THIS COULD BE YOUR FINEST HOUR.

Next Generation Optical Internets

Enabling the Minds of the Future, TODAY

Stanley L. Stevens

Manager, Advanced Internet Initiatives

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Agenda

THIS COULD BE YOUR FINEST HOUR.

- **Internet2 History**
  - ✔ The National Backbone Networks
  - ✔ Technical Shortcomings & Cures
- **Enter MPLS**
- **SmartPhotoniX - The Next Generation Optical Internet**
- **Introduction to Marconi**
  - ✔ Brief Overview
  - ✔ Our Dedication to the Internet2 Project
  - ✔ International Projects
- **Our Commitment to Brazil**
- **Why Marconi**

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Internet2 History

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- **Formed in 1996, The University Corporation for Advanced Internet Development, launched the Internet2 Project.**
- **Growth in Membership**
  - ✔ 176 regular University members
  - ✔ 72 Corporate members
  - ✔ 36 Affiliate members
- **Built high speed national backbone**
- **Create leading edge R&E network**
- **Enable new generation of applications**
  - ✔ High Definition Television (HDTV)
  - ✔ Real Time Video Collaboration
  - ✔ Archived Video Storage
  - ✔ Voice Integration

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National Networks

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- **Internet2 Backbone Networks**
  - ✔ vBNS
  - ✔ Abilene
- **United States Federal Government Networks**
  - ✔ DREN
  - ✔ ESnet
- **International Backbone Networks (31 Partnerships)**
  - ✔ RNP 2 (Brazil)
  - ✔ TANet (Taiwan)
  - ✔ CUDI (Mexico)
  - ✔ DFN-Verein (Germany)
  - ✔ Israel-IUCC (Israel)
  - ✔ SingAREN (Singapore)

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Internet2 Backbone Networks

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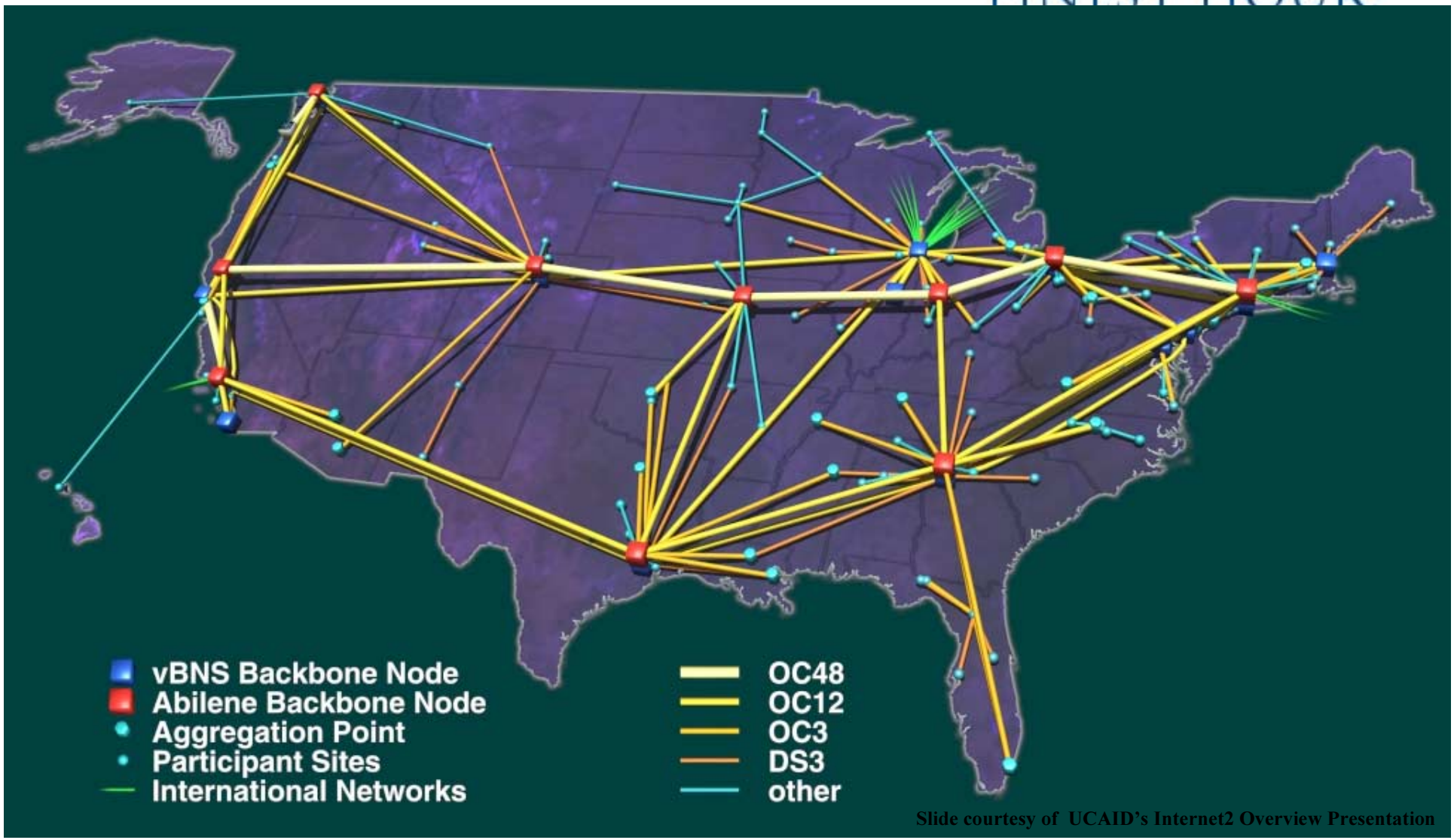

Slide courtesy of UCAID's Internet2 Overview Presentation

Technical Shortcomings & Cures

THIS COULD BE YOUR FINEST HOUR.

- **Quality of Service**
  - ✔ IP Multicast
  - ✔ RSVP
  - ✔ Diff serv
- **IPv6**
- ***MPLS***
- **Security**
- ***Migration to bigger pipes (DWDM & Optical)***
- **Delivering on the promise of "Research & Collaboration"**

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MPLS Current Practice & Market Forces

THIS COULD BE YOUR FINEST HOUR.

- **Today: Layered Model.**
  - ✔ ATM backbone surrounded by big “Core” IP routers.
  - ✔ IP over ATM.
- **Market Forces:**
  - ✔ IP becomes universal service interface.
    - ➠ VPNs, Voice, data (Internet, intranet, extranet), IP multicast.
  - ✔ Traditional router vendors trying to push inward to displace ATM backbone.
  - ✔ Optical Internetworking poised to grab the very core of the network hierarchy.

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The Requirement: Connections

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- **Marketing Debates**
  - ✔ Not IP vs. ATM
  - ✔ Not MPLS vs. ATM
- **Technical Reality: Connection-oriented vs. connectionless**
  - ✔ ATM
  - ✔ IP enabled by MPLS
- **Connection oriented traffic allows for traffic engineering and bandwidth guarantees (QoS) - and is already provided today in technologies like ATM and Frame Relay.**
- **IP alone is a connectionless protocol. Its forwarding decision are made on a hop by hop basis.**
  - ✔ MPLS enables to COLL behavior.
- **The pinned-up connection is relatively permanent, thereby allowing for resources to be reserved and allocated.**
  - ✔ Traffic Engineering, QoS and Congestion Aware Routing

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MPLS: The Common Ground

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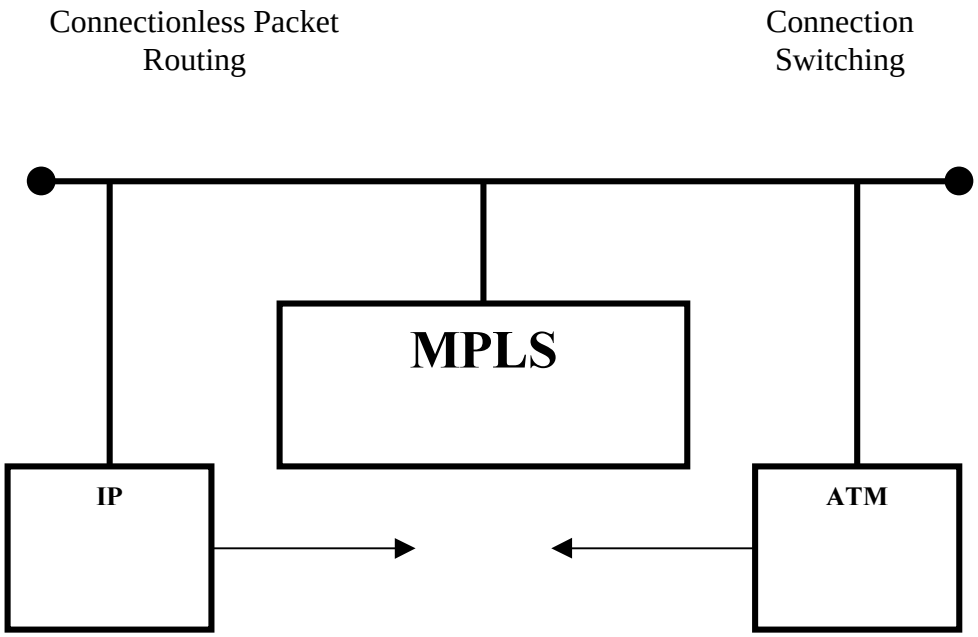
- **ATM Switches**
  - ✔ Connection oriented Networking
- **Traditional Routing**
  - ✔ IP Routing and forwarding
- **MPLS**
  - ✔ Connections for IP



- **ATM already has the right experience with the necessary algorithms.**
- **Connection types: Is your MPLS vendor delivering 1994 technology?**

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Different Products Perform Critical Functions

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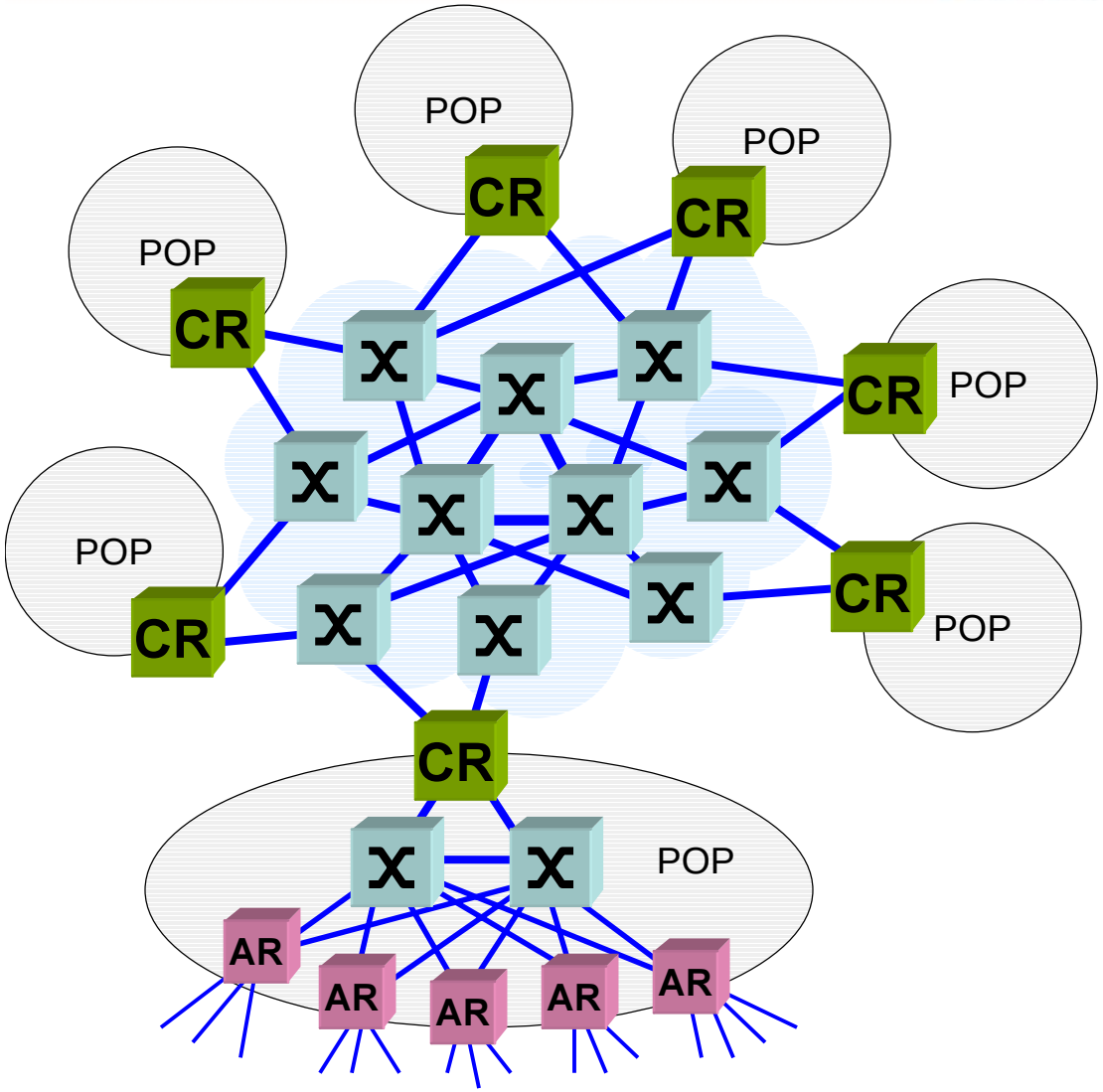

- **IP Routers:**
  - ✔ Classify Traffic
  - ✔ Forward IP
- **ATM Switches:**
  - ✔ Provide Raw Switching Capacity
  - ✔ Provides connection-oriented link layer, that enables:
    - Traffic Engineering
    - Hard QoS
    - Traffic management
    - Constraint-Based / Congestion-aware routing

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Advantages of MPLS network

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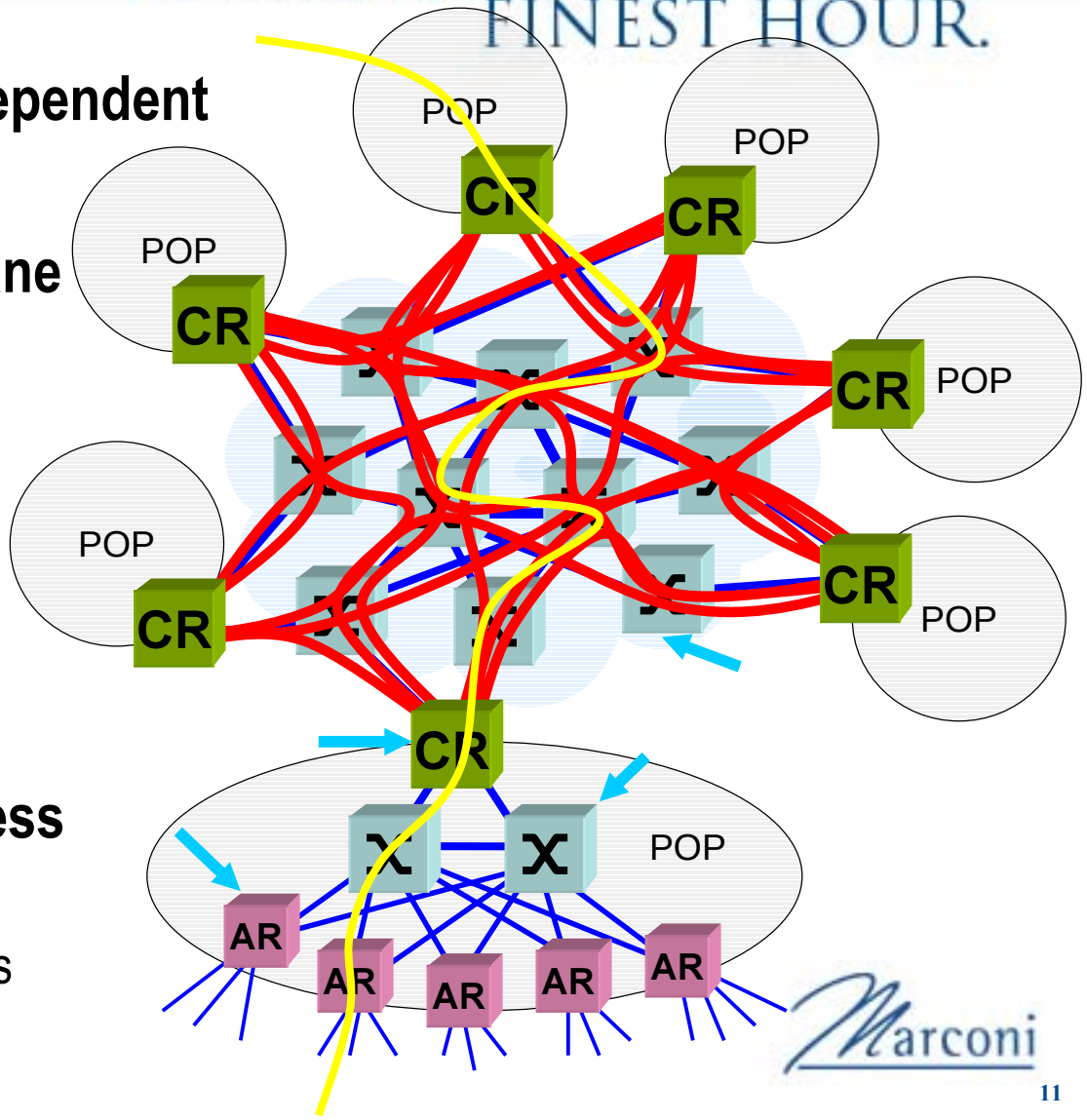
- **Transport technology independent**
- **End to end connections**
- **COLL in single control plane**
  - ✔ TE
  - ✔ TM
  - ✔ QoS
  - ✔ CR
- **Greater tunnel hierarchy**
- **N2 adjacencies gone**
- **Minimizes IP lookup process**
  - ✔ Intelligence at edge
  - ✔ Core can be simpler switches



Hybrids Redefine Multi-Service

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- **Multi service past:**
  - ✔ Voice
  - ✔ Video
  - ✔ Data
- **Multi service now:**
  - ✔ POS, ATM, FNNI, IP interface to customer
  - ✔ Option of MPLS on top of all
  - ✔ Hybrid acts as adaptation layer
- **Connection oriented service, enable multi-application uses:**
  - ✔ Voice video data

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MPLS Summary

THIS COULD BE YOUR FINEST HOUR.

- **MPLS promises to be a powerful unification technology**
  - ✔ Marrying the best of IP and ATM
- **It will take time to meet all high expectation.**
  - ✔ Functional replacement
  - ✔ Network management
- **MPLS is not vanilla IP.**
- **MPLS is just a technology, with great potential**
  - ✔ Must enable new services (revenue)
  - ✔ Reduce operational burdens (costs)
- **Hybrid Switches enable a low risk migration process, while enabling a truly multi-service network.**

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SmartPhotoniX

THIS COULD BE YOUR FINEST HOUR.

- Market Drivers
- Maintaining the Competitive Edge
- The Future is Photonics
- SmartPhotoniX
- SmartPhotoniX - Why Marconi Communications
- SmartPhotoniX - The products

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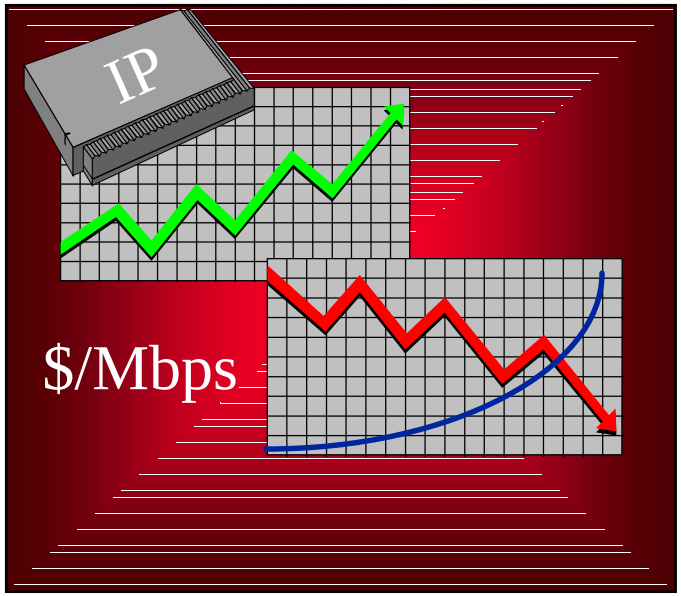
Forces Driving Network Change

THIS COULD BE YOUR FINEST HOUR.

- **Bandwidth Demand**
  - ✔ Rapid growth in IP
  - ✔ Falling cost of bandwidth
  - ✔ Exponential growth



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Forces Driving Network Change

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- Bandwidth Demand
  - ✔ Rapid growth in IP
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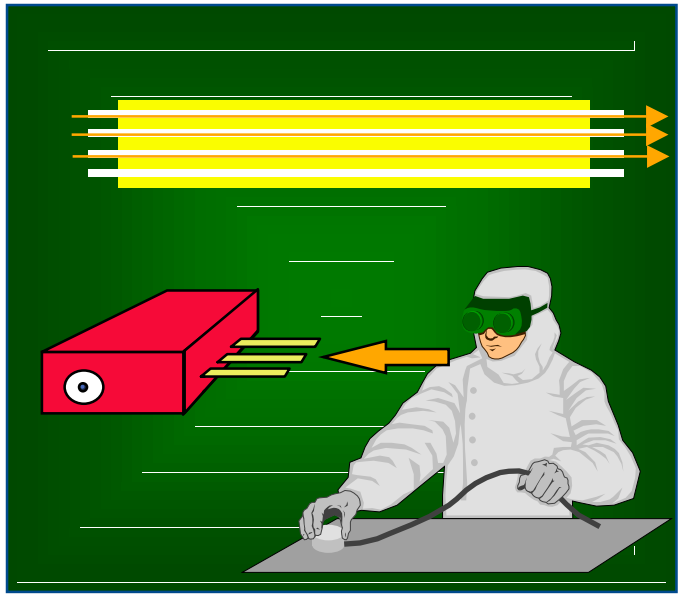
- **Network Infrastructure**
  - ✔ Fibre capacity nearing exhaustion
  - ✔ Developments in Optical technology



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Data-driven Future Traffic Growth

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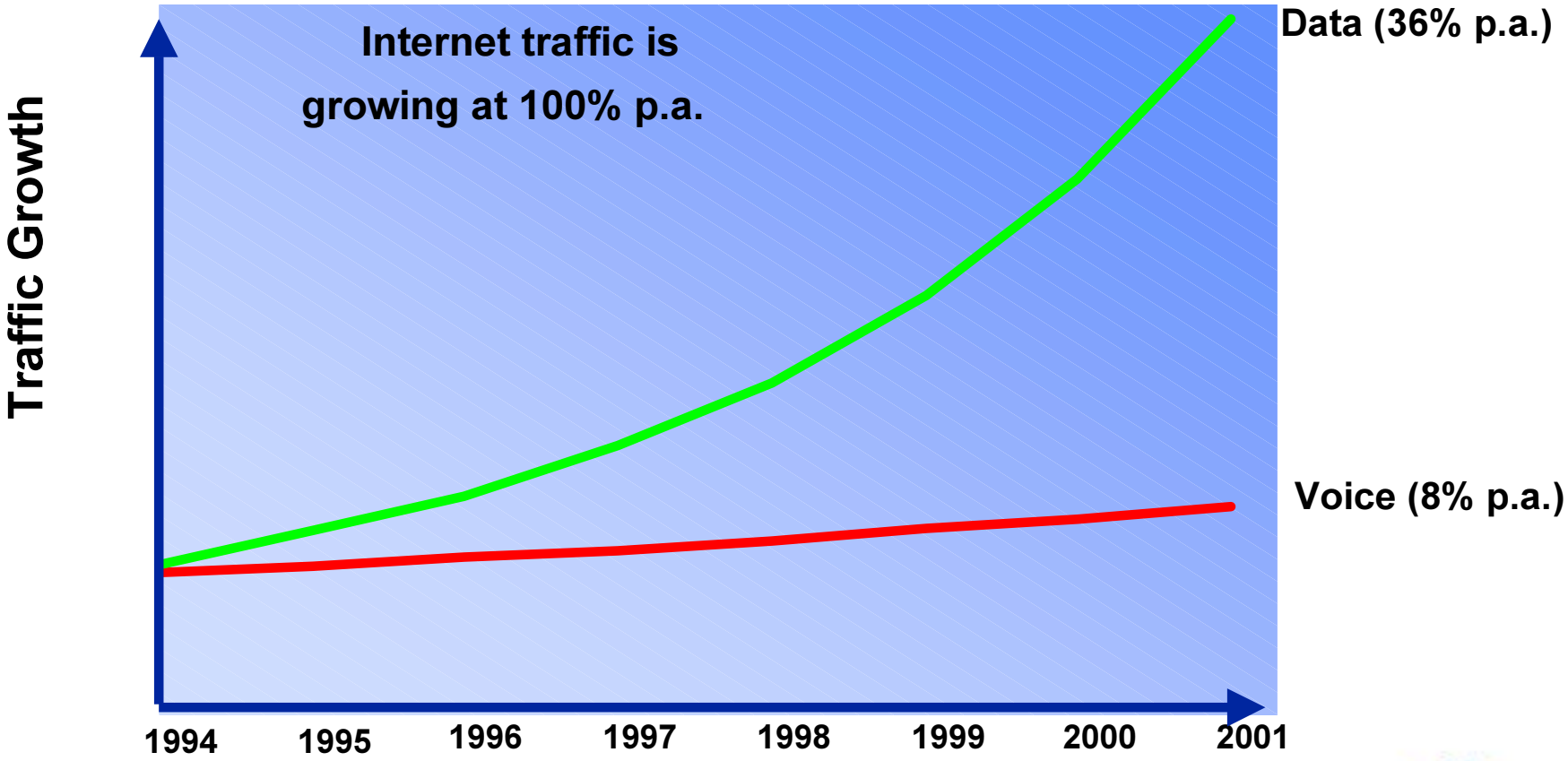

Source: Frost & Sullivan

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The Way Forward

THIS COULD BE YOUR FINEST HOUR.

- **Options for growing capacity:**
  - ✔ Install additional fiber
  - ✔ Migrate to higher speed TDM
  - ✔ Deploy new technology - Photonics

- **Options for growing responsiveness:**
  - ✔ Install additional fiber
  - ✔ Migrate to higher speed TDM
  - ✔ Deploy new technology - Photonics

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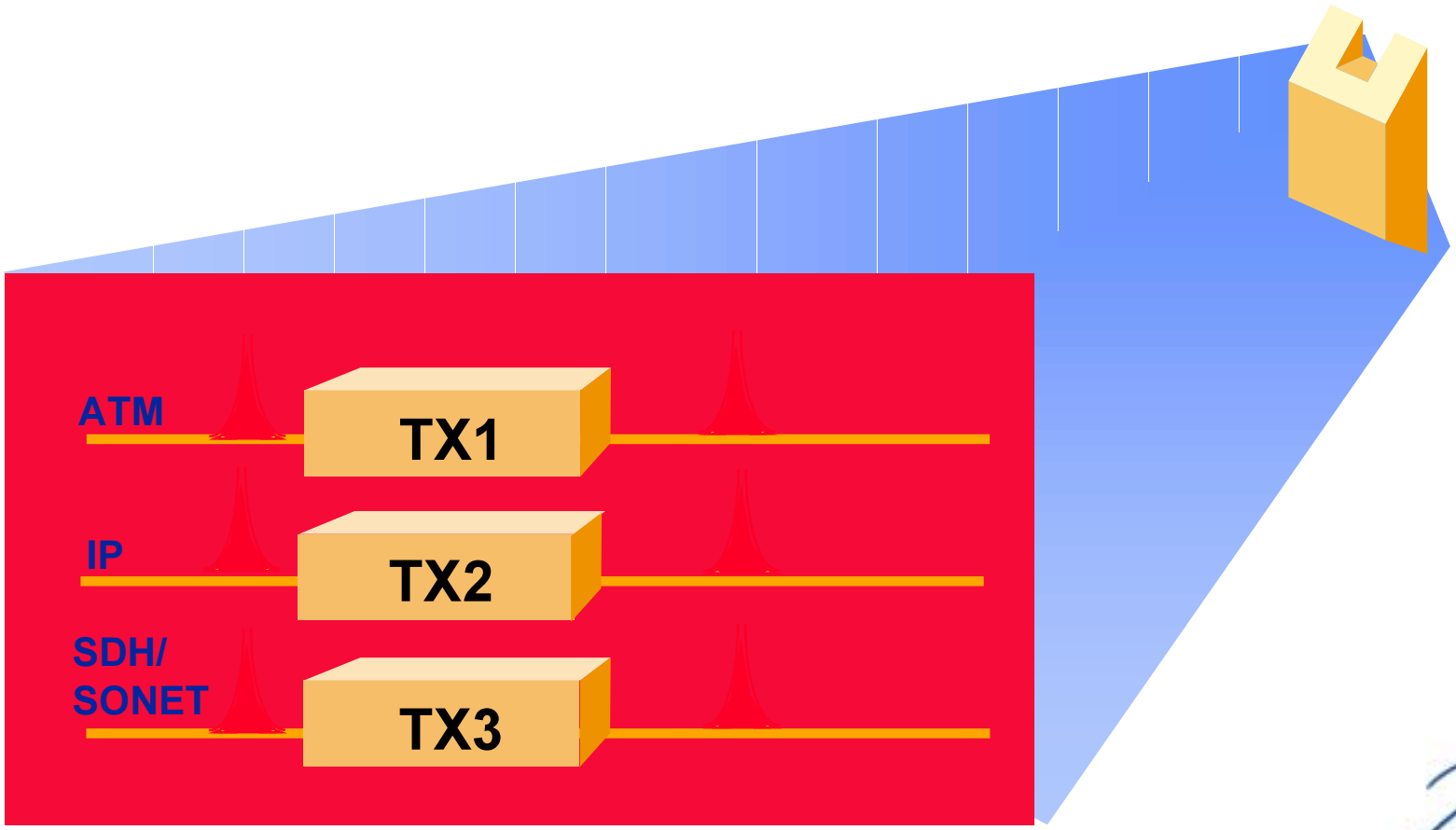
Before Photonics

THIS COULD BE YOUR FINEST HOUR.

- Single fiber, single wavelength (color)



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Deploy new technologies - Photonics

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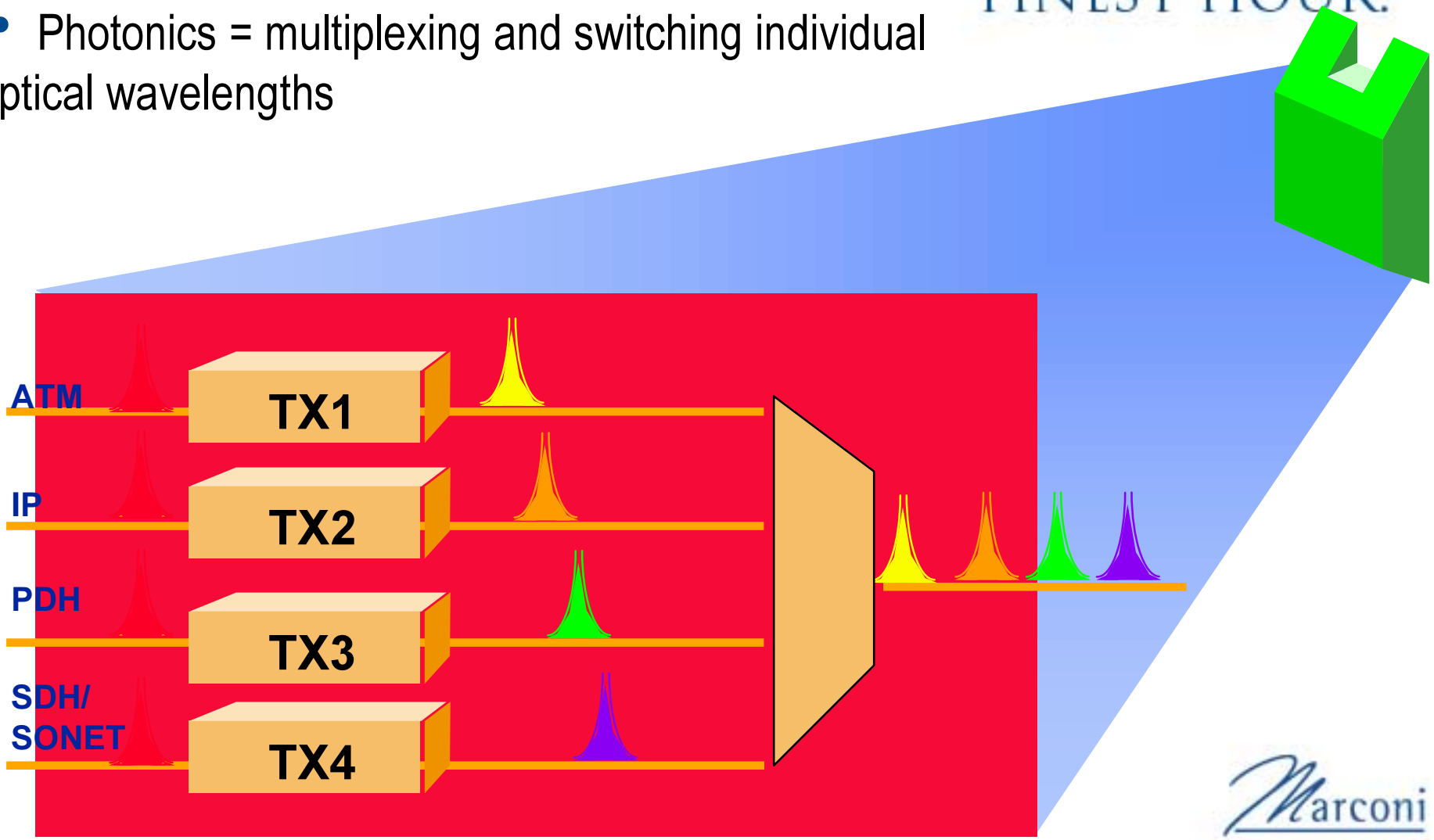
- Photonics = multiplexing and switching individual optical wavelengths



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Photonics = Traffic Independence

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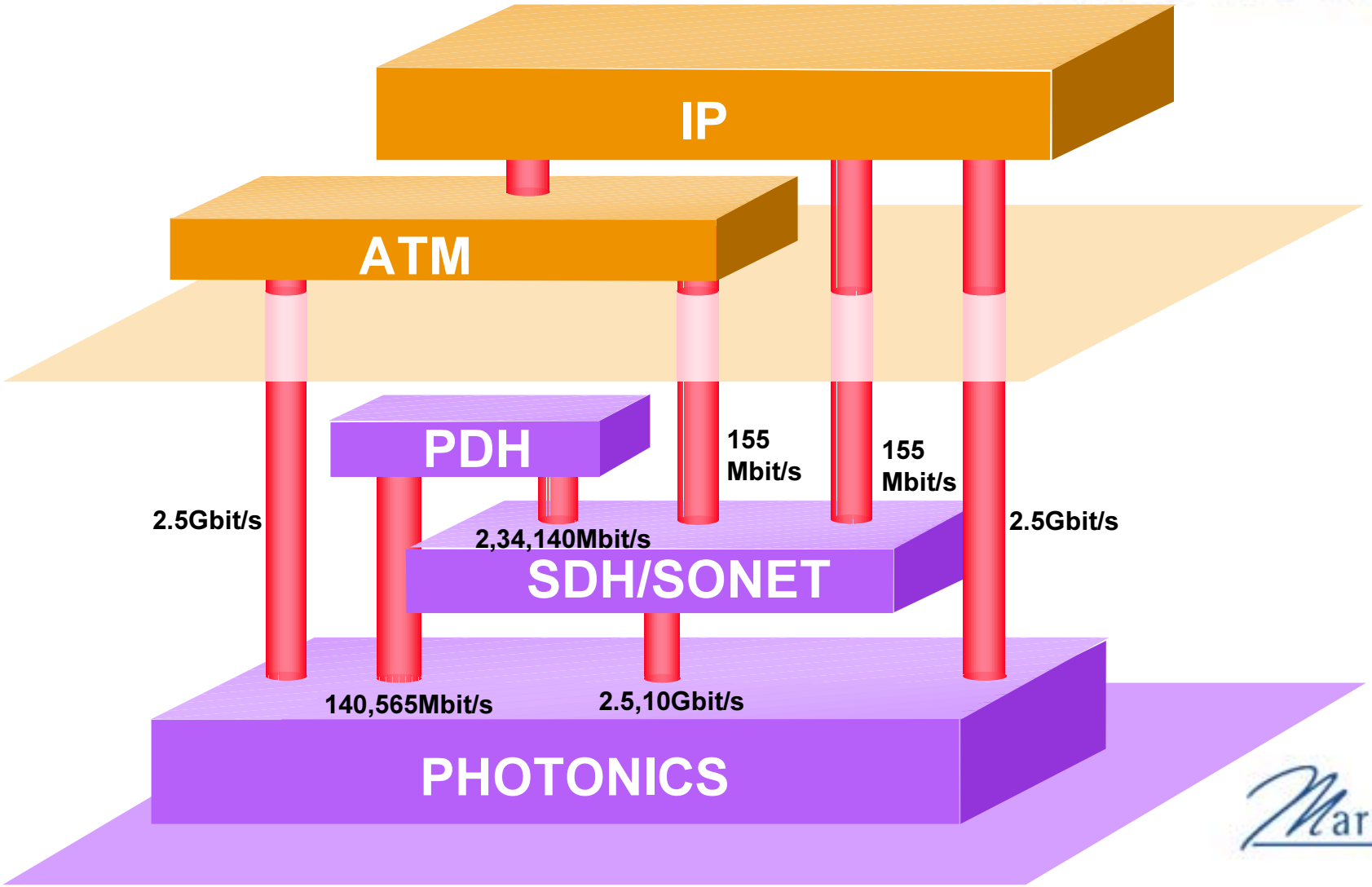

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Photonics Offers:

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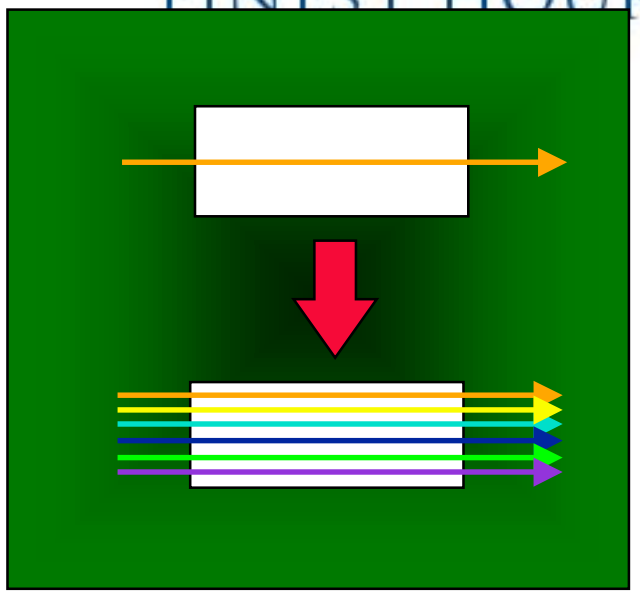
- Capacity multiplication
- Traffic independence



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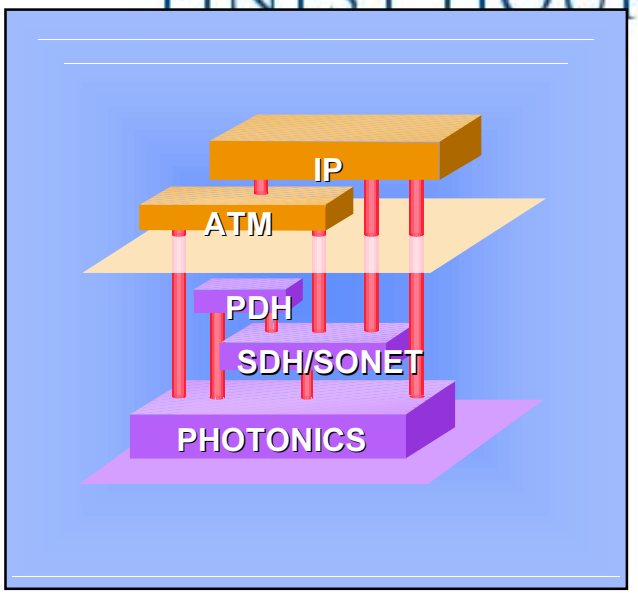

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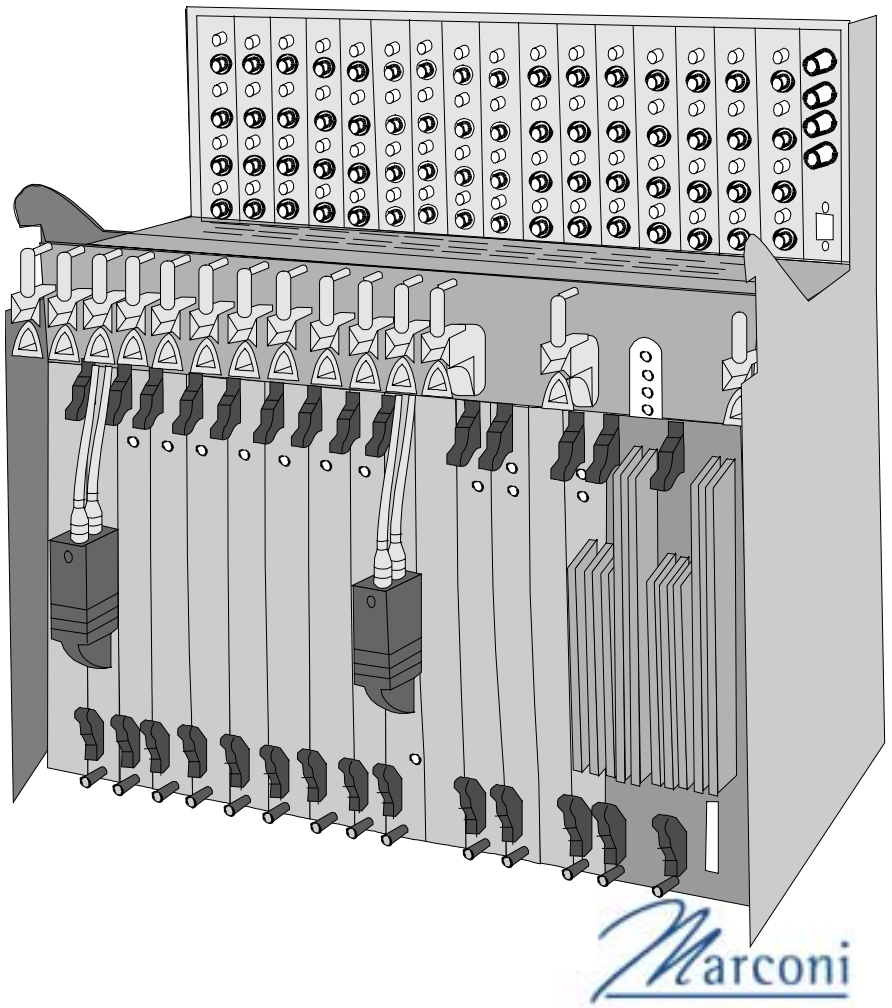
Why SmartPhotoniX?

THIS COULD BE YOUR FINEST HOUR.

- **Breadth of product offering**
  - ✔ Dense Wave Division Multiplexing (DWDM)
  - ✔ Synchronous Digital Hierarchy (SDH)
  - ✔ Synchronous Optical NETwork (SONET)
- **Scaleable to 640 Gbps Capacity**
- **QoS with optical sub-network connection and multiplex section protections options**
- **A future-proof network, enabling rapid reaction to demands for new services and bandwidth.**



Smart Photonix Family

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- **Optical Line Systems**
  - ✔ PLT16 – 16 Wavelength at 2.5 Gbps per Wavelength
  - ✔ PLT40 – 40 Wavelength at 2.5 Gbps per Wavelength
- **Optical Add-Drop Multiplexer**
  - ✔ PMA8
    - 160 Gbps capacity
    - 16 East/West Channels (8 channels on a single fiber)
    - Operates at 2.5 Gbps or 10 Gbps per channel
  - ✔ PMA32
    - 640 Gbps capacity
    - 64 East/West Channels (32 channels on a single fiber)
    - Operates at 2.5 Gbps or 10 Gbps per channel

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Current Internet2 Backbone Networks

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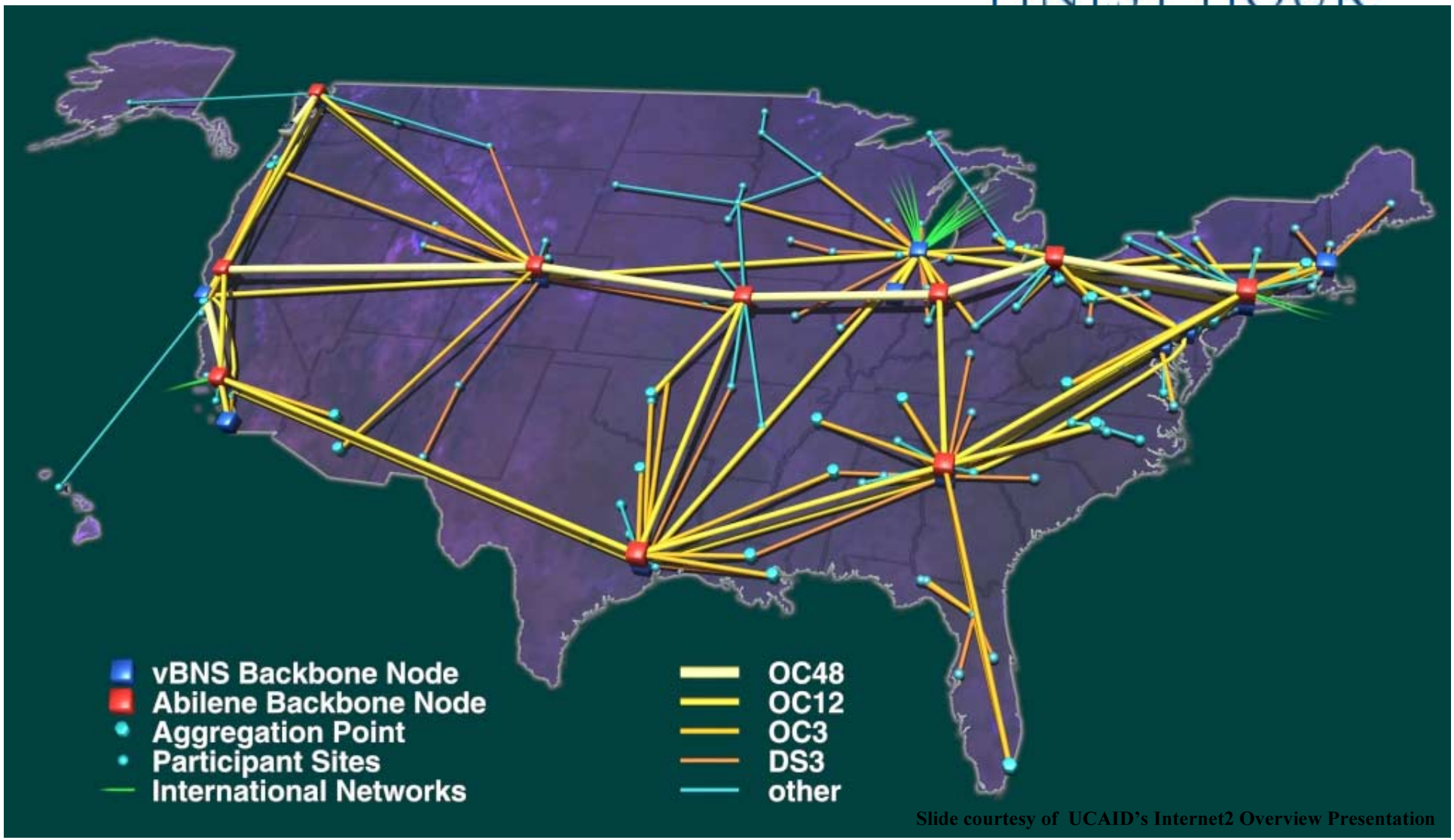

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The Next Generation Optical Internet

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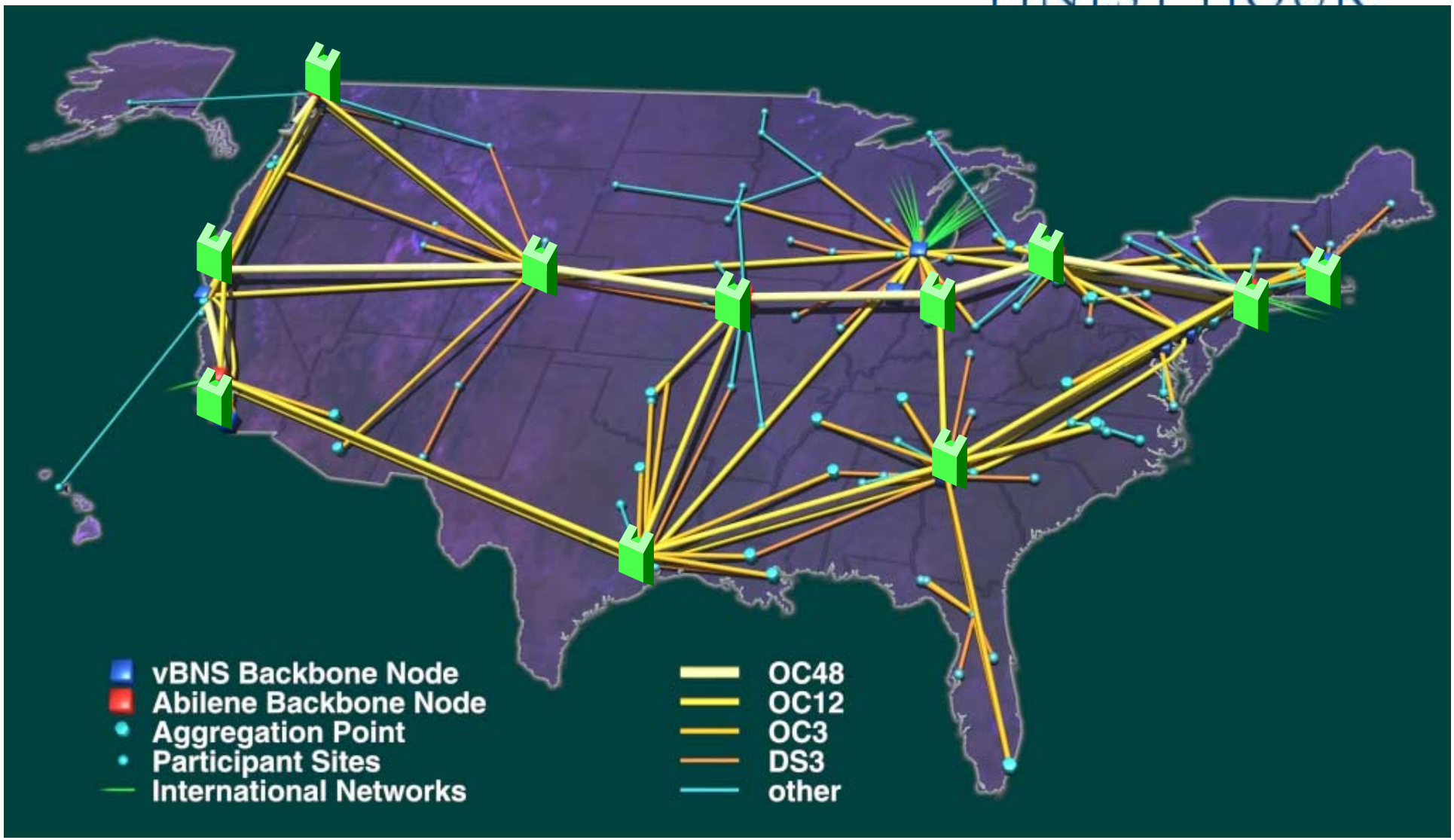
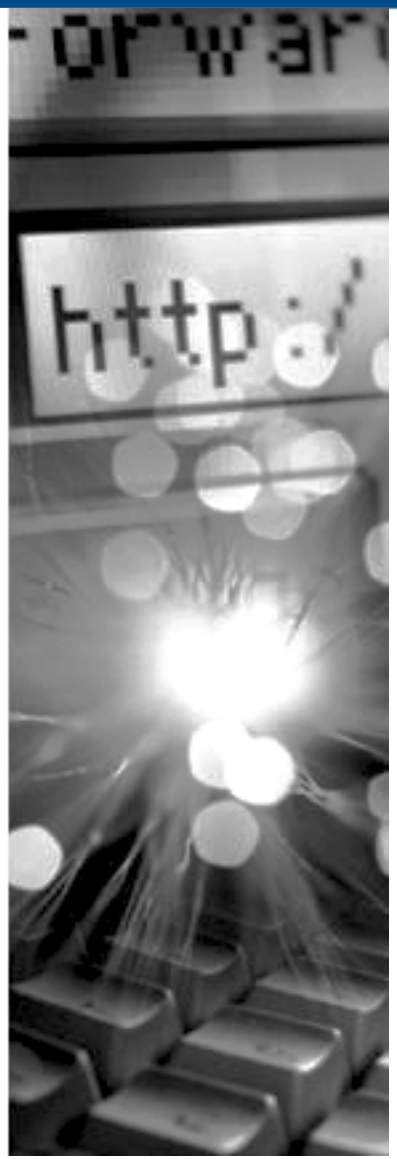


About Marconi



THIS COULD BE YOUR FINEST HOUR.

- **Marconi, plc** ***(Parent Company located in London, UK)***
  - ✔ Systems, Capital, Communications & Services
  - ✔ $ 8+ billion 1999 pro forma revenues
  - ✔ 41,000 employees
- **Marconi Communications** ***(Pittsburgh, PA)***
  - ✔ $ 5 billion, 1999 pro forma revenues
  - ✔ 40% US, 60% ROW
  - ✔ 17,000 employees (estimated)
- **Market Cap: $41 billion**
  - ✔ Traded on London Exchange
  - ✔ Member; “FTSE 100”
  - ✔ Symbol; MNI

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Leading the Market

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#1 - Backbone Core provider to the Internet

- ✔ *Both UUNET and Cable & Wireless-USA deploy Marconi*
- ✔ *Together represent 70+% global ISP backbone transport*

#1 - "Deep Fiber" Access

- ✔ *2+ million lines installed*
- ✔ *Fiber to the Node, to the Curb & to the Home*

#1 - Global SDH

- ✔ *33+% market share (source: Dataquest, Ryan Hankin and Kent)*

#1 - ATM-based Enterprise Solutions

- ✔ *32% market share (source: Dell'Oro Group)*

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Marconi – Built on World Class Solutions

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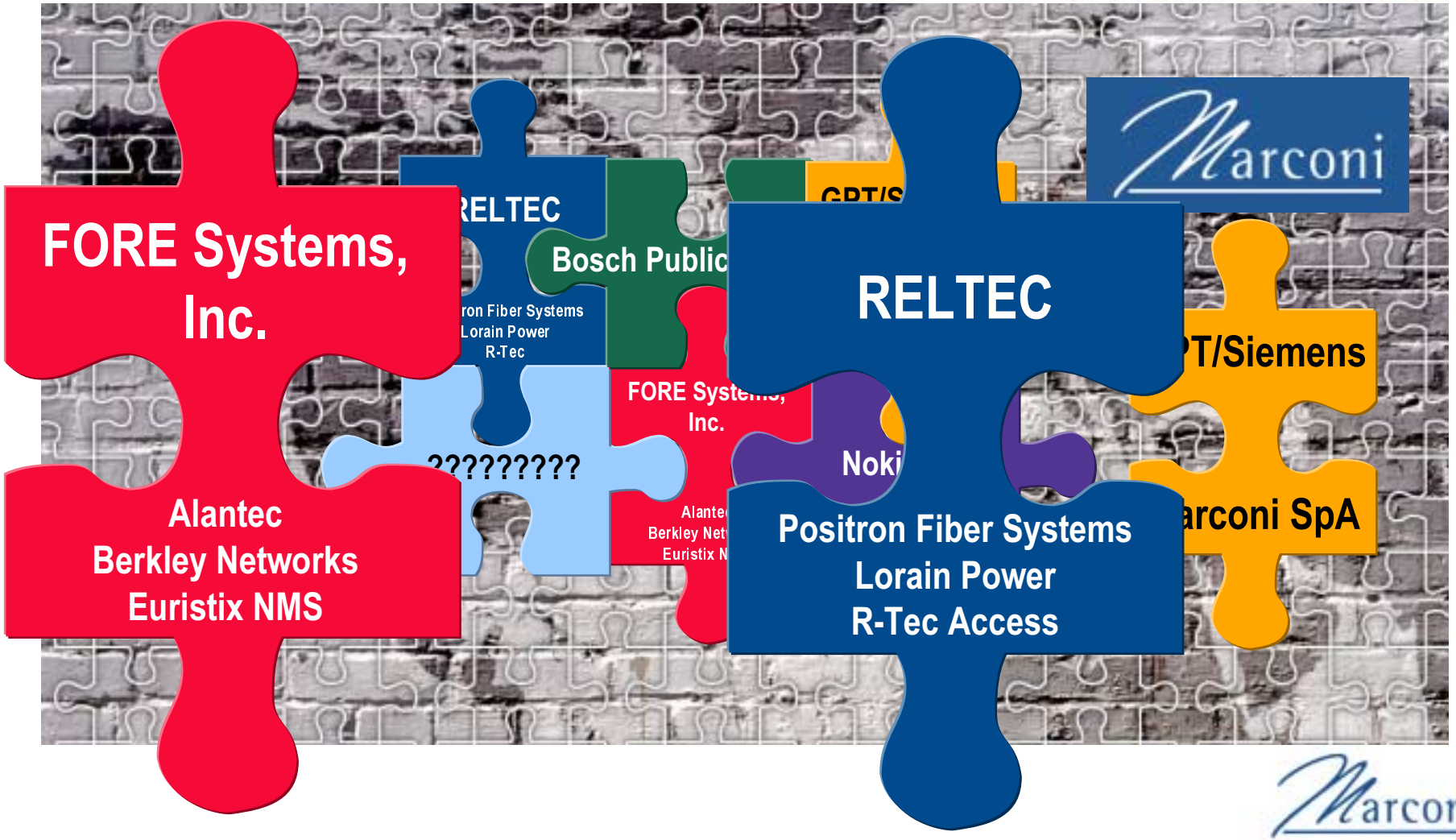

A Few Education Customers

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George Washington MIT Ohio State Purdue Texas A&M

Cal Tech Carnegie Mellon University of Texas Virginia Tech

University of Minnesota Abilene Christian Penn State UCLA

New Hampshire University of Wisconsin State of CA (CSUnet)

Harvard University Columbia University University of Maryland

North Carolina State National University of Singapore Cornell

Vanderbilt Mississippi State State of PA (SSHEnet) Arizona

Case Western Reserve Keio University Michigan State

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Summary of Marconi's Involvement

THIS COULD BE YOUR FINEST HOUR.

- Early Internet2 Corporate Partner
- Deployed in over 60% of world's Advanced Internet Initiatives
- Majority of Gigapops globally deploy Marconi ATM
- Member of Internet2 QoS working committee
- Participating in QBONE trials

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International Partnerships

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Our Commitment to Brazil

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- **Marconi's Internet & Telecommunications Technologies (MIT^2)**
  - ✔ Vendor agnostic course curriculum
  - ✔ Student developed curriculum via Fellowships
  - ✔ Multi-level Focus (K-12 & Higher-education)
  - ✔ Migration towards local, regional, and national accreditation via partnerships
- **Marconi's Graduate Research Fellowship Program**
  - ✔ "Finance" research through fellowships
  - ✔ Driven by Deans and/or Professors
  - ✔ Requirements defined, in joint, by Marconi and University
  - ✔ Foster collaboration efforts between Internet2 fellowship Universities & International Partner's
- **Marconi's Under-Graduate Internship Program**
  - ✔ Host Under-Graduate Students for summer program
  - ✔ Needs determined by Marconi Human Resources

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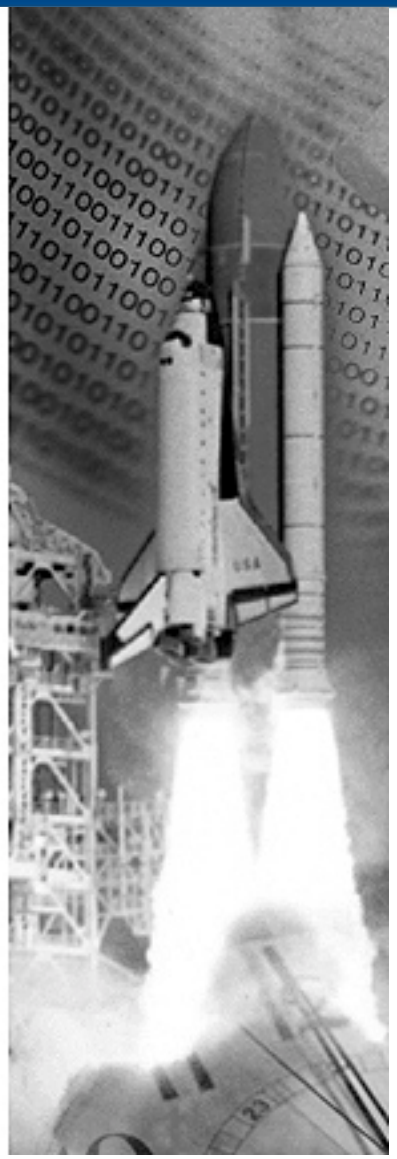
Why Marconi Communications



THIS COULD BE YOUR FINEST HOUR.

- **Marconi emerges on the World Stage as a TIER 1 player**
  - ✔ World-class Attributes: People - Products - Services - Resources - Customers
- **Total focus on 21st Century Network Solutions**
  - ✔ Worldwide leader in providing DWDM, SDH, SONET, & ATM solutions
  - ✔ Extensive R & E dollars dedicated to developing leading-edge Optical Networking - SmartPhotoniX
- **Dedicated Sales & Marketing Resources**
  - ✔ Tailored programs that meet your Goals & Challenges
- **Global Professional Services and Support**
  - ✔ Network Design & Planning
  - ✔ Installation Services
  - ✔ Premier Technical Support

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Thank You!

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