Polling Centralized Control Protocol Point To Multi-Point Multi-Service “Channelized” Ethernet

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Topics

- P2MP Deployment Topology
- Unidirectional versus Bidirectional
- Provisioned Guard Band
- Simple Polling Centralized Control Protocol (PCCP)
- Physical Layer Addressing in OAM Frames
- P2MP Service Frame Format
- Initialization
- Operation
- New terminals
- Comparisons

Real World P2MP Topologies

- Deployment Topology governed by economics
- Splitter/Taps close to end point
  - Reduction of multi-fiber cable distances
  - Reduction of splices
  - Span location topology for lower maintenance – easy to find passive splitter/tap
- Close distance margin between end points
- Multi-tenant building – single floor
- Optical to side of house, copper in house

Unidirectional Versus Bidirectional

- Non-interactive Content – Unidirectional
  - Legacy TV
  - Digital Cable TV
  - Pay Per View
  - Home Theater Pay Per View
  - High Bandwidth – increasing in future
  - Service requests and management – very low bandwidth
- Interactive Content – Bidirectional
  - Video Calling
  - Voice over Ethernet
  - Internet
  - Internet Gaming and Multi User Gaming
  - Low bandwidth initially – increasing in future
  - Asymmetrical today – Symmetrical in the future- Uplink never exceeds downlink
- 95/5 per user – 65/35 per topology
  - 650+Mb unidirectional to 10Mb bidirectional per user
  - 650Mb unidirectional to 320Mb bidirectional per span
- Unidirectional Traffic Relatively Constant, Regardless of “Take Rate”

Provisioned Guard Band

- High ratio of Unidirectional to Bidirectional Traffic
- Limited margin of distance between end-points
- Interleave of unidirectional traffic with bidirectional traffic guard bands bidirectional traffic
- Low “Take Rate” Reduces Bidirectional Traffic and Increases Guard Band
- Fixed Unidirectional Traffic Provides Easy Fixed Provisioning of Unidirectional to Bidirectional Guard Band

Physical Layer Addressing in OAM Frames

- Each Port Has Unique Ethernet MAC Address
- Physical Layer Address – equivalent to “labels” used by WIS
- 10 bit field provides 1024 addresses
- PLA is on Slave physical facility port
- All ones, Broadcast – All zeros, Control
- Some reserved for Unidirectional traffic – Others reserved for Bidirectional Traffic
- Implementation and deployment controls split of unidirectional and bidirectional addresses

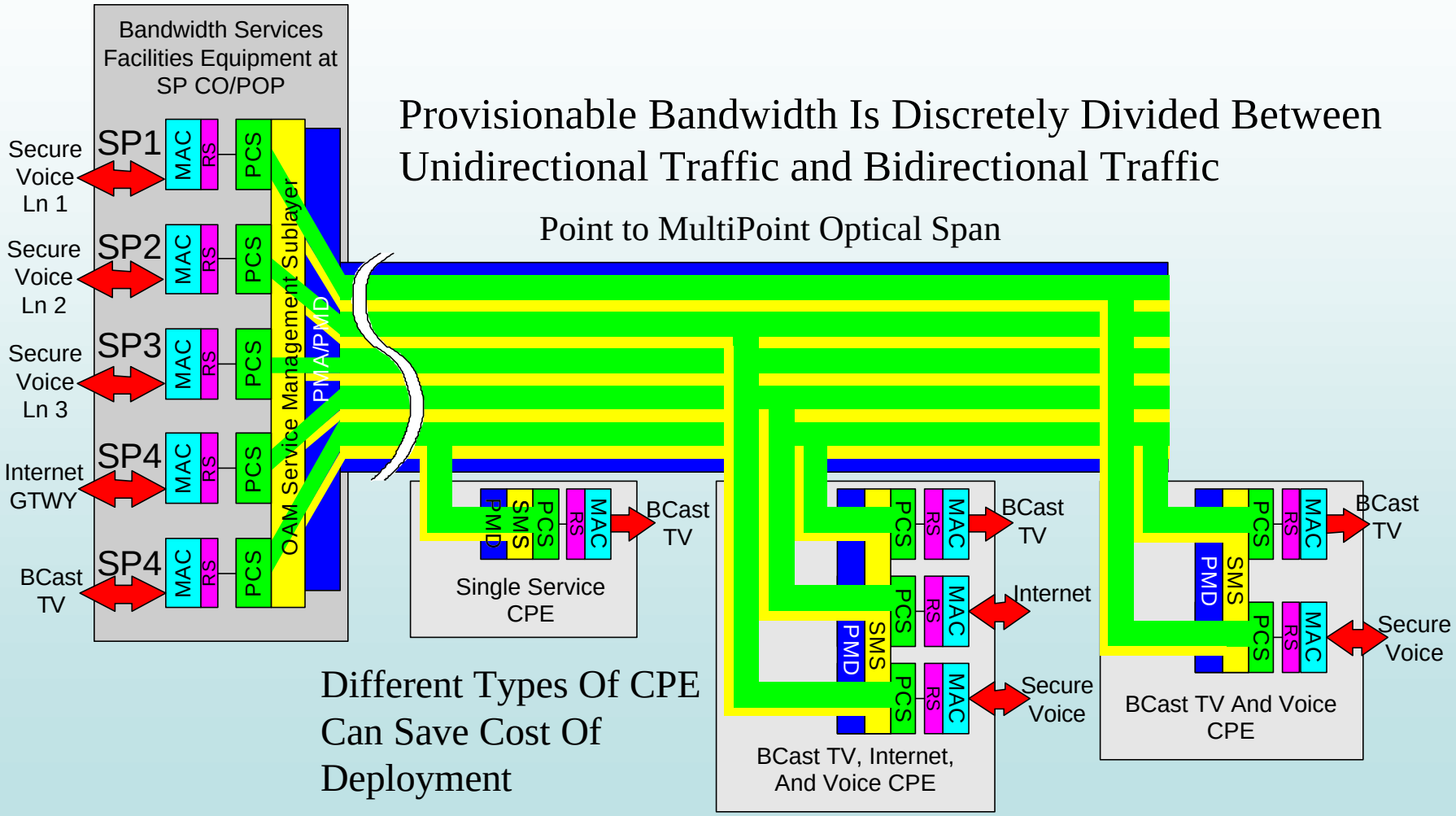
Simple Polling Centralized Control Protocol (PCCP)

- Head end system is Master of p2mp span
- Tail end systems are slaves of Master
- Master is always sending to all slaves
- Master controls when each slave sends
- Master polls slaves and provides transmission grant control messages
- Each specific slave will not transmit until it receives a specific grant control message

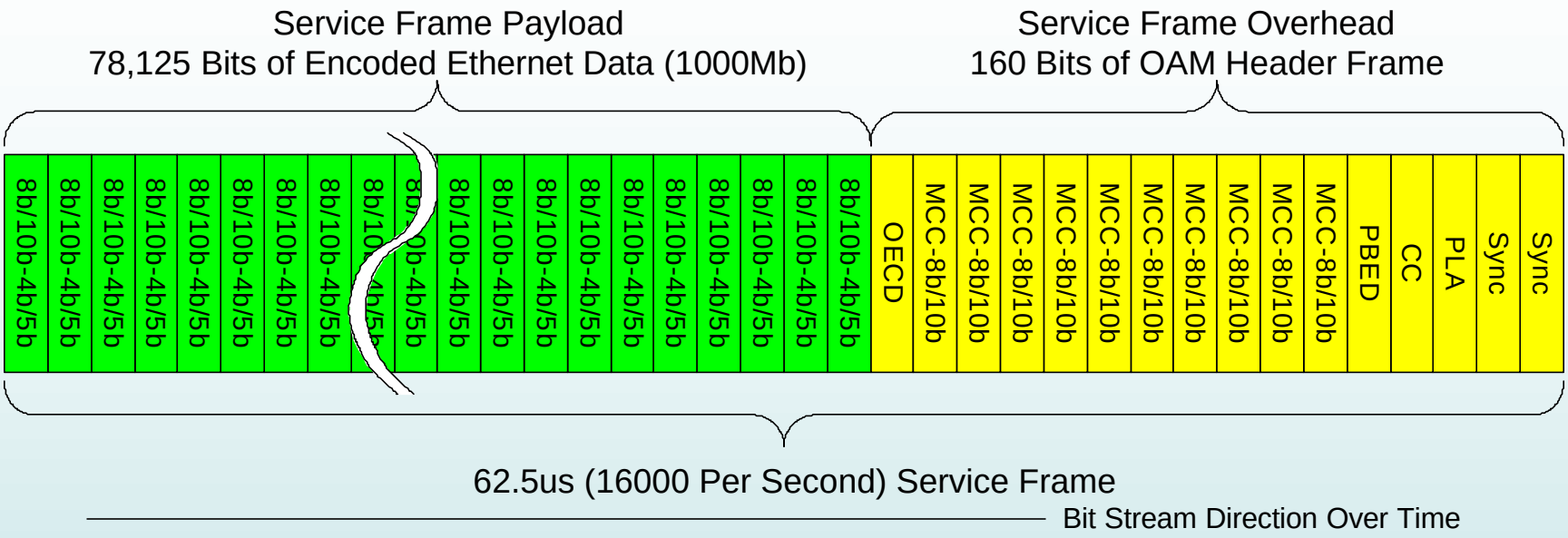
“Out Of Band” OAM – Unbundled Services Support

- Out of Band OAM Provides Each Service Channel With It Own Discrete MAC/PCS
- Provides for Full Support of 802.1D
- Provides For Secure Facilities For Services Needing The Segregation
- Provides Support For Physical Layer Addressing To “Channelize” Ethernet P2MP
- Provides Method To Send Transmission Grant Polls To CPE

Unbundled Service Delivery Is Easy With “Channelized” Ethernet



P2MP Down Link Service Frame

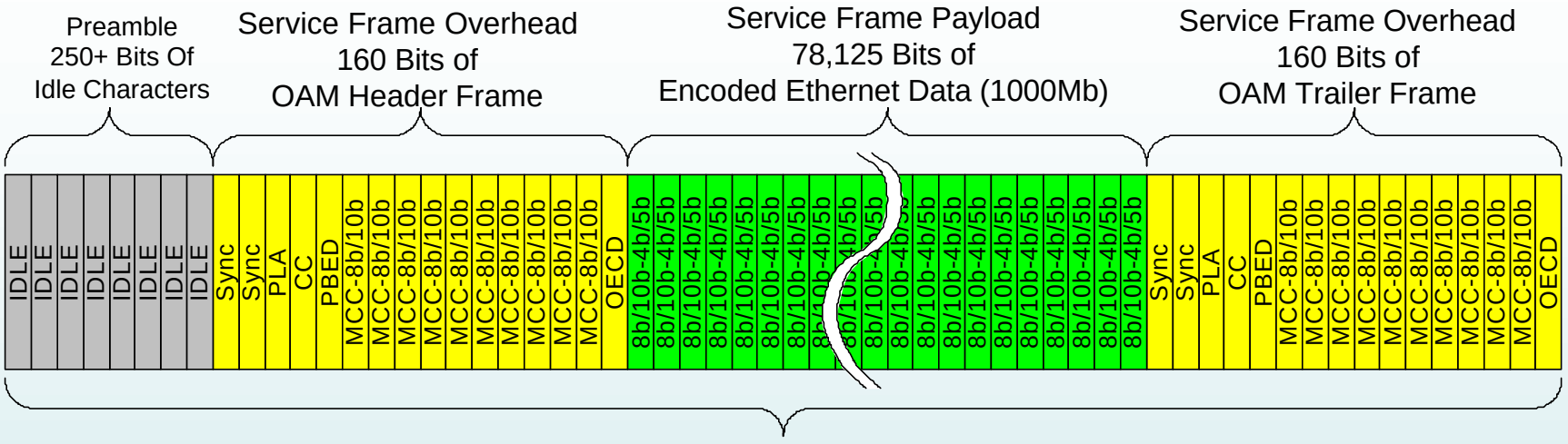


P2MP PCCP Uses “Channelized” Ethernet “Out Of Band” OAM Frame Format
Service Frames Are Divided Into Unidirectional And Bidirectional

The Command and Control Field Of A Bidirectional Service Frame Provides
The Transmission Grant Command To The Uplink MAC/PCS Port
With The Service Frame’s PLA

Down Link Bit Stream Clock Recovery Provides Up Link Bit Clock

P2MP Up Link Service Frame



Adds Preamble And Trailer OAM Frame To Down Link Frame Format

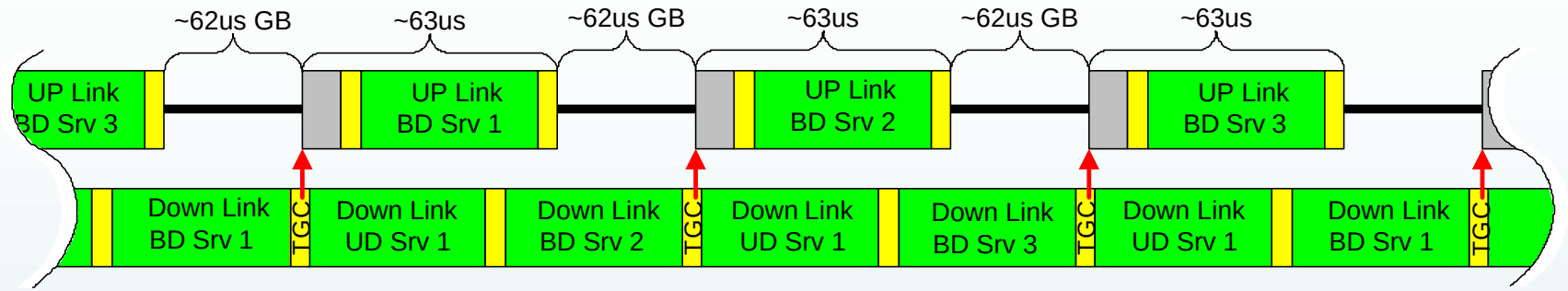
Uplink Service Frames Only Support Bidirectional Traffic

The Preamble Provides For PMA Bit Clock Synchronization

OAM Trailer Frame Provides Uplink Status, MDIO and MCC Response Uplink Traffic For Unidirectional Services On CPE

Each CPE Must Have At Least One Bidirectional Service Port

Up Link Guard Band Characterization



Up Link Guard Band Is Provisioned By The Amount Of Bidirectional Traffic Supported On The Deployed Service Span

Even At 50% Aggregate Utilization Of Bidirectional Traffic, Up Link Guard Band Is Equivalent To About 8Km Between The Closest and Longest Distance CPE

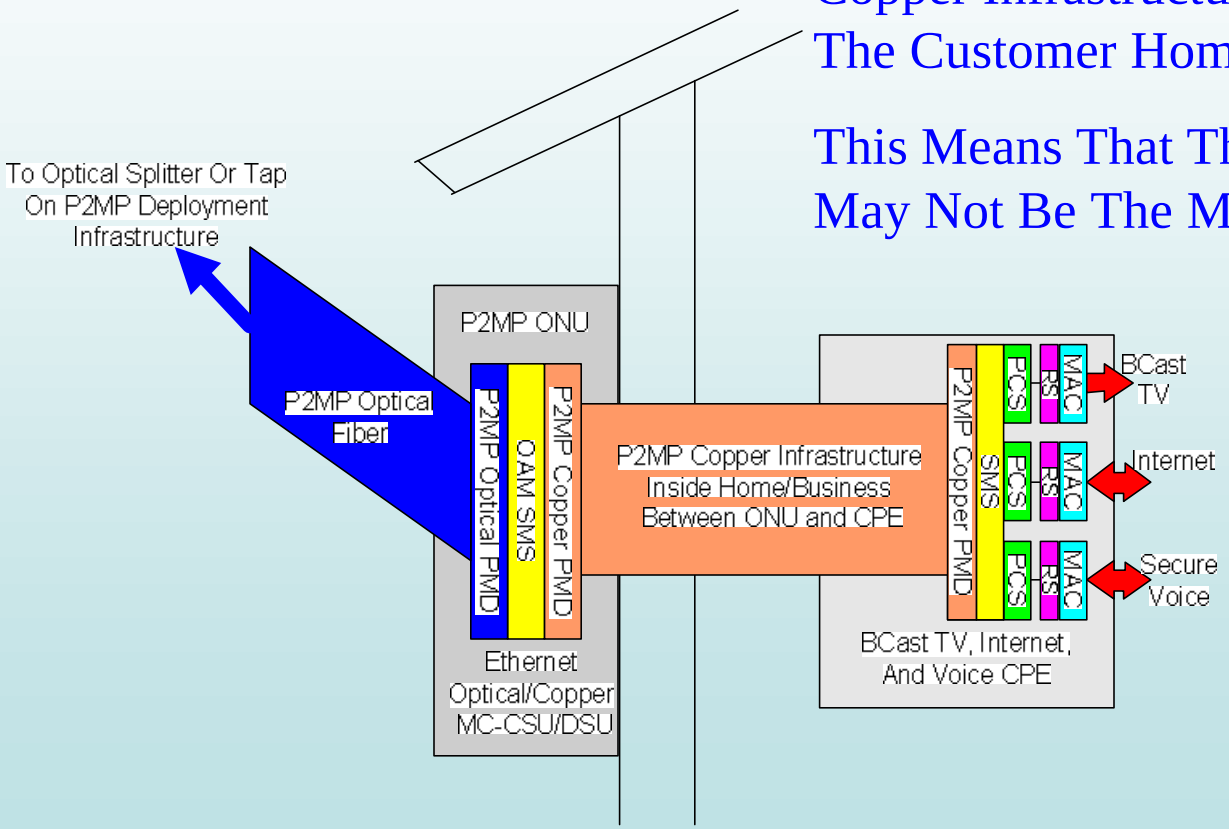
Guard Band Characterization Summary:

- 50% Utilization Provides An Up Link SF Every 125us
- Each Up Link SF Is ~63us, Leaving A Bit Signal Guard Band Of ~62us
- Optical Ramp Up and Ramp Down Times Average 10us Each Leaves ~42us
- At 5us Per Km, ~42us Is A Little Over 8Km Distance Guard Band Between Closest ONU and Most Distant CPE – Covers Much Greater Than 95% Of All Deployments

The P2MP ONU Is Not Always The CPE

Some Service Providers Want To Have Copper Infrastructure Inside The Customer Home Or Business

This Means That The Most Distant ONU May Not Be The Most Distant CPE



The Additional Distance And Latency Have To Be Part Of The Deployment Guard Band Provisioning Requirements

Easy “Cookie Cutter” Engineering

- Deployment Infrastructure Engineering And Services Provisioning Guide Lines Can Be “Cookie Cutter”
- Known Topologies Provides Known Distance Latency Variance
- Known CPE Extension Infrastructure Provides Known Additional Distance And Latency
- Guard Band Provisioning Of Each Deployed Span Can Be Easily Calculated and Defined At Time Of Construction And Installation – Does Not Require Complex Dynamic Ranging Protocols

Comparison – PCCP And MPCP

- PCCP Uses Hardware Provisioned Guard Bands – Little Or No Integrated Software
  - Low Cost And Easy To Develop
- MPCP Use Complex Auto Ranging Hardware And Complex Integrated Software To Determine Guard Band Provisioning
  - High Cost And Complex To Develop
- "Out of Band" OAM Up Link Service Frames Designed To Support Management Responses For Both Unidirectional and Bidirectional Service Traffic
- Integration of MPCP With Other Forms Of Proposed OAM To Support Unidirectional Traffic Is Unknown
- PCCP and "Out Of Band" OAM Is Designed Around Integration Of Functional Requirements Of All Topologies And Deployments
- MPCP Is Developed With Out Integration With OAM Proposals And Support Of Other Topologies And Deployment Diversity

Summary
Polling Centralized Control Protocol

- Simple To Implement Using “Out Of Band” OAM “Channelized” Ethernet
- Lower Complexity Hardware With Little Or No Software Means Lower Costs To Vendors For Hardware And Development
- “Cookie Cutter” Engineering Makes Infrastructure Deployment Lower Cost
- Low Cost To Service Providers Makes It Easier To Do Successful Deployments
- More Successful Service Provider Deployments Makes The Market For Wider Market Acceptance