

Broadband Access Using Ethernet in the First Mile (EFM)

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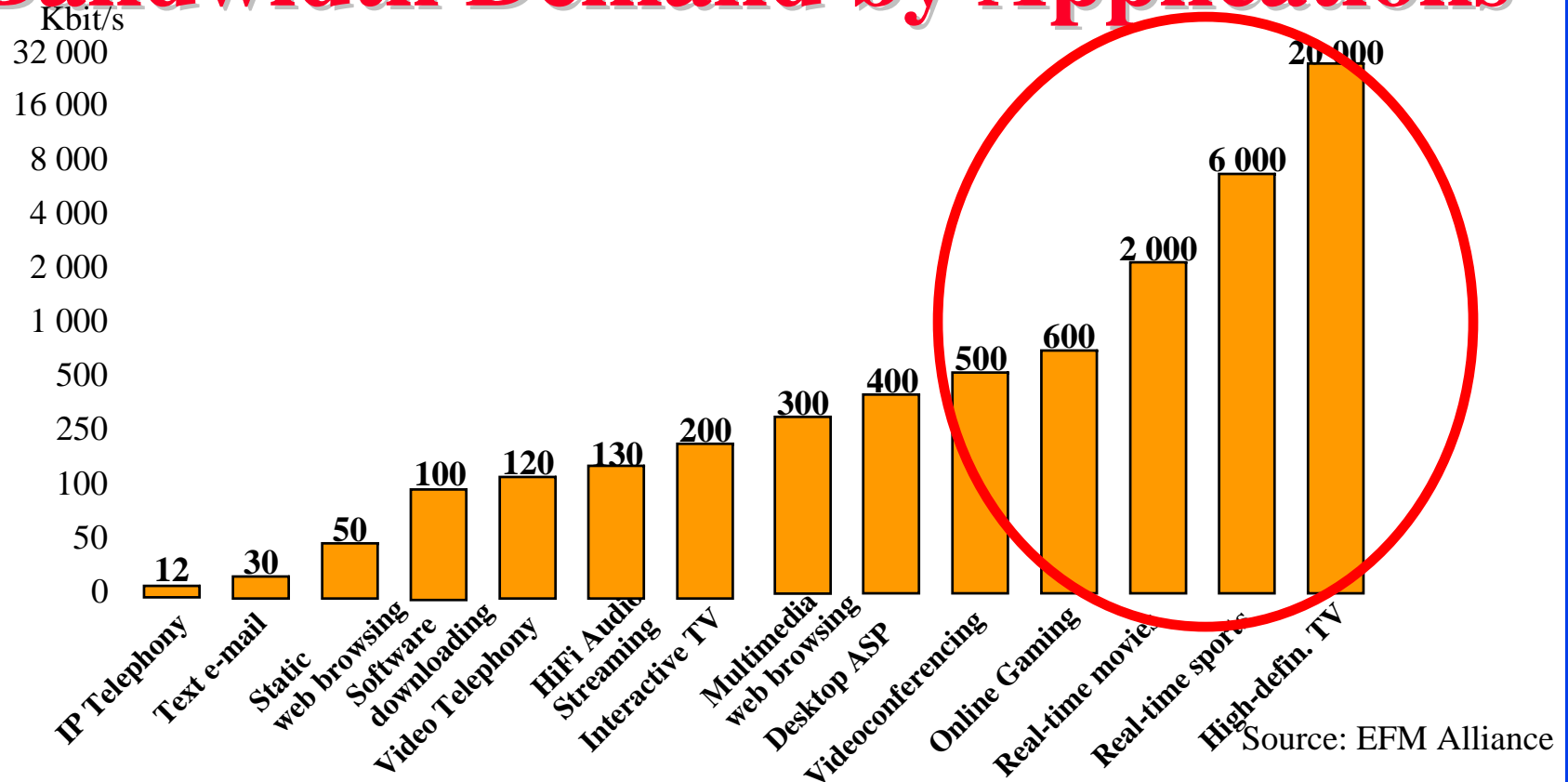


- ❑ The Market Drivers
- ❑ Ethernet in the First Mile
- ❑ Ethernet Passive Optical Network (EPON)
- ❑ EPON vs GPON
- ❑ Recent PON Developments
- ❑ EFM Product Differentiators

The Market Drivers

- ❑ Global Competition \Rightarrow National initiatives:
 - ❑ Japan (clear leader; 530,000 homes with fiber out of 600,000 as of July, 03) (source: FTTH Council 10-03)
 - ❑ Korea, Canada, Sweden, China, Holland, Germany, UK, France, Australia, US beginning to move in the direction
- ❑ Fiber prices have come down drastically (\$200 to \$500/Subscriber) to similar levels as DSL
- ❑ Copper plant typical life span 25-30 years; ILECs use PONs for rebuild and green field installations.
- ❑ New homes in US (1 to 1.5M per year; all potential for FTTH)
- ❑ US FCC ruling of removing restrictions from RBOCs; incentive for FTTH

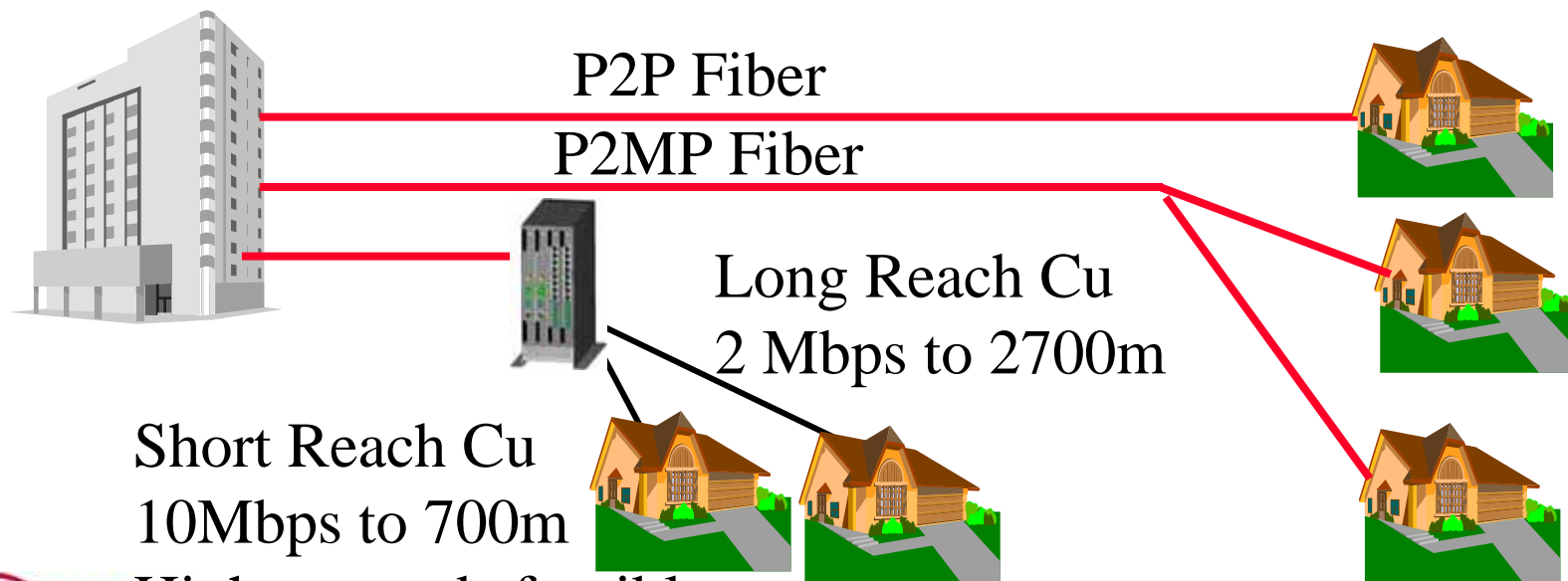
Bandwidth Demand by Applications



- ❑ **Music**, Streaming Video Downloads off the Web
- ❑ Gigabyte File Transfers, Peer-to-peer
- ❑ Real Time Data and Storage Back-Ups over the WAN

Ethernet in the First Mile

- ❑ Standards: IEEE 802.3ah EFM working Group
- ❑ Originally called Ethernet in the Last Mile
- ❑ Ref: <http://www.ieee802.org/3/efm/public/index.htm>
- ❑ Marketing: EFM Alliance, www.efmalliance.org



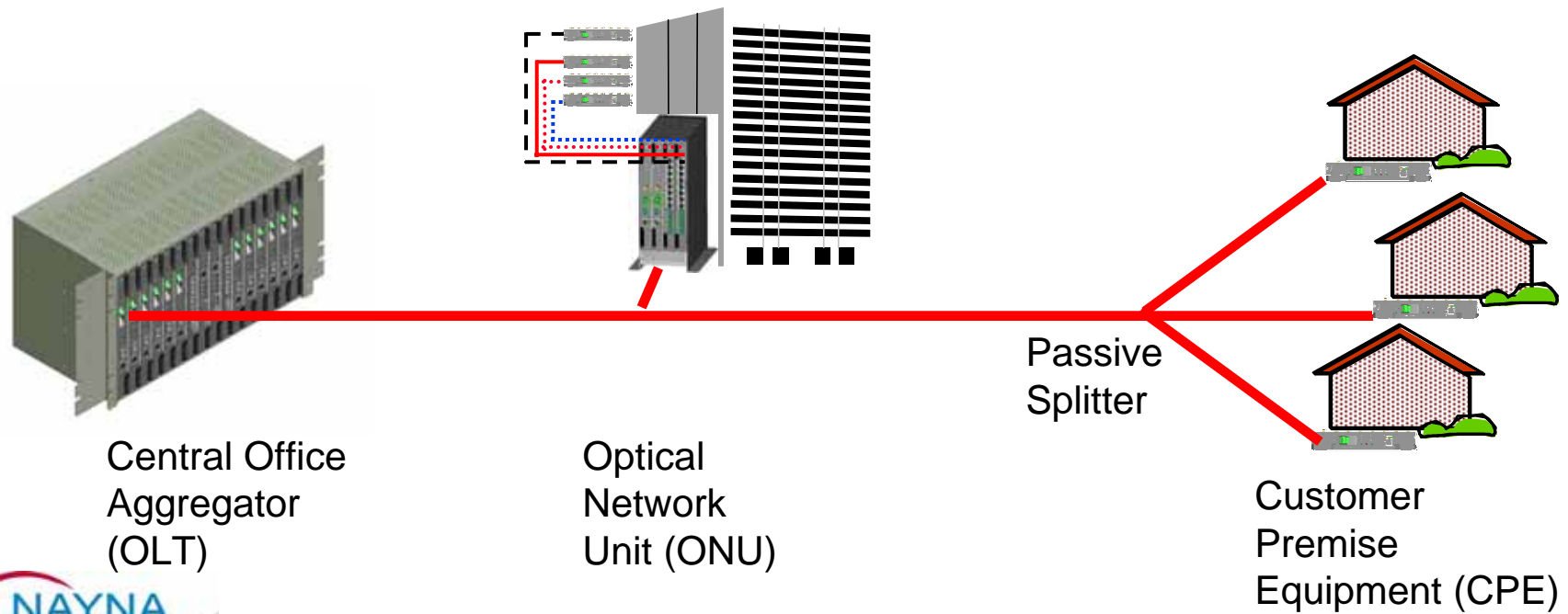
Higher speeds feasible

EFM PHYs

- ❑ 2BASE-TL Baseband PHY based on **SHDSL**, $L \Rightarrow 2.7\text{km}$
- ❑ 10PASS-TS Duplex on a single voice UTP pair using VDSL
QAM constellations are used to modulate carriers of **DMT**, $S \Rightarrow 0.7\text{km}$. Pass \Rightarrow Voice+Data
-O = Central Office, -R = CPE
- ❑ 100BASE-LX10 Duplex Fiber PHY w 10km 1310nm laser
- ❑ 100BASE-BX10-D Bi-directional **1550nm** downstream laser
- ❑ 100BASE-BX10-U Bi-directional 1310nm upstream laser
- ❑ 1000BASE-LX10 Extended (10km) 1310nm long-wavelength laser
- ❑ 1000BASE-BX10-D Bi-directional **1490nm** downstream laser
- ❑ 1000BASE-BX10-U Bi-directional 1310nm upstream laser
- ❑ 1000BASE-PX10-D PON 1490nm downstream laser 10 km
- ❑ 1000BASE-PX10-U PON 1310nm upstream laser 10 km
- ❑ 1000BASE-PX20-D PON 1490nm downstream laser 20 km
- ❑ 1000BASE-PX20-U PON 1310nm upstream laser 20 km

Ethernet Passive Optical Network (EPON)

- ❑ A single fiber is used to support multiple customers
- ❑ No active equipment in the path \Rightarrow Highly reliable
- ❑ OLT assigned time slots upstream.
- ❑ Optical Line Terminal (OLT) in central office
- ❑ Optical Network Terminal (ONT) on customer premises
Optical Network Unit (ONU) at intermediate points w xDSL



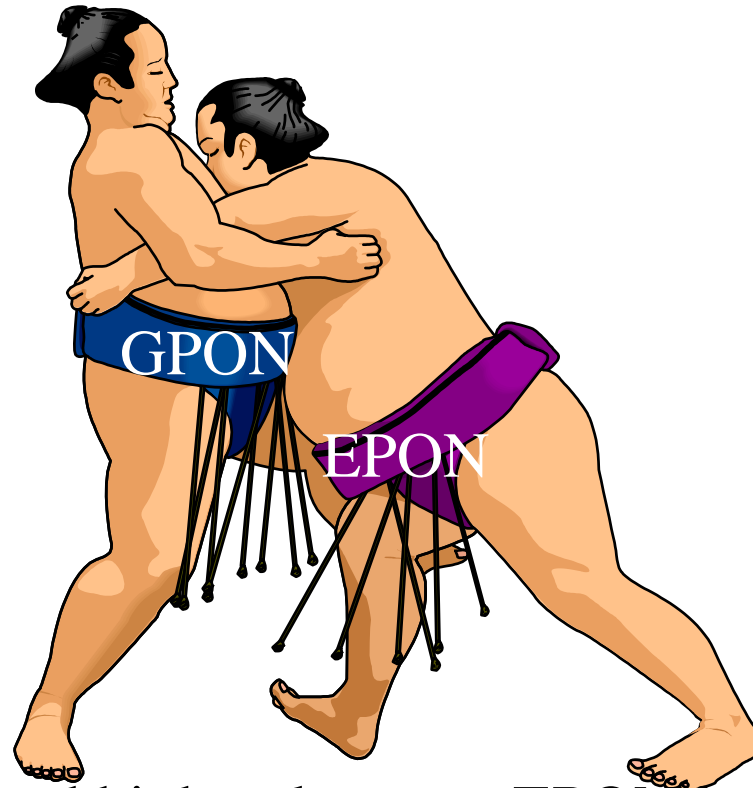
Why PONs?

- ❑ **Reduced OpEx:** Passive network
 - ❑ High reliability \Rightarrow Reduced truck rolls
 - ❑ Reduced power expenses
 - ❑ Shorter installation times
- ❑ **Reduced CapEx:**
 - ❑ 16 -128 customers per fiber. Solves conduit congestion.
 - ❑ 1 Fiber +N transceivers vs N Fibers + 2N transceivers
- ❑ **Increased Revenue Opportunities:**
Multi-service: Data, E1/T1, Voice, Video
- ❑ **Scalable:**
 - ❑ CO Equipment Shared \Rightarrow New customers can be added easily
 - ❑ Bandwidth is Shared \Rightarrow Customer bandwidth can be changed

Types of PONs

- ❑ **APON:** Initial name for ATM based PON spec.
Designed by Full Service Access Network (FSAN) group
- ❑ **BPON:** Broadband PON standard specified in ITU G.983.1 thru G.983.7 = APON renamed
 - ❑ 155 or 622 Mbps downstream, 155 upstream
- ❑ **GPON:** Gigabit PON standard specified in ITU G.984.1 and G.984.2
 - ❑ 1244 and 2488 Mbps Down, 155/622/1244/2488 up
- ❑ **EPON:** Ethernet based PON draft being designed by IEEE 802.3ah.
 - ❑ 1000 Mbps down and 1000 Mbps up.

EPON vs GPON



- Low-cost optics and high volume \Rightarrow EPON is much cheaper.
Compatible with enterprise networks. Easier to maintain.
EPON being planned by US Community networks and by carriers in Japan, Korea, China

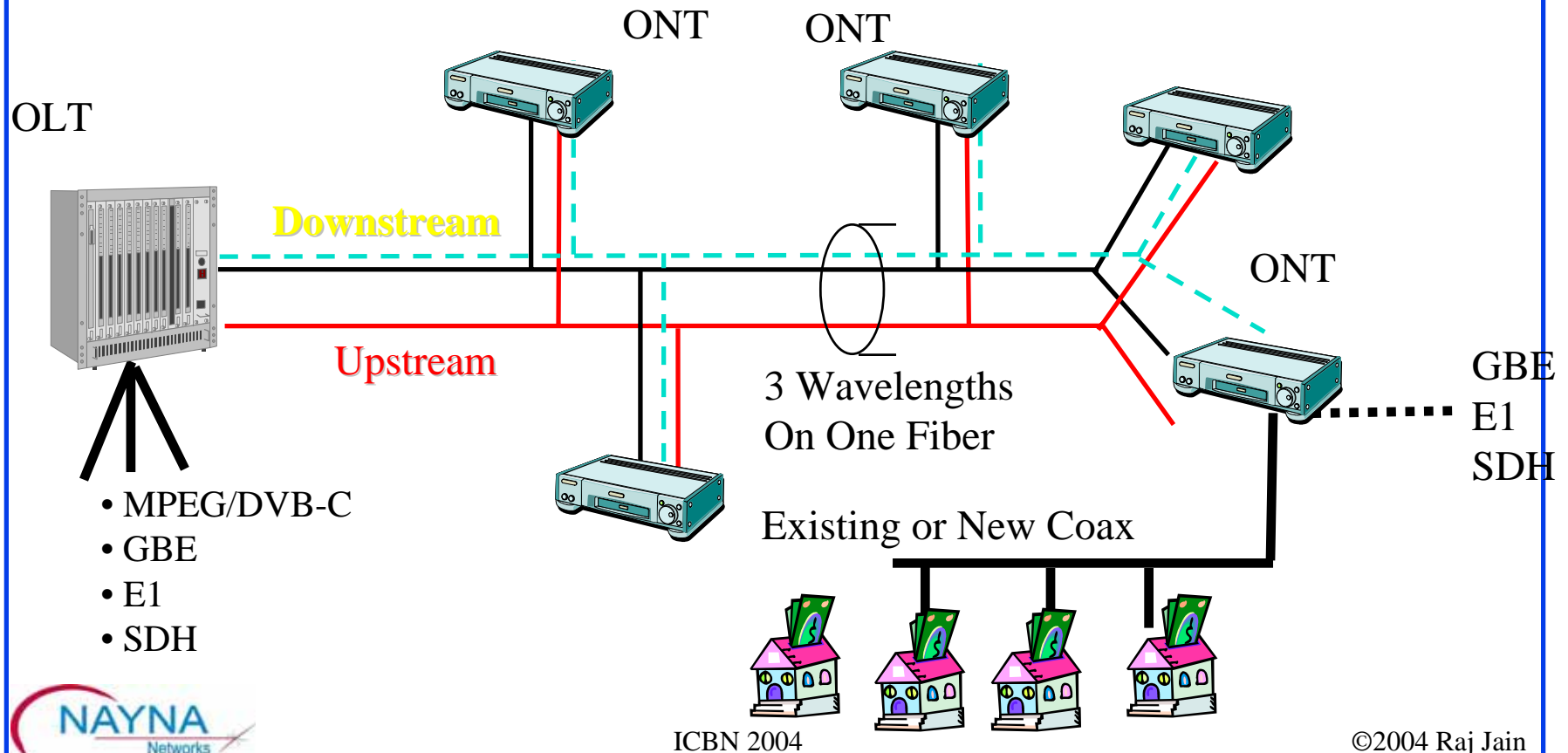
Recent PON Developments

- ❑ GPON recommendations G.984.x are out. EPON draft is almost final.
- ❑ FCC removed fibers from unbundling
- ❑ SBC, Verizon, Bellsouth issued an RFP in USA
 - ❑ Carriers in Japan and Europe are seriously investigating FTTH
 - ❑ Most big telecom vendors were caught off-guard with no PON equipment
- ❑ NTT issued 2 RFPs on EPON
- ❑ Most action in Access rather than in Core or Metro
- ❑ Venture Financing for PON is up
 - ❑ Several PON companies received funding this year
- ❑ Over 800 Communities in USA are investigating fibers to home using PONs
- ❑ Fiber-to-the-Home Installations Expected to Reach Approximately One Million by 2004 [FTTH Council]

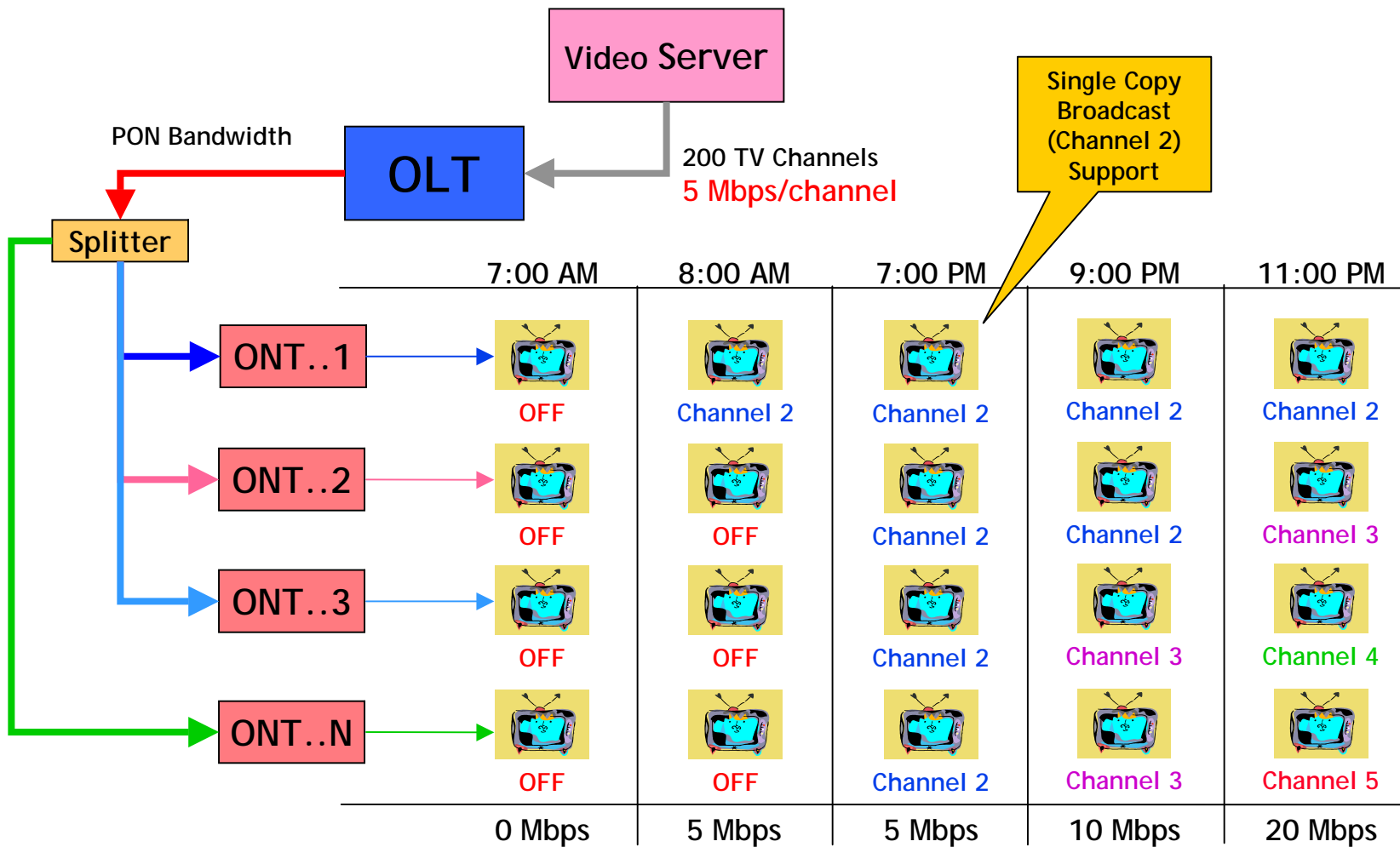


Broadcast Video Over PON

- ❑ Analog or Digital Video on 1550 nm.
- ❑ Revenue enhancing opportunity for CATV MSOs
- ❑ Revenue for Telecom carriers using Video over IP

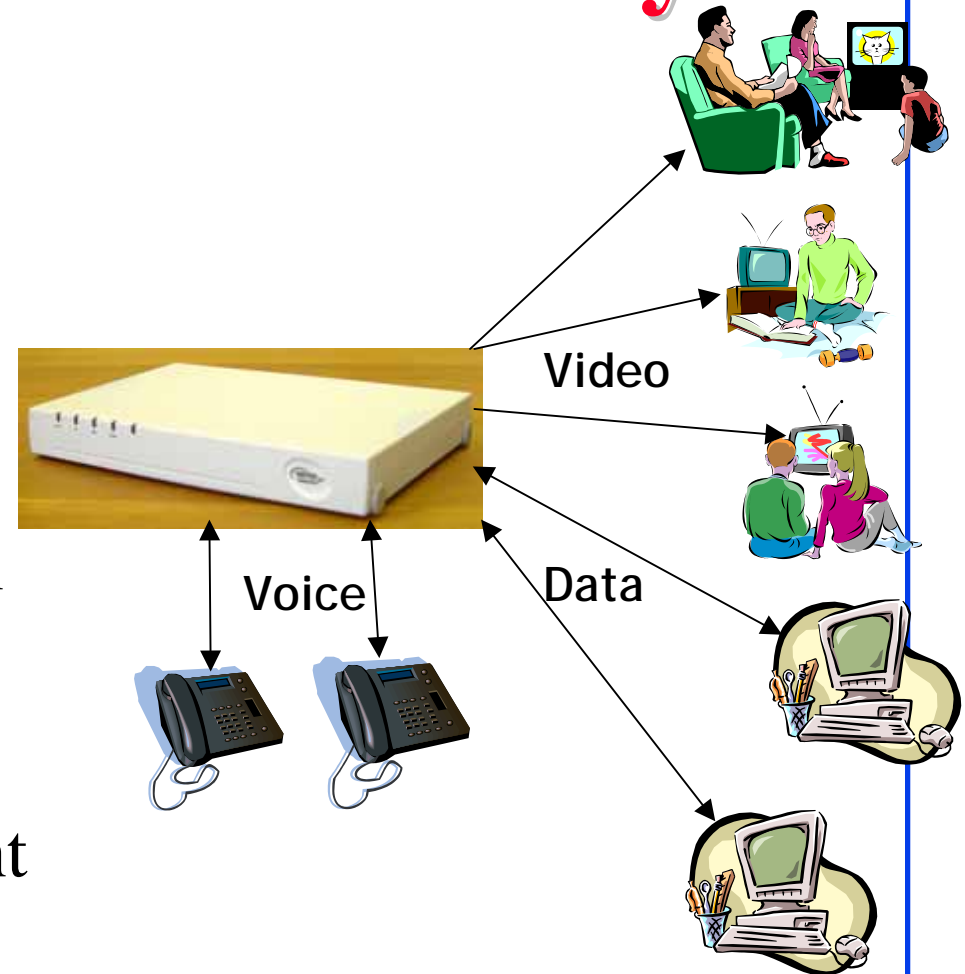


Broadcast TV Bandwidth Optimization over PON



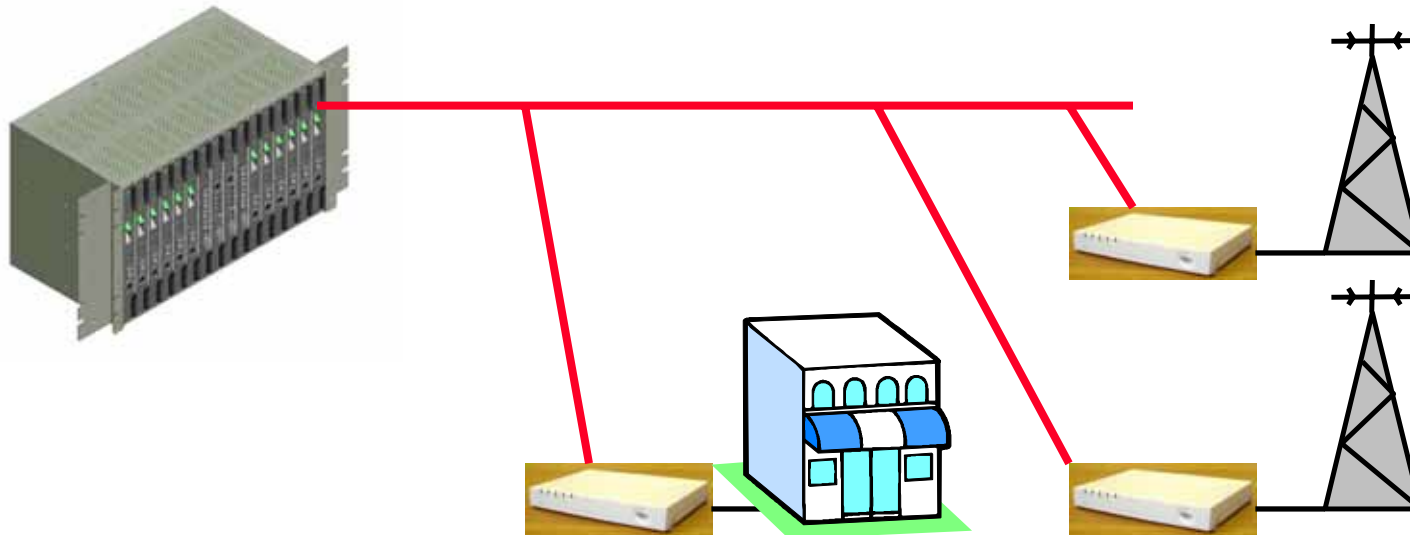
SOHO/Residential Gateways

- ❑ 10/100 Ethernet ports
- ❑ per-Port Rate control
- ❑ Video-over-IP ports
- ❑ POTS ports
- ❑ Manageable from Central Office
- ❑ Low Cost \approx DSL
Fast Return on Investment



TDM over EFM

- ❑ Leased lines (T1/E1/J1) are still a big revenue generators for ILECs. Used for PBX traffic by businesses.
- ❑ Pseudo Wire Edge-to-Edge (PWE3) working group in IETF is defining a standard for TDM over IP
- ❑ Cellular operators are investigating using EFM for backhaul



EFM Product Differentiators

❑ Revenue Enhancing Features:

- ❑ Multi-Service Support: Internet, Video, Voice, TDM
⇒ IEEE 802.1p support, QoS, High-speed switching
- ❑ Video: Analog, Digital and IP Video services
- ❑ Multiple ISP and VoD service provider support
- ❑ Multiple data services with throughput, delay, Jitter
- ❑ SLA monitoring
- ❑ End-user Authentication: Prevent unauthorized usage

❑ CapEx Reduction Features:

- ❑ Support any mix of network topologies: P2P, Bus, Tree, ...
- ❑ Optimized multicast traffic throughput (Broadcast Video)

EFM Product Differentiators (Cont)

❑ OpEx Reduction Features:

- ❑ Plug and Play CPE
- ❑ Automatic CPE Configuration from Central office
- ❑ Integration with Carrier OSS via SNMP

❑ Customer Satisfaction Improvement Features:

- ❑ Customer privacy and security via VLANs
- ❑ Supports customers' VLANs
- ❑ Redundancy support for high-availability



Summary

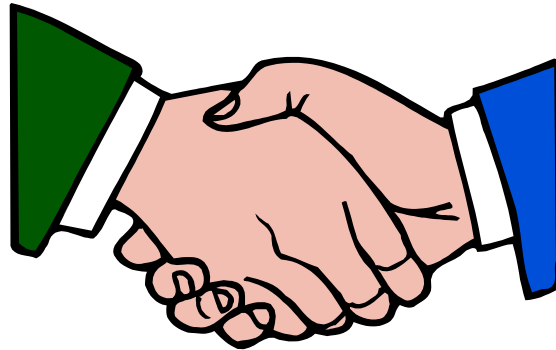
1. 2004 will be the year of EFM.
2. EFM reduces OpEx and CapEx for carriers and increase carrier revenue opportunities with value-added services
3. Multi-service support in next-generation EFM products is a key differentiator.
4. EFM products need to offer quad-play: Data, voice, video, and TDM to be effective



References

- ❑ Lightreading, <http://www.lightreading.com>
- ❑ EFM Alliance, www.efmalliance.org
- ❑ FTTH Council, www.ftthcouncil.org
- ❑ IEEE 802.3ah Working Group,
<http://www.ieee802.org/3/efm/>

Thank You!



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