FTTH China 2009
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8-9 September, 2009

PMC
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Enabling connectivity. Empowering people.

Delivering High Quality Service over FTTH

Amir Sheffer, PMC-Sierra

Agenda

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- **PMC-Sierra Overview**
  - **PMC is the only vendor in the world to offer OLT and ONU/ONT for ALL**
- **Fiber Deployment Models**
- **Downstream Bridging**
- **TCP Download**
- **Congestion Management**

PMC-Sierra Overview

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- PMC-Sierra is the premier *Internet infrastructure* semiconductor solution provider
- Major areas of product focus include:
  - **COMMUNICATIONS**: WAN Infrastructure (Wireline; Wireless), FTTH (EPON; GPON)
  - **ENTERPRISE**: Enterprise Storage (FC/SAS/SATA), Laser Printers, Networking, SMB NAS
- 2008 revenues totaled $525 million; net cash of $286 million*
- Company has approximately 1,000 employees worldwide (Q2'09)

*(as of June 28, 2009)

PMC-Sierra's FTTH Gbit/s PON Advantages

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- **High performance, field proven end-to-end solutions for EPON (IEEE 802.3ah Ethernet in the First Mile) and GPON (ITU-T G.984) standards**
- **PMC technical team co-wrote IEEE 802.ah standard that first defined Gbit/s PON FTTH technology**
- **Enable configurable high system performance in a multi-service environment for access, wireless backhaul and cable TV networks**
- **Worldwide leader in FTTH mass market deployment**
  - More than 8 million PMC's PON ONU/ONT devices deployed
- **PMC has the largest market share of FTTH silicon**
  - Shipping two-thirds of the world's FTTH silicon

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- **Fiber Deployment Models**
- Downstream Bridging
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FTTx –Deployment Options

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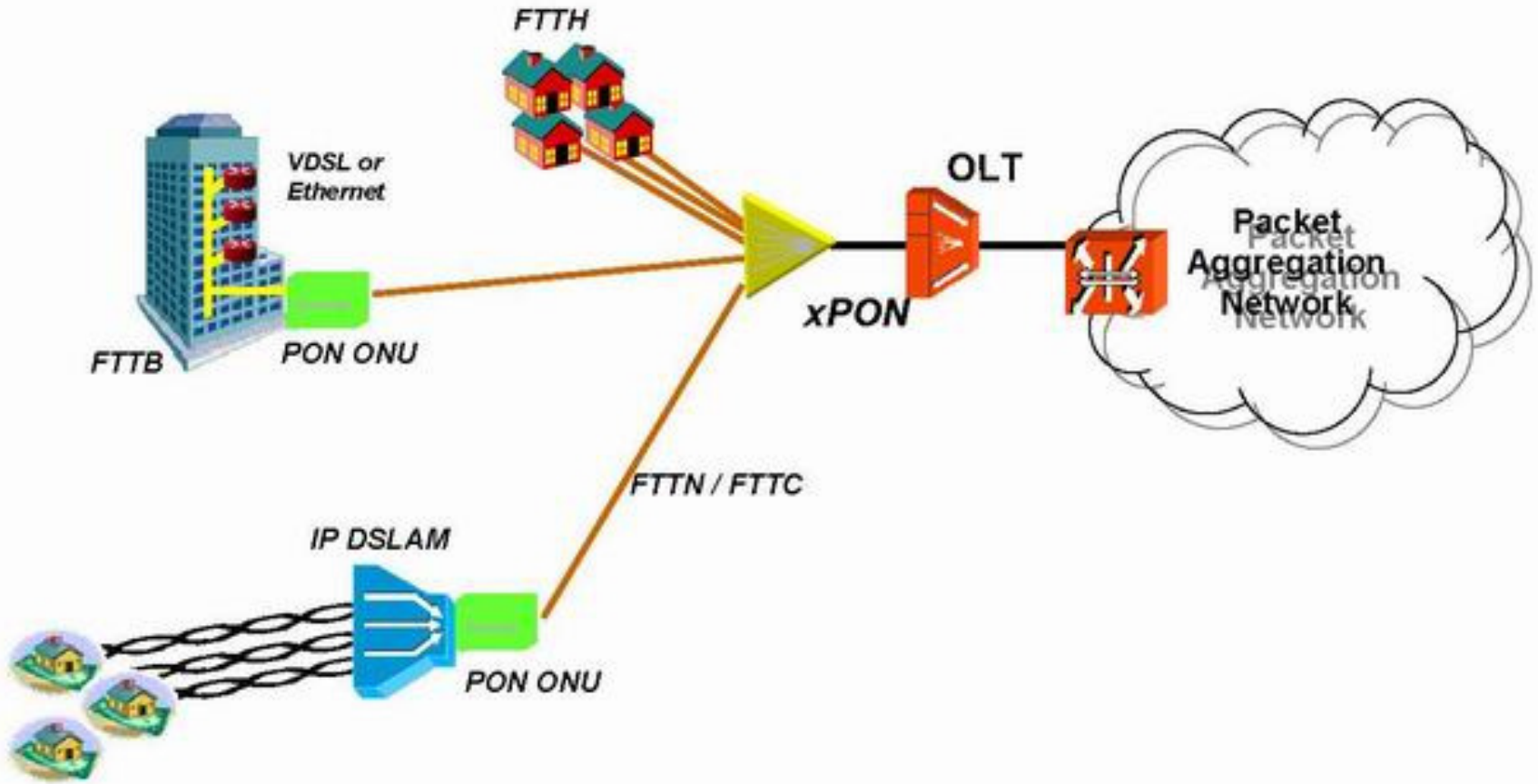

The MDU Functionality

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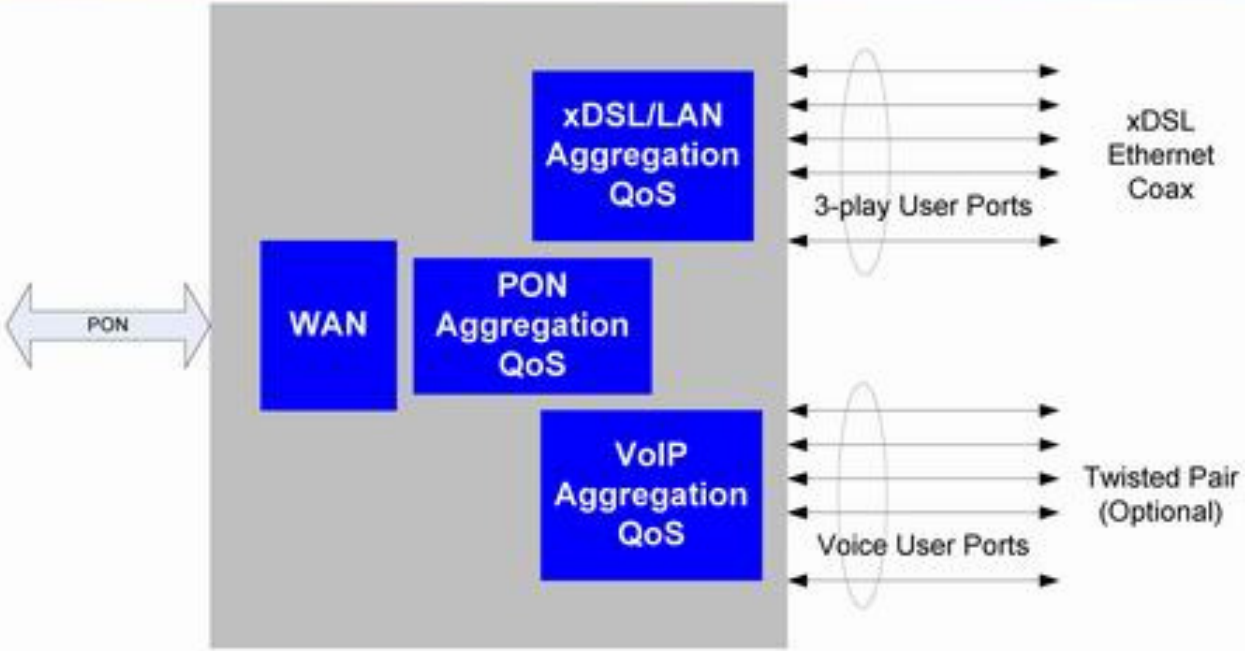

- **MDU is an aggregation system, bridging between copper plant and fiber infrastructure**
  - Up to 128 subscribers, up to 8 services per subscriber
- **Aggregation and QoS comply with TR-156**
  - Mapping of subscriber flows into queues / T-CONTs
- **Multicast-aware bridging in the MDU – IGMP snooping and proxy**
- **DSL Aggregator/Ethernet Switch is unaware of 'real' upstream allocated throughput/speed**

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- PMC-Sierra Overview
- Fiber Deployment Models
- **Downstream Bridging**
  - **UNI throughput has an effect on UDP services**
- TCP Download
- Congestion Management

Downstream Bridging in the MDU
Assumptions

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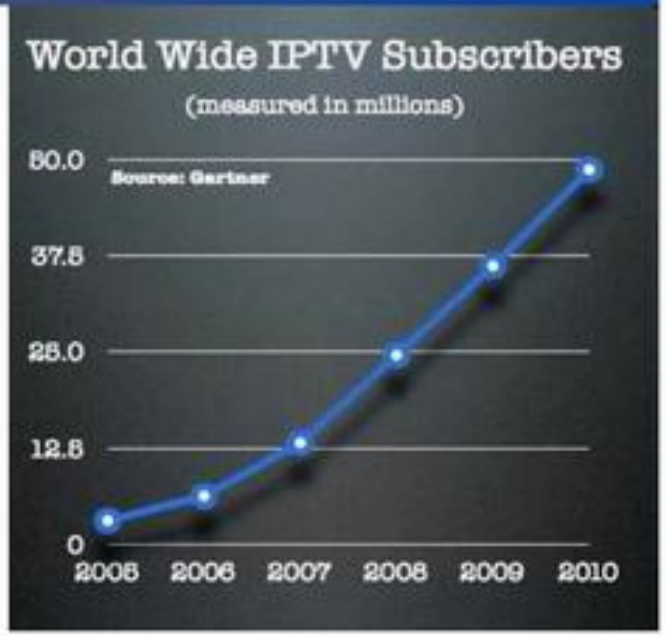
- **Many services today are based on UDP protocol**
  - IPTV
  - VoD
  - Audio streaming
- **In most cases, the subscriber SLA includes guaranteed data throughput and the above services are additional to the guaranteed SLA**
- **The carrier wants to burst these services downstream as fast as possible**
  - Clear sessions quickly
  - Improve customer experience
- **....but, without service degradation to other users**
- **The ONT burst handling capability is key to achieving high quality**



Downstream Bridging in the MDU
Bit Rates – Does the UNI Match the PON Speed?

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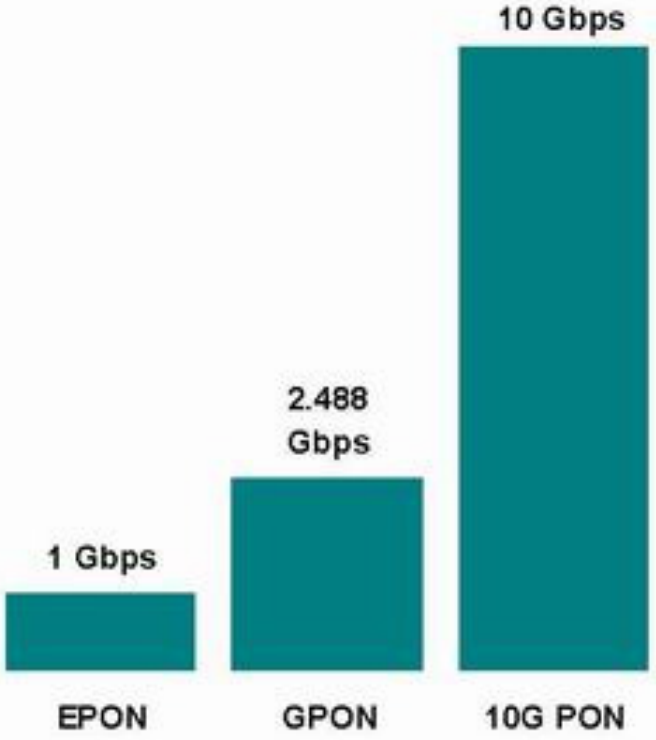
- **Bridging speed is perceived to be the PON downstream speed**
  - EPON: 1 Gbps
  - GPON: 2.488 Gbps
  - 10G EPON / GPON: 10 Gbps
- **Perception: "GPON is faster than EPON" Is it really so?**
- **ONT downstream speed and burst handling depend on the width of the narrowest pipe in the chain: *the UNI***
- **PON to Ethernet bridging at ONT**
  - 1G EPON and 10G xPON have matching Ethernet bit rates
  - GPON does not have a matching bit rate



Downstream Bridging in the MDU
UNI Implementation for Maximum Service

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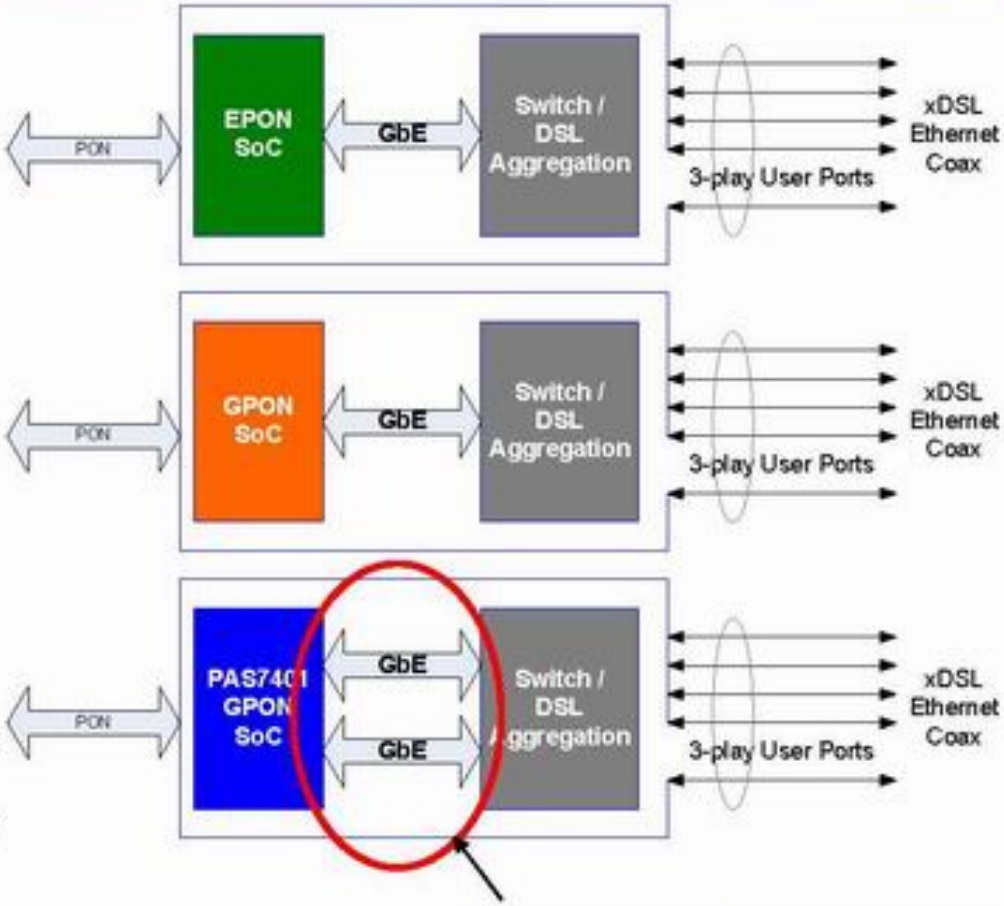
- **FTTB: MDU serving 32 subscribers**
  - PON-fed VDSL DSLAM, VDSL IADs; or
  - PON-fed MDU with FE to the apartments, RGs
  - All 32 subscribers share a single uplink
- **Triple-Play Service: VoIP, IPTV, Data over the user port**
- **EPON line rate is 1Gbps, so single GbE UNI is the straightforward choice**
- **But GPON line rate is 2.488Gbps, why settle for 1Gbps UNI?**
- **Wire speed downstream provides:**
  - Maximum utilization of the GPON network
  - More bandwidth to the user



PAS7401 GPON ONT bridges 2Gbps ***constant*** throughput at ***any*** packet size

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- PMC-Sierra Overview
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- **TCP Download**
  - **The effect of upstream latency on TCP performance**
- Congestion Management

TCP Service in the PON Network
Assumptions

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- **The majority of *data* services are TCP-based**
  - Web surfing
  - Email
  - FTP download
  - File sharing

- **Subscriber SLA guarantees data throughput**
- **The carrier wants to burst these services downstream as fast as possible**
  - Clear open sessions quickly
  - Improve customer experience
- **….but, without service degradation to other users**
- **The link latency is key to achieving high quality**

TCP Performance
No Correlation with Link Speed—Latency is Critical

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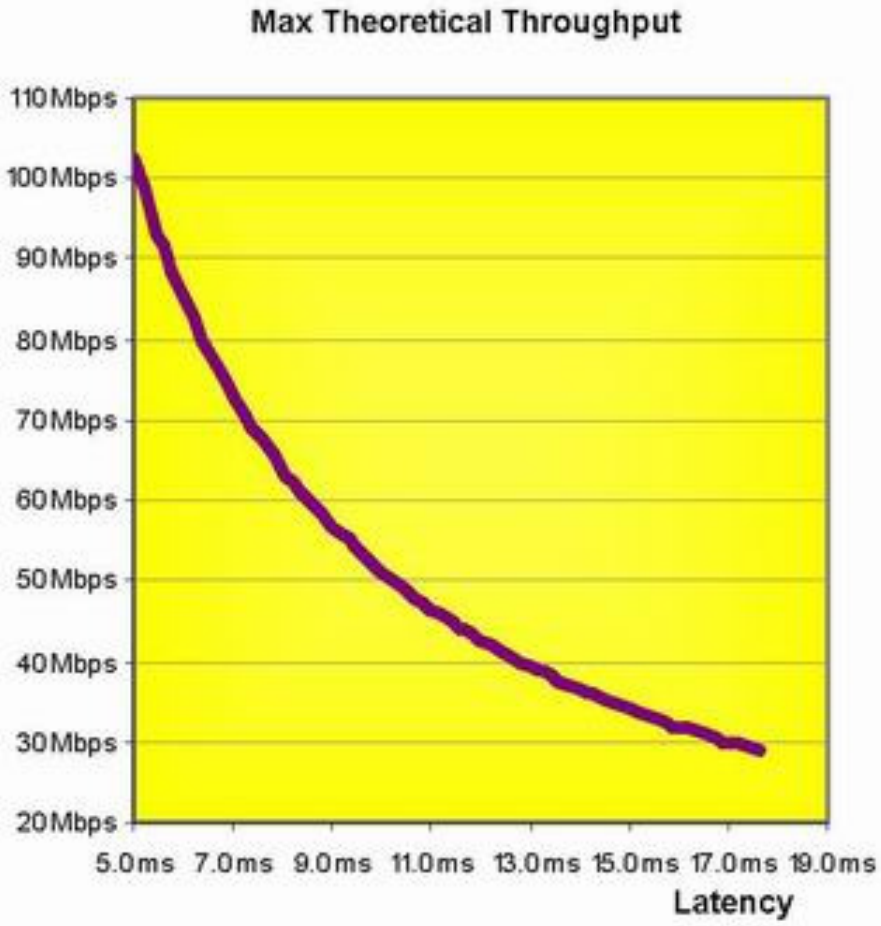
- **TCP throughput basics**
  - Theoretical max throughput [Mbps] = ~ packet size [Kbit] / RTT [ms]
  - Realistic Max Throughput [Mbps] = ~ TCP Window size [Kbit] / RTT [ms]
- **GPON's higher bit rate is irrelevant if latency is not controlled**
- **Low latency equals:**
  - Faster TCP download
  - Better customer experience
  - Shorter time for session completions
  - Simpler shaping of bursts



DBA and Latency
Not Just OLT

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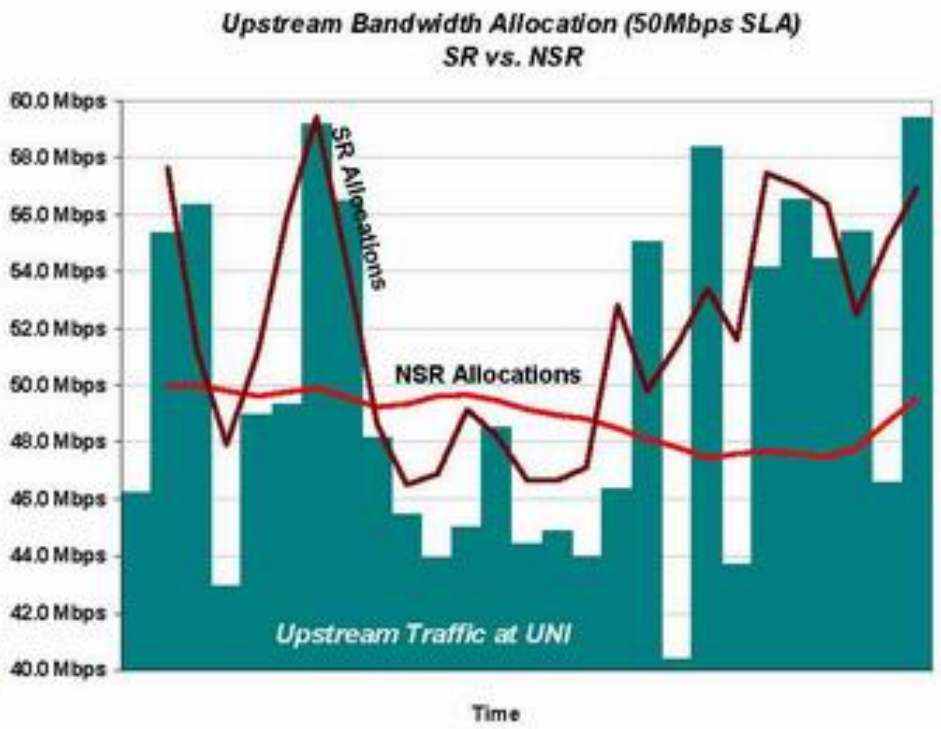
- **Low latency upstream channel is a joint responsibility of the OLT and ONT**
- **GPON allows for 3 DBA types**
  - Static: very simple, very inefficient, not desired
  - Non-Status Reporting: OLT only, simple, inefficient
  - Status Reporting: OLT+ONT, efficient
- ***Only the SR-DBA is latency optimized***
- **Low latency SR DBA requires:**
  - Real-time, accurate queue status reports by the ONT
  - Short processing time at the OLT



TCP Download in the PON Network
Available Bandwidth Per User

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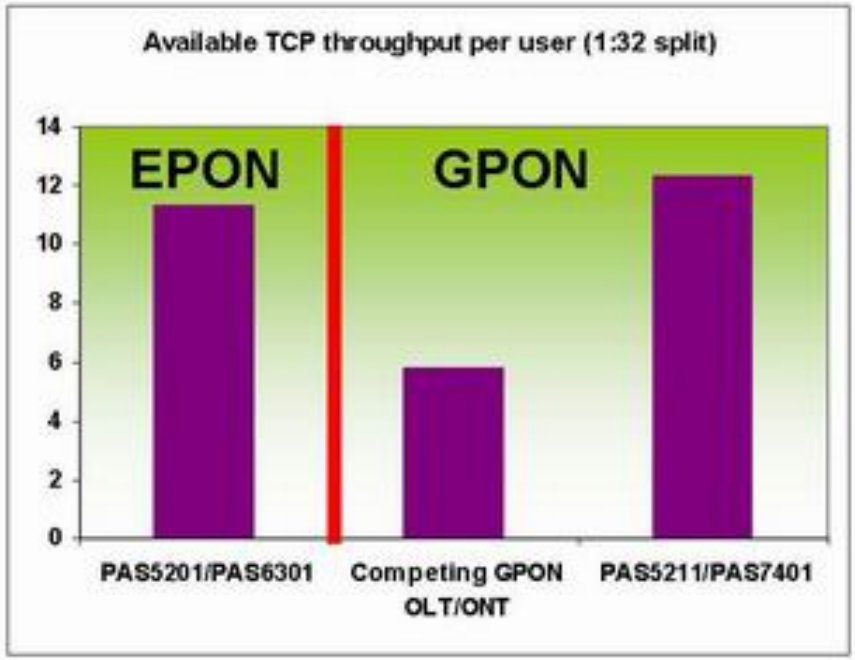
- **EPON and GPON can provide similar TCP throughput**
  - Latency is the key
  - Downstream bit rate is secondary
- **GPON**
  - PMC chipset DBA support is the most efficient; Accurate, real-time reports at short cycles
  - Other GPON chipset DBAs are very basic, reports may not be accurate, DBA cycles may be long
- **EPON**
  - Accurate, real-time reports at short cycles



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- PMC-Sierra Overview
- Fiber Deployment Models
- Downstream Bridging
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- **Congestion Management**
  - **Guaranteeing VoIP quality in congested network**

Congestion Management

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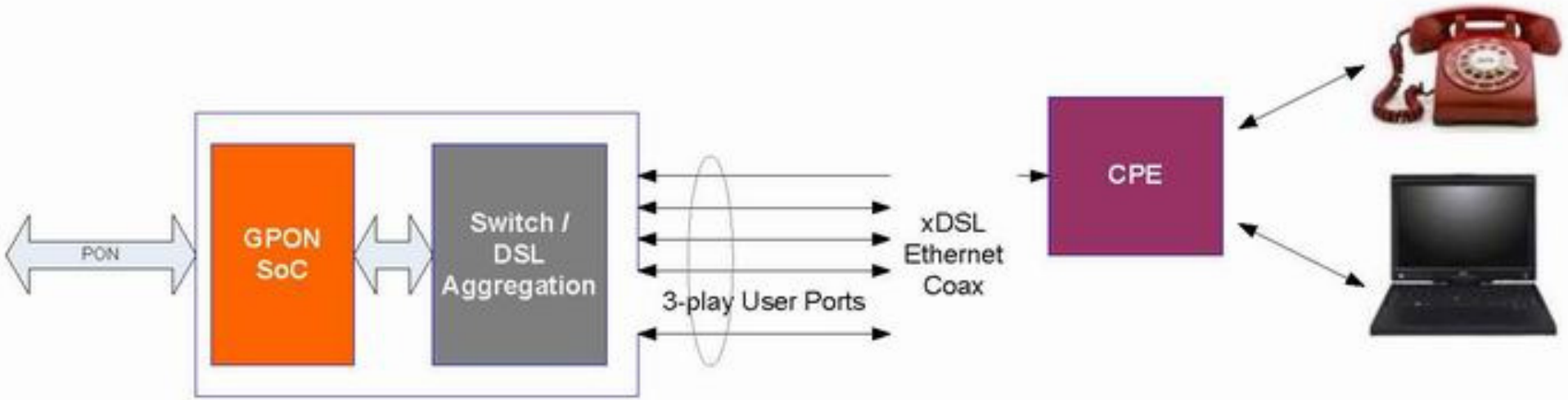
- In every PON, the upstream channel is a shared media
- An ONU/ONT is allocated a fraction of the total upstream bandwidth
- In a congested upstream, it is up to the ONU/ONT to provide QoS



Handling Multiple Upstream Services
A Practical Example

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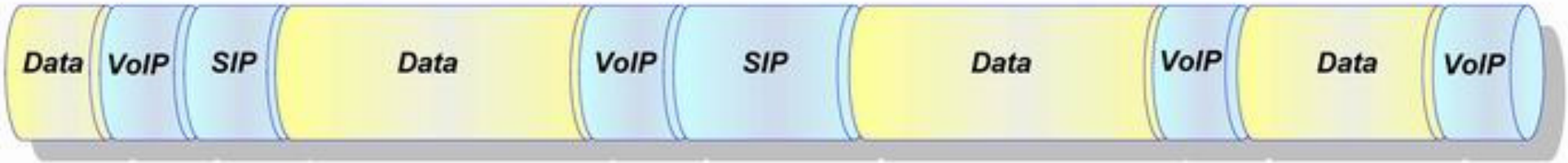
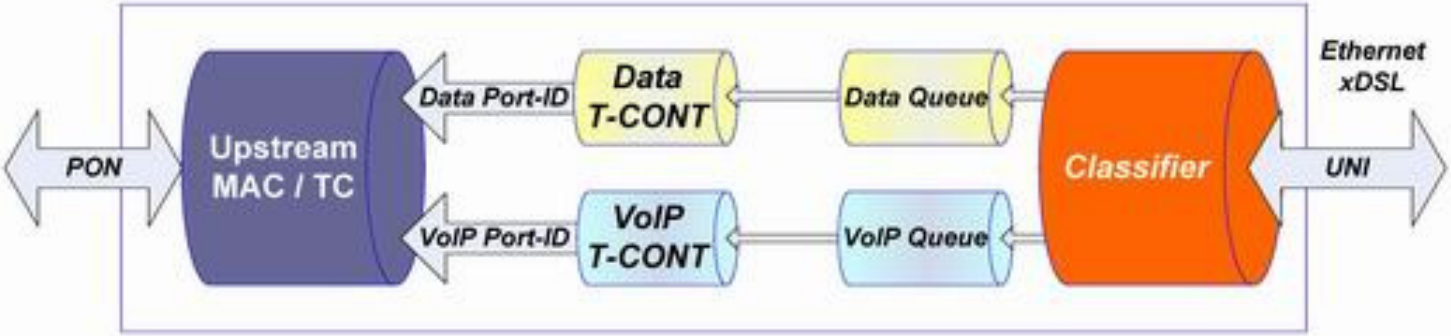
- Each service mapped to a different VLAN
- VoIP packets consist of both voice media and SIP messages
  - Media bandwidth: 192Kbps, constant
  - SIP bandwidth: 20Kbps, bursty
- This is how the upstream traffic is received at the UNI:



- And this is the typical upstream queuing at the GPON SoC



Is This Enough to Deliver High Voice Quality?

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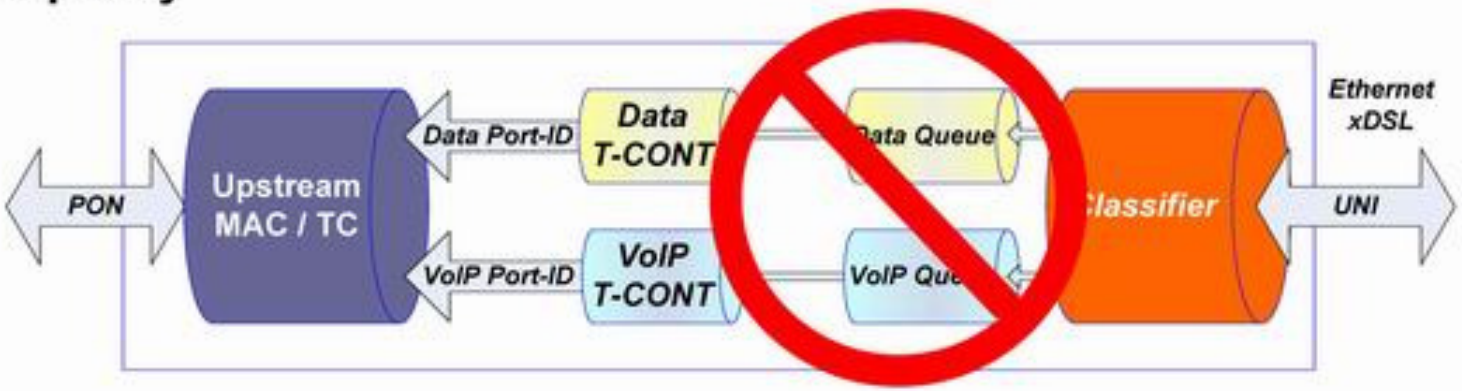
- This queuing scheme is insufficient
  - SIP is bursty
  - SIP is lower priority than voice media
  - SIP messages can be long and cause head-of-line blocking
  - VoIP cannot suffer from latency and jitter

- When the upstream is congested, the SIP messages would impact the voice quality



True Congestion Management

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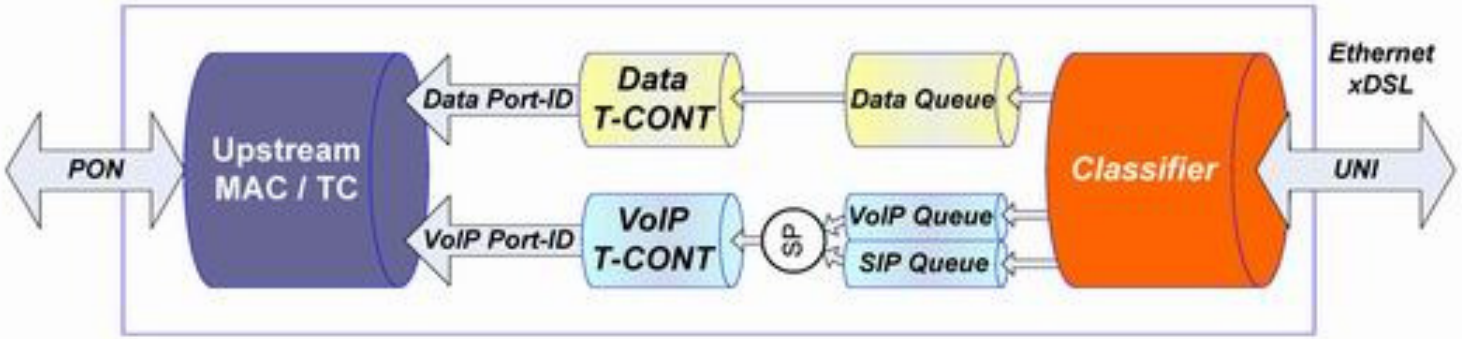
- The queuing scheme must change as follows:
  - Voice media and SIP mapped to different queues
  - Queues mapped to the same GEM Port, same T-CONT
  - Strict priority scheduling, voice before SIP

- What are we solving?
  - SIP burstiness
  - Lowering the SIP priority
  - Minimizing latency and jitter



Summary

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- Throughput and low latency are critical for user experience
- Wire speed burst capability improves streaming
  - The UNI speed should match the PON in an MDU
- Low latency improves TCP and business services
  - Advanced DBA in the OLT
  - User- and service-aware ONU
- PMC-Sierra has solutions for both

EPON Platforms

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GbE ONU

Multi-Port ONU

OLT

GPON Platforms

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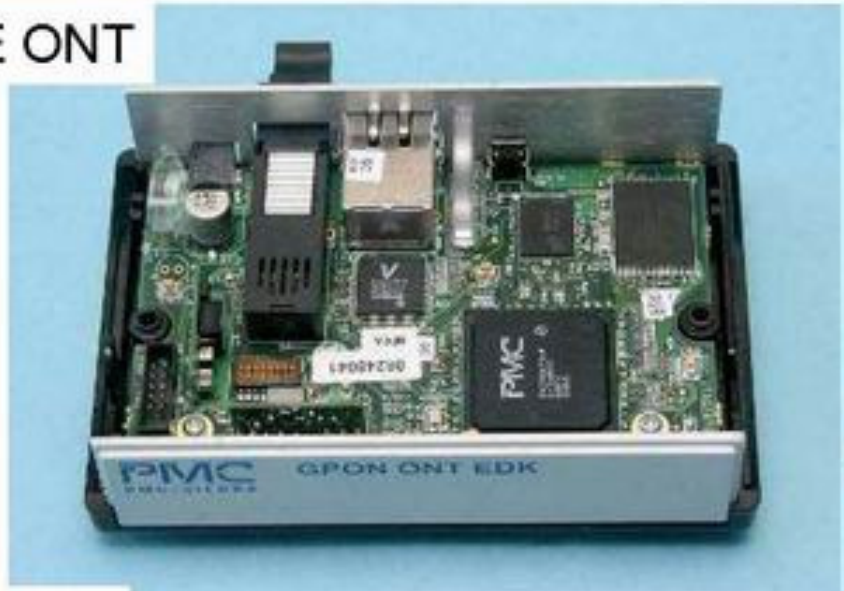
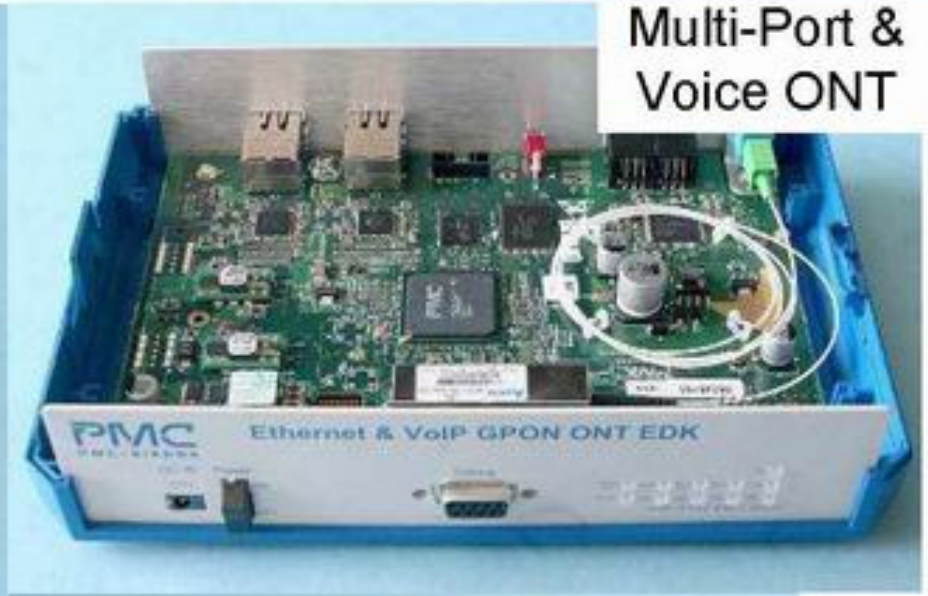
GbE ONT



Multi-Port & Voice ONT



Gateway

OLT

10G Development Platforms

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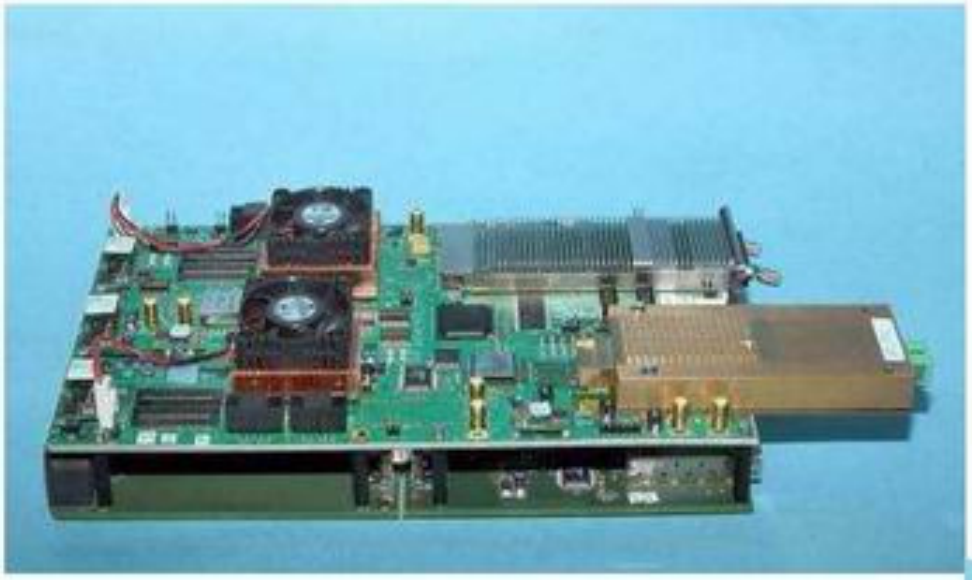
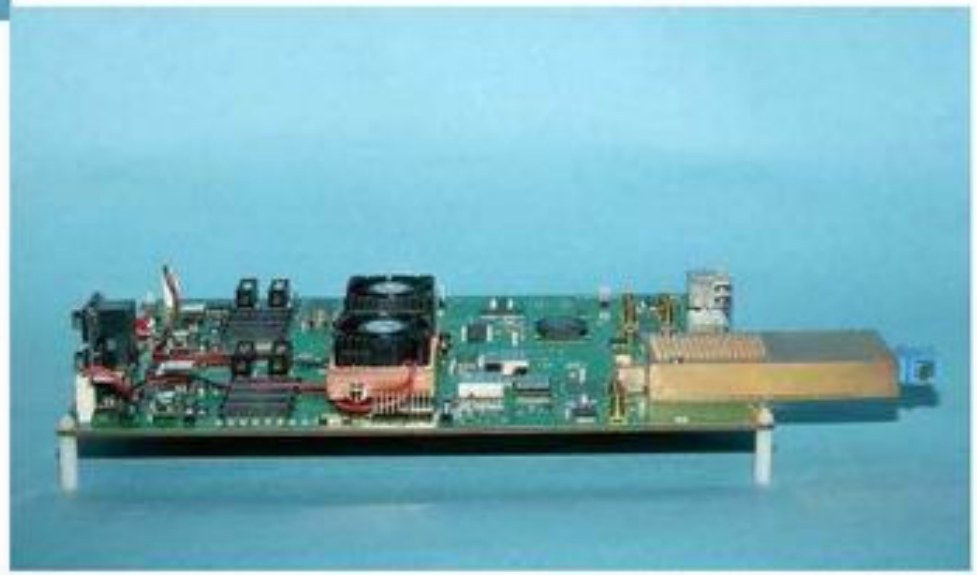


OLT

ONU



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