market**

 - Multi-Domain provisioning**

 - Capacity planning**

 - Over-provisioning is expensive**

 - No Multicast**

 - For NRENs without Dark Fibre access: TDM over multiple lambdas is only alternative**

Conclusions



Conclusions I

- If a NREN has a chance to acquire dark fibre for a reasonable price & conditions, go for it. **now!**
- Most NRENs will be hybrid (Transport/IP)
- A scalable dual-stack IPv4/IPv6 IP base service will always be needed
- Some NRENs will bring perfect service for Grid apps purely based on the IP network
- **There are some benefits for looking at services and SLAs, first, before nailing down architectures**

Conclusions II

- **Don't do full investment for what you will need in 5 years now... but let's not get caught in a trap, investment protection is more than a marketing term...**
- **Underlying transport networks should use a standards based IP based Control Plane, e.g. GMPLS**
- **GMPLS is still far from being complete**
 - Many details in Standards missing, Inter-Domain, Deployment expertise**
- **Other work areas**
 - GMPLS Bandwidth Broker Integration,**
 - Completion of the AAA Integration**
 - Virtualization of the Network Infrastructure**
- **Vendors are willing to talk long term strategy and share Carrier experiences...**

Q and A



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