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> Ethernet in Carrier Networks: Industry and Standards Perspectives

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Agenda

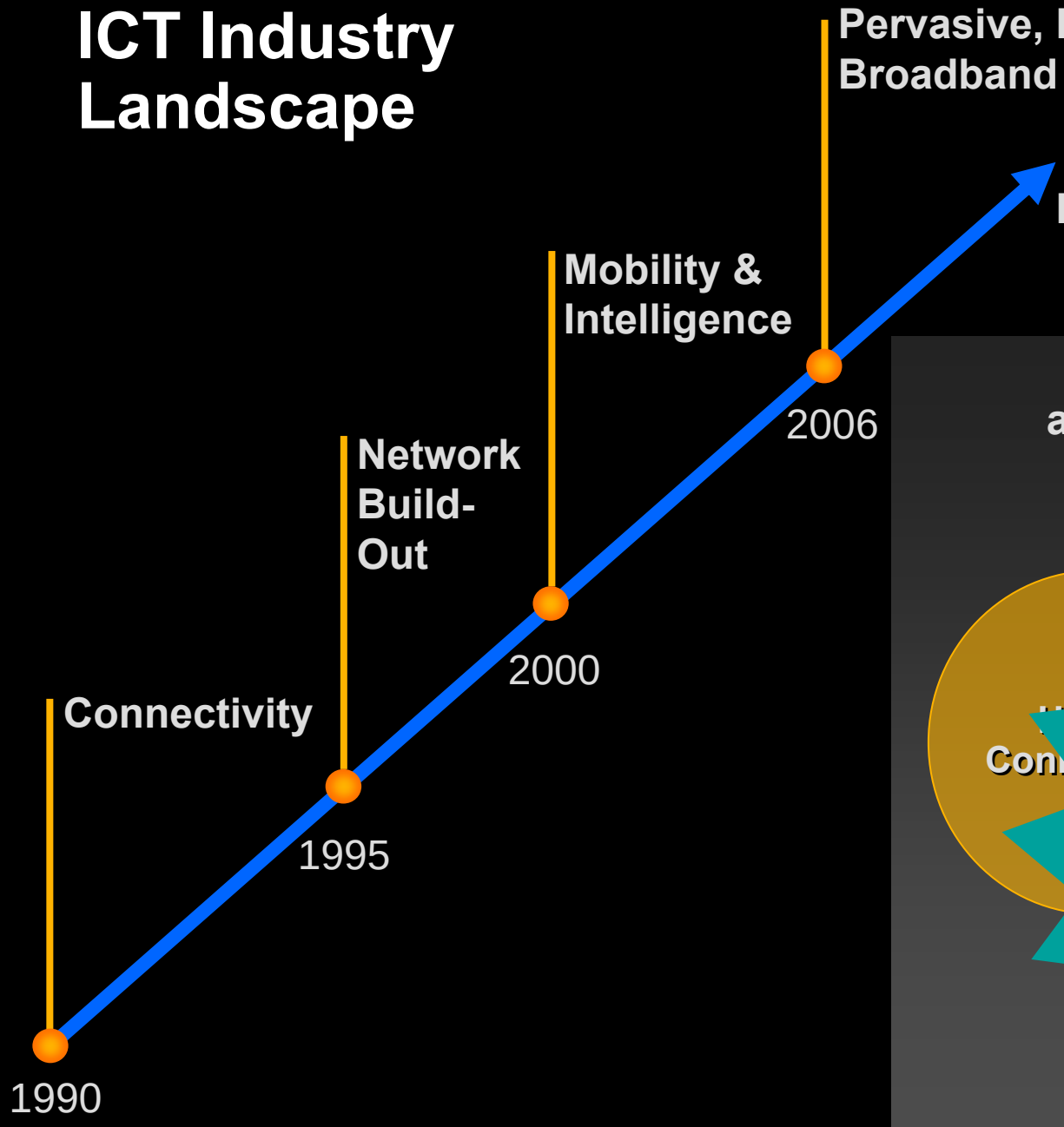
> State of the Industry

> Evolution of Ethernet

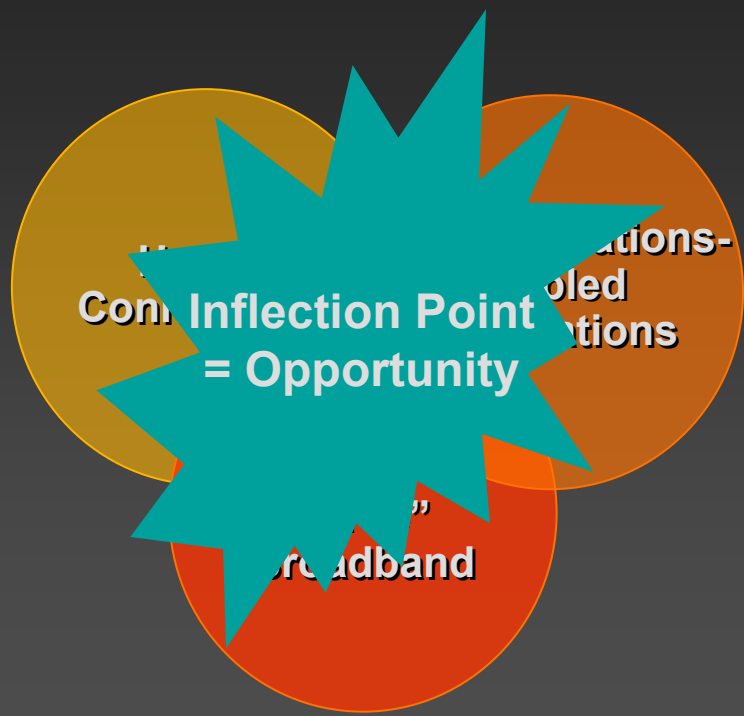
> IEEE / ITU-T Cooperation

> Summary

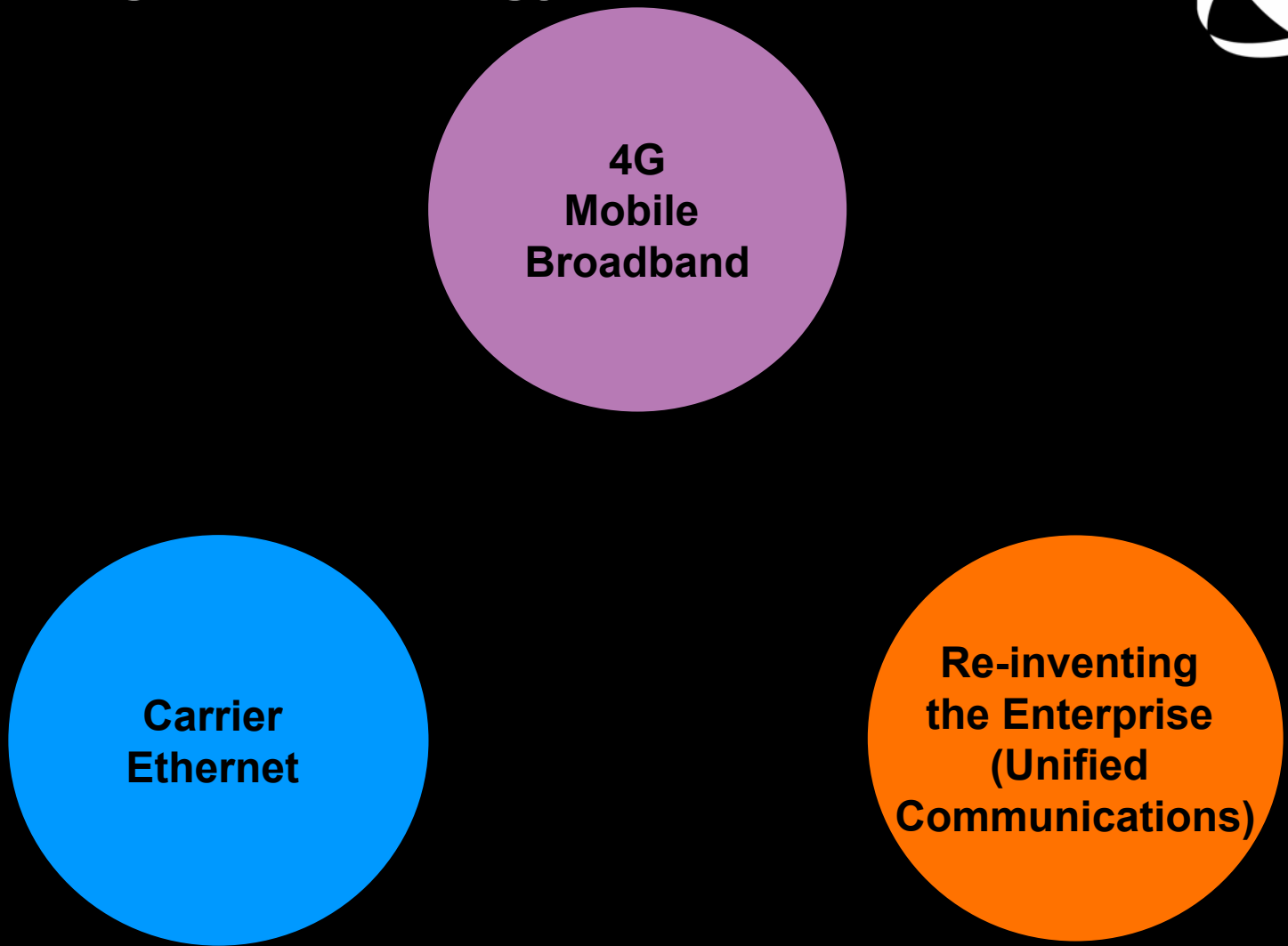
ICT Industry Landscape



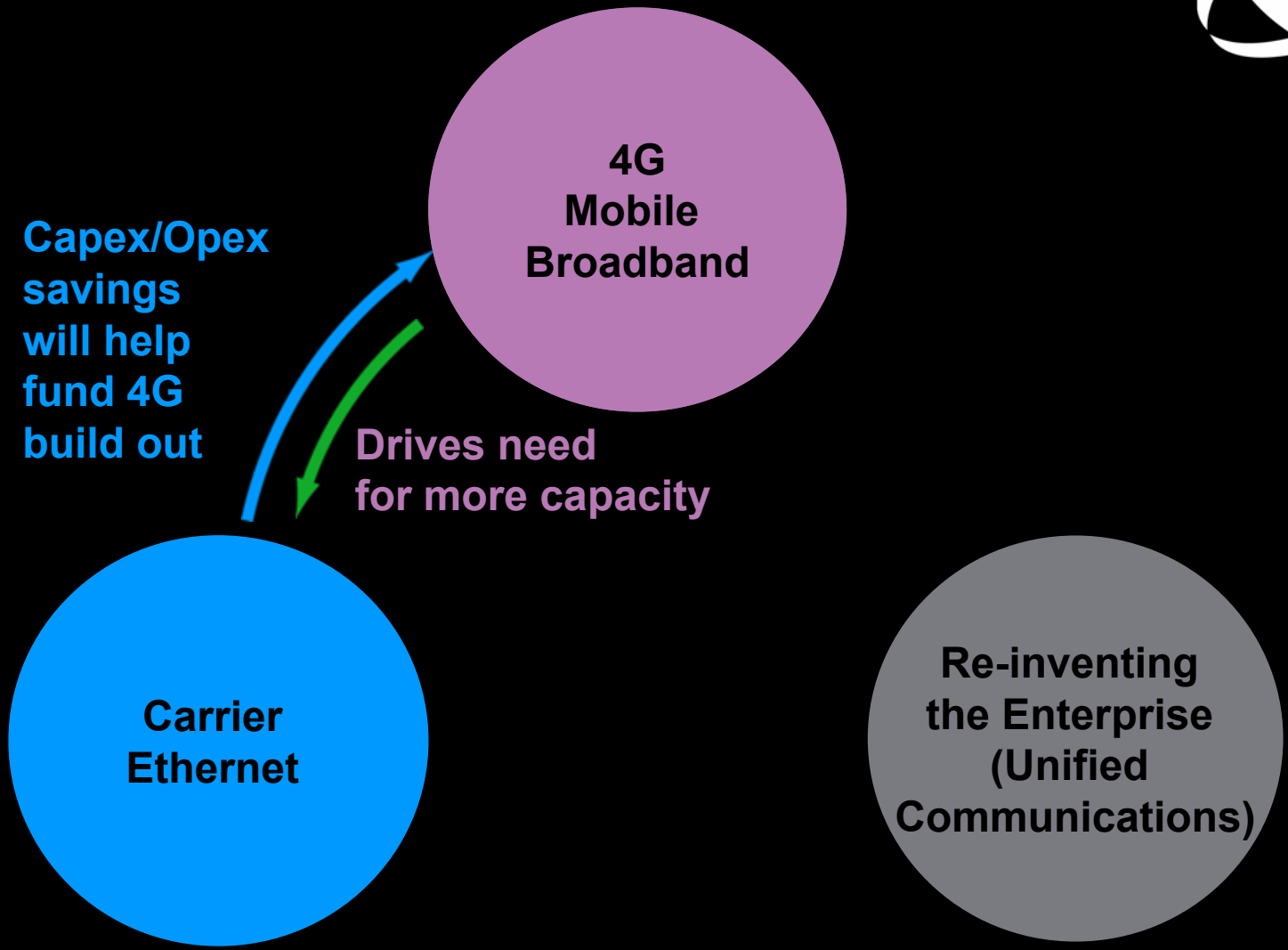
Three Mega-Trends are Shaping the Future



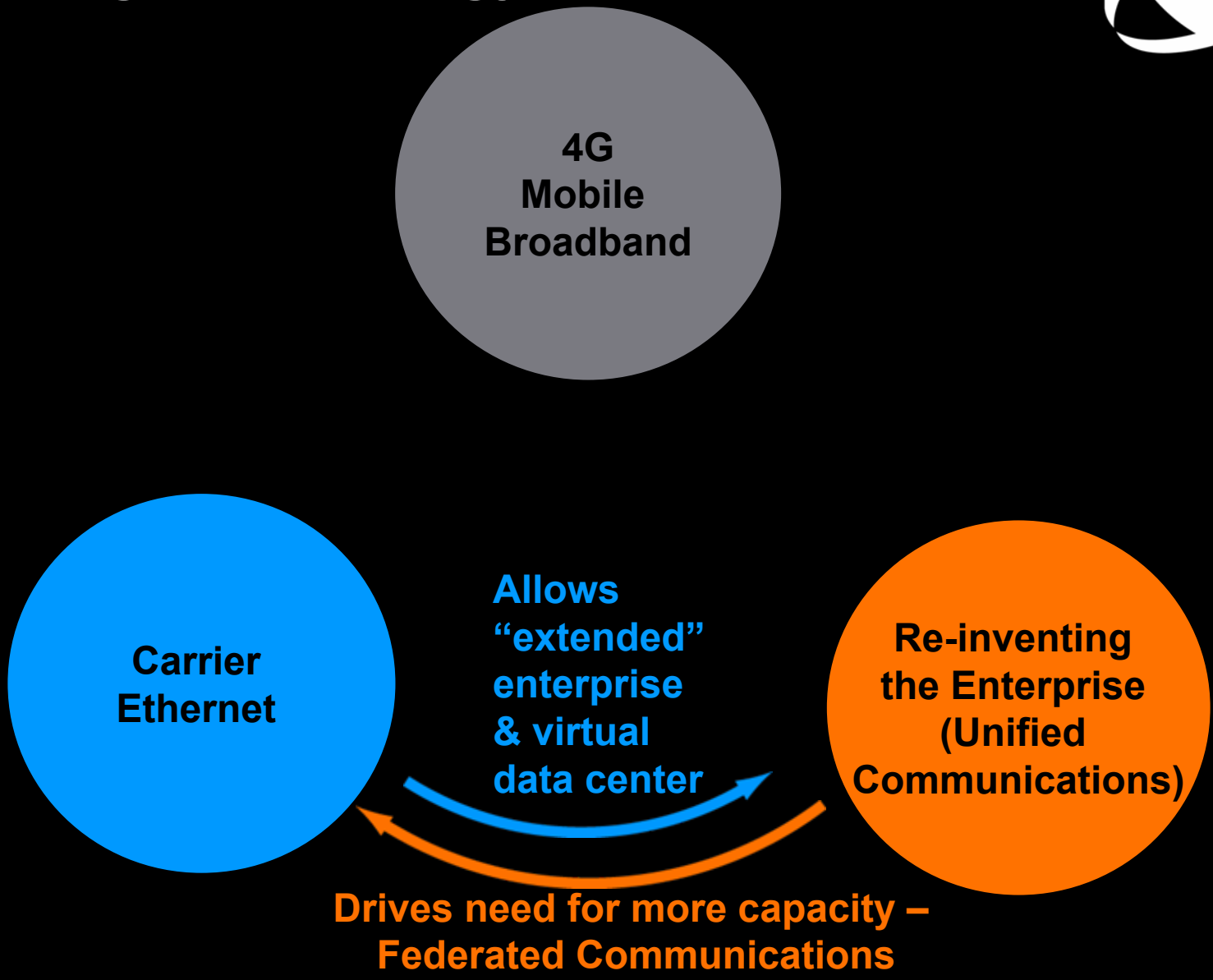
A Synergistic Strategy



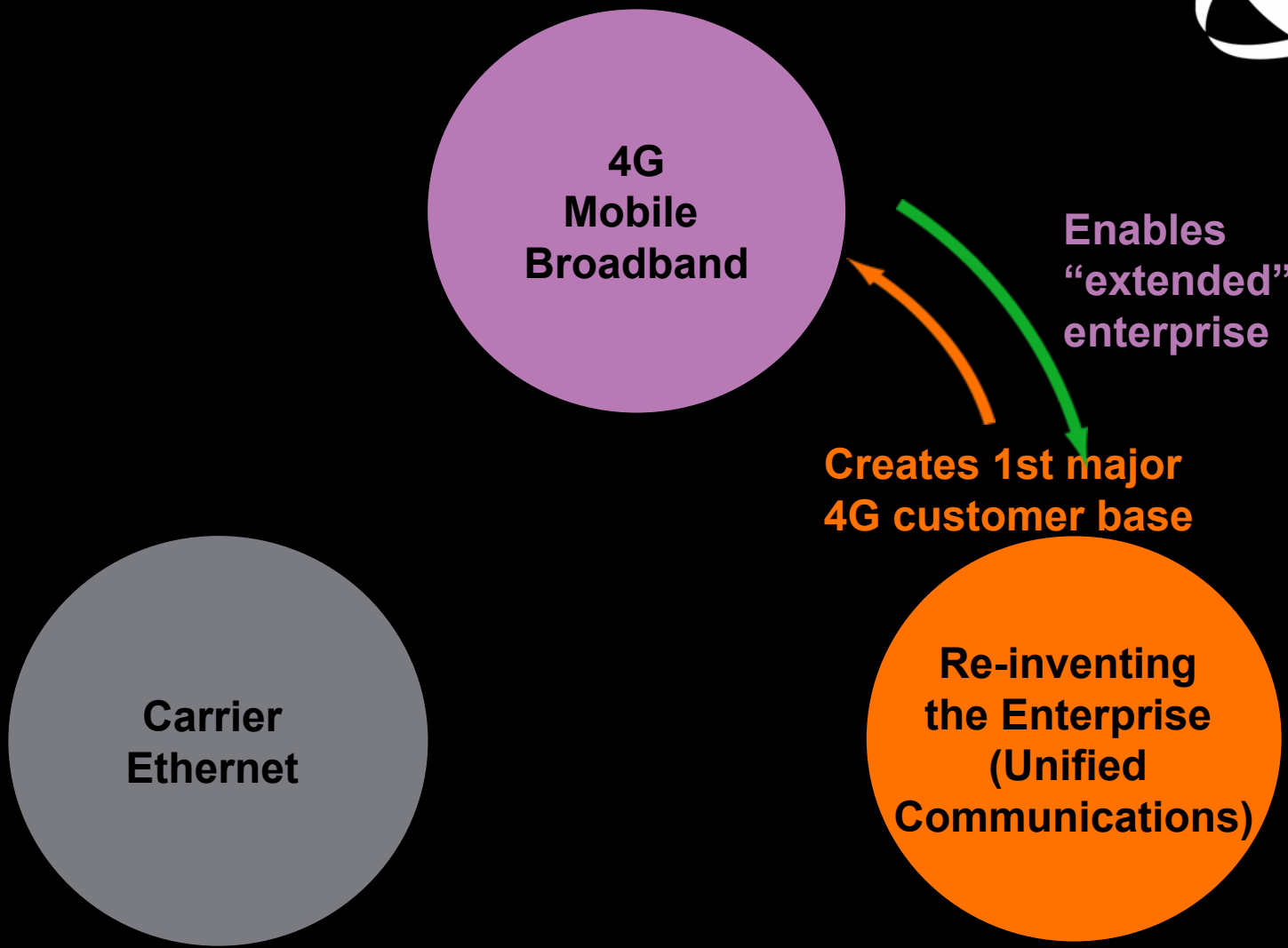
A Synergistic Strategy



A Synergistic Strategy

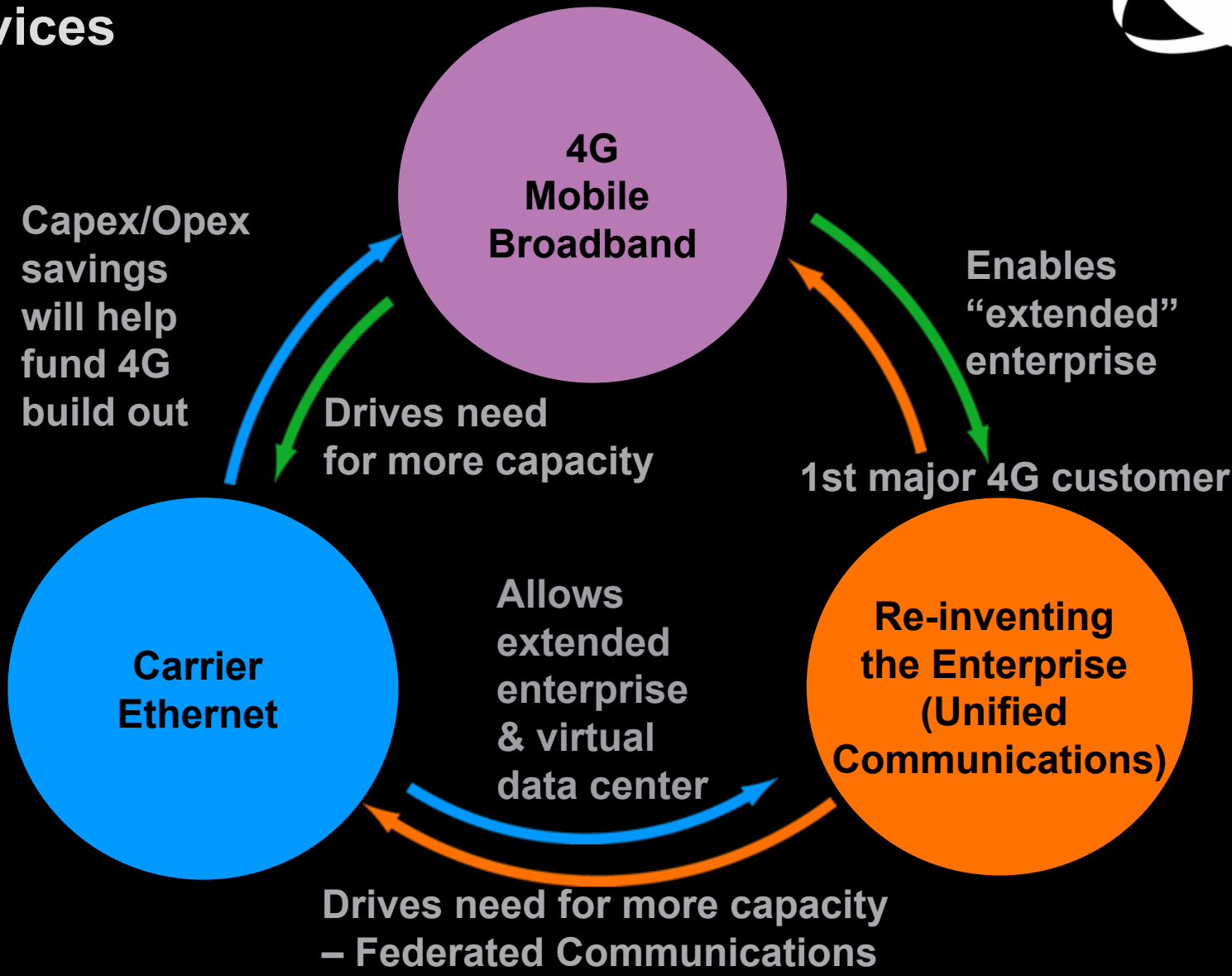


A Synergistic Strategy



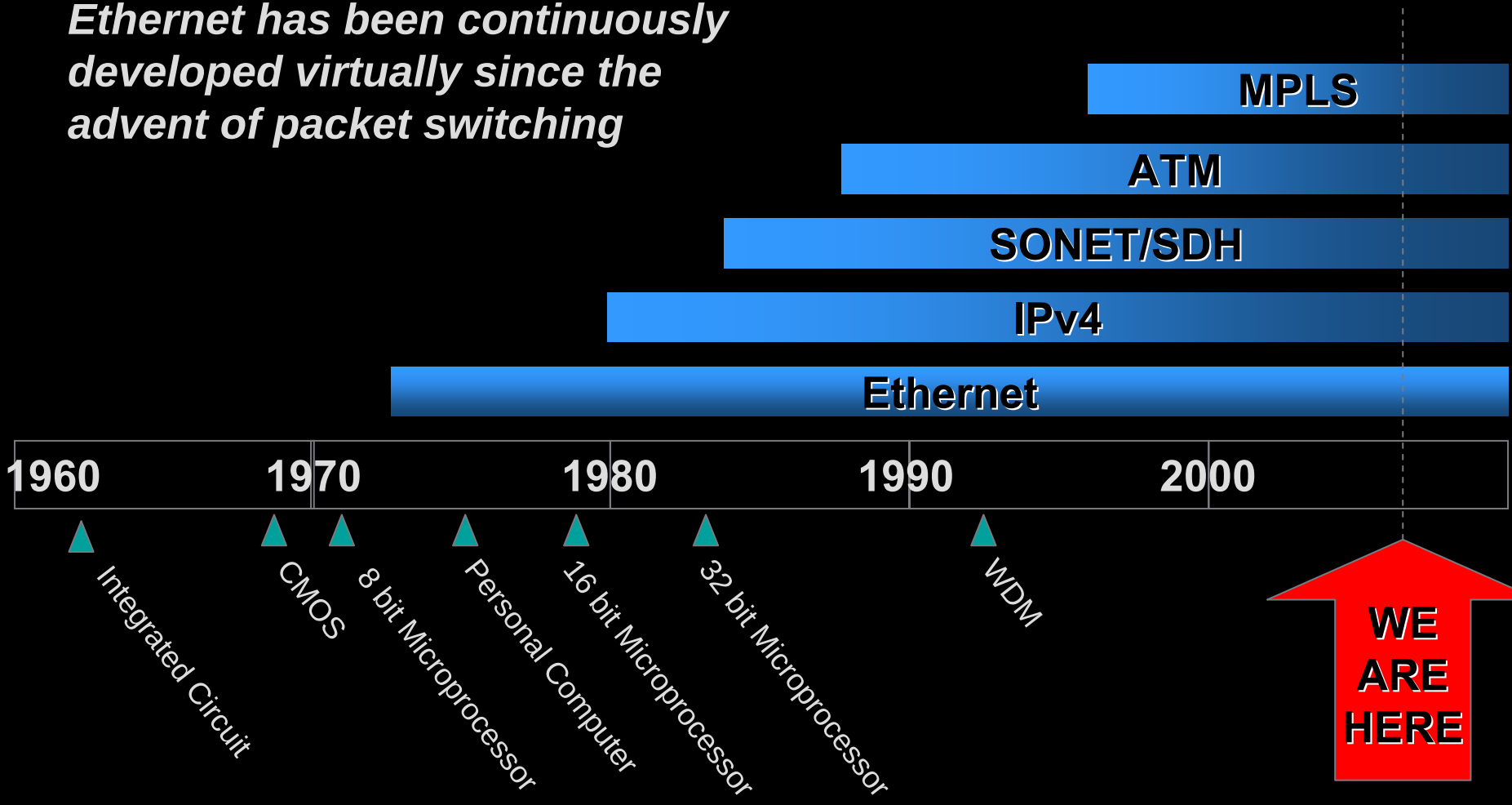
A Synergistic Strategy

Services



Ethernet as the Granddaddy Technology

Ethernet has been continuously developed virtually since the advent of packet switching



Beneficiary of 30+ years of Engineering

> 1973 CSMA/CD – shared media collision detect

> 1980s Bridging – extend reach, extend scaling

> 1988 VLANs – extend scaling, extend functionality

> 1990s Carrier Optical interfaces – extend reach

> 2000s

- Q-in-Q – Enhanced VLAN
- MAC-in-MAC - scalability
- OAM – operational enhancement
- Mgmt inventory – operational enhancement

Measured and studied multi-vendor collaborative development

Beneficiary of 30+ years of incumbency

> Ethernet dominates the LAN

> Everything carries or is carried by Ethernet

- Carries: consequence of incumbency in the LAN
- Carried by: Consequence of increasing dominance in MAN/WAN

> IETF RFCs

- Over 750 RFCs reference Ethernet
  - Close to exceeding the sum of ATM, FR, SONET and MPLS combined….
- The LAN segment is a key building block of the Internet

What in Ethernet's DNA drives its longevity?

> ….when many technologies have fallen by the wayside: Token ring, DQDB, X.25 etc…

> Design principles

- Backwards compatibility
- Complete specification & conformance statements
- Specify all bits – no room for proprietary extensions
- Generous provision for proprietary protocols
- Fully self describing – look at a packet and you can tell
  - Where it came from (SA-MAC)
  - Where it is going to (DA-MAC)
  - What the payload is…
  - Queuing discipline

What else ….?

> Ethernet started as a broadcast medium

> All other modes of connectivity can be derived from basic Ethernet behavior of “broadcast and filter”
  - The concept of “filtering” is deeply embedded in Ethernet

> A connection is simply an extreme example of filtering…

> As a consequence Ethernet inherently is more capable than other L1/2/3 technologies in terms of the connectivity options…

Ethernet is the most fundamentally advantaged and flexible technology

Acknowledgement of Ethernet as a Carrier Packet Transport Technology

> MEF
  - Numerous industry recognized specifications for Ethernet services

> DSLF
  - Now considers Ethernet the dominant infrastructure
    - TR101 Migration from ATM to Ethernet based aggregation

> TMF:
  - Ethernet Management Specifications

> ITU-T
  - Increasing number of recommendations

Emergence of Ethernet as a Carrier Technology in IEEE 802

- > OAM 802.1ag CFM
  - Fault Management and Performance Management capability
  - Ethernet self identification permits it to be instrumented as if P2P
- > 802.1ad Q-in-Q
  - Tagging recursion
- > 802.1ah MAC-in-MAC
  - Layer recursion
- > 802.1Qay PBB-TE
  - Optimization for P2P & P2MP transport
- > 802.1aq SPB – Shortest path bridging

Emergence of Ethernet as a Carrier Technology in ITU-T

- OAM: Y.1731
- Architecture: G.8010
- Carrier Equipment: G.8021
- Protection: G.8031, G.8032
- Ethernet Services: G.8011
- Carrier Interfaces: G.8012

The future of Ethernet

> Ethernet continues to gracefully evolve

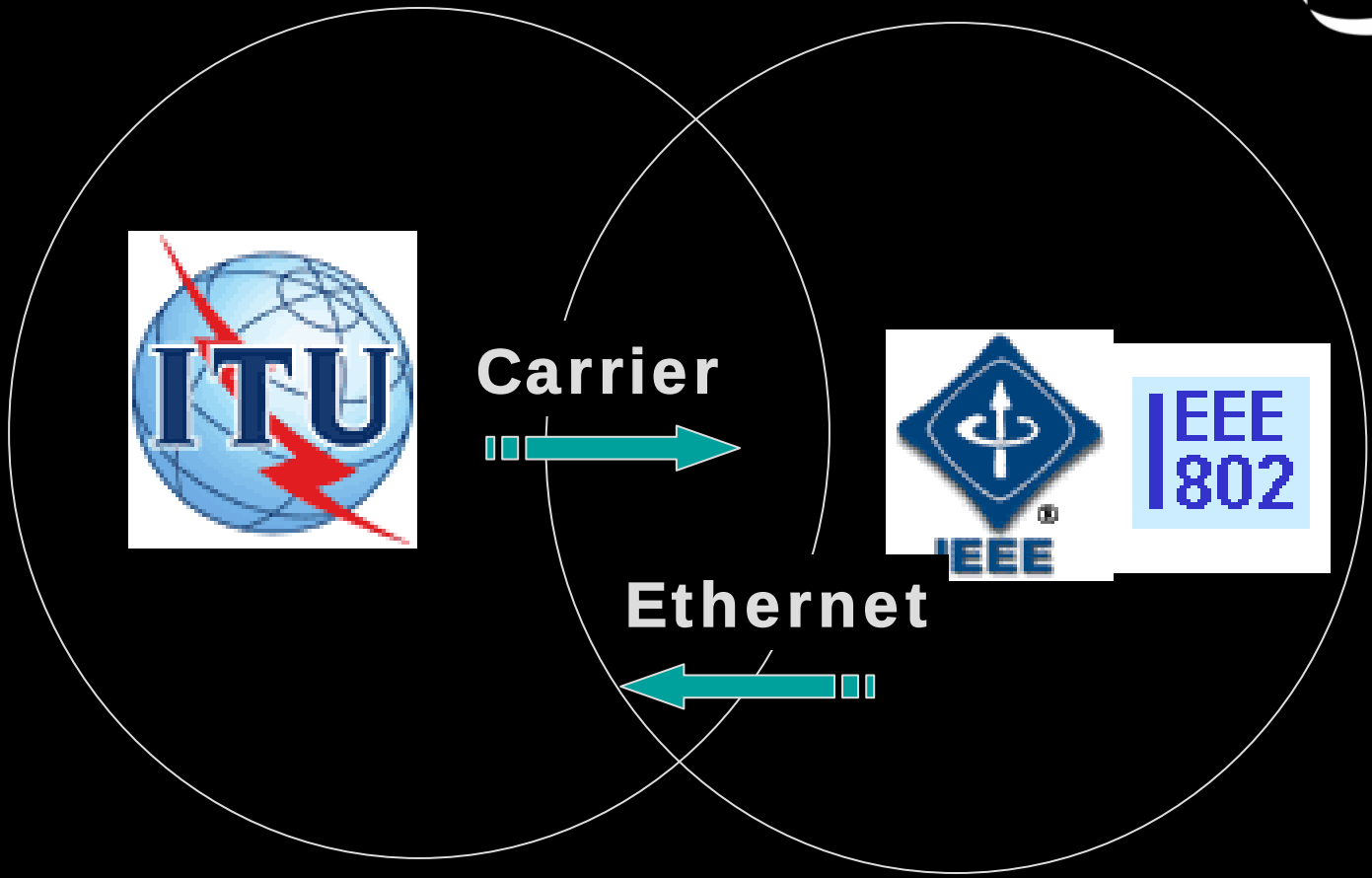
> Some selected examples

> Capability
- PBB-TE recognized that the VLAN was not a spanning tree but COULD be a complete virtual network
- If distinct behaviors could be assigned to VLAN ranges, the toolkit was broadened
  - Common interface addressing, OAM etc.
- Currently manifesting itself in 802.1aq SPB, 802.1Qay PBB-TE
- This direction is far from exhausted

> Scaling
- 802.3 HSSG examining 40G and 100G options
  - Continuing the trend of periodically growing bandwidth an order of magnitude

Ethernet continues to exhibit scaling and feature growth which position it to take a major role in Carrier NGNs

Critical Intersection



Carrier Ethernet is an Intersection
Standards Cooperation is Critical for Success

IEEE / ITU-T Cooperation

- Emergence of Ethernet as carrier technology is an opportunity for IEEE/ITU cooperation
  - IEEE is THE body of Ethernet expertise
  - ITU-T is the body of expertise for networking and carrier requirements
- 802.1ag-Y.1731 is example of fruitful cooperation
  - IEEE specified fault management
  - ITU-T enhanced IEEE work with performance management

Example: Ethernet OAM Enhancements For Carrier Grade

OAM Function	Traditional Ethernet	Carrier Ethernet	Enhancements
Discovery		√	802.3ah, 802.1AB
Continuity Check		√	802.3ah, P802.1ag
Connectivity (Trace) Check		√	P802.1ag
Performance Monitoring Statistics, Threshold Alerts	.3 link & .1 bridge MIBs	√	802.3ah, MEF, Y.ethperf
Non-Intrusive Loopback		√	P802.1ag
Intrusive Loopback		√	802.3ah
Forward Defect Indication		√	Y.1731
Backwards Defect Indication		√	802.3ah, P802.1ag, Y.1731
Restoration / Protection	802.3ad	√	G.8031

Ethernet is well specified - Carrier extensions were easy

ITU-T / IEEE Governance Cooperation

> June 2006: IEEE-SA becomes ITU-T Sector Member

> Sep 2006: Technical Liaison appointed by the IEEE-SA BOG to the ITU-T

> Feb 2007: MOU mutual promotion of events of common interest was agreed in February 2007

> May 2007: First event promoted under MOU: IEEE Global Standards and Developing Economies: Broadband Access and Infrastructure Seminar, Tunis May 9-10

> May 2007: IEEE 802.1 and 802.3 Interim Meeting hosted by ITU-T in Geneva May 28-31

> June 2007: This Joint ITU-T/IEEE Workshop on Carrier-class Ethernet in Geneva May 31-April 1

> June 2007: ITU-T welcomes IEEE 802 participants to its 4-15 June Plenary

Excellent momentum lately – Let's build on it!

Why are we here….?

> To strengthen collaboration, foster the cooperation, and increase momentum
  - To better understand the “cultures” of two world leading standards development organizations
  - To build personal relationships between the participants of the two organizations
> To further explore a number of areas where ITU-T/IEEE cooperation will bear fruit
> Promote Ethernet as an NGN technology
  - Equipped with tools for network transformation

This Workshop Topics

> Ethernet Access

> Ethernet Transport

> Ethernet Bridging Architecture

> Ethernet OAM & Management

> QoS, Timing and Synchronization

Free Online Access to Published Standards & Documentation

> Get IEEE 802 Standards
http://standards.ieee.org/getieee802/index.html

> ITU-T Recommendations
http://www.itu.int/ITU-T/publications/recs.html

> MEF Specifications
http://www.metroethernetforum.org/techspec.htm

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