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LESSONS LEARNED FROM COVID-19 PANDEMIC

Congestion Avoidance/Mitigation and Capacity Concerns

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Agenda

- Top Seven Steps to Address Capacity Concerns
- CMTS Suggestions
- Laser Clipping Theory
- Adding More Capacity
- Going Forward & Planning for Next Inevitable Event
- **Note** : Over 1 year of traffic growth in less than 1 month!

First Four Steps to Address Capacity Concerns



1. Service Group (SG) = 1 Fiber Node (FN)

- US Segmentation
- Physical Node Splits (m x n RPD)



2. Verify No Uncorr FEC and “Clean” Plant

- Fix causes of post-FEC errors first, they = packet loss
- **Note** : OK to ignore D3.1 correctable codeword errors



3. Run Highest US and DS Modulation and Ch Widths

- Utilize D3.1 as much as possible
- More spectrum allocation – maybe “steal” from video
- Utilize/exploit “Powerboost™”; DS and US
- **Good time to evaluate VoIP modulation!**

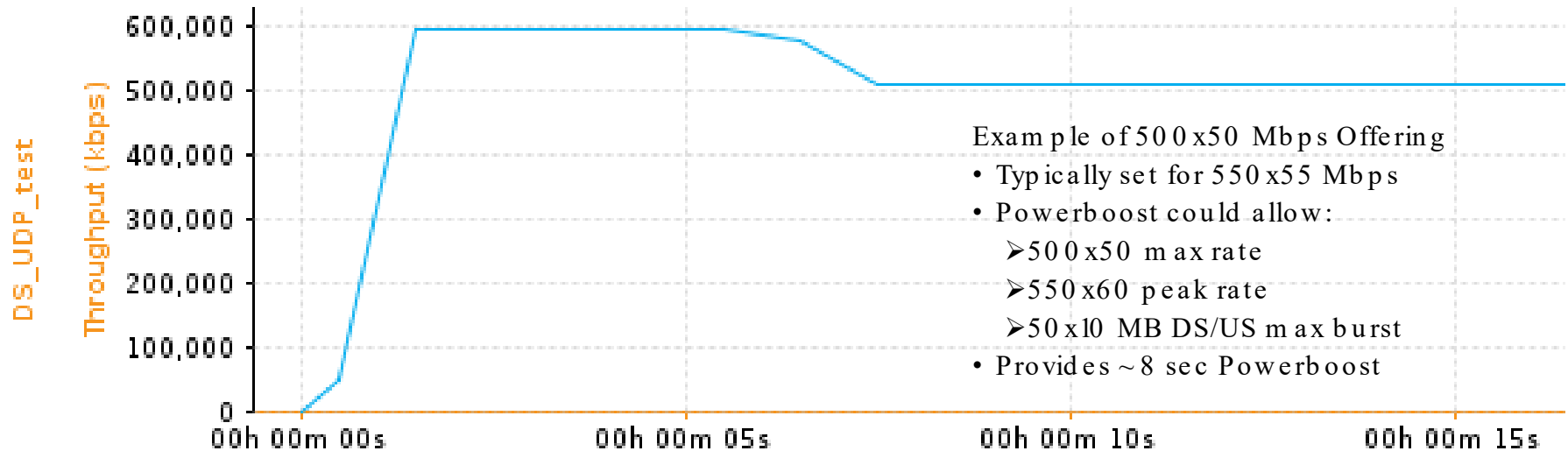


4. Eliminate Overhead

- Eliminate some primary DSs
- Less US chs per MAC domain (more MAC domains)
- Remove “stale” service flows
- **Ack suppression**

DOCSIS 3.0/3.1 DS Capacity

- Can exploit Powerboost™ and peak-rate TLV to satisfy speed test without over-provisioning the typical 10 % (some systems could be at 20 %!)
- CM file with 510 Mbps max rate, 600 Mbps peak rate, and 70 MB DS max burst
 - Approximately 6 sec Powerboost achieved



Last Three Steps to Address Capacity Concerns



5. Control Abusers and DoS Attacks

- Cloning – DMIC, BPI+, “Hotlist”
- Over-Use/Abuse - Deep Packet Inspection (DPI) & Subscriber Traffic Management (STM)
- Arp Attacks, IGMP Joins? - Filters/Access Lists (ACLs), SBRL
- Expiring Certs - Allow/Deny Lists



6. Optimize CMTS Efficiency & Provide Traffic Priority

- Load balancing
- D3.1 graceful profile management
- US & DS resiliency/partial mode



7. Implement/Expand Cache Servers

- Work with content providers to strategically place content storage

OSI Layer 1 – Physical Layer

Split Node

Thanks, Captain Obvious

Segment US

- BDR/EDR makes this easier
- May need to double mac domains for 1:2 architectures

Add More DOCSIS Channels

Thanks, Captain Semi-Obvious

Add/Increase D3.1

- Increase DS OFDM ch width & implement higher modulation
- Activate D3.1 US OFDMA

Distributed Access Architectures (DAA)
Complement D3.1

- Digital fiber links improve US & DS RxMER
- No laser clipping!

CMTS Global Config & General Suggestions

Throttle

CM Ranging

- [no] cable throttle-modem init-rate 32 holdoff-time 45 flush-rate 300
- cab up rate-limit-bwreq exempted-priority <priority>
- Sh cab throttle-modem

Prioritize

Pre-Registration Traffic

- (config)#cable qos pre-registration us-priority [0-7]
- **Note** : Setting all BE flows > priority 0 can lead to issues
- D3.1 CMs may have AQM

Utilize

nRTPS for Call Signaling

- Non-contention request guarantees call signaling during high congestion

CMTS Suggestions (cont)



“Stale” Service Flows

- cab service flow activity-timeout 300
- Add to CMTS global config so flows with no activity > 300 seconds are torn down if CM/eMTA does not do it automatically



DOCSIS 3.0 Voice Traffic Steering

- cab docsis30-voice downstream req-attr-mask 0 forb-attr-mask 80000000
- By default D3.0 DS VoIP is bonded & may cause DS latency or jitter
- **Note** : Some CPE exhibit low speed test if VoIP flow also present
- **Note** : US voice traffic is never bonded (nor are other scheduled flows)



Manage Service Tiers

- When adding faster service tiers be sure to delete old slower ones that are obsolete!
- **Warning** : Slow to fast ratio cannot be more than 1:1000. If it is, the slower rate could constrain the faster rate!

Cable Interface Config Suggestions

Allow

- VoIP Calls to Stay Online if CM Enters US Partial Mode
 - `cab upstream resiliency sf-move UGS (NRTPS & RTPS)`

Allow

- Fair Sharing of US Traffic Between D3.1 & 3.0 CMs
 - `cab upstream qos fairness`

Activate

- US Partial Mode Based on Data Burst MER Readings
 - `cab up resil data-burst snr 24 ufec 1 cfec 0 hys 4`

Adjust

- CM Insertion Interval & CM Ranging Opportunities
 - `cab insertion-interval auto 120 1000 or (60 480)`

Minimize

- US Collisions w/ Range & Data Back-off Changes
 - `cab up x range-backoff 3 6`
 - `cab up x data-backoff 3 5 (looking at 4 6)`

High US Utilization, Types of Applications & Laser Clipping



More US utilization (Ring doorbell, gaming, bad CMs..) coupled with applications not using UGS; Vonage, Skype, Zoom, Webex, WIFI calling...will increase probability of Req collisions



Customers with audio-only will have more Contention Requests vs Piggyback Requests

Video calls would increase US throughput requirements and piggybacking would probably occur more often



DS OTT video and its TCP acks that must be sent on US could be exacerbating the issue



These collisions could lead to laser clipping and dropped packets



Note : Laser clipping would not occur on digital fiber links in distributed access architectures (DAA) like remote -PHY

CM Ranging Causing Power Spikes

- CM on low value tap will normally only need to transmit maybe 35 dBm V and if it ranges it could go as high as 57 dBm V
 - HE test CMs notorious for this if proper attenuation not added
- Utilize conditioned taps w/ built-in EQs to help alleviate this since CMs all Tx between 40-50 dBm V and will not have large range to ramp up
- Work-around to laser clipping
 - Install RPD (☺) – Digital optical link has no laser clipping
 - Decrease levels into laser by 3-6 dB with expected lower MER!
 - CMTS config change (-3 to -6 dBm V vs default of 0)
 - Pad movement from HE to node
 - Compromise with Pad and CMTS change
 - ✓ 3 dB pad movement from HE to node & -3 dBm V on CMTS

One Customer's Plan



Add Extra 3.2 MHz, 64-QAM Ch

- Adds ~13 Mbps



Split MAC Domains

- Cumbersome due to outside plant/node & hub cabling



Convert 1 or 2 ATDMA to OFDMA

- Could be issue with lack of D3.1 CPE



Implement Subscriber Traffic Management (STM)

- Can track "heavy" users
- Potentially limit speed for everyone automatically during certain times

Adding D3.1 OFDMA US



Tested 3 SC-QAM US carriers with 14 MHz OFDMA



Placed OFDMA as high as possible in low-split



Tested larger carrier with exclusion for SC-QAMs

- Decided that 14 MHz of continuous spectrum was best due to overhead of 2 chs and overall performance
- Also tested with 8-10 actives deep

Another Customer's Goals & Plans

Perform as few node splits as possible

Deployed 96 MHz D3.1 DS OFDM and will add another 96 MHz in congested nodes

Added OFDMA at bottom end of US spectrum

Considering 204 MHz split with analog or DAA

Considering DMIC to reduce theft of service

- **Note** : OK to ignore correctable codeword errors

- With exclusion band for DSG

- Advise extreme caution with analog!

Adding 5th US Channel

- US Max Tx drops by 3 dB once you exceed 4 US chs in TCS
 - **Note** : Max Tx is based on modulation of first ch ranged
- Assuming large amount of 8 -ch US capable CMs, suggest 5 -ch US BG and just 1, 4 -ch BG with 4 best US freqs (chs)
- Things to Keep in Mind
 - More USs in mac domain creates more DS map overhead
 - ✓ ~.4 Mbps per US; moving to every 4th DS as Primary helps
- **Note** : D3.1 TaFDM not advised because of inefficiencies
- CM US Frequency Limit
 - Abandon SC -QAMs above expected freq cutoff & allocate for D3.1 OFDMA
 - Still potential issue for D3.1 CMs in house with external bad devices
 - Setting initial ranging (IR) for D3.1 OFDMA much higher than expected freq cutoff may help it not range and relegate it to D3.0 lower US BG
 - ✓ Not guaranteed since IR is BPSK!
 - **Solution** : US partial mode based on uncorr FEC

Planning for Next Inevitable Event

- Implement subscriber-based subscription model
 - For quick activation of more channels/capacity
- Have segmentable nodes
 - Future segmentation for quick activation
- Implement DAA
 - Better performance and complementary to D3.1
- When available, implement D4.0 LLD features
 - PGS
 - Cisco DPS feature – cab upstream dps
 - ✓ Helps US latency in long CIN delay DAA, lowers latency for DS TCP
 - ✓ **Note** : Intel/TI Puma 5 CMs don't seem to benefit

Top Closing Points

- If you build it, they will use it
 - Bigger “pipes” are always better
- Always start with Layer 1 for troubleshooting
 - Eliminate as many variables as possible
 - WiFi, VPN, speed test site
- Take advantage of all CMTS features to provide most efficient service to your customers with self-healing capabilities
 - Don’t “cut off your nose to spite your face” - “I don’t want to make it too good or my techs won’t fix anything”!
 - ✓ Monitor more and educate everyone
- Be proactive vs reactive
 - Use all available tools like PNM, FBC, CMTS & CM info, IPDR/SNMP, Flap list,
- Build in headroom & contingency plans
- Good time to educate customers on advantage of using eMTA for audio portion of their calls & noise suppression!
- “Hope for the best, but plan for the worst”

Thank You!

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