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Echo Cancellation Techniques

for Supporting Full Duplex DOCSIS

Hang Jin
Distinguished Engineer
Cisco Systems

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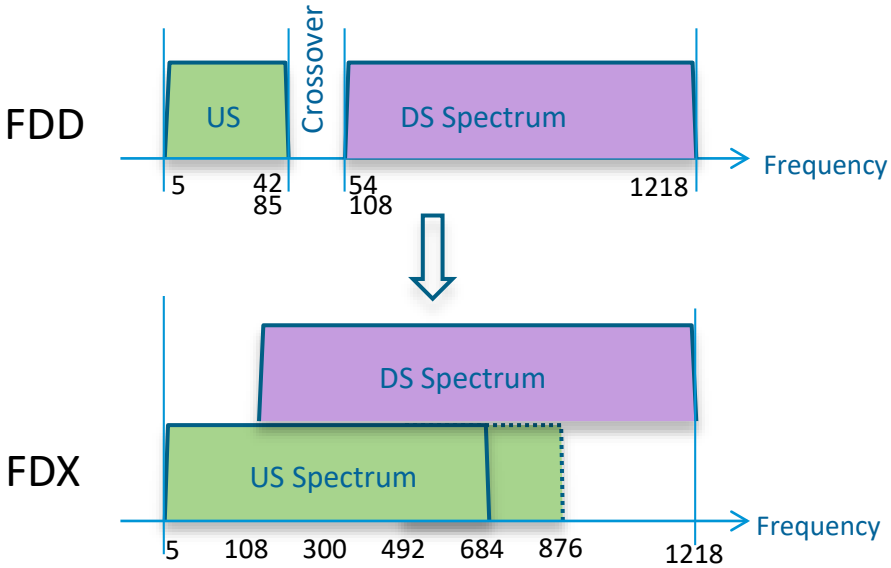
FDX DOCSIS – Continuing Innovation



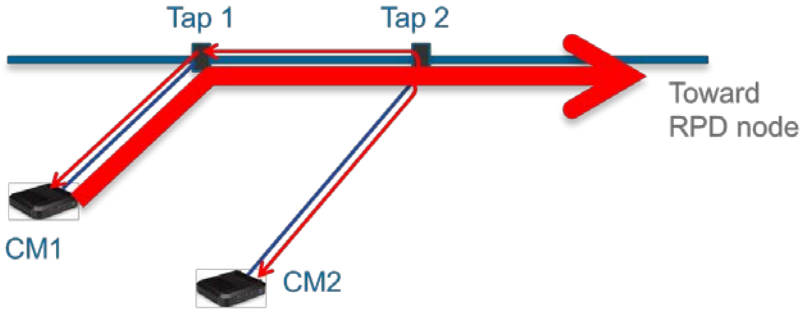
- Allows DS and US to use the same RF spectrum at the same time, doubling spectral efficiency.
- 10x more US capacity; 10 Gbps x 5 Gbps throughput design target.
- Works best with fiber deep (N+0) with remote PHY node; FDX and RPD are a match-made-in-heaven.
- Currently FDX is in specification; base design was contributed by Cisco.

FDX DOCSIS – The Challenges

Interference at RPD node

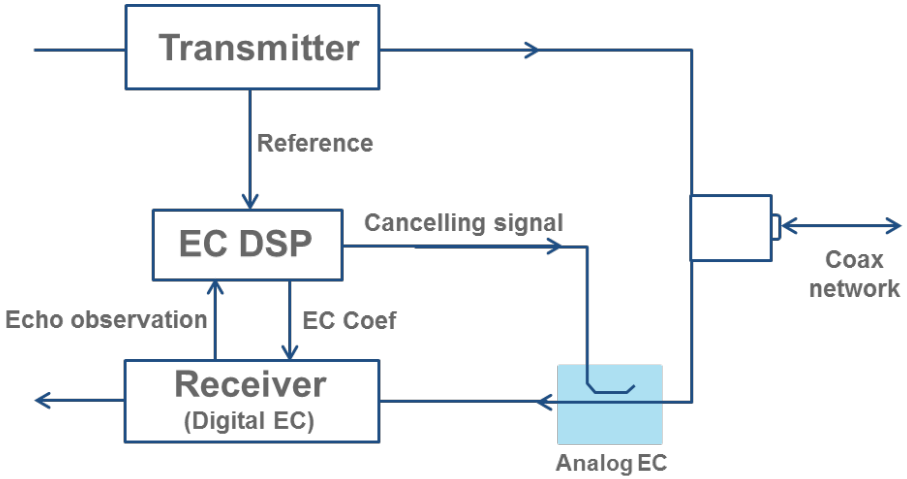
Large transmitted signal coupled/reflected back to receiver – co-channel interference

Interference at CM and among CMs

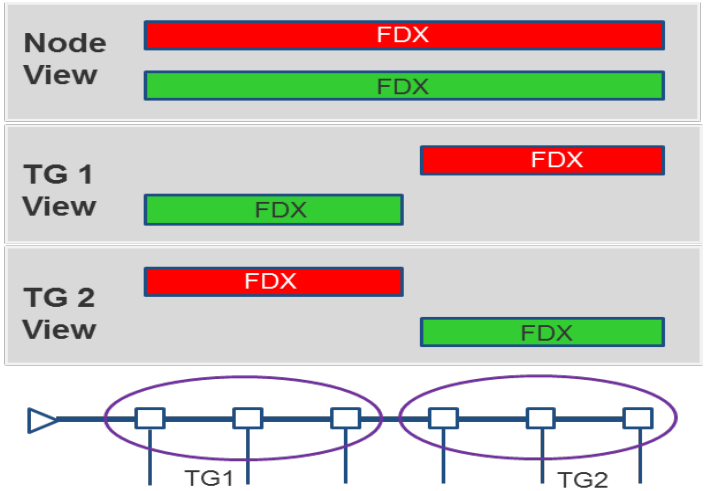


Both co-channel and adjacent channel interference

Interference Suppression/Avoidance

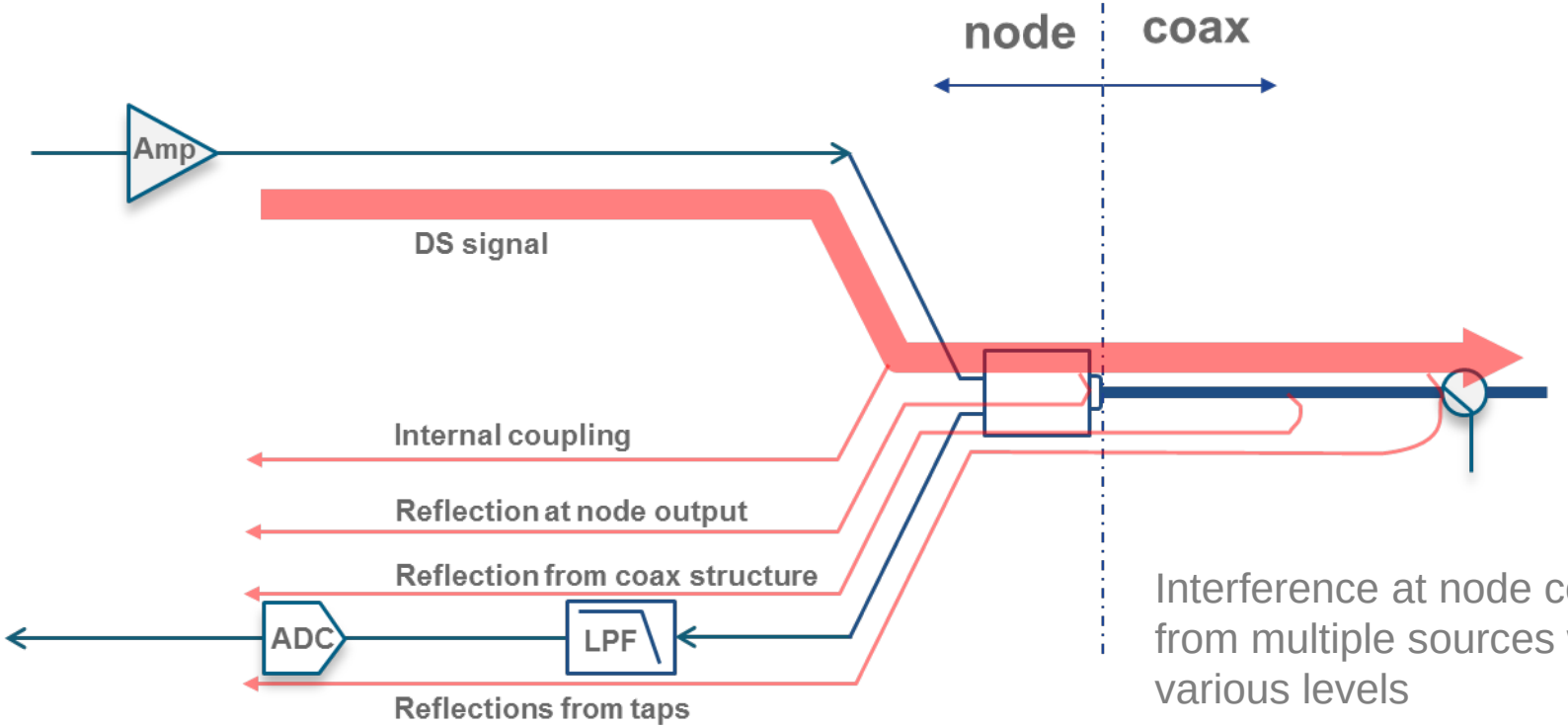


Self-interference suppressed through echo cancellation (EC)



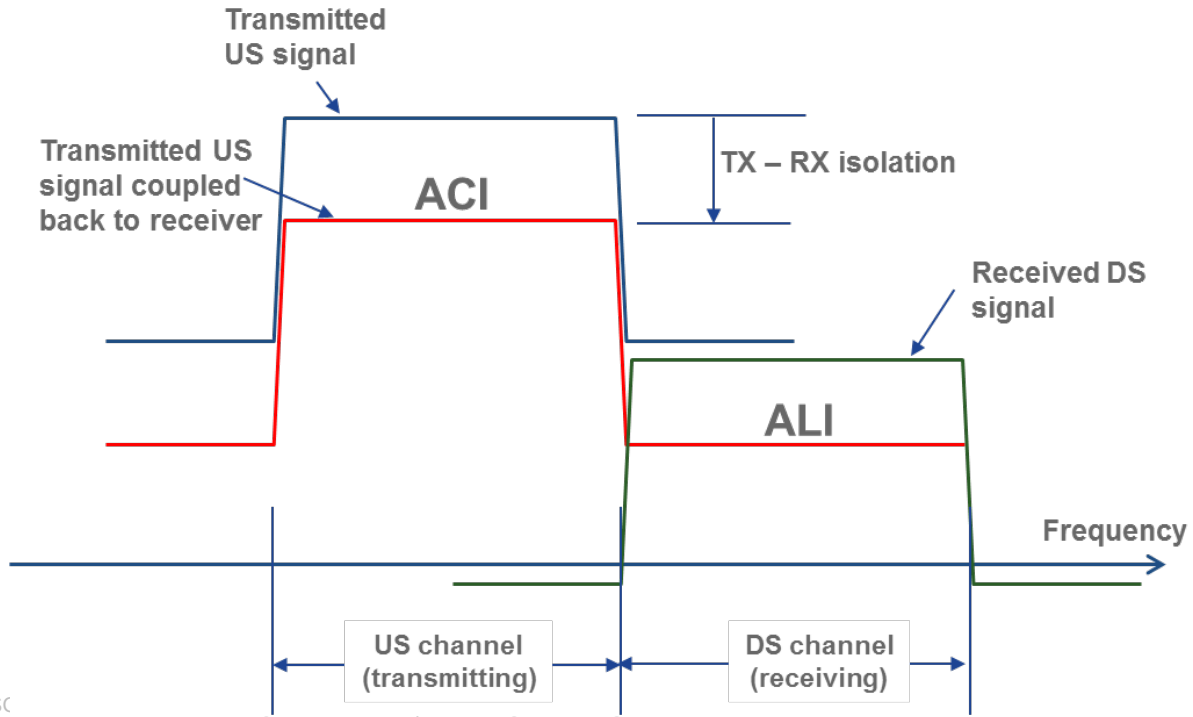
Interference among CMs avoided through intelligent scheduling

Self-Interference at Node



Interference at node comes from multiple sources with various levels

Self-Interferences at CM

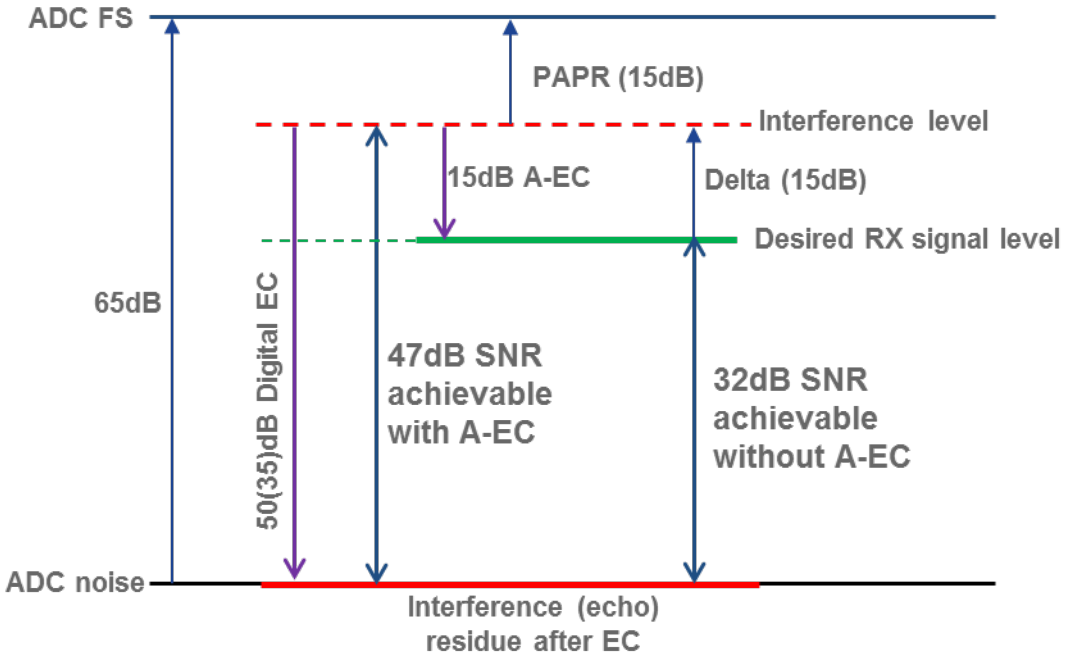


ACI: Adjacent channel interference

ALI: Adjacent leakage interference

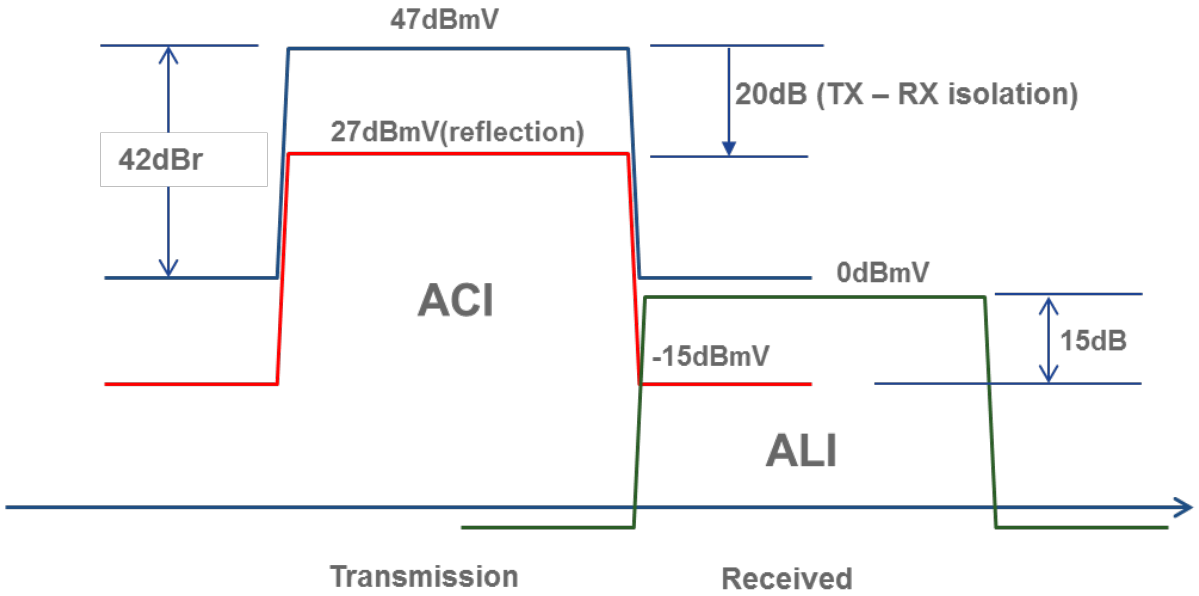
Self-interference at CM comes from adjacent channels

EC Performance Target - Node



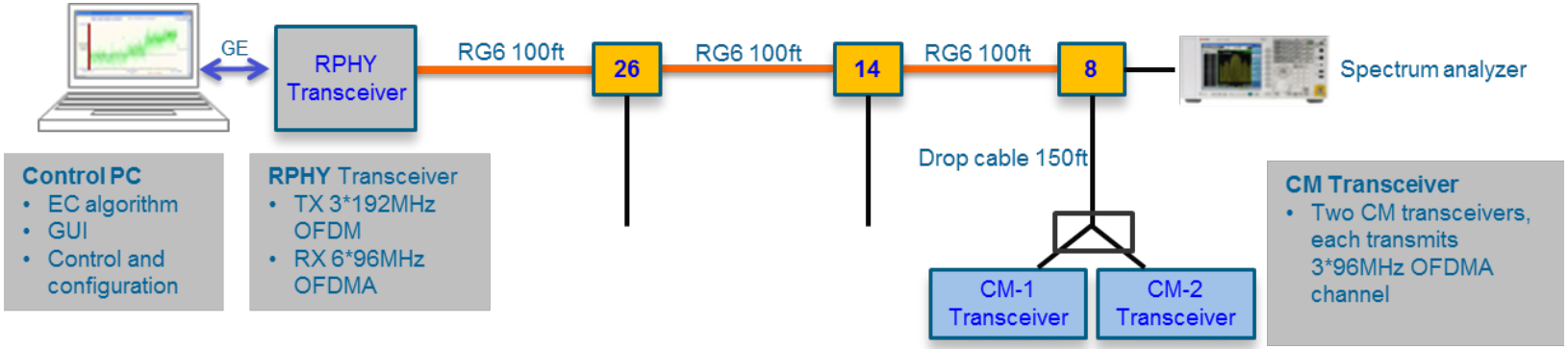
- Interference could be 15 dB higher than desired US signal in power
- 32 dB achievable SNR without analog EC
- 47 dB achievable SNR with analog EC (15 dB gain of analog EC)

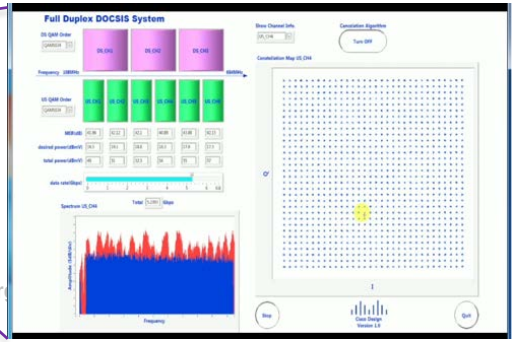
EC Performance Target - CM



- 25 dB cancellation required for both ALI and ACI in order to support DS 4096-QAM.

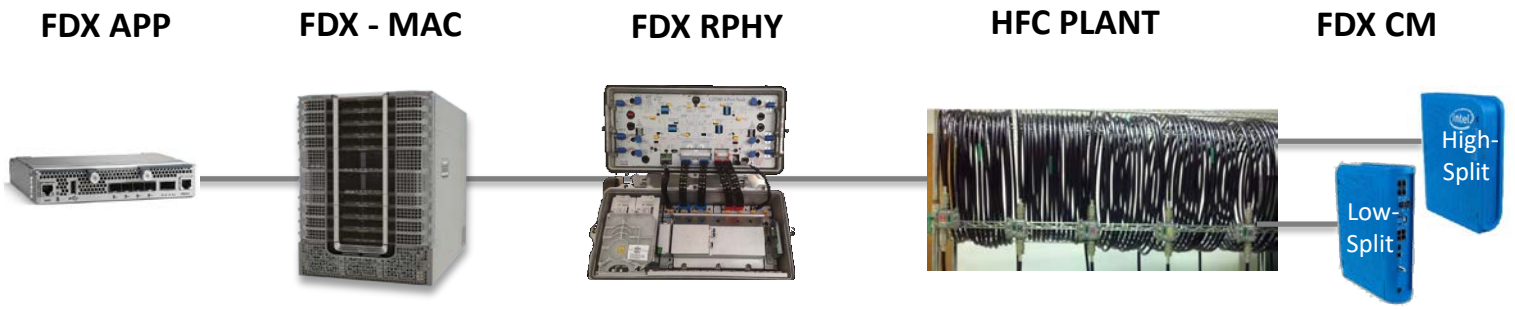
EC Lab Prototype System

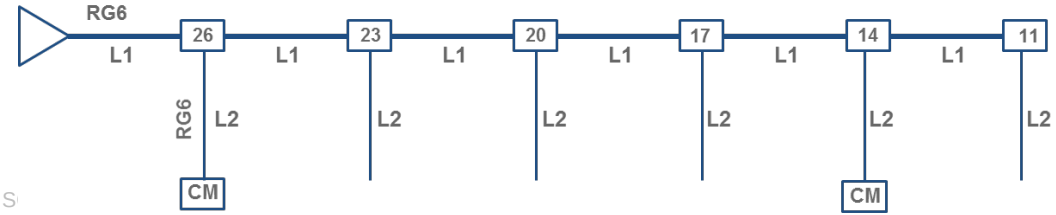




TCP = 73.8 dBmV
>37 dB post EC MER achieved

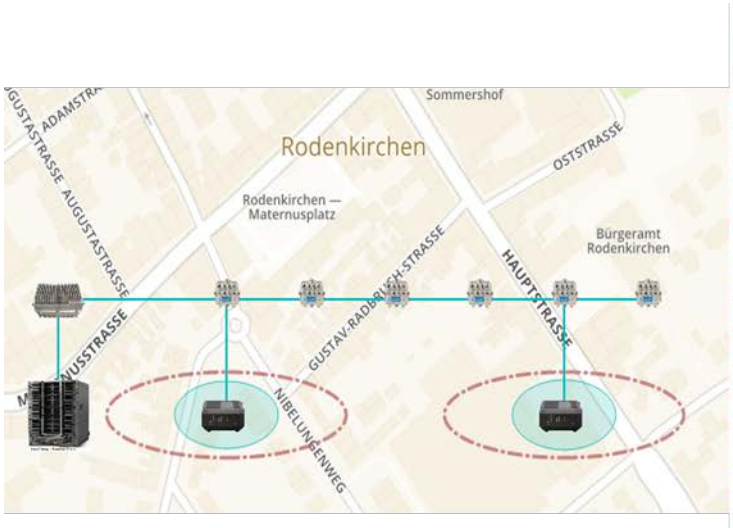
Live FDX DOCSIS PoC System Demo

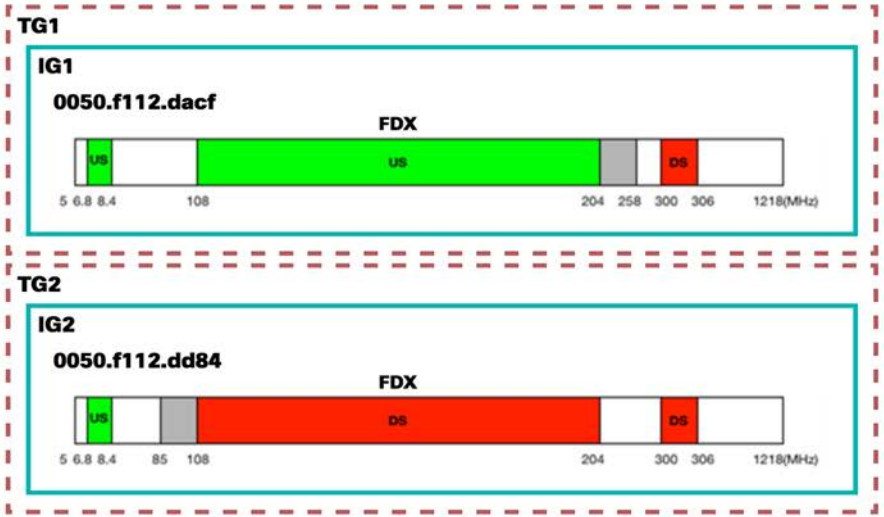




Series 6 cable, L1=L2=80 ft, tap type: 4 ports, Cisco taps (Surge Gap taps, no equalizer)

Live FDX DOCSIS PoC System Demo

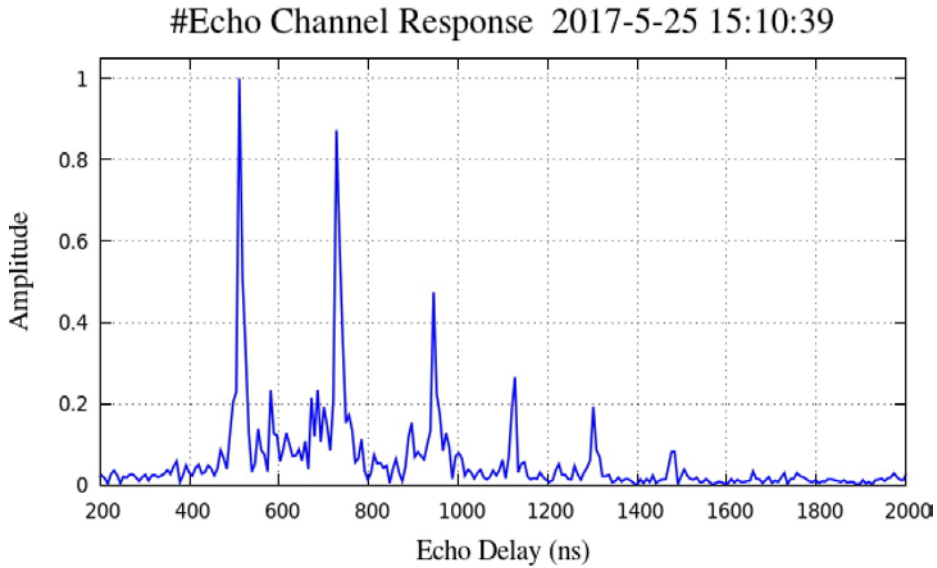


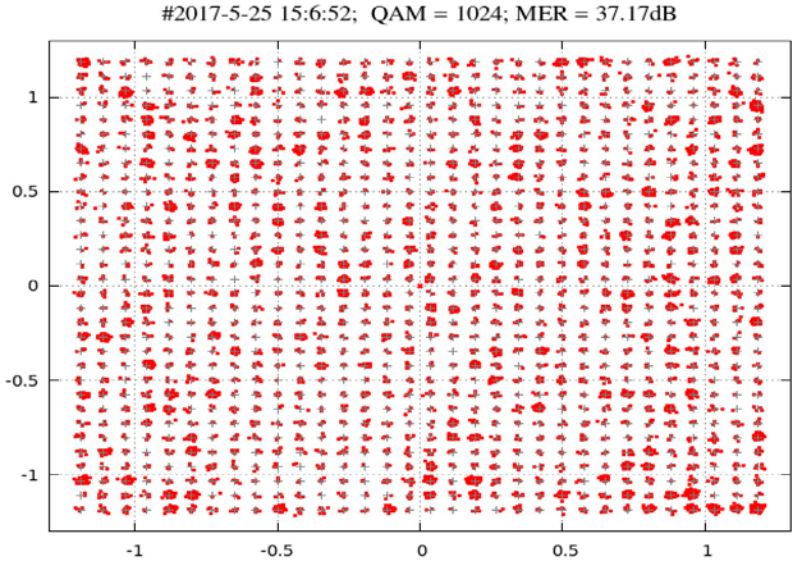


CMs are separated into different IGs based on RF isolation

One FDX channel (108 MHz to 204 MHz) used as DS or US channel for different TGs

Live FDX DOCSIS PoC System Demo





Post-EC MER = ~37 dB. DS throughput = ~940 Mbps, US throughput = ~620 Mbps

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THANK YOU!

Hang Jin
hangjin@cisco.com
469-255-2666

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