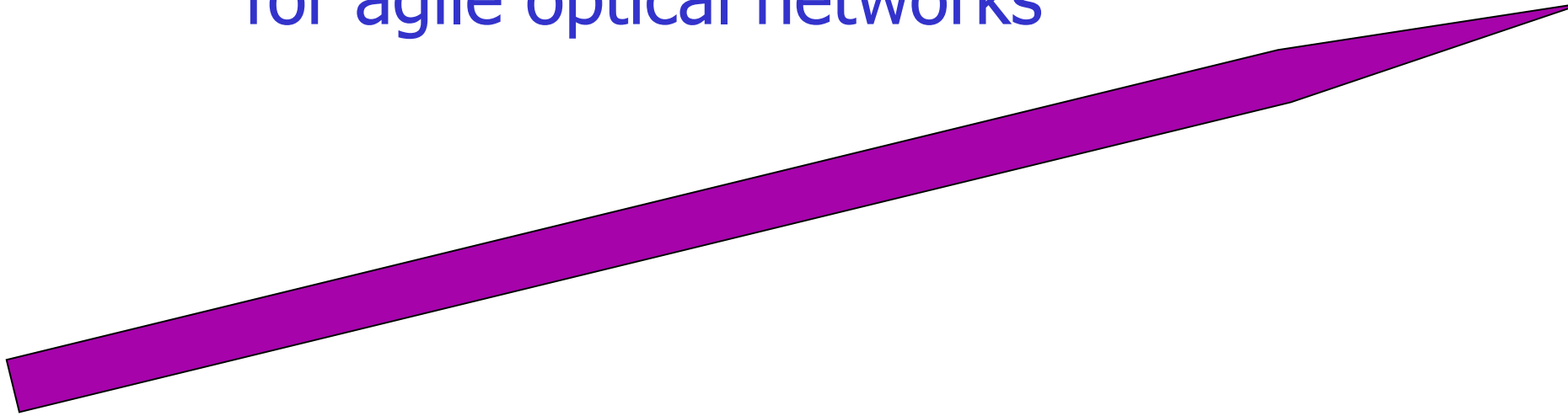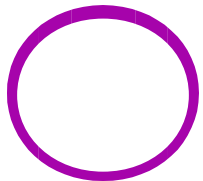# Services and Applications' infrastructure for agile optical networks

More questions than answers

Tal Lavian

Services and Applications' infrastructure for agile optical networks ?

- Huge advancements in optical devices, components and networking.

    - The underline of the Internet is optical – How can we take advantage of this?

    - How can the applications take advantage of this?

- Agile Optical Network is starting to appear. What services and interfaces we'll need between the optical control and the applications?

    - What are the applications?

    - The Internet architecture was built on some 15-20 years old assumptions. Are some modifications needed?

- Is packet switching good for all? In some cases, is circuit switching better? (move TeraBytes of SAN date, P2P, Streaming)

- End-to-End Argument – Is is valid for all cases?

    - What cases not? What instead?

- The current Internet architecture is based on L3. What is needed in order to offer services in L1-L2?

- Computation vs. Bandwidth 10X in 5 years
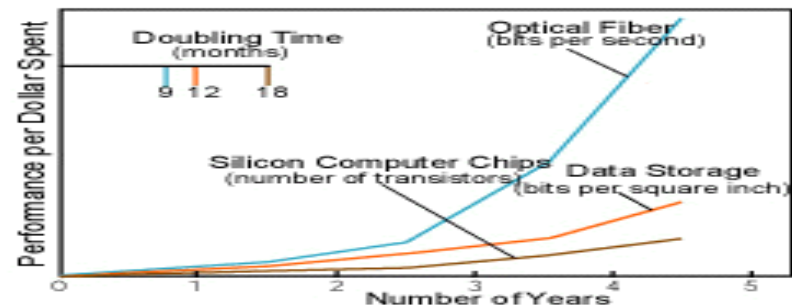
How Optical Agility differ? (vs. L3 Routing)

- Current internet architecture is based on L3 routers with static connection of routers ports (point to point)

- Until recently it took 4-8 month to set an optical link coast to coast.

  - Need to cross and contract with 4-6 organization with lawyers

  - Need patch panel with manual cable setting

  - Need static configurations

  - Extremely expensive (10G Monthly - $1M)

- current peering is mainly in L3, BGP and policy

- New fast provisioning in ASON (seconds)

  - A head of time static rout computation

  - MPLS, MP! S, CR-LDP, RSVP-TE

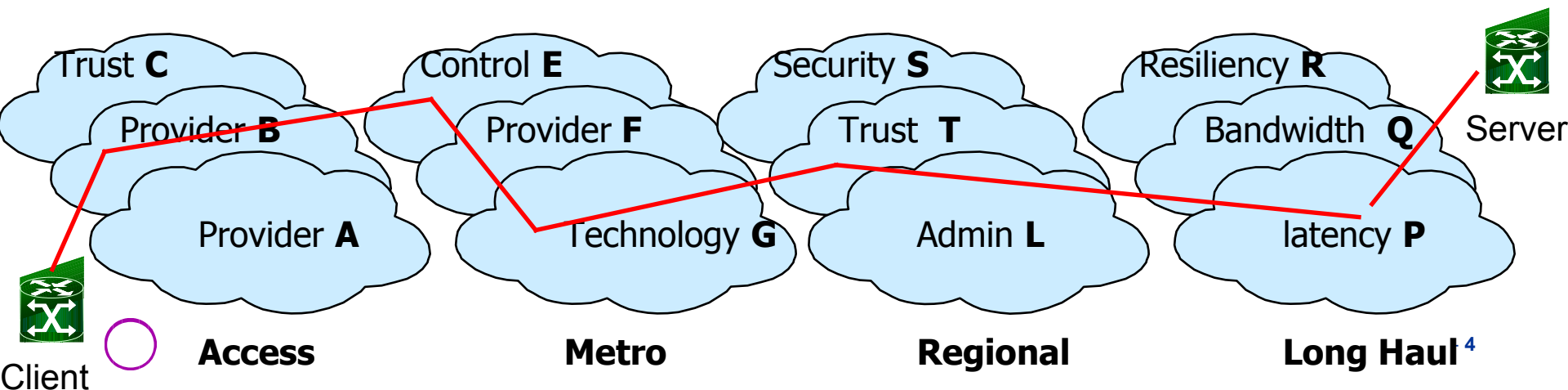- New Service Architecture and mechanisms for composing services
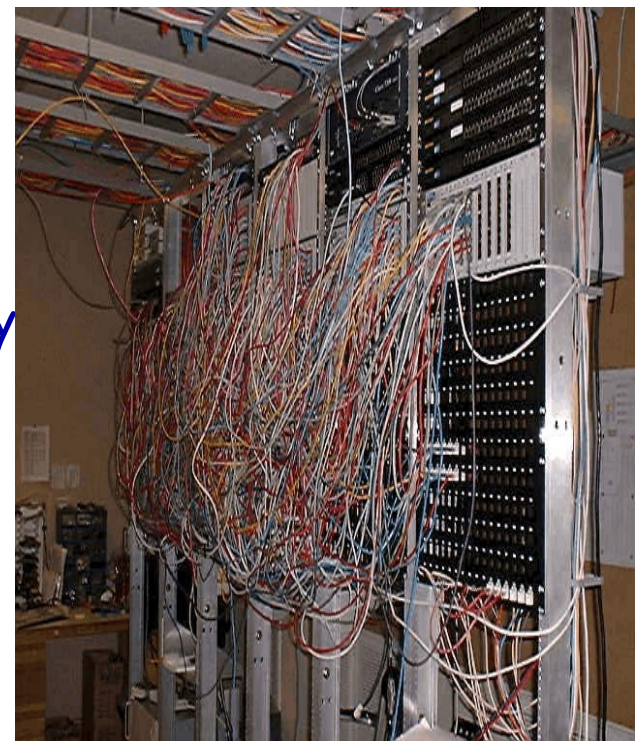
Manual connectivity

Service Composition

Current peering is mainly in L3. What can be done in L1-L2?

- The appearance of optical Access, Metro, and Regional networks

- L1-L2: Connectivity Service Composition

  - Across administrative domains

  - Across functionality domain (access, metro, regional, long-haul, under-see)

  - Across boundaries (management, trust, security, control, technologies)

  - Peering, Brokering, measurement, scalability

- Appearance of standards UNI – NNI

Trust **C**

Provider **B**

Provider **A**

Control **E**

Provider **F**

Technology **G**

Security **S**

Trust **T**

Admin **L**

Resiliency **R**

Bandwidth **Q**

latency **P**

Server

Client

Access

Metro

Regional

Long Haul [4]

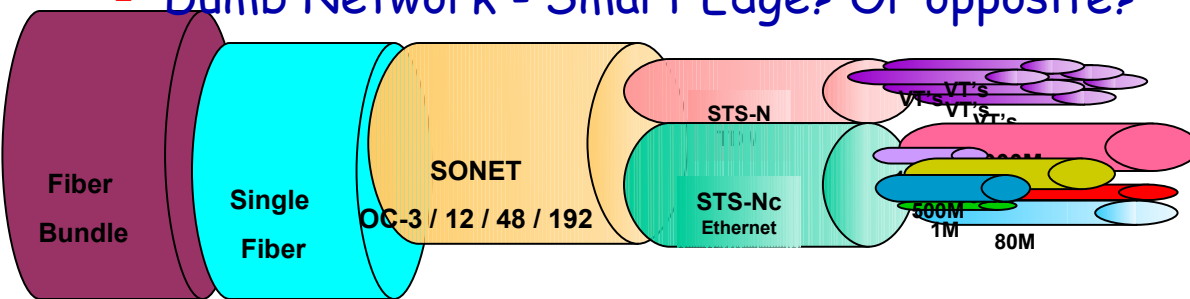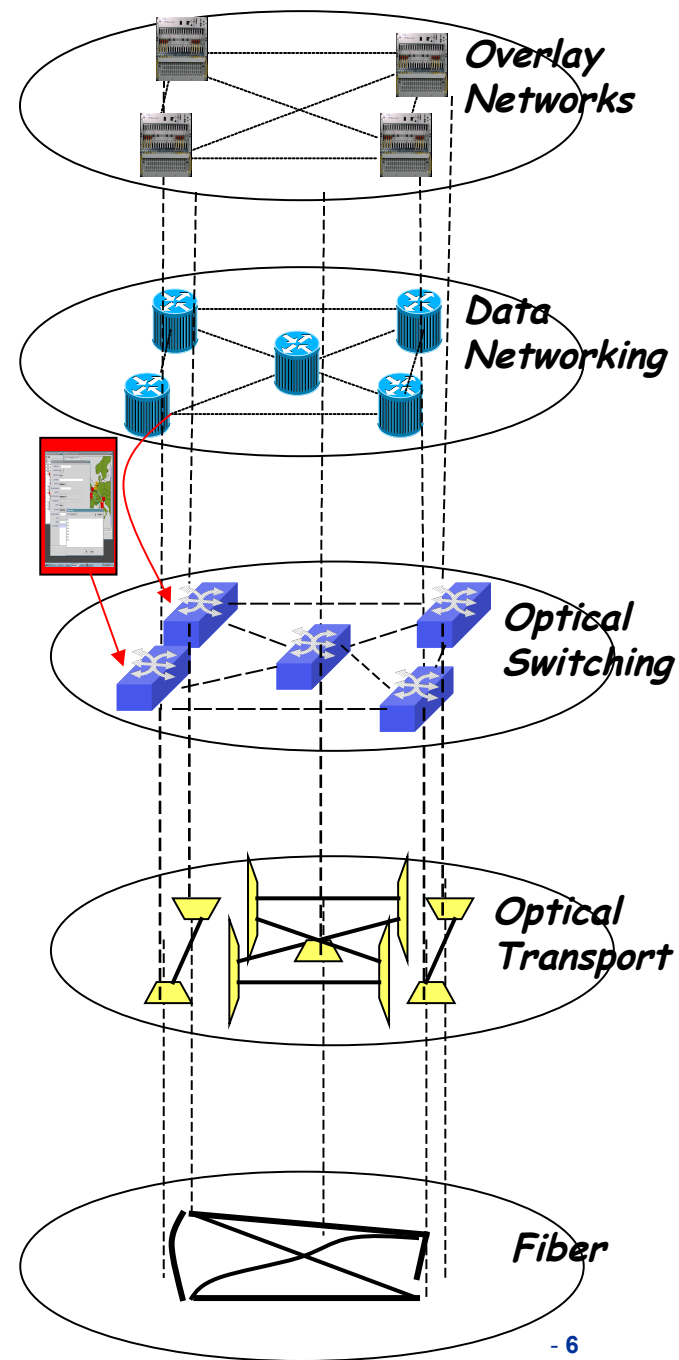# Compose new type of Applications?

Dynamic L2VPN: enable new type of applications

- Agile connectivity for:
    - SAN across metro, regional and long haul.
    - Plain disk remote storage
    - Backup (start remote backup when the tape in Nebraska is ready and when all the optical connection are ready to be set)
- Set dynamic bandwidth connectivity to the Internet
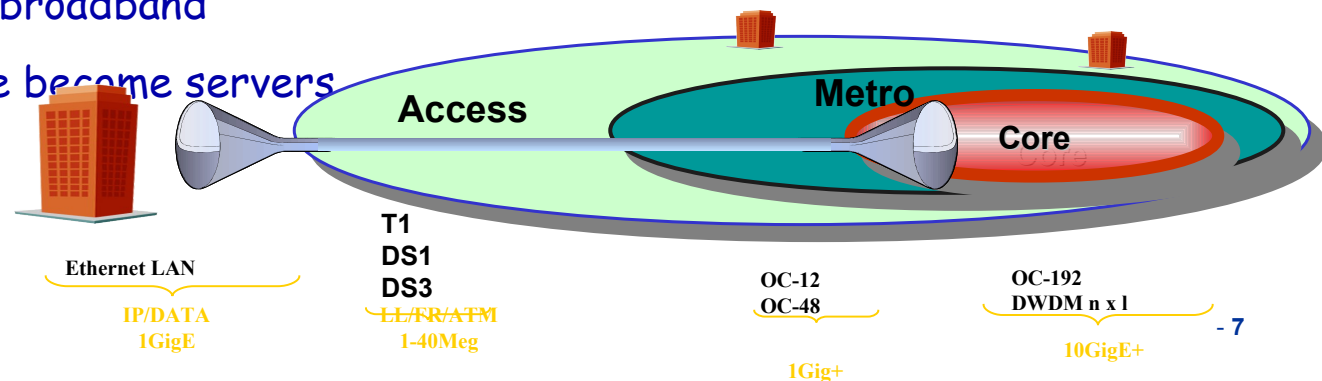   - What architecture changes are needed?
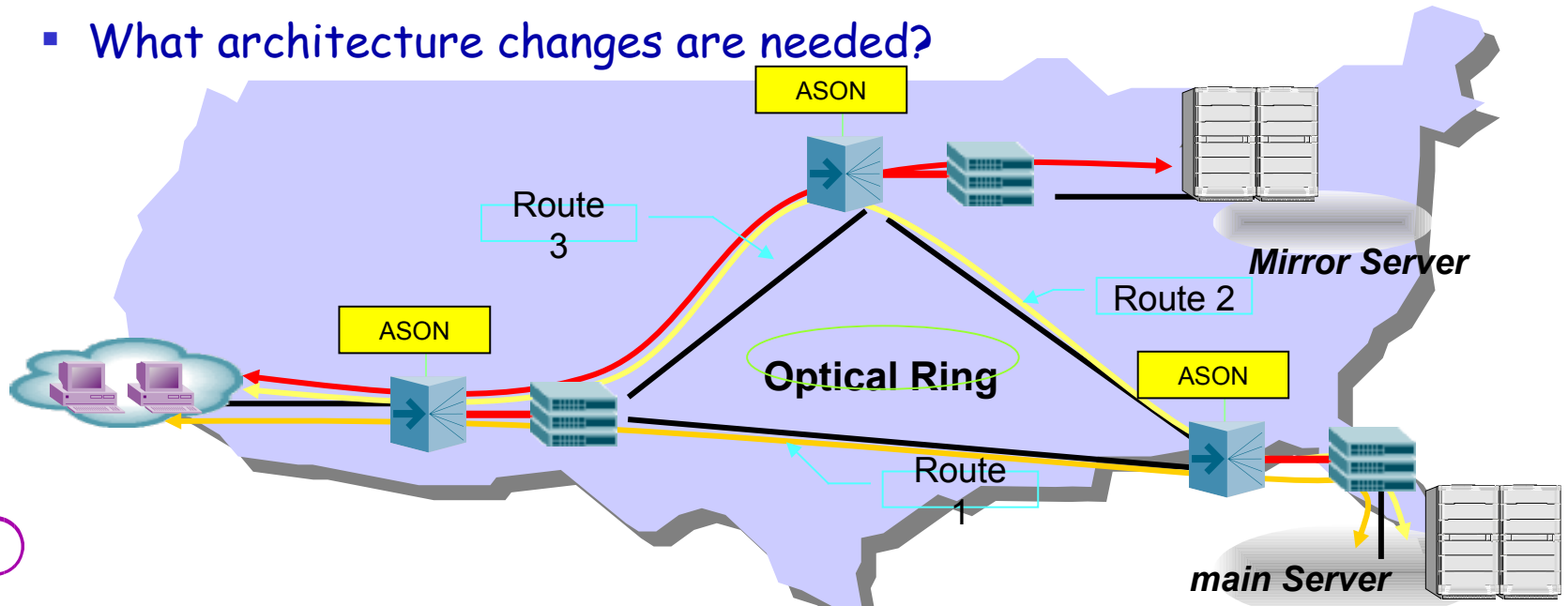
Technology Composition

- L3 routing – drop packets as a mechanism
  - (10^{-3} lose look good)
  - Circuit switching – set the link a head of time
- Optical networking – bit transmission reliability
  - (error 10^{-9} -10^{-12})
- **L3 delay – almost no delay in the optical layers**
- Routing protocols are slow – Optics in 50ms
  - Failure mechanism redundancy
- **DWDM ! s tradeoff– higher ! bandwidth vs. more ! s**
  - For agile L1-L2 routing may need to compromise on bandwidth
- **RPR – break L3 geographical subnetting**
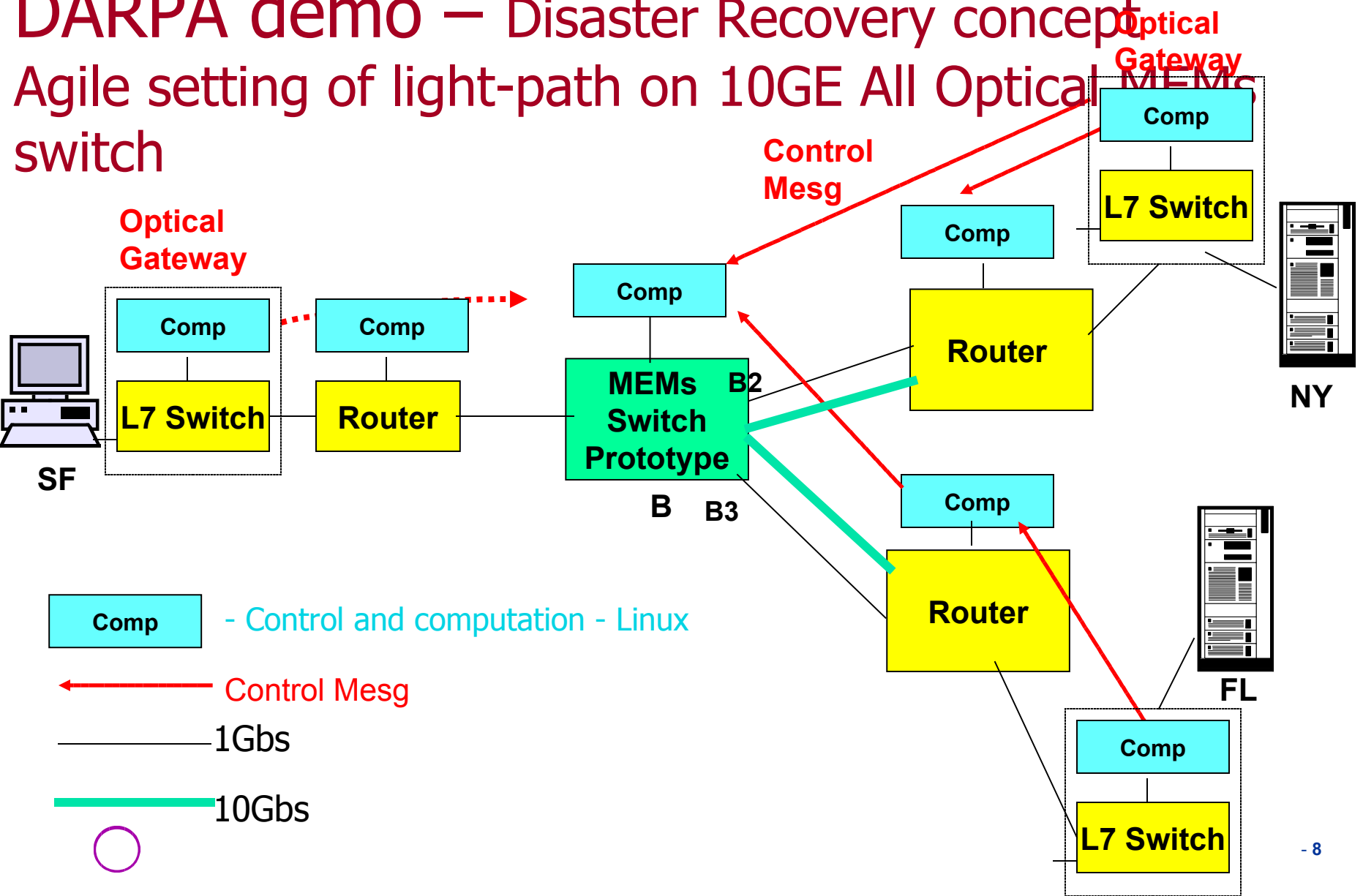- Dumb Network - Smart Edge? Or opposite?

Overlay Networks

Data Networking

Optical Switching

Optical Transport

Fiber

Fiber Bundle

Single Fiber

SONET

OC-3 / 12 / 48 / 192

STS-N

STS-Nc
Ethernet

VT's

- 6

New Architecture Challenges

- **We are facing enormous growth of traffic. How the current L3 centric architecture handle this growth?**

- **Supply - New technologies for the Last Mile**
  - Servers and storage are moved to Data Centers with big data pipes
  - Optical Ethernet, MEF, L2VPNs, Passive Optical Networks (PON)
  - Competition in the last mile, mainly business access

- **Demand – The need for more bandwidth**
  - Distribution of data, storage and computation.
  - Streaming, virtual gaming, video conferencing,
  - P2P, KaZaA, Morpheus - the next big thing that consume traffic?
    - Social differences, downloads of Gigabits a day
  - Dialup move to broadband
  - PCs on the edge become servers

Access   **Metro**   **Core**

Ethernet LAN

IP/DATA
1GigE

T1
DS1
DS3
LL/FR/ATM
1-40Meg

OC-12
OC-48
1Gig+

OC-192
DWDM n x l
10GigE+

DARPA demo – Disaster Recovery concept

Agile setting of light-path on 10GE All Optical MEMs switch

Optical Gateway

Control Mesg

Optical Gateway

Comp

L7 Switch

NY

Comp

Router

Comp

L7 Switch

Router

Comp

MEMs Switch Prototype

B2

B **B3**

Comp

Router

FL

Comp

L7 Switch

SF

Comp   - Control and computation - Linux

⟵ Control Mesg

— 1Gbs

━━ 10Gbs

○

- 8

Backup Slides
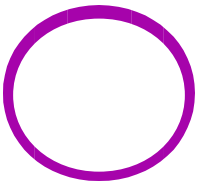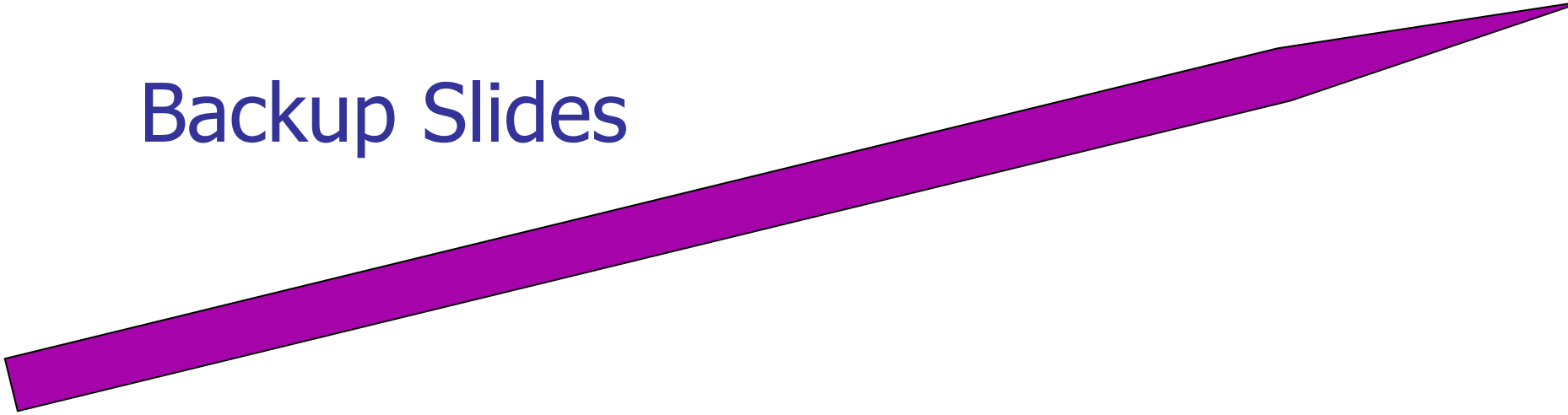
Networking Issues

- Electrical versus Light
- Copper versus Fiber
- Wired versus Wireless
- Packet versus Circuit
- Flow versus Aggregate
- Stateless versus stateful
- Fixed versus Programmable

- End-to-End versus Hop-by-Hop
- Unicast versus Multicast
- Centralized versus Distributed
- Peer-to-Peer versus Client-Server
- Connectivity versus Service.
- Vertical versus Horizontal
- Users versus Provides

**It is impossible to eliminate one completely in favor of the other!
So, how are we composing the next generation Internet?**

- Service Architecture instead of Connectivity Architecture
- Composing end-to-end services by negotiation
- Deploying Optical Agility with Programmability and Scalability properties

Packet vs. Circuit

Packet Switch

- data-optimized
  - Ethernet
  - TCP/IP
- Network use
  - LAN
- Advantages
  - Simple
  - Low cost
- Disadvantages
  - unreliable

Circuit Switch

- Voice-oriented
  — SONET
  — ATM
- Network uses
  — Metro and Core
- Advantages
  — Reliable
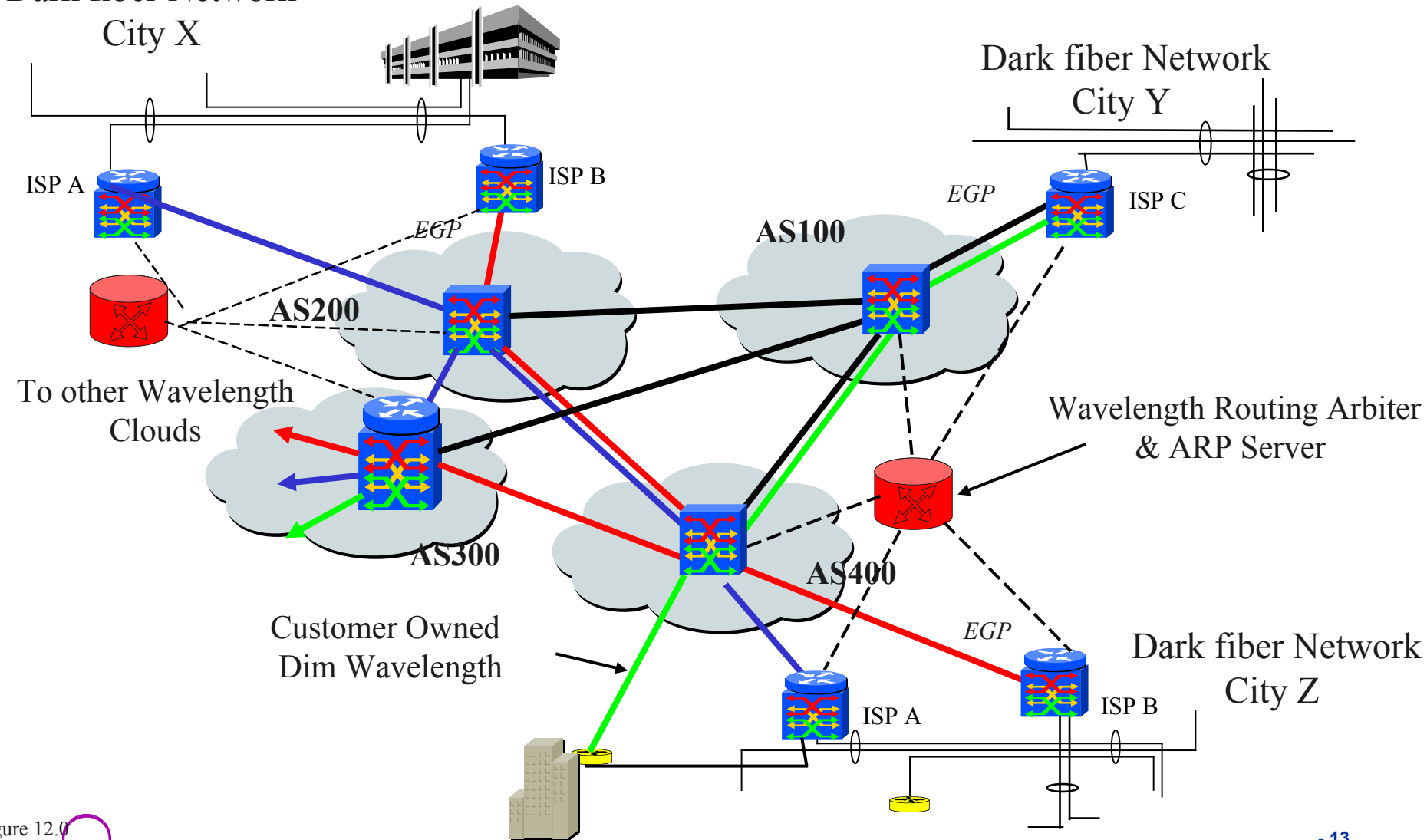- Disadvantages
  — Complicate
  — High cost

Networking – Composing the Next Step ?

- How are we composing the next Internet?

  - Elimination

  - Addition

  - Combination

  - Survival of the fittest

- Composing the Internet = Choosing and combining components to construct services, at the same time optimizing some utility function (resources, monetary, etc)

  - Service Architecture

  - Optical Core

  - Programmability

  - Scalability

  - Composing by negotiation

Canarie Optical BGP Networks

Dark fiber Network City X

ISP A

ISP B

Dark fiber Network City Y

EGP

ISP C

AS100

AS200

To other Wavelength Clouds

Wavelength Routing Arbiter & ARP Server

AS300

AS400

Customer Owned Dim Wavelength

EGP

Dark fiber Network City Z
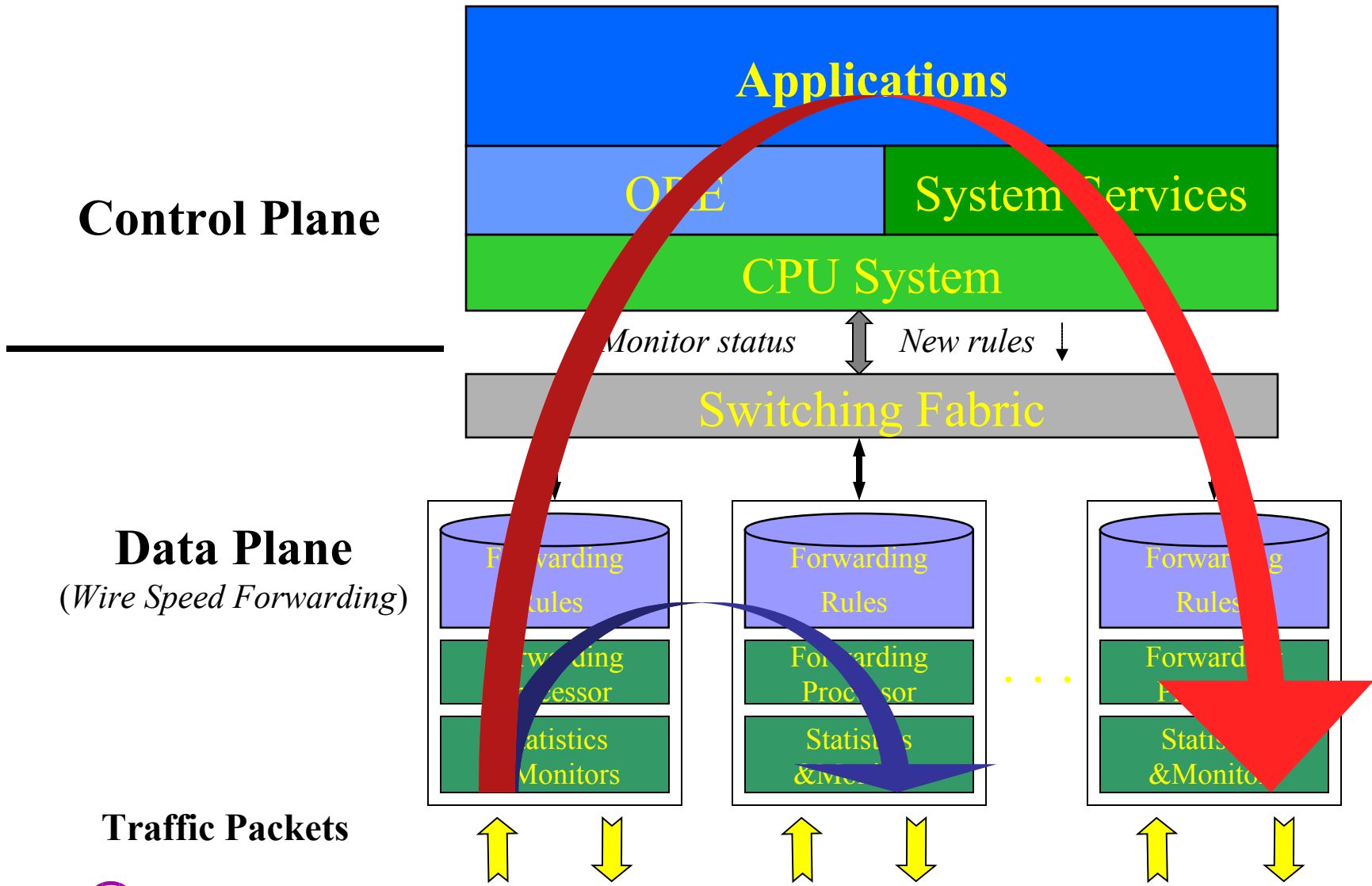
ISP A

ISP B

Figure 12.0

Impedance Mismatch

- Cross boundaries (Control, Management, security)

- Cross Technologies (Sonet, DWDM, ATM)

- Cross topologies (P2P, Rings all types, mesh,)

- Circlet , packets

- Speeds (1.5, 10, 51, 100, 155, 622, 1G, 2.4G, 10G…)

- Fiber, copper, wireless

- Level of media security

Openet Architecture

Control Plane

Applications

ODE

System Services

CPU System

Monitor status   *New rules*

Switching Fabric

Data Plane
(*Wire Speed Forwarding*)

Forwarding Rules

Forwarding Rules

Forwarding Rules

Forwarding Processor

Forwarding Processor

Forwarding Processor

Statistics &Monitors

Statistics &Monitors

Statistics &Monitors

Traffic Packets

Scalable Bandwidth and Services