Broadband Access Using Ethernet in the First Mile (EFM)

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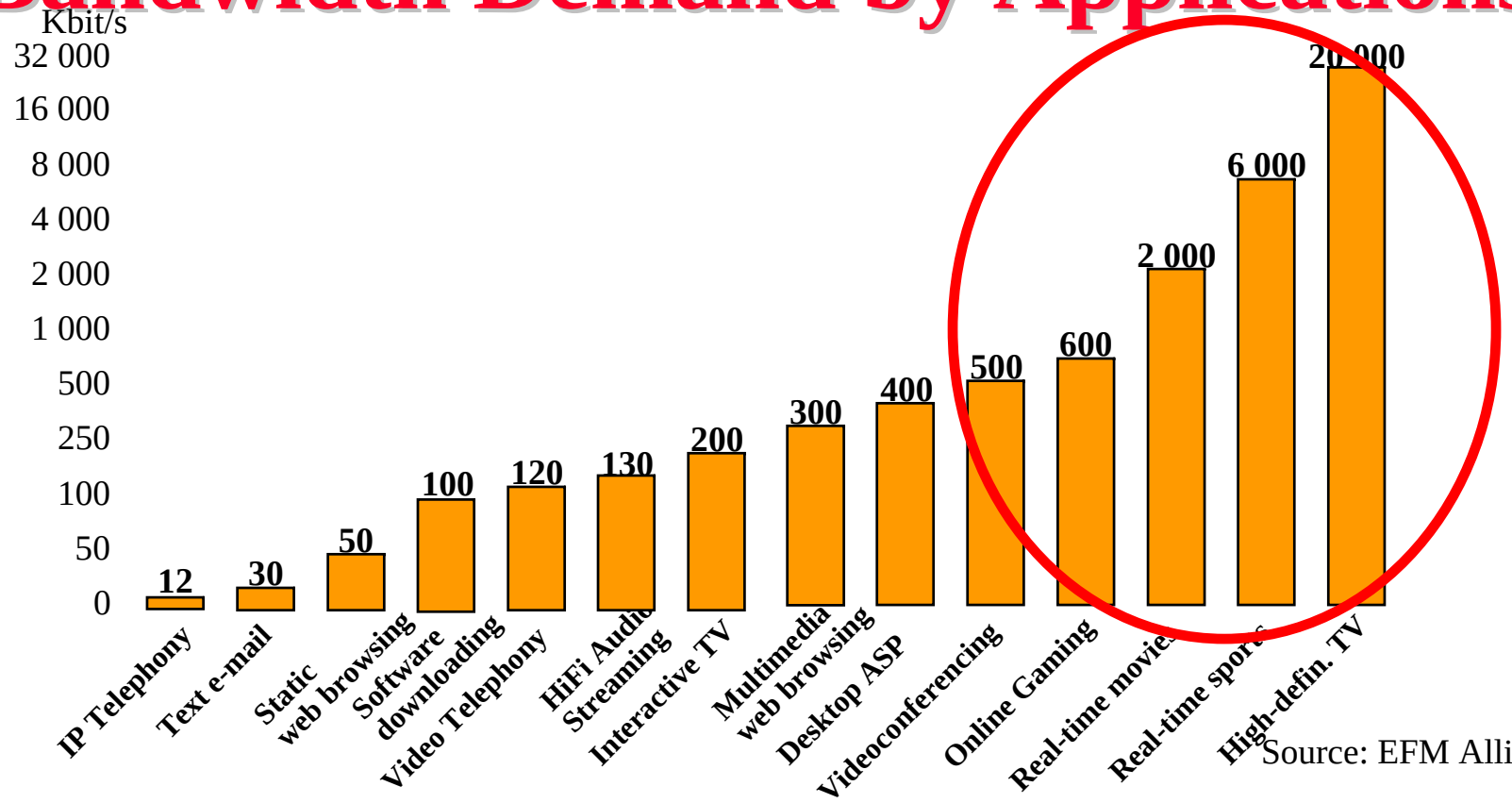
Overview

- 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 ⇒ 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.
- Over 800 Communities in USA are investigating fibers to home using PONs
- US FCC ruling of removing restrictions from RBOCs; incentive for FTTH

Bandwidth Demand by Applications

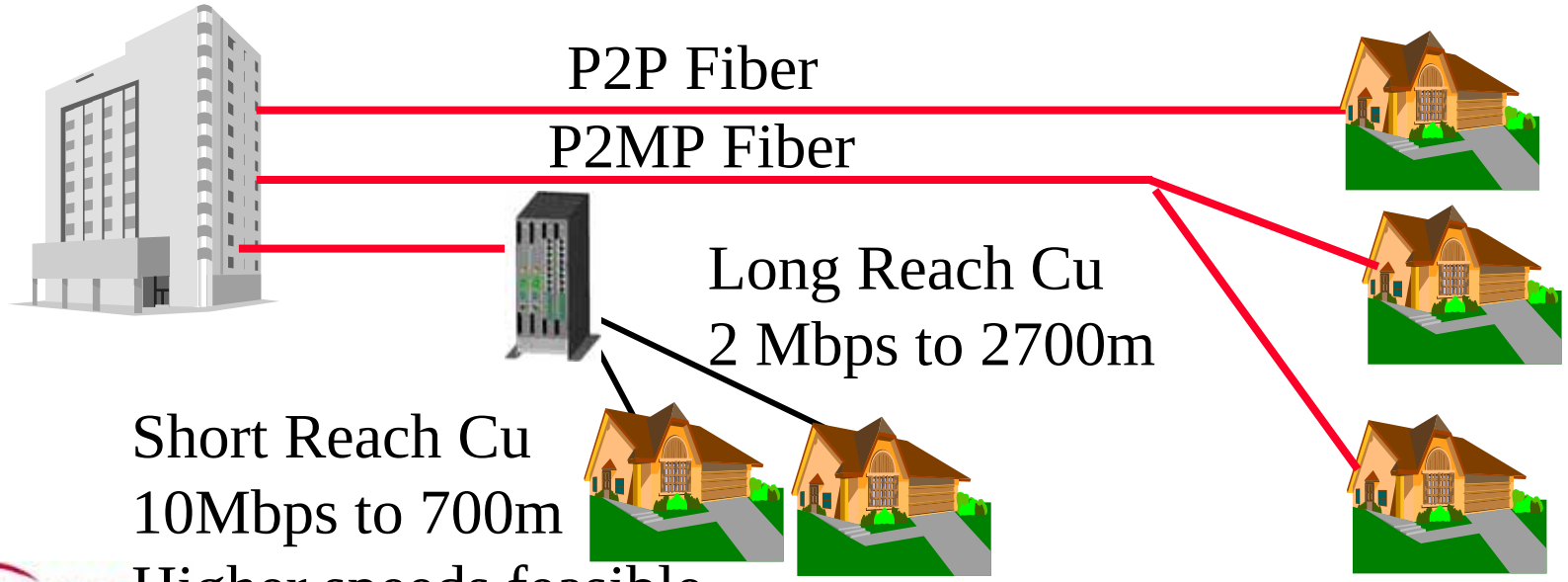


Source: EFM Alliance

- 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

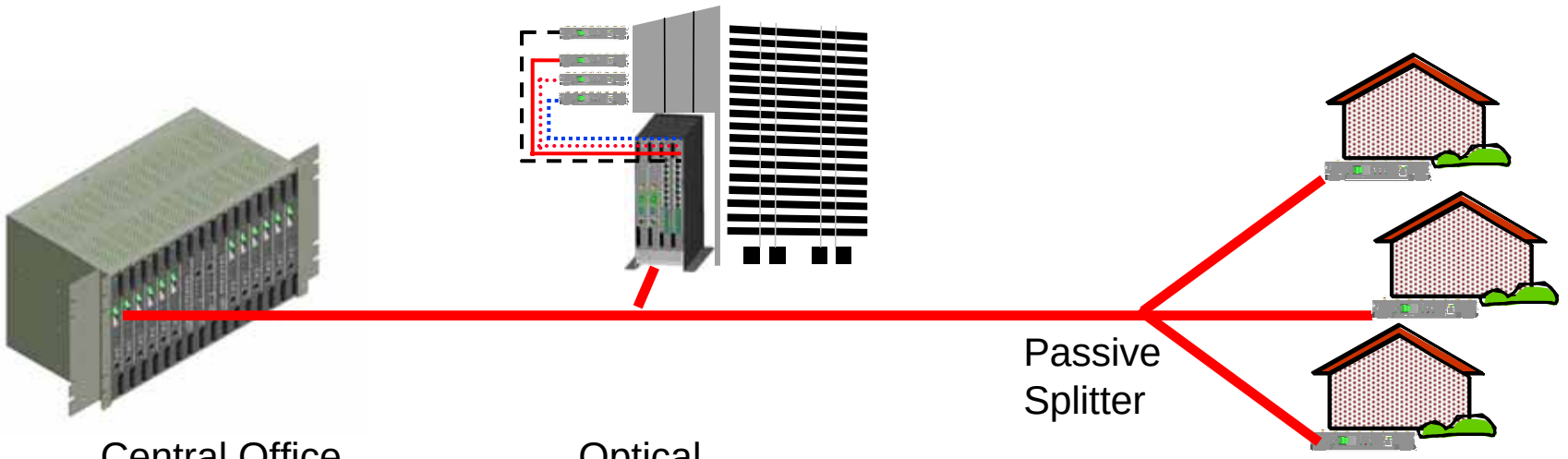


EFM PHYs

2BASE-TL	Baseband PHY based on SHDSL, L ⇒ 2.7km
10PASS-TS	Duplex on a single voice UTP pair using VDSL QAM constellations are used to modulate carriers of DMT, S⇒0.7km. Pass⇒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 ⇒ 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 ⇒ 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 ⇒ New customers can be added easily
  - Bandwidth is Shared ⇒ 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.893.7 = 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.

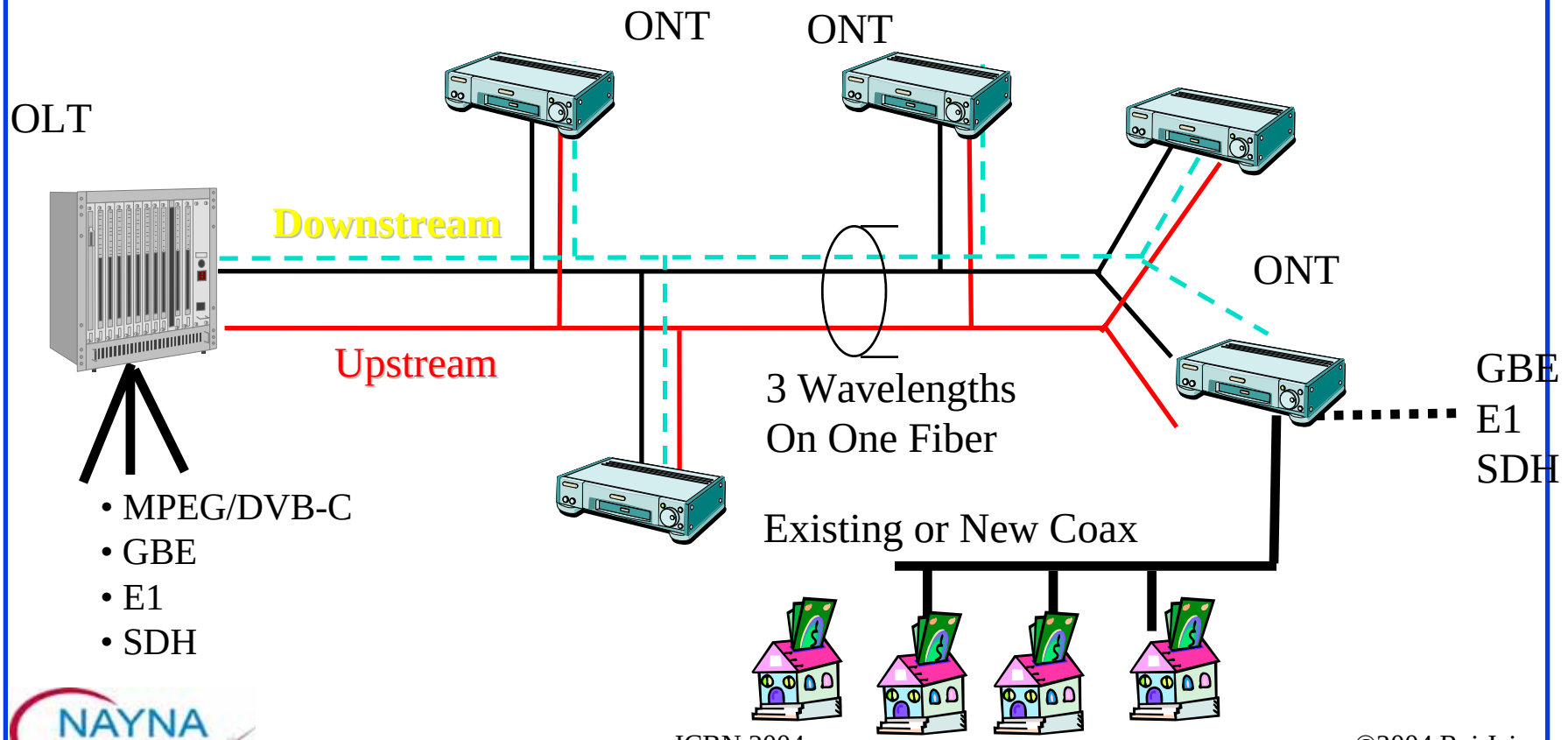
Recent PON Developments

- 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
- Fiber-to-the-Home Installations Expected to Reach Approximately One Million by 2004 [FTTH Council]

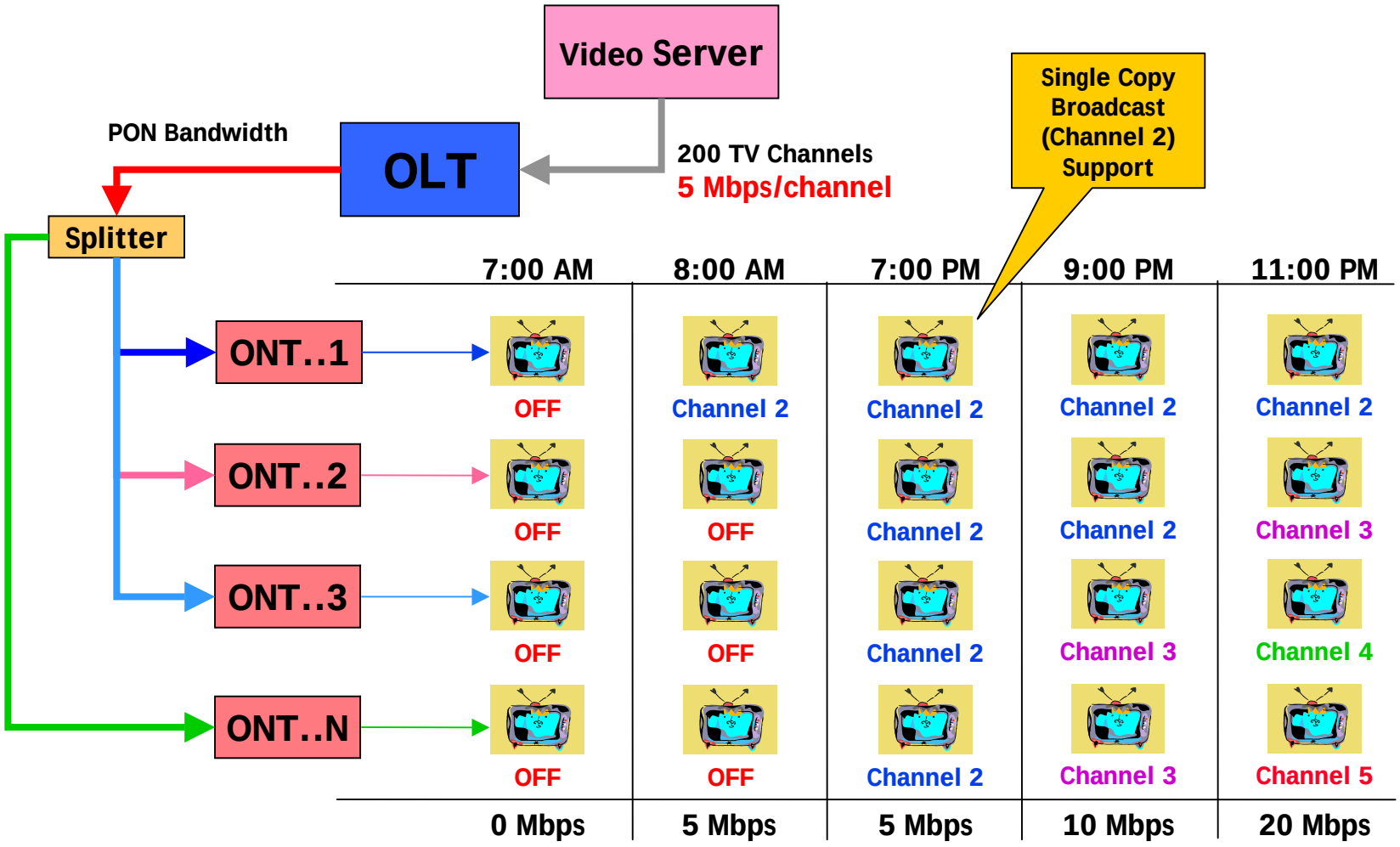
Conclusion: 2004 will be the year of PON and EFM

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

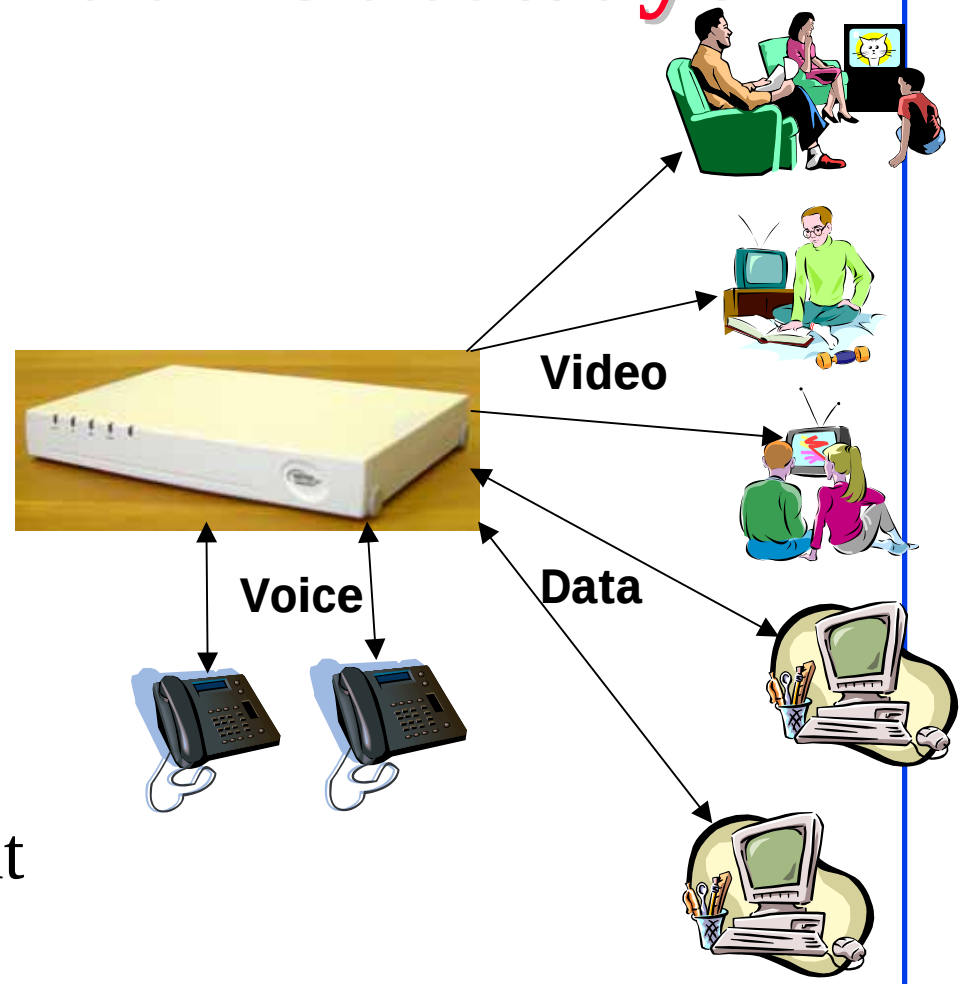


Broadcast TV Bandwidth Optimization over PON



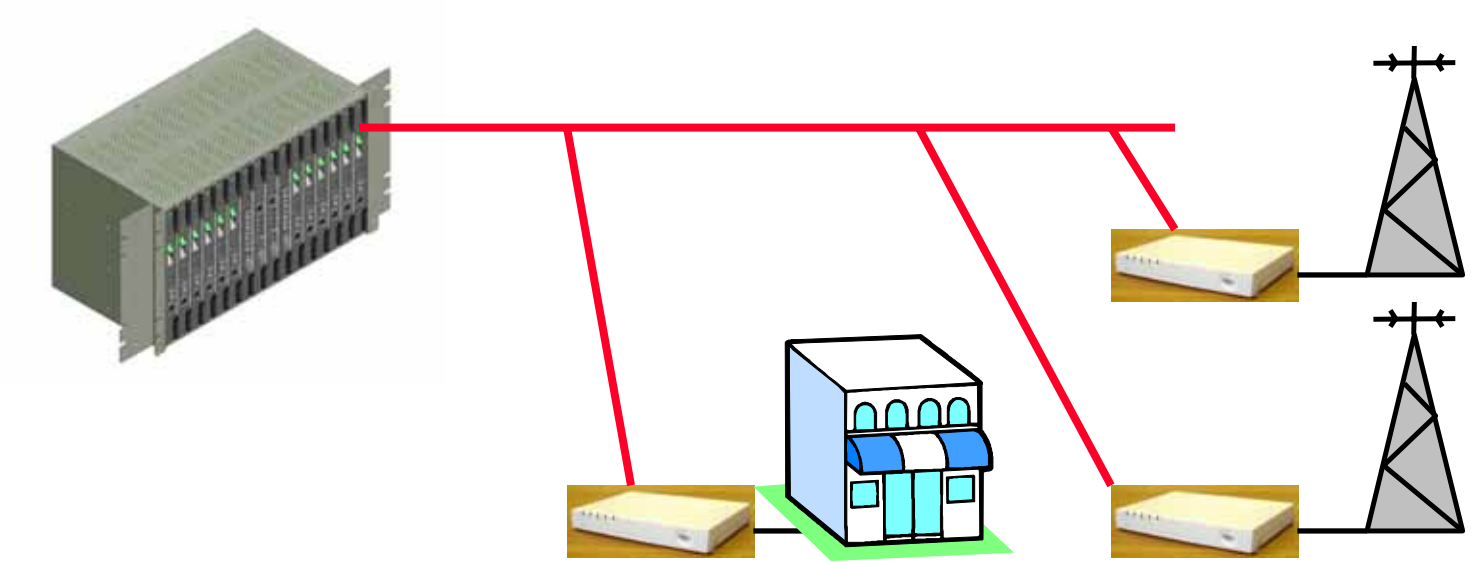
SOHO/Residential Gateways

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



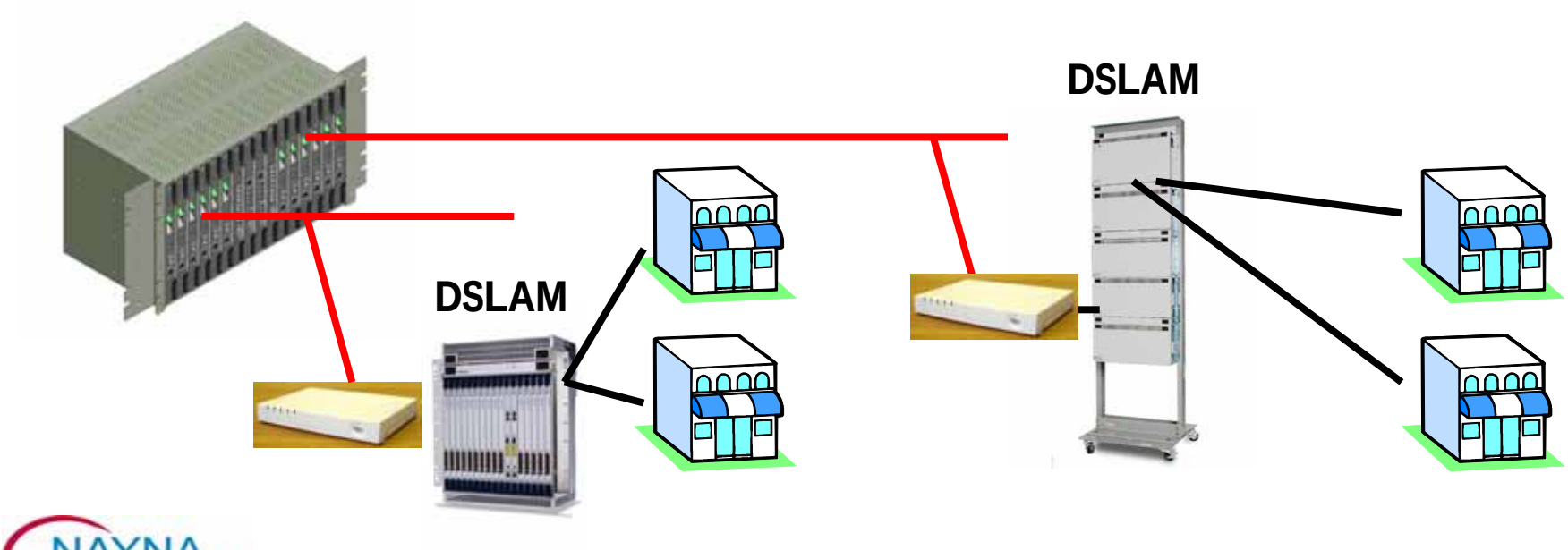
TDM over EFM

- 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 + xDSL

- EFM to the curb
- 2-100 Mbps service over copper
- Legacy ATM based DSL service legacy residential CPEs



EFM Product Differentiators

- **Revenue Enhancing Features**:
  - Multi-Service Support: Internet, Video, Voice, TDM
    $\Rightarrow$ 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

NAYNA Networks

References

- Lightreading, http://www.lightreading.com
- EFM Alliance, www.efmalliance.org
- FTTH Council, www.ftthcouncil.org
- IEEE 802.3ah Working Group, http://www.**ieee**802.org/3/efm/

Thank You!

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