Entertainment Video over RPR

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CATV Architectures

Primary Hub
>50-100K HP

Master HE

Digital

Data, AM Fiber

Data, AM Fiber

Optical Node

Coax

500-2000 Home Area

AM Fiber

Secondary Hubs
10-25K Homes Passed (HP)
Unmanned

VOD Servers

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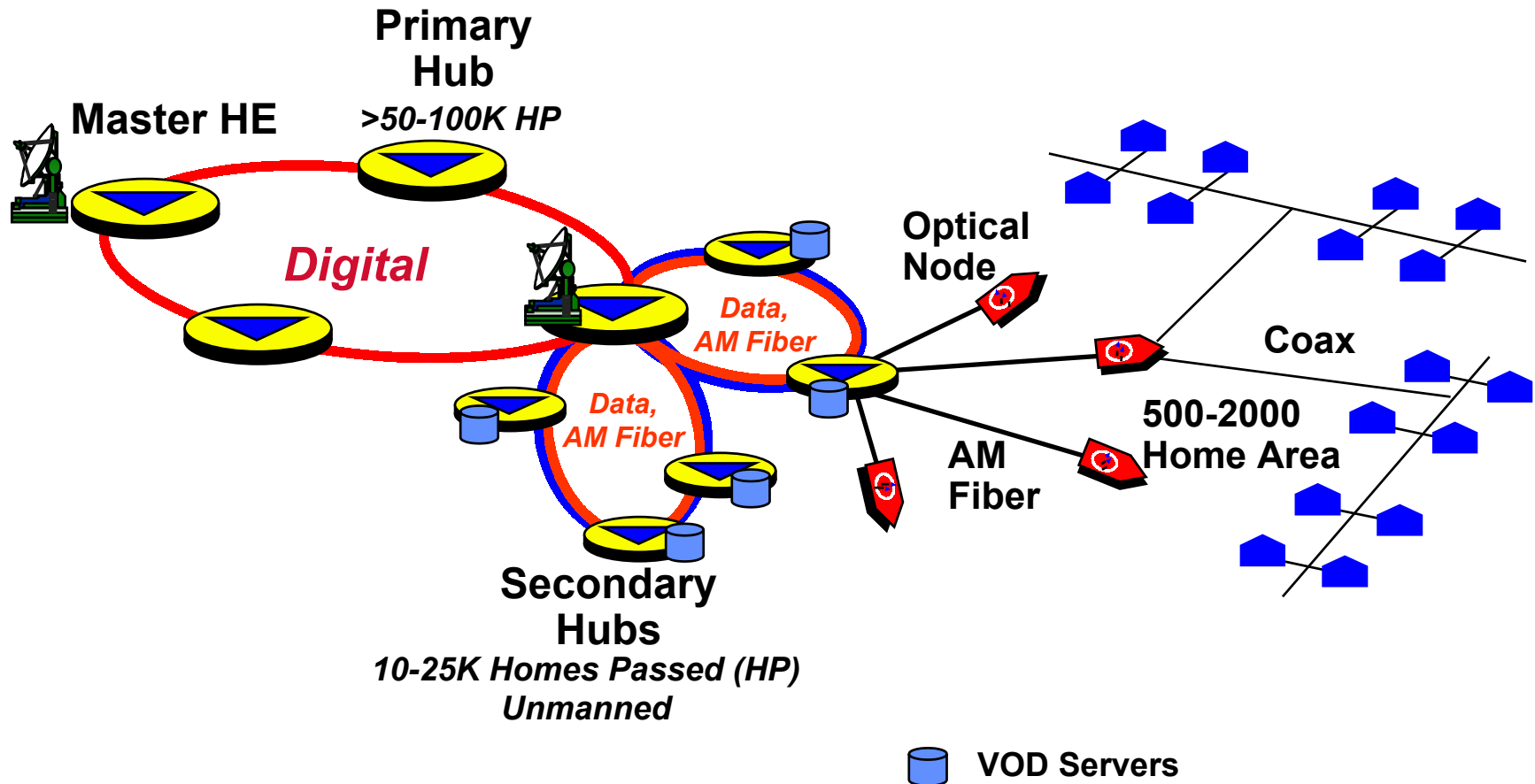
Projected Video on Demand (VOD) Traffic per Hub

20K	**HP per Hub**
x 0.75	**Cable Penetration**
x 0.5	**Digital Subscribers ?**
x 0.1	**Simultaneous Users ??**

750	**streams**
x 3.5	**Mbps/stream**

2.6	**Gbps**

- **Typical 3 hubs/ring due to AM fiber**
- **But… VOD servers are going into hubs due to inadequate transport**
  - **Results in duplication of content and higher storage costs**
- **Headend- PVR traffic could greatly exceed this**

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CATV Systems

- Given the need for CATV to transport huge amounts of packets to CATV hubs, what are some of the issues on how to do this?

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MPEG is 3 Things

- **International standard* that includes 3 categories:**
  - Video and Audio compression (*-2,*-3)

    Enables bit rate reduction for a program from >100 Mbps to a few Mbps

  - Systems/Transport (*-1)

    Defines 188 byte packet used for virtually all satellite and CATV transmission of entertainment-quality digital video/audio
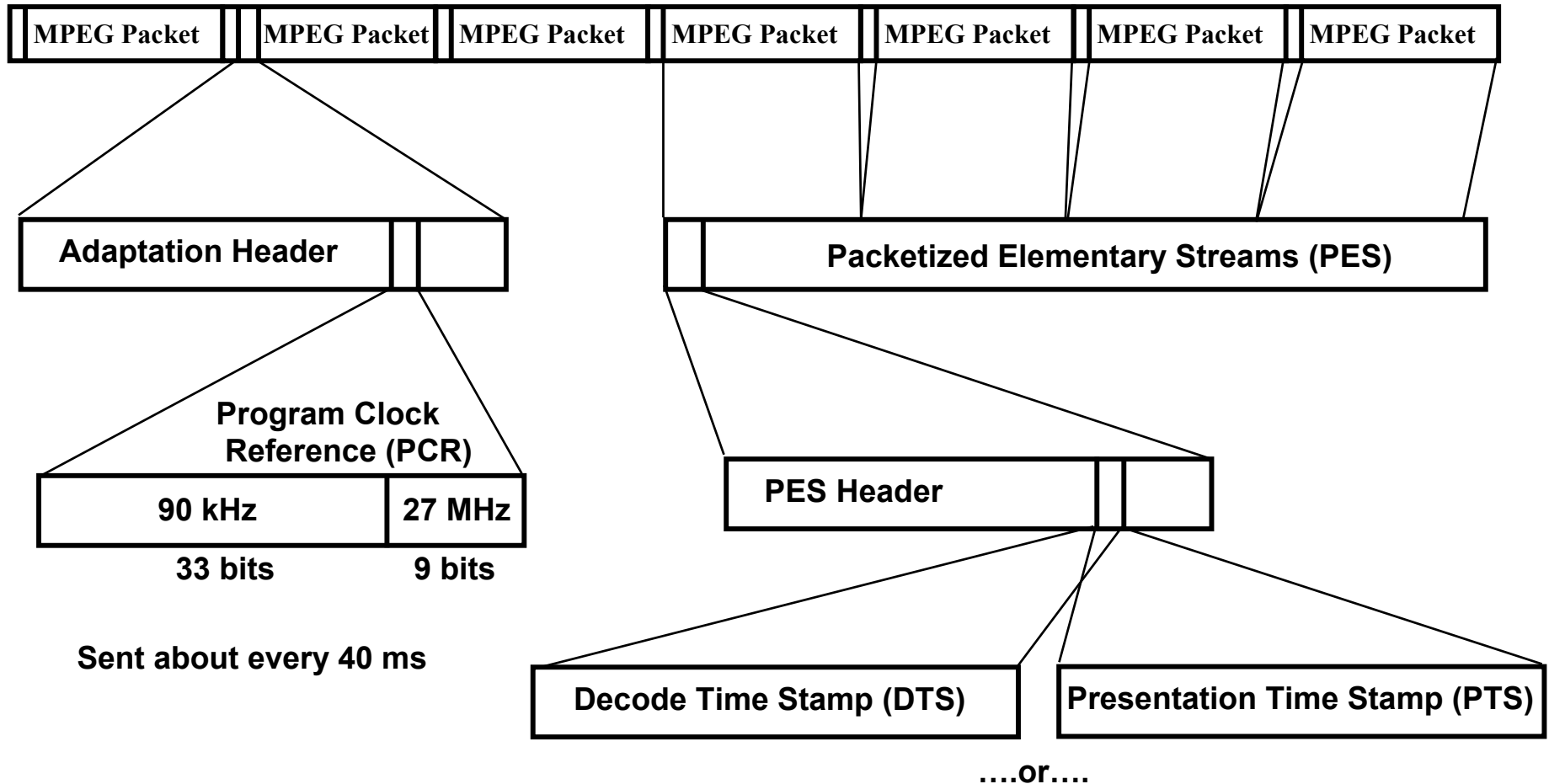
  - Signaling (*-6)

    Digital Storage Media Command and Control (DSM-CC) enables control of dynamic broadcast and interactive "sessions" for programs and data.

    Also defines broadcast "data carousels" that can provide data and files to diskless set-tops.

* ISO/IEC 13818

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MPEG Transport

| MPEG Packet | MPEG Packet | MPEG Packet | MPEG Packet | MPEG Packet | MPEG Packet | MPEG Packet |

Adaptation Header

Packetized Elementary Streams (PES)

Program Clock Reference (PCR)

90 kHz	27 MHz
33 bits	**9 bits**

Sent about every 40 ms

PES Header

Decode Time Stamp (DTS)

Presentation Time Stamp (PTS)
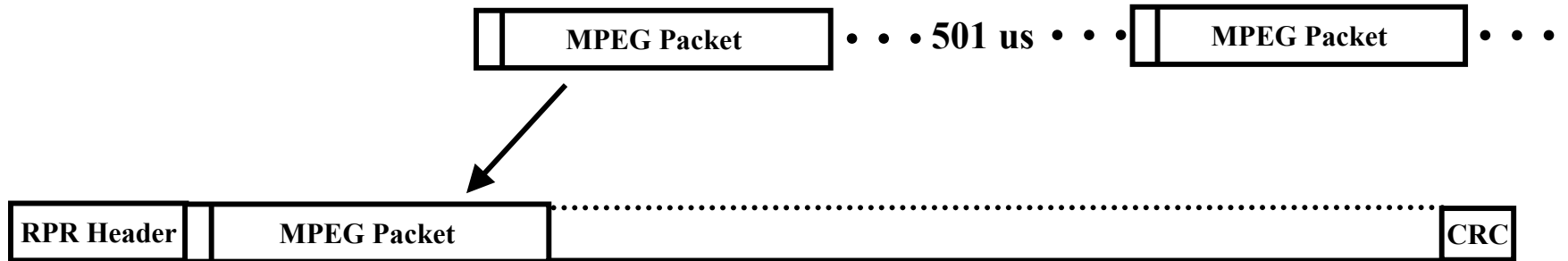
….or….

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6

MPEG Transport Synchronization

- **In MPEG Transport the receiver is locked to the transmitter using PCRs**
    - **Source for frame, line rates, chroma subcarrier**
    - **Permits small buffers and quick channel changes**
    - **Prevents freeze-frames due to buffer overflow/underflow**

- **Time stamps based on absolute PCRs are used to:**
    - **Decode content at proper time (DTS)**
    - **Present content at proper time (PTS)**
    - **Assures lip-sync**

- **These things are in hardware in all entertainment-quality settops**

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Packetization Jitter

3 Mbps MPEG Transport Stream

| MPEG Packet | • • • 501 us • • • | MPEG Packet | • • • |

| RPR Header | MPEG Packet | .... | CRC |

- **In this example, the first MPEG transport packet is delayed half a millisecond for each subsequent packet in the same frame**

- **In a 3 packet frame the first packet may be jittered by 1 millisecond**

- **Most settops want <500 microseconds**

- **Modulators often dejitter packets**

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Delay

- Interactive video delays not as critical as telephony
  - e.g. commercial surfing, camera angles, IM
  - Movies
    - Ordering
    - Trick Modes - Pause/FF/RW
- Telephony/Videophone on cable
  - Delay requirements similar to POTs

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CATV Systems

- Similar to carriers in
  - Wanting more administrative control
  - Needing traffic engineering
    - Deterministic routing
- Different from carrier in that
  - Know what the content is
    - Have their own content to sell
  - Don't want to be just a pipe
  - Huge emphasis on costs
    - 5 Gbps pipe at consumer prices
- In CATV systems
  - Efficiency is very important
    - Buy separate "stat muxers" to squeeze in 20% more video

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Thumbs Up

- MPLS
    - Enables MPEG "virtual circuits"
        - Short label can denote meaning beyond its bits
        - Efficiency
- CR-LDP
    - Simple
    - Traffic Engineering
    - Administrative control
        - Explicit routing to Layer 3 routing continuum
- Diff Serv
- Resilience
    - Not spoiled on 50 ms. 100 ms might be fine.
- One-byte node addresses

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Thumbs Down

- Long Headers
  - Inefficiency
- Misordered packets during normal operation
  - Tolerable during protection or recovery
- SONET "quantizing"
- RED on MPEG streams
- Low bandwidth rings

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