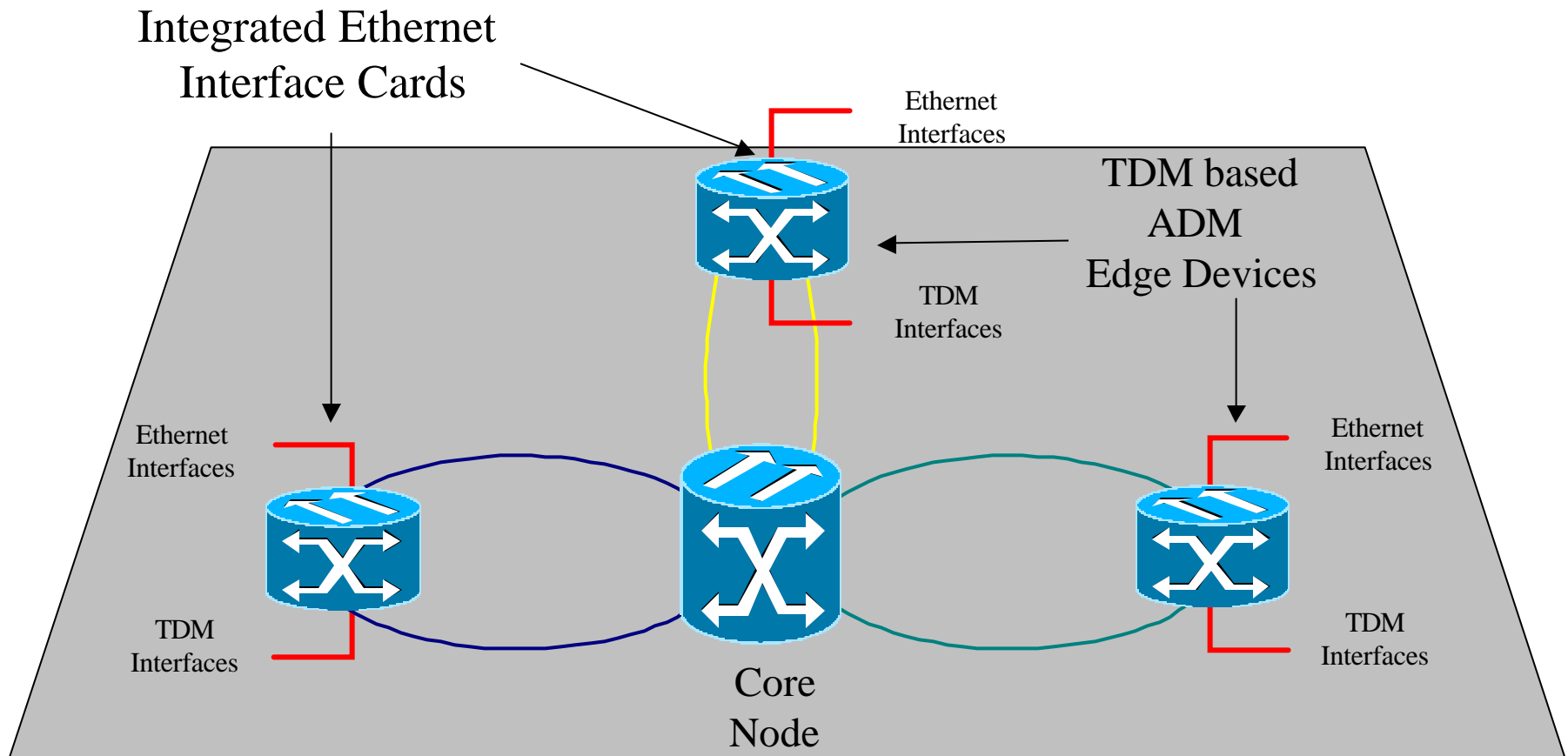# RPR Usage:
A Carriers' Carrier Perspective

IEEE802.17   Orlando, FL

May 14, 2001

Phase 1 Architecture - Pt to Pt ENET services

Integrated Ethernet
Interface Cards

Ethernet
Interfaces

TDM based
ADM
Edge Devices

TDM
Interfaces

Ethernet
Interfaces

TDM
Interfaces

Ethernet
Interfaces
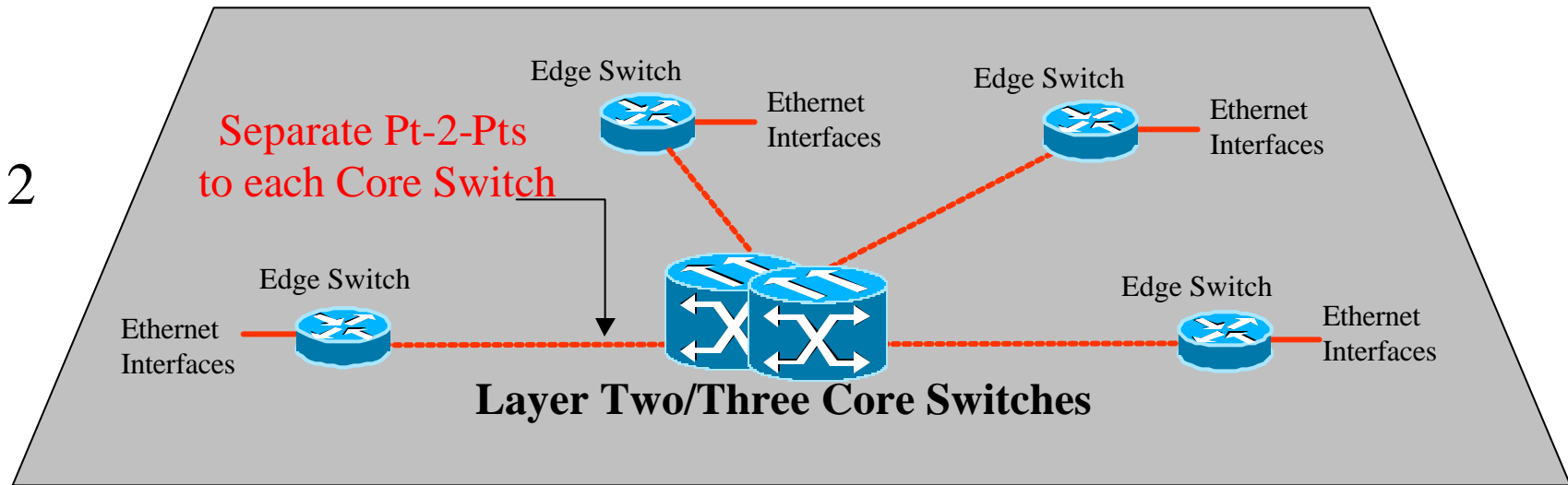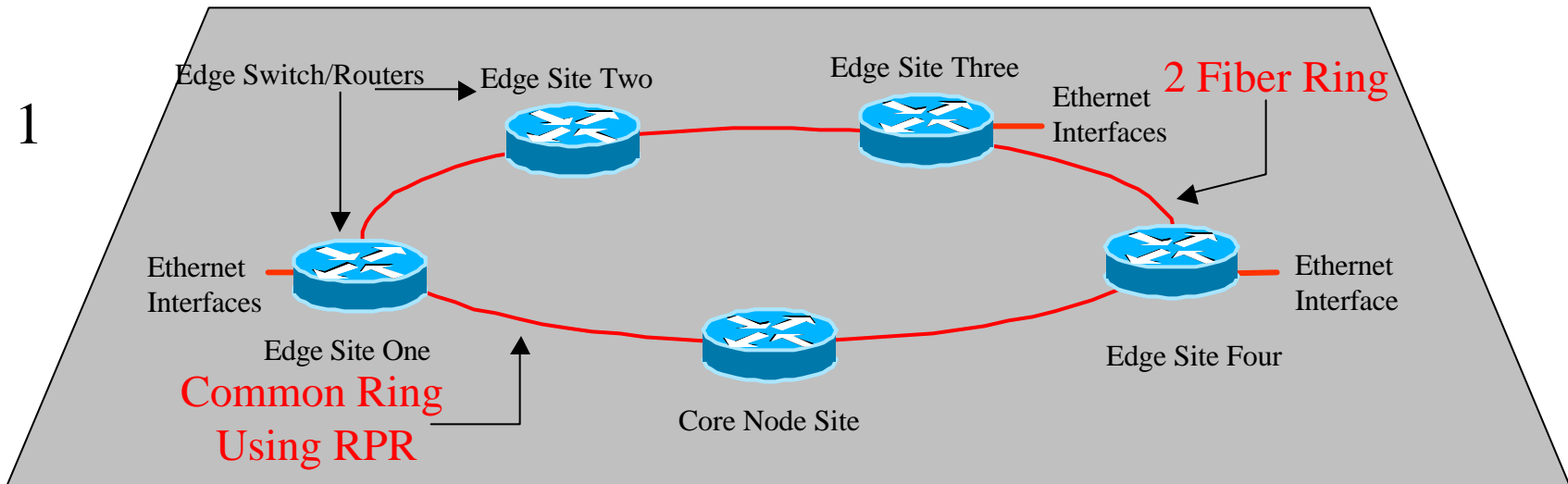
TDM
Interfaces

Core
Node

Architecture Overview

- Metro ring sizes of 11km – 105km; ave. 35km
- Interconnect LEC Co-Lo, Carrier Hotels, Large Enterprises
- Four 9's reliability
- Most GbE connections that LGN transports will be line rate
- No stat muxing capability on the network
- All traffic stays within the metro space

Architecture Trade-Offs

- Point to Point fibers optimized for Network Services
  - Lower equipment cost
  - Maximum capacity per site
  - Excessive fiber usage
- Multi-Node Rings offer fiber efficiency
  - More expensive H/W
  - Bandwidth Reuse
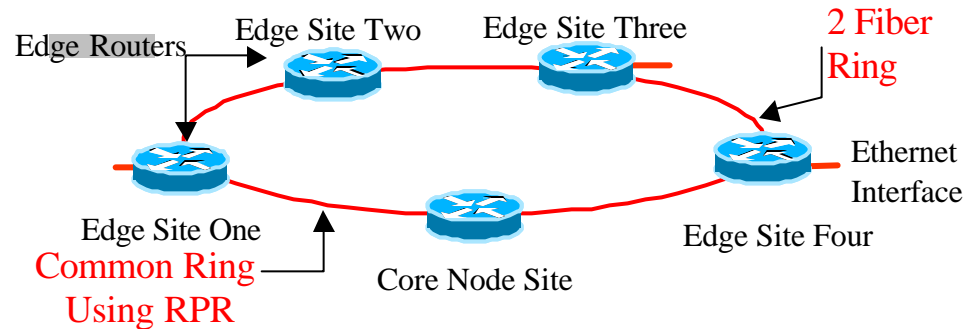 - Potential for maximum capacity per site

Phase 2 Architecture Options

1

Edge Switch/Routers → Edge Site Two

Edge Site Three

Ethernet Interfaces

2 Fiber Ring

Ethernet Interfaces

Ethernet Interface

Edge Site One

Edge Site Four

Common Ring Using RPR

Core Node Site

2

Edge Switch

Ethernet Interfaces

Edge Switch

Ethernet Interfaces

Separate Pt-2-Pts to each Core Switch

Edge Switch

Ethernet Interfaces

Edge Switch

Ethernet Interfaces

Layer Two/Three Core Switches

Preliminary RPR Points

- Pros
  - Fiber Conservation
  - Equipment Cost
    - In the Parallel GbE exercise Core cost averaged ~30% of total cost (Excluding Core Router), but was only 1 site compared to 4 edge locations
    - A true multi-node ring architecture would lower core cost. No direct Core connect required for each edge location so fewer GBICs
    - Edge cost will rise…since we would have the additional cost of RPR technology compared to just GbE
    - Depending on market/fiber layout, could save significantly by not having to use long haul (ZX) optics in data equipment
  - Bandwidth provisioning
    - It I s Ethernet, so it will find its L2 peers
    - Depending on traffic patterns (what is going where), LGN will not have to oversubscribe the ring and by using spatial reuse gain some of the economic benefits of bandwidth reuse on every segment of the ring
    - LGN will be able to oversubscribe a segment of the ring but use priority to allocate bandwidth to critical circuits and gain the benefits of over-subscription

Edge Routers   Edge Site Two   Edge Site Three   2 Fiber Ring

Ethernet Interface

Edge Site One   Edge Site Four
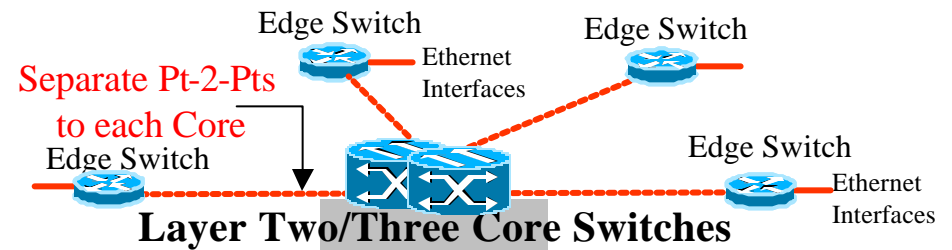
Common Ring Using RPR   Core Node Site

- Cons
  - Multi-node ring fiber topology
    - Operational impact on fiber, maintenance, record keeping
  - Testing and monitoring
    - TDM plan is to monitor and test at the core, a multi-node ring will require RMON test access and monitoring points at each edge location
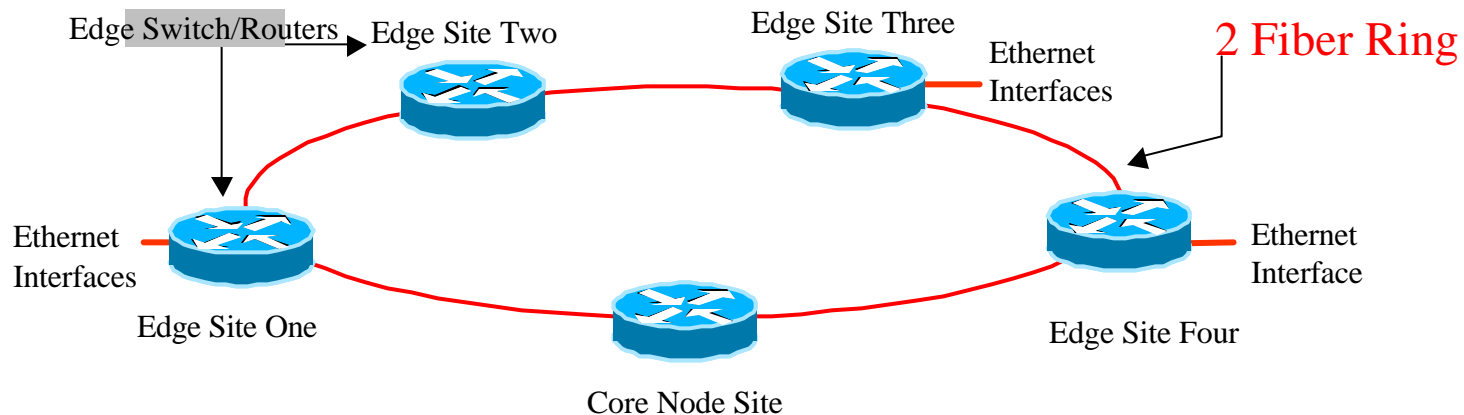
Preliminary L2/L3 Points

- Pros
  - Maintains Star Pt2Pt fiber topologies
    - No fiber operational impact, record keeping
  - Equipment Cost
    - Edge cost would be lower…since we do not have the additional cost of RPR technology compared to just GbE

  - Bandwidth provisioning
    - Depending on traffic patterns (what is going where), LGN will not oversubscribe any one segment of the network; but still gain some the economic benefits of over subscription at the Edge by buffering and rate limiting
  - Testing and monitoring
    - This implementation supports the TDM plan to monitor and test at the core.

  - Core Router supports peering
    - Allows LGN to connect to anyone else at layer 3

Edge Switch   Edge Switch
          Ethernet
          Interfaces

Separate Pt-2-Pts
to each Core
Edge Switch   Edge Switch
                                              Ethernet
Layer Two/Three Core Switches   Interfaces

- Cons
  - Excessive Fiber Usage
  - Need of Core Router
    - Additional equipment installation, maintenance and management
  - Equipment Cost
    - Depending on market/fiber layout, significant impact with long haul (ZX) optics in data equipment
    - Core cost will be higher due to redundant nodes and multiple GBICs (2 per Edge site)

Model – Analysis

Edge Switch/Routers   Edge Site Two   Edge Site Three   Ethernet Interfaces   2 Fiber Ring

Ethernet Interfaces   Edge Site One   Core Node Site   Edge Site Four   Ethernet Interface

- Used 2.488 Gbps RPR interfaces versus two 1Gbps Pt2Pt connections per Edge
  - LX/LH GBICs for RPR model and ZX GBICs for Pt2Pt model
- Assumed 100% bandwidth reuse on each segment of ring
  - 8 fiber pairs for pt2pt vs 1 fiber pair for RPR
- Modeled a min/max fiber cost based upon incremental cost of using one pair in a deployed cable versus a fully loaded, amortized cost for each pair
- Hardware cost delta at the CORE: 12.1% less with RPR
- Hardware costs delta for the EDGE: 100.1% higher with RPR (RPR card $$)
- Fiber cost change: 7X less with RPR
- Overall cost delta: 39.3% higher at Max fiber cost with RPR
- Analysis with 8 EDGE sites per ring has 15X less fiber cost and 36.2% higher total cost with RPR

Recommendations

- If the main benefit of RPR is to be fiber gain, then it has to become as cheap as Ethernet itself to show an advantage
  - At 33 nodes on a RPR the overall cost delta vs Pt2Pt gets smaller; 35.5%

- Focus on 10GbE RPR technology and above
  - Not enough ring bandwidth at 2.5Gb to justify RPR and multiple nodes on a ring; even with bandwidth reuse in a non-oversubscribed ring

- Standardize on IEEE 802.1 MAC. Keep RPR implementations on layers above
  - Allows interop with non-802.17 equipment

- Network Management interfaces support CORBA
  - Support TMN architectures of Carriers
    - Typically EMS layer