

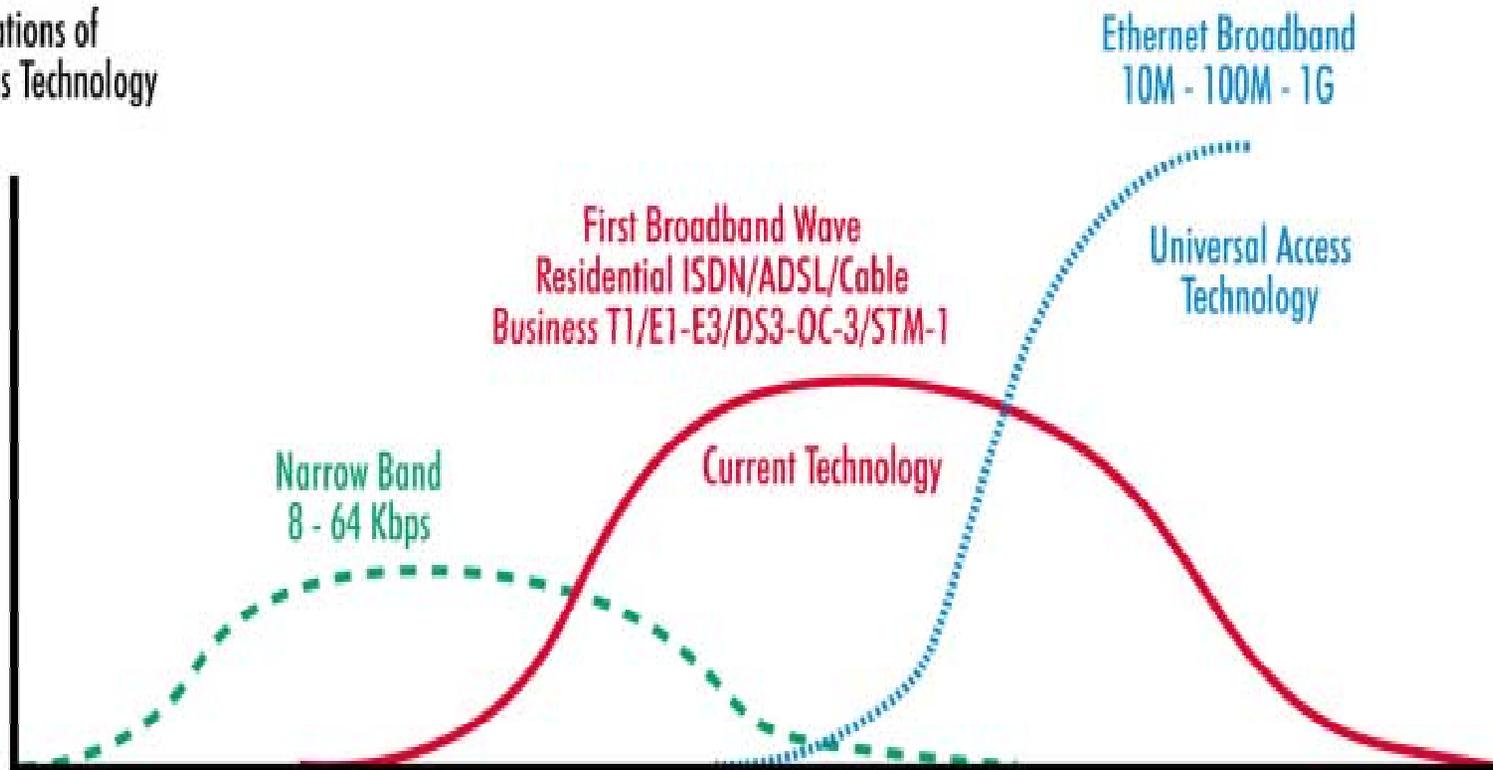
Ethernet in the First Mile Briefing

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October, 2004



Evolution Broadband Access

Generations of
Wired Access Technology



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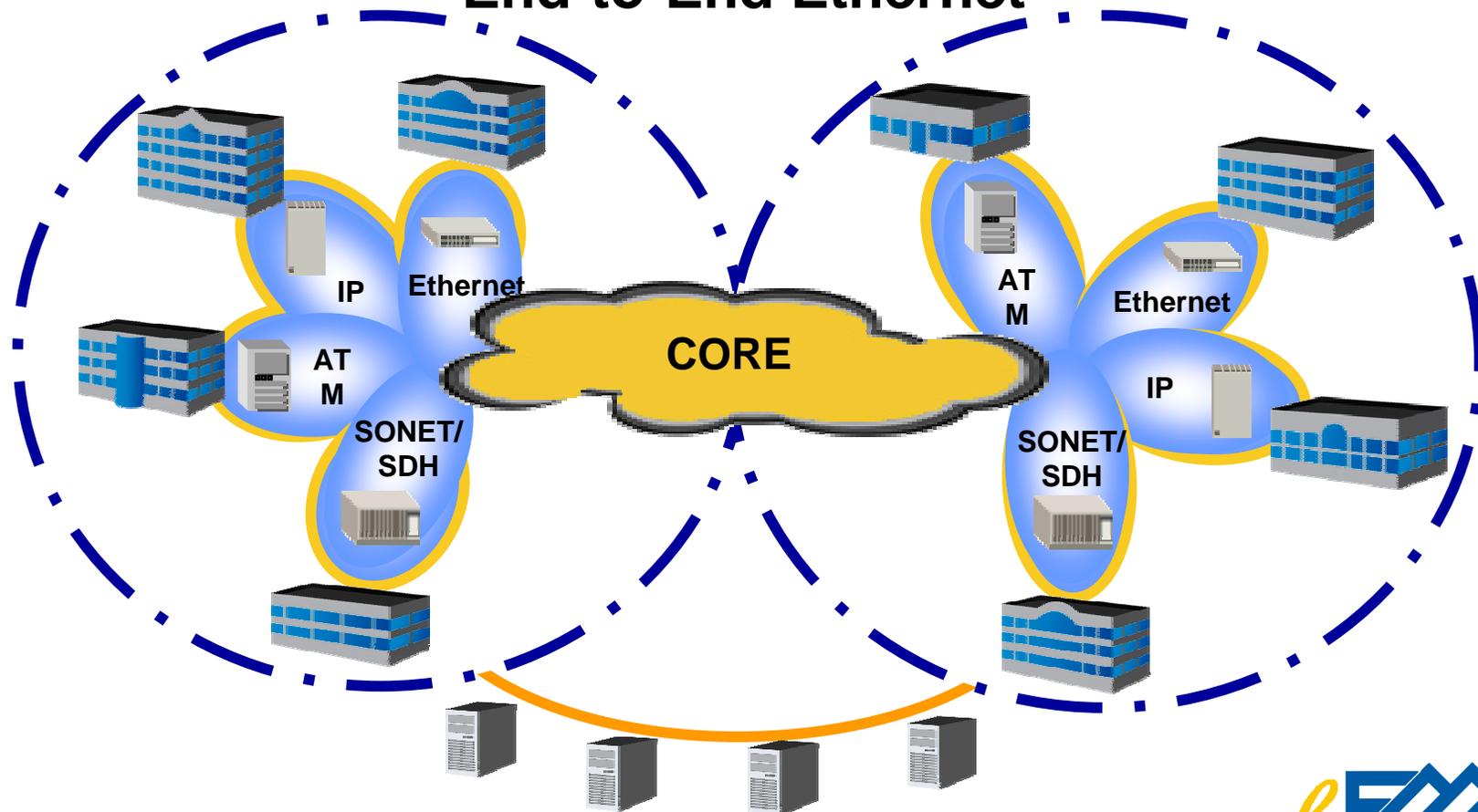
Streamlining the Data Path

Data Traffic Originates as Ethernet

Every Step in Between Adds Cost & Complexity

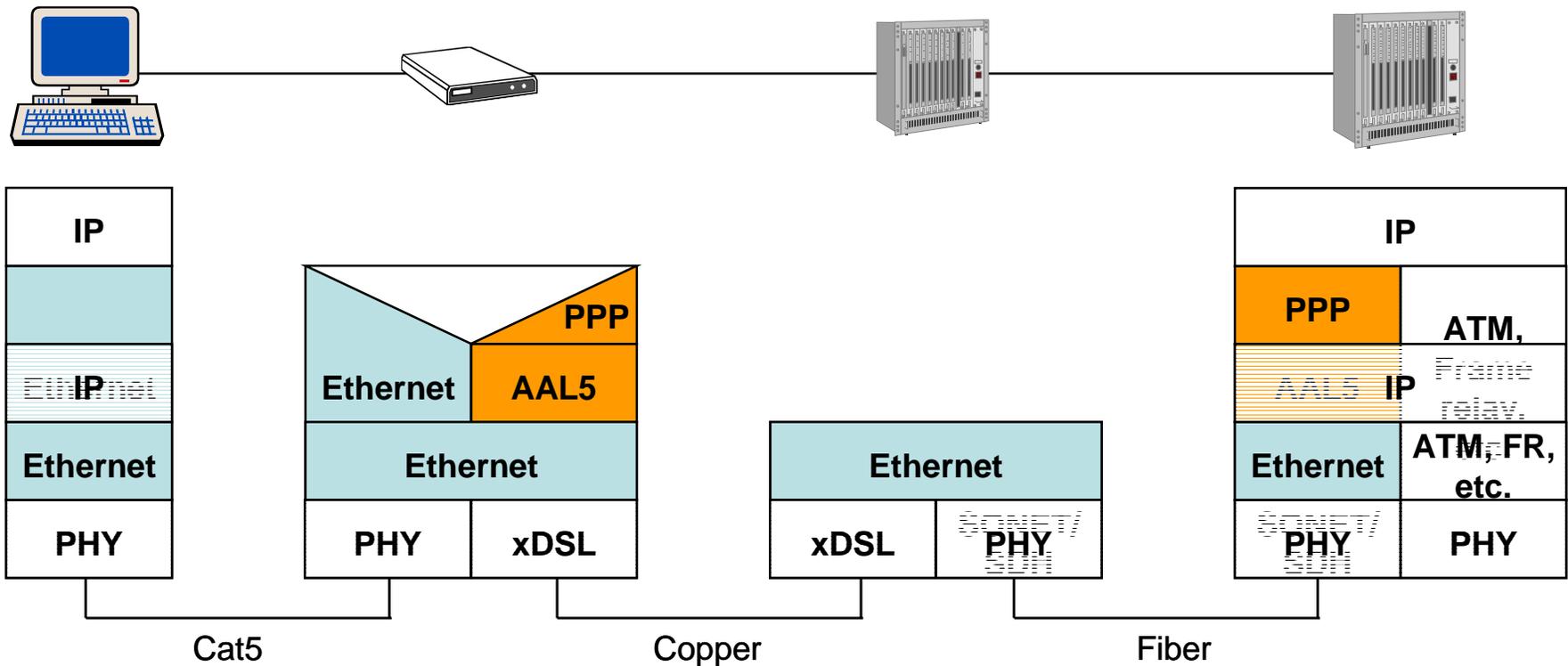
Data Traffic Terminates as Ethernet

End-to-End Ethernet



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Efficient Data Transport



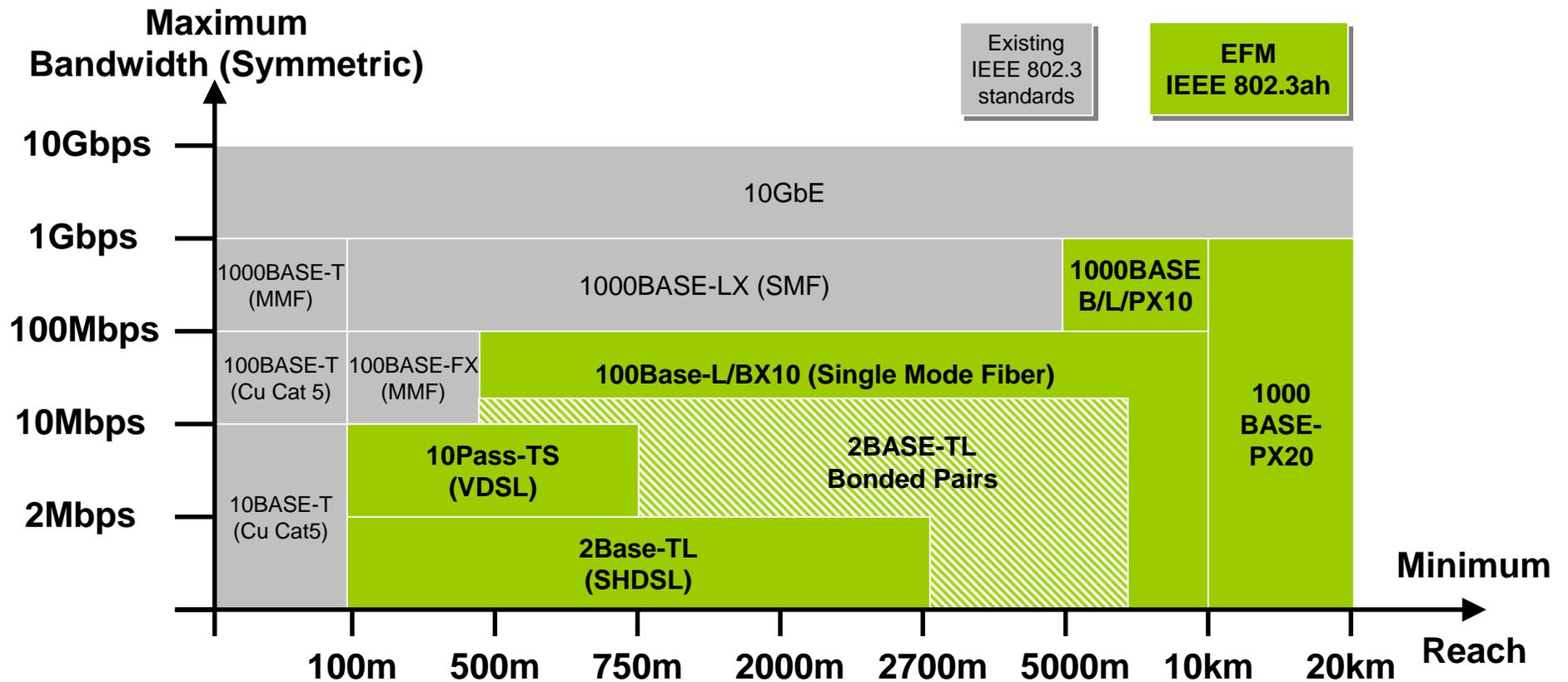
An Ethernet access network avoids protocol translations

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802.3ah EFM standard

Comprehensive suite of Standard First Mile port types



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802.3ah EFM standard

Application within the Access Network

- **Greenfield IP/Ethernet Broadband access networks**
 - FTTH Applications
- **FTT-Remote/Building access**
 - VDSL in the First ½ Mile – P2P GbE in the Second Mile
 - VDSL in the First ½ Mile – EPON in the Second Mile
 - 100BASE-T in the first 1/16 Mile – P2P GbE in the Second Mile
- **Residential FTT-User – Multi-Tenant Units**
 - 1Gbps Ethernet Passive Optical Network – 6 or 12 mile reach
 - 100Mbps/1Gbps Ethernet P2p Optical Network – 6 mile reach
- **Metro Ethernet Access**
 - Multi-Pair Copper Access – n*2Mbps delivered from CO nodes
 - Fiber-to-the-Premises – 100M/1Gbps P2P or 1Gbps PON
- **Fixed Wireless access networks**
 - Fiber connected WiFi access points and WiMax access nodes

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Ethernet Networking – proven to win volume battles

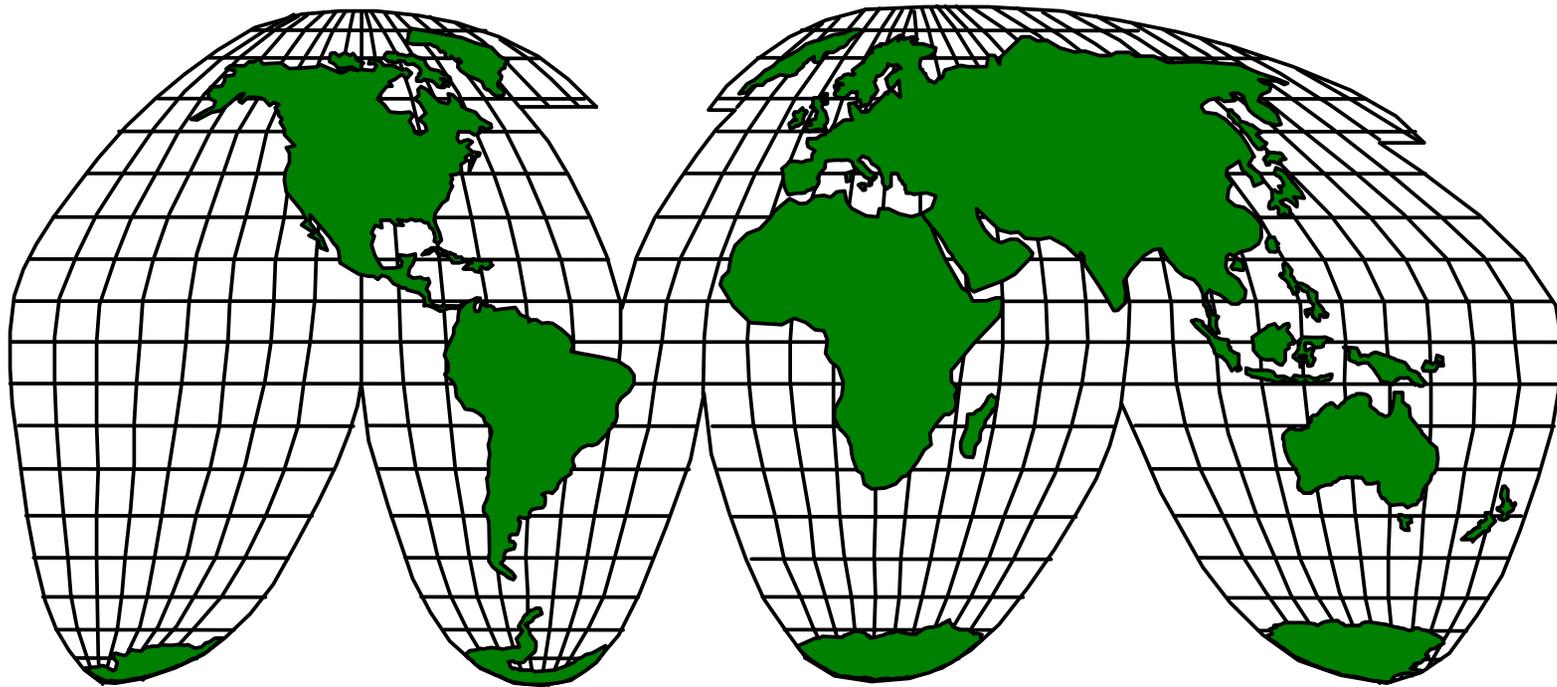
Desk Top	Switched LANs	High Speed Fiber links	WLL/ Hotspots	Metro Networks	Subscriber Access
10BaseT 802.3i	100BaseT 802.3u	GbE 802.3z	WiFi 802.11b/g	10GbE 802.3ae	EFM 802.3ah
Token Bus 802.4 Token Ring 802.5 ATM 25	100VG ANYLAN	FDDI OC-3 / STM-1/4	HiperLAN2 LMDS	ATM/SONET NG SONET RPR	A/B/G-PON ATM-xDSL

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IEEE 802.3ah

A Simple Global Standard

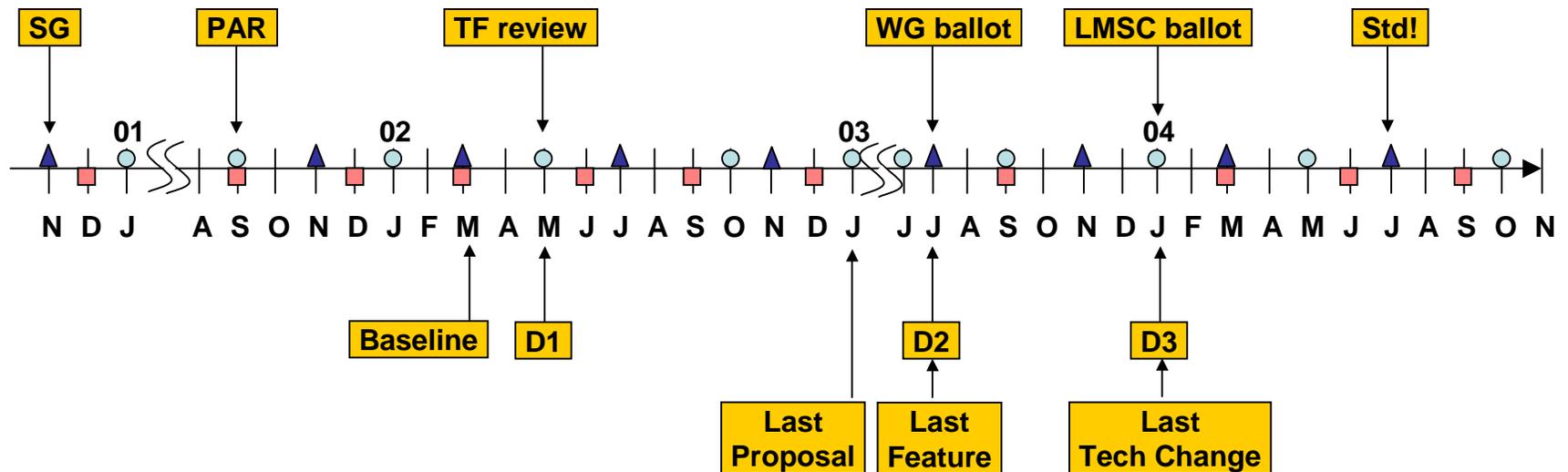


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EFM Timeline

802.3ah standard completed!

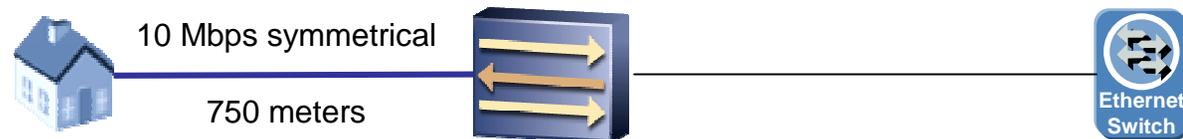


- ▲ 802 Plenary
- 802.3 Interim
- IEEE-SA Standards Board

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EFM Copper - Short Reach 10PASS-TS

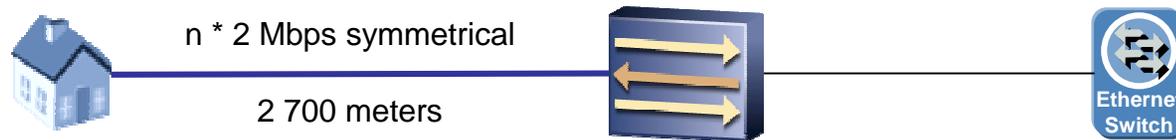


- Business and Residential access over existing copper loops.
- Existing (Cat3) copper loops with POTS left unaffected.
- Reach for Ethernet over copper increased up to 750m.
- Ethernet Speed – minimum 10Mbps symmetrical
- Open i/f Terminal play – One single VDSL line-code chosen.

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EFM Copper - Long Reach 2BASE-TL

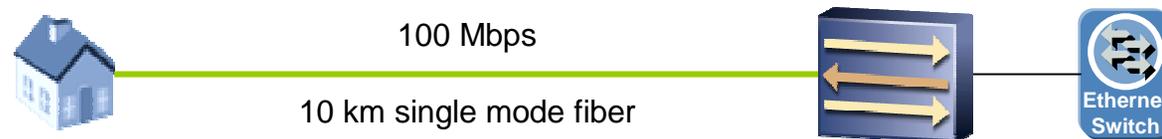


- Business and access over long copper loops
- Reach for Ethernet over copper increased up to 2 700m.
- Sub Ethernet Speed – Symmetrical minimum 2Mbps
- Ethernet Speed with Link Aggregation over multiple pairs.
- Enabler for consolidation of disturbing E1/T1/HDSL sources.

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EFM Fiber Point-to-Point 100BASE-LX & 100BASE-BX



- Business and Residential access over Single Mode Fiber
- Reach for Ethernet over fiber increased up to 10 km.
- 100Mbps – Direct fiber access at lowest possible cost
- Options defined for either single or dual fiber infrastructure
- Dedicated fiber/s per user – flexibility for future upgrades

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EFM Fiber Point-to-Point 1000BASE-LX & 1000BASE-BX



- Business and Residential access over Single Mode Fiber
- Reach for Ethernet over fiber increased up to 10 km.
- 1Gbps – Maximized performance to each user.
- Options defined for either single or dual fiber infrastructure
- Dedicated fiber/s per user – flexibility for future upgrades

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EFM Fiber Point-to-Multipoint 1000BASE-PX

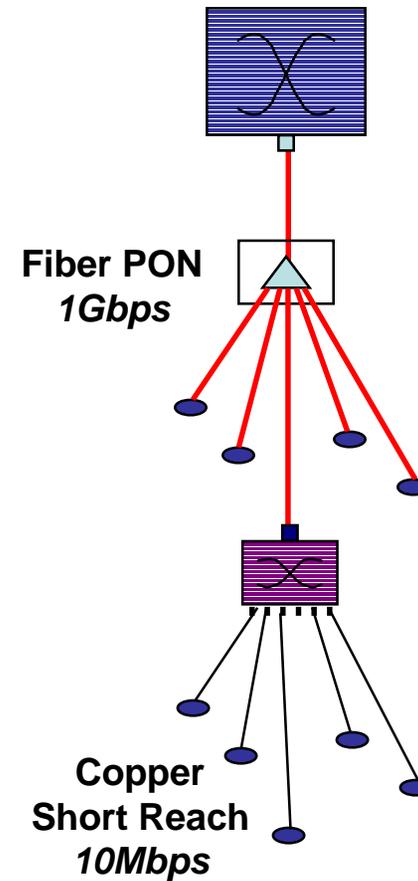
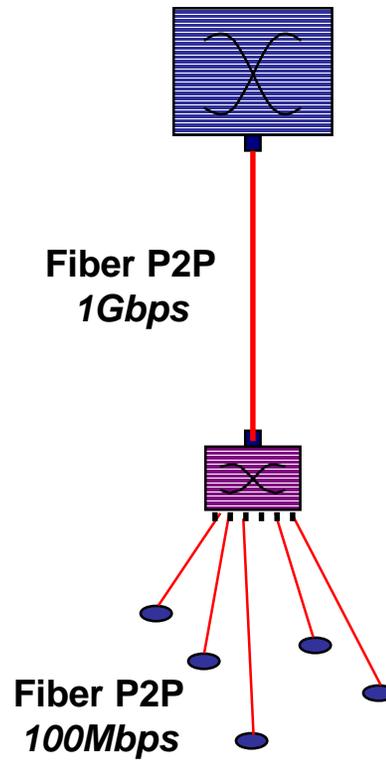
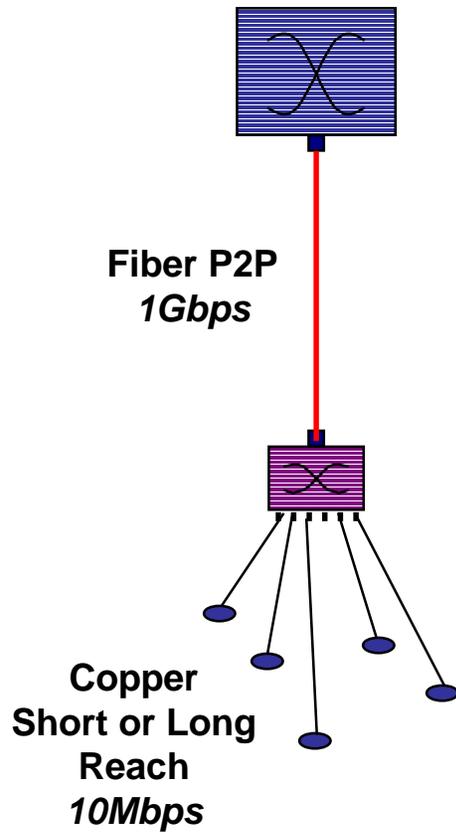


- Business and Residential access over Single Mode Fiber
- Reach for Ethernet over fiber increased up to 10/20km.
- 1Gbps – Available bandwidth shared by up to 16 users
- Fiber loop designed to concentrate traffic to few fibers.
- An Ethernet based alternative for Passive Optical Networks.

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Possible EFM Hybrid Topologies

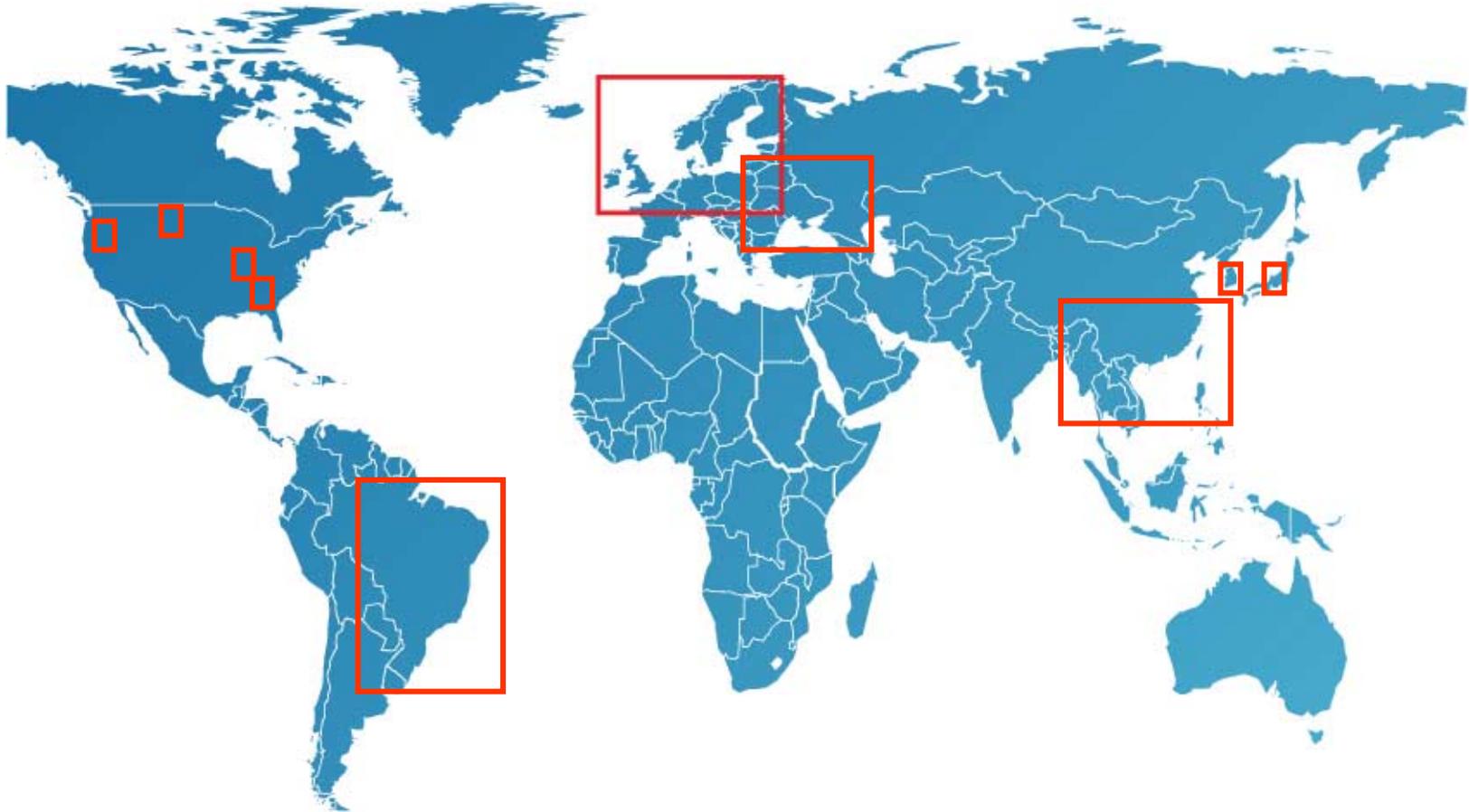


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OAM

- Provide link level management of EFM equipment using Ethernet frames
 - Fault detection and isolation
 - Signal integrity and monitoring
 - Test and diagnostic capabilities
- OAM mechanism will be the basis of Ethernet OAM applications like MEF “Service-Ping”

Ethernet in the First Mile Activity



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Summary

- IEEE p802.3ah EFM Std Complete
 - Optical
 - Copper
 - OAM
- EFM has a strong value proposition for Universal Broadband Access
- EFM deployment is underway

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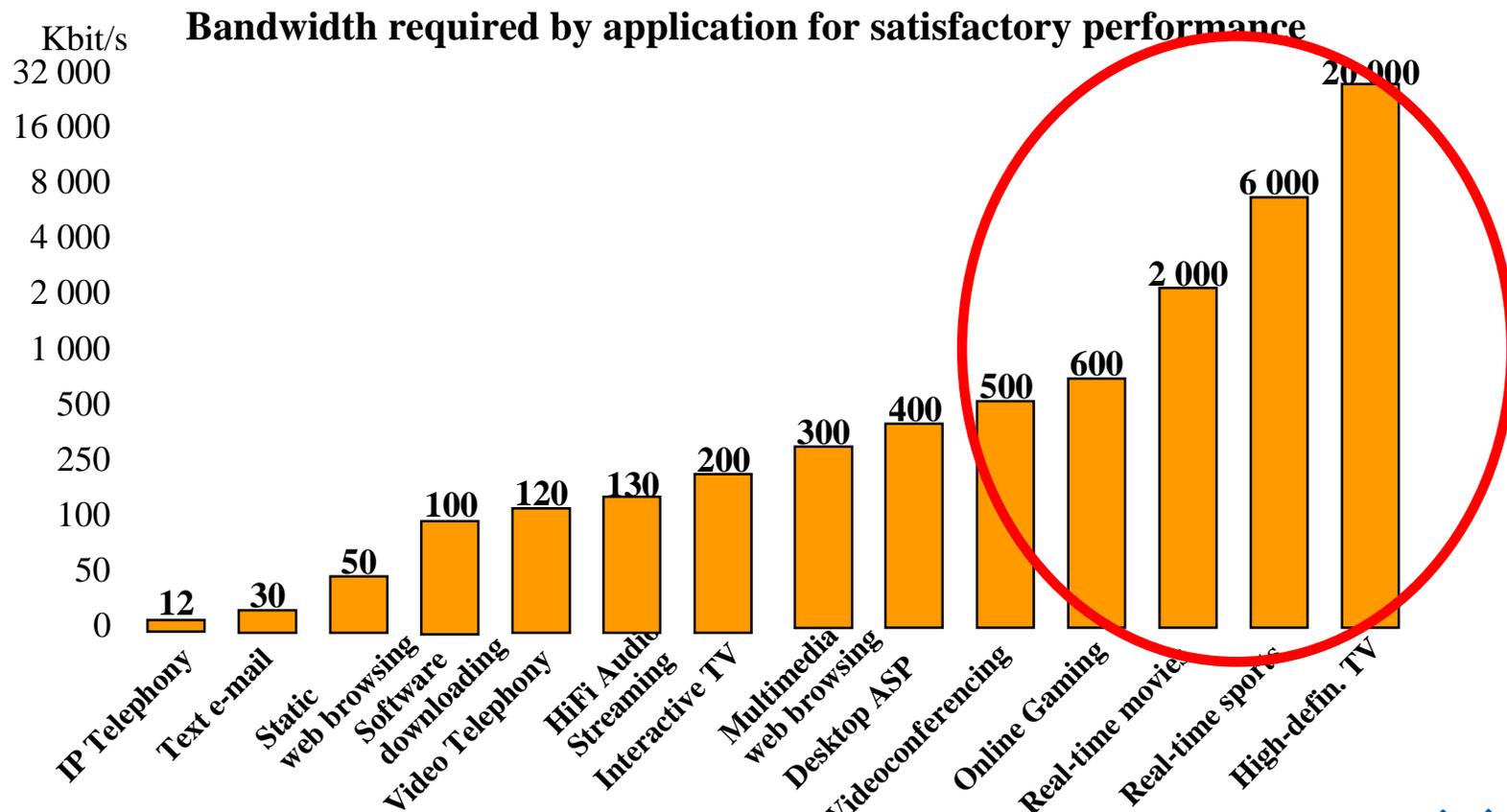


EFM Carrier Applications

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Future-Proof for Video & Voice



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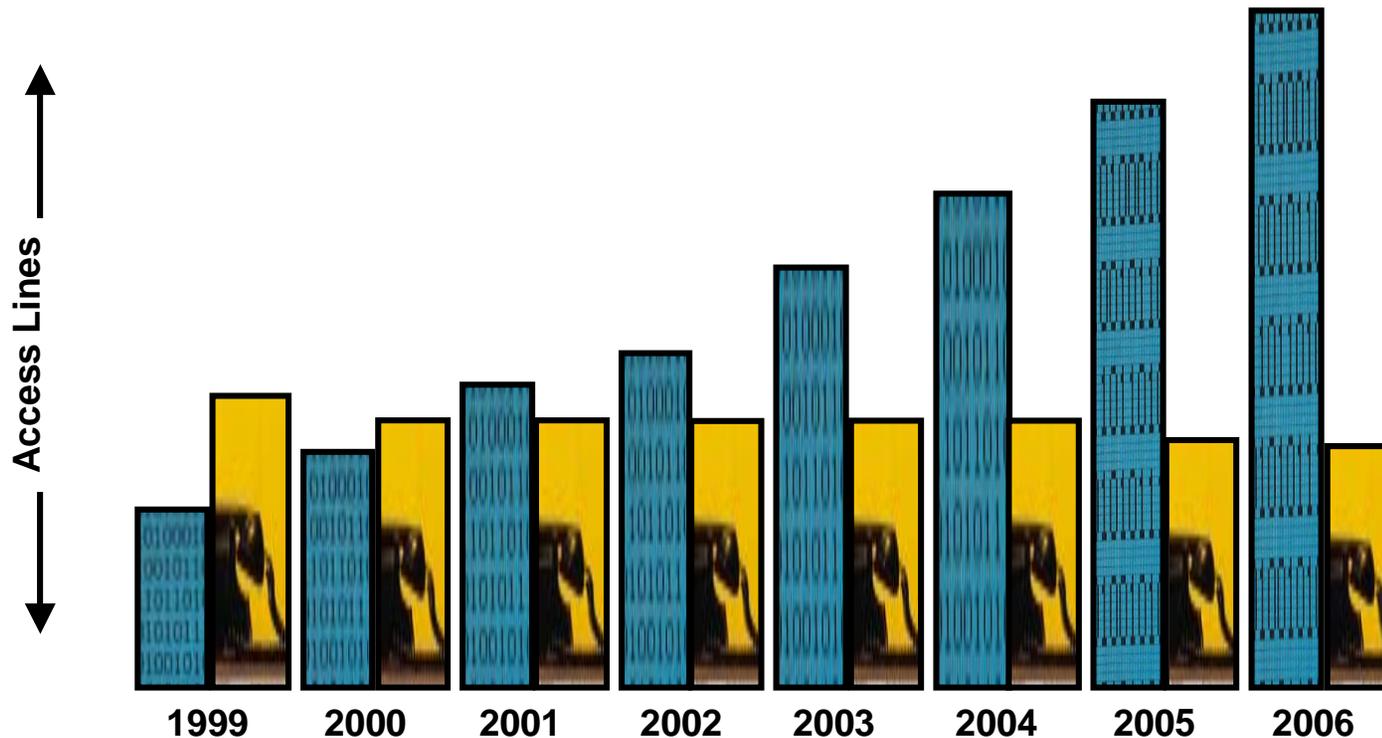


The Opportunity: A Shift to Data

56% of US businesses increased bandwidth in 2003¹

Total access bandwidth purchased by US business locations grew 49% from mid-2000 to mid-2003²

Traditional dedicated data access lines continue to grow at >21% (CAGR)



¹In-Stat/MDR, April 2004

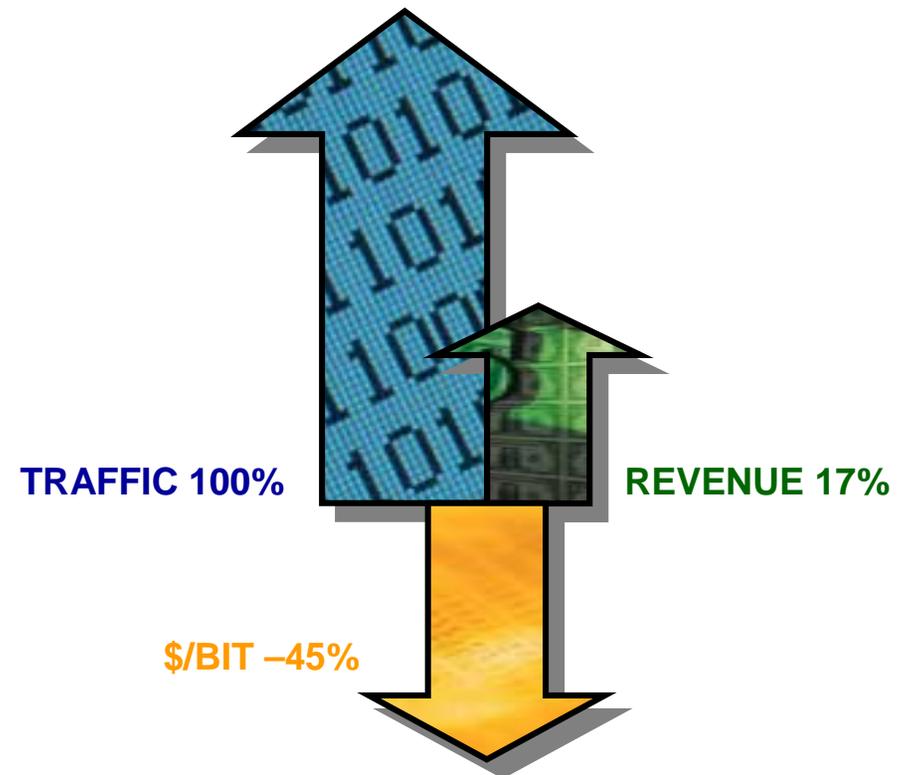
²RHK, March 2004

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The Imperative: Data Not Offsetting Declining Voice Revenues

- Carriers want to generate more revenue from data traffic on their “voice” infrastructure
 - At a lower cost per bit
 - With existing infrastructure
- Carriers need to deliver similar services to all customers
 - Over fiber and copper
 - Anywhere in the access network
- Carriers need an alternative to legacy data services



Source: RHK

Perfect Fit Provisioning



- Small and Medium Businesses are required to purchase too much or too little bandwidth
 - The leap from T1 to T3 is cost prohibitive
 - High bandwidth services require new facilities

	Non-Recurring Charges	Month-to-Month	12 to 36 Months	37 to 60 Months
56 Kbps	\$400.00	\$40.00	\$35.00	\$25.00
64 Kbps	\$400.00	\$40.00	\$35.00	\$25.00
1.536 Mbps	\$525.00	\$328.00	\$295.00	\$255.00
44.210 Mbps	\$1,225.00	\$2,800.00	\$2,600.00	\$2,400.00

BellSouth Fast Packet Transport Services - Alabama, April 30, 2001
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Two Network Paradigms

ATM in the Last Mile



Ethernet in the First Mile

- Network Technology brought out into the access
- Mix of ATM, IP and RF for Service delivery
- Service delivery based on PPP & PVCs
- Cell based voice services
- Poor support for Broadcast services

- User Technology brought up into the access
- IP for Service delivery
- Service delivery based on VLANs
- Packet based voice services
- Multicasting capabilities

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Adoption of EFM in the Market Place

Key trends driving the global introduction of EFM

100%

Universal Penetration Goal



Multi-Service Capable

\$\$\$

Low roll-out CAPEX

100Mbps

Very High Performance

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Broadband Access Facts & Figures – Japan is Extending Metro with FTTH



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Adoption of EFM in the Market Place

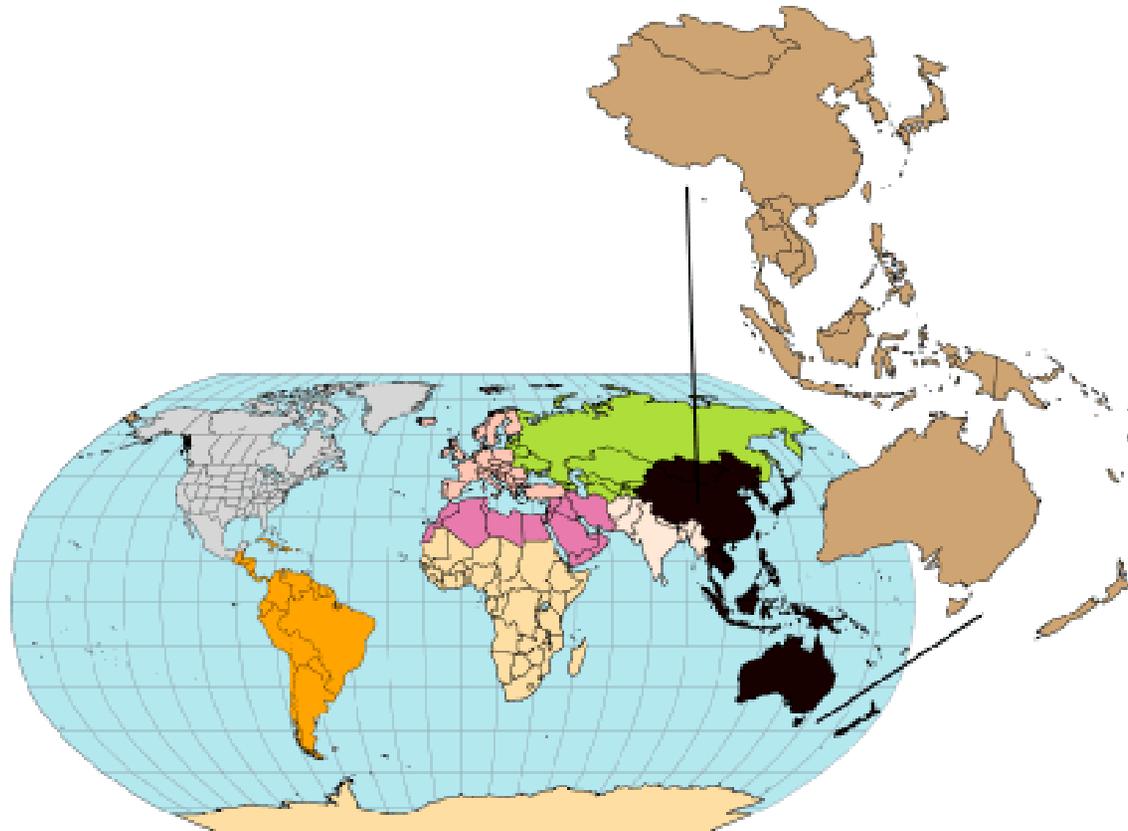
1000BASE-PX - Japan's FTTH Choice

- **Japan:** Already >1.2M FTTH subs
 - Korea & China following progress/adoption
- **NTT:** CAPEX >\$2.5B on FTTH in FY2004
- **Silicon:** In volume production for both CPE & CO
- **Passavé:** Announced >500K IEEE802.3ah EPON ports
- Prime Choice for **aerial fiber** infrastructure globally

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Broadband Access Facts & Figures – Asia-PAC is to leading EFM deployments



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Adoption of EFM in the Market Place

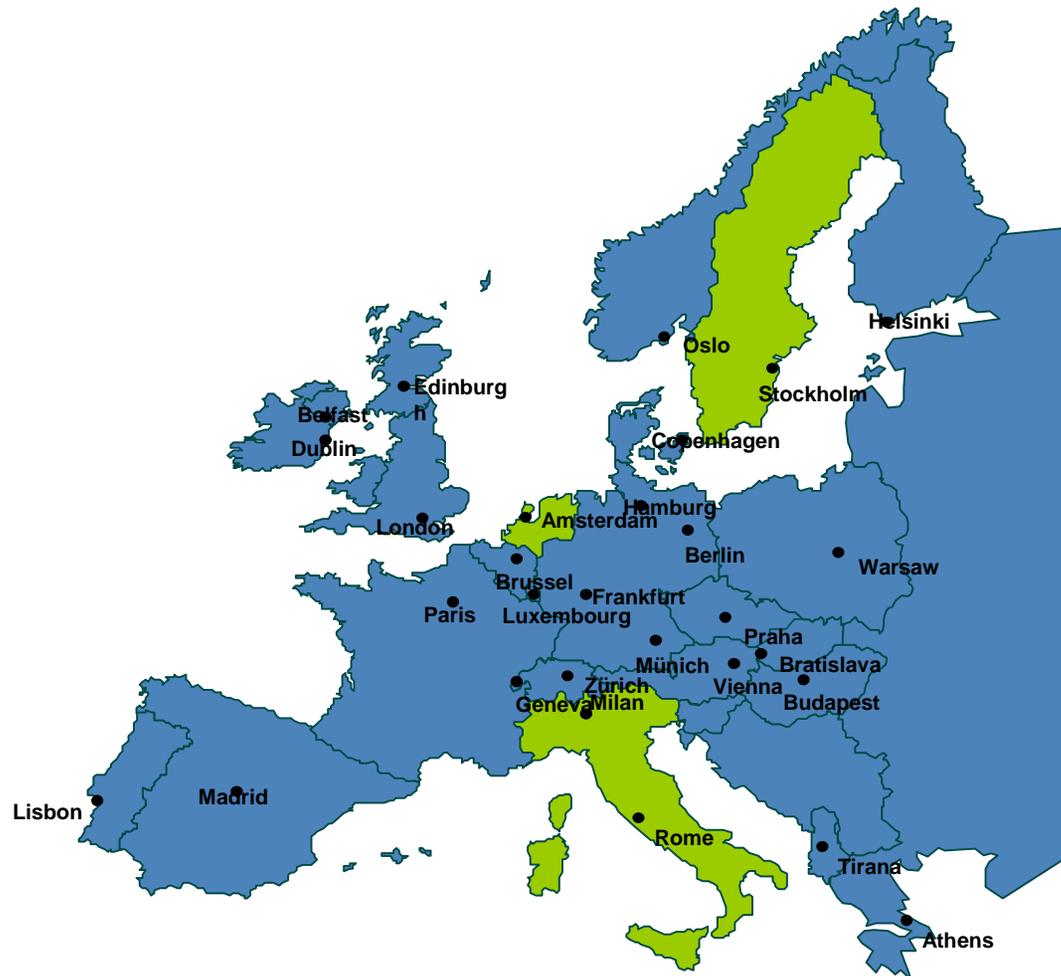
10BASE-TS boosting copper speed in Korea, China and Japan

- **Evolving as the prime VDSL technology**
 - Superior to ATM-VDSL1 and QAM-VDSL
- **Korea:** Broadband Penetration saturation
 - Competition based on HSI performance to keep/win customers
- **China:** Incumbents and alternatives offering copper-based broadband services
- **Japan:** Fierce DSL Mbps race with three large players
 - ADSL2+ and ADSL++ introduced in 2003/4
 - FTT-Building with EFM-VDSL final step before FTT-User

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Broadband Access Facts & Figures – European Adoption of EFM technology



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Adoption of EFM in the Market Place

100BASE-LX – Deployed in European FTTH roll-outs

- **Holland:** FTT User for Infrastructure re-build
 - PTT
 - Municipalities
- **Scandinavia:** FTT-MDU for residential access
 - 10M/10M service offerings starting at \$30
 - >500k lines deployed
- Potential for direct **Business fiber access** from CO
 - Re-gaining market momentum

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Impact of the EFM Standard

- Ethernet is becoming the clear choice for broadband service delivery
 - Metro Ethernet Networks
 - Ethernet First Mile Access
- Ethernet provides a range of bandwidth
 - Facility-free provisioning
 - Eliminates service-media dependencies
- Ethernet enables the triple-play
 - Service bundling increases profitability and subscriber retention

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Background Information

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EFM Value Proposition

2BASE-TL (SHDSL) competitive advantages

	2BASE-TL	IMA (ATM) SHDSL	Multi-Pair SHDSL
Service optimization	IP traffic	ATM traffic	TDM Traffic
Bonding Overhead	5%	20-40%	20-40%
Bonding Delay	2-4ms	25-100ms	2-4ms
Ethernet/IP Conversion	Not required	Required	Required
Operation on pairs with different Quality/Rates	Yes	No	No
Noise Immunity	Medium – High (implementation specific)	Low (Long recovery time)	Low (Single pair loss drops link)
Management complexity	Low	High	N/A
Applicable standards	IEEE	?	G.SHDSL

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EFM Value Proposition

10PASS-TS (VDSL) competitive advantages

	10BASE-TS	100BASE-T	ATM-VDSL1
Service optimization	IP Multi-Service	IP Multi-Service	Hybrid IP & ATM
Network applications	FTT Bldg/Curb	FTT Building	FTT Curb
Copper infrastructure	Cat3	Cat5/6	Cat 3
Copper serving area	½ Mile (750m)	1/16 Mile (100m)	1 Mile (1.5km)
Max b/w (DS/US)	50M / 30M	100M / 100M	50M / 30M
Baseband POTS	Yes	No	Yes
Second Mile Trunks	P2P GbE	P2P GbE	BPON / GPON
QoS / Provisioning	VLANs	VLANs	End-2-end PVCs
Applicable standards	IEEE, ITU-T, ANSI & ETSI	IEEE	ITU-T, ANSI & ETSI

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EFM Value Proposition

100BASE-LX/BX (P2P Fiber) competitive advantages

	100BASE-LX/BX	100BASE-FX	OC-3 STM-1
Service optimization	IP Multi-Service	IP Multi-Service	ATM access
Network applications	FTT Home	FTT Home	FTT Business
Fiber infrastructure	SMF	MMF	SMF
Fiber serving area	6 miles (10km)	¼ Mile (500m)	?
Bandwidth (DS/US)	100M / 100M	100M / 100M	155M / 155M
OAM mechanisms	EFM-OAM	EFM-OAM	F4/F5 flows
Feeder networks	P2P GbE	P2P GbE	ngSONET
QoS / Provisioning	VLANs	VLANs	End-2-end PVCs
Applicable standards	IEEE	IEEE	ITU-T, ANSI & ETSI

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EFM Value Proposition

1000BASE-LX/BX (P2P Fiber) competitive advantages

	1000BASE-LX10	1000BASE-BX10	OC-12 STM-4
Service optimization	Metro Ethernet	Metro Ethernet	ATM access
Network applications	FTT Business	FTT Business	FTT – Fortune500
Fiber infrastructure	<u>Dual SMF</u>	<u>Single SMF</u>	Dual SMF
Fiber serving area	6 miles (10km)	6 miles (10km)	?
Bandwidth (DS/US)	1G / 1G	1G / 1G	155M / 155M
OAM mechanisms	EFM-OAM	EFM-OAM	F4/F5 flows
Feeder networks	10GbE	10GbE	OC-48/192 rings
QoS / Provisioning	VLANs	VLANs	End-2-end PVCs
Applicable standards	IEEE	IEEE	ITU-T, ANSI & ETSI

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EFM Value Proposition

1000BASE-PX (EPON) competitive advantages

	1000BASE-PX10/20	BPON	GPON
Service optimization	IP	ATM	ATM
Network applications	FTT Home	FTT Office	FTT Home
Fiber infrastructure	Single SMF	Single SMF	Single SMF
Fiber serving area	12 miles (20km)	6 miles (10km)	12 miles (20km)
Bandwidth – DS	1,25Gbps	622Mbps	1,25 or 2,5Gbps
Bandwidth - US	1,25Gbps	155Mbps	155M to 2,5Gbps
Feeder networks	GE/10GbE	OC-48/192 rings	OC-48/192 rings
QoS / Provisioning	VLANs	End-2-end PVCs	End-2-end PVCs
Applicable standards	IEEE	ITU-T, ANSI & ETSI	ITU-T, ANSI & ETSI

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