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Test Environments and Methods for Validation of DOCSIS 4 Devices

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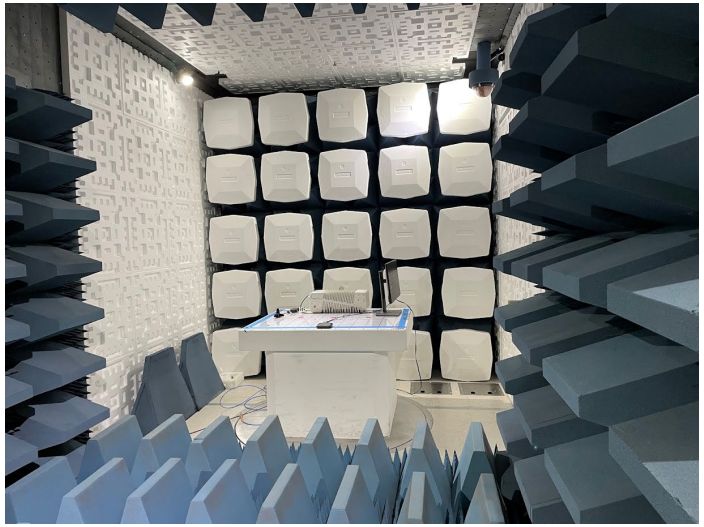
Introduction

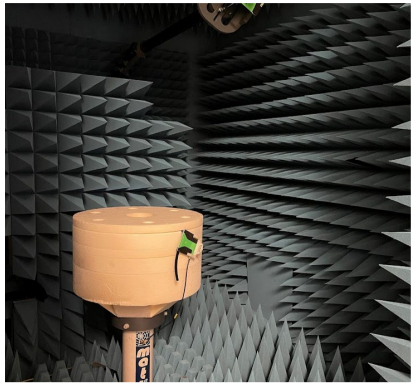
The Comcast Physical and Environmental team is responsible for hardware evaluation for deployment into Comcast.

Our main functions are

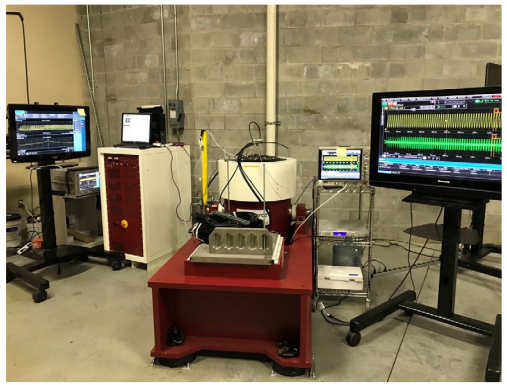
- Research
- Product evaluation and change management
- Root cause analysis
- Standards development (CMD)
- Quality verification assurance



Our technology environments

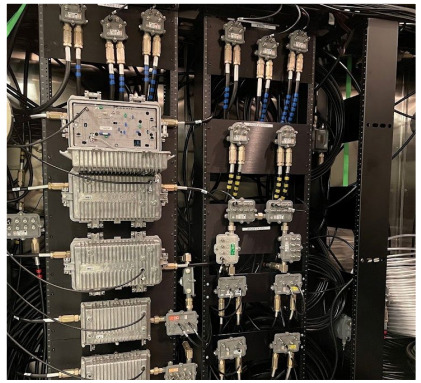


ELECTROMAGNETIC COMPATIBILITY



MECHANICAL

MATERIAL ANALYSIS



END-TO-END ENVIRONMENTAL

DOCSIS 4.0 implementations

Extended spectrum DOCSIS

- Downstream spectrum extended to 1.8 GHz
- Attenuation increases with frequency

Full duplex DOCSIS

- Upstream spectrum extended to 684 MHz
- Echo cancellation mitigates interference between transmission and reception

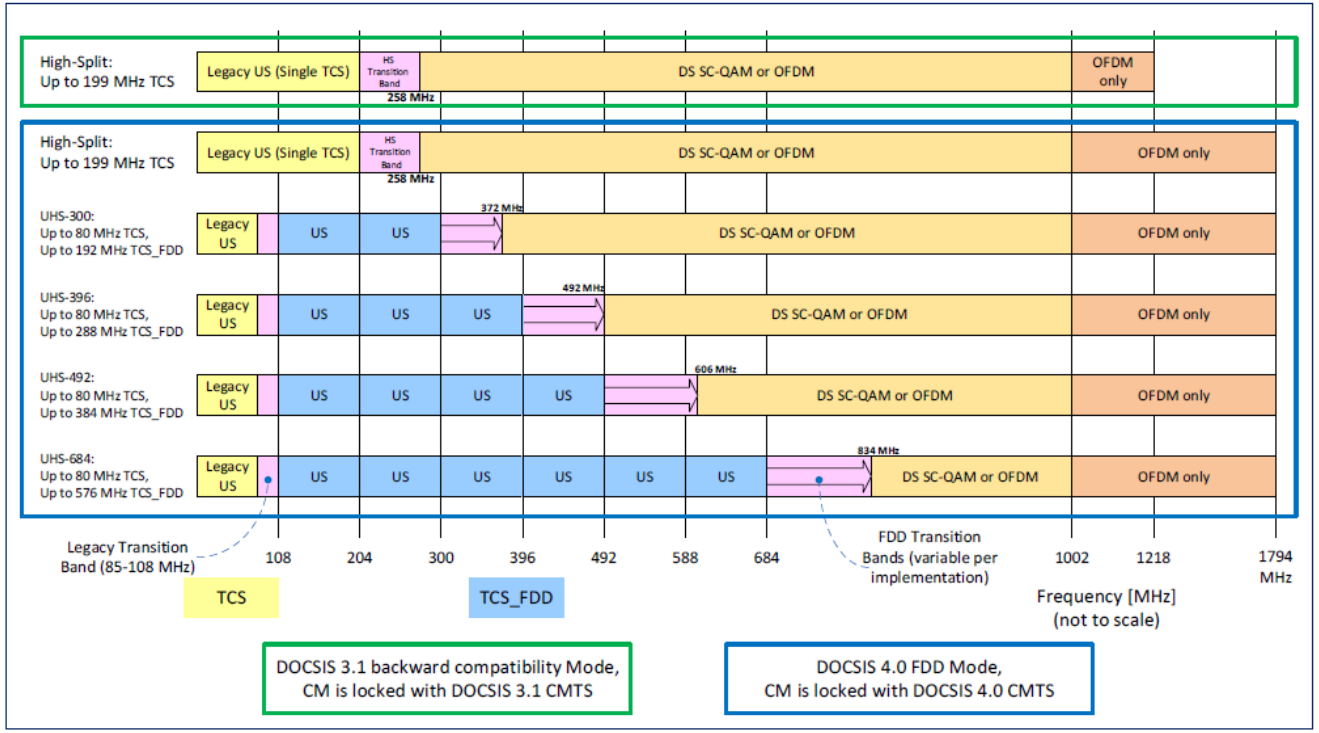
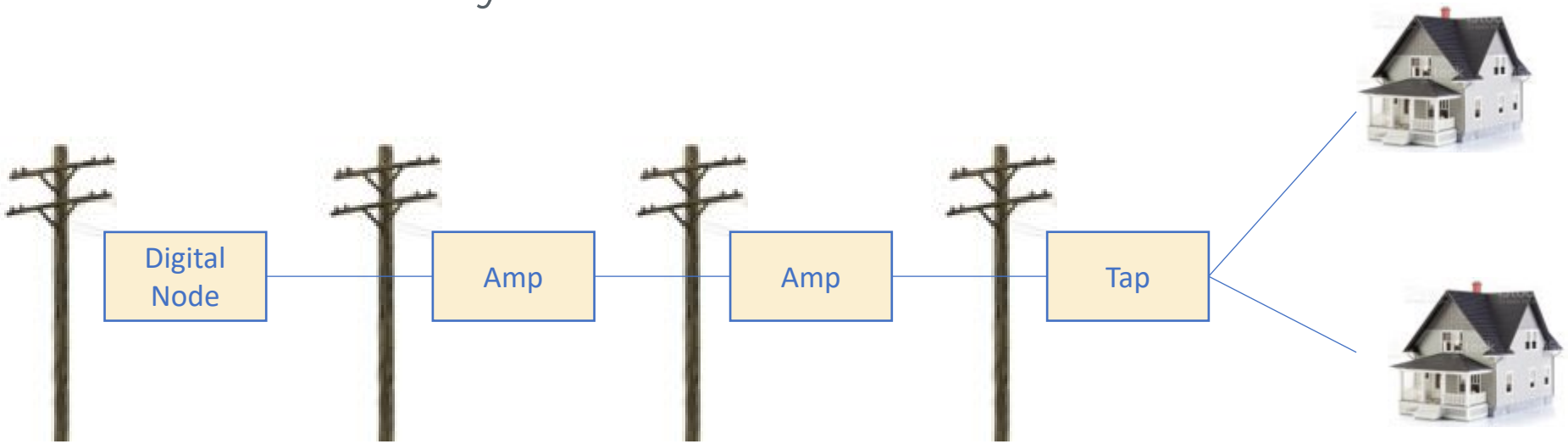


Figure 25 - Configurable FDD Upstream Allocated Spectrum Bandwidths

Source: CableLabs Data-Over-Cable Service Interface Specifications DOCSIS® 4.0

Our Environment

- Variety of networks due to geography, power, and density
- Cascade of plant components (nodes, amplifiers, taps, cables, connectors) contribute to RF performance
- Impairments from craftsmanship or other causes
- Temperature and humidity

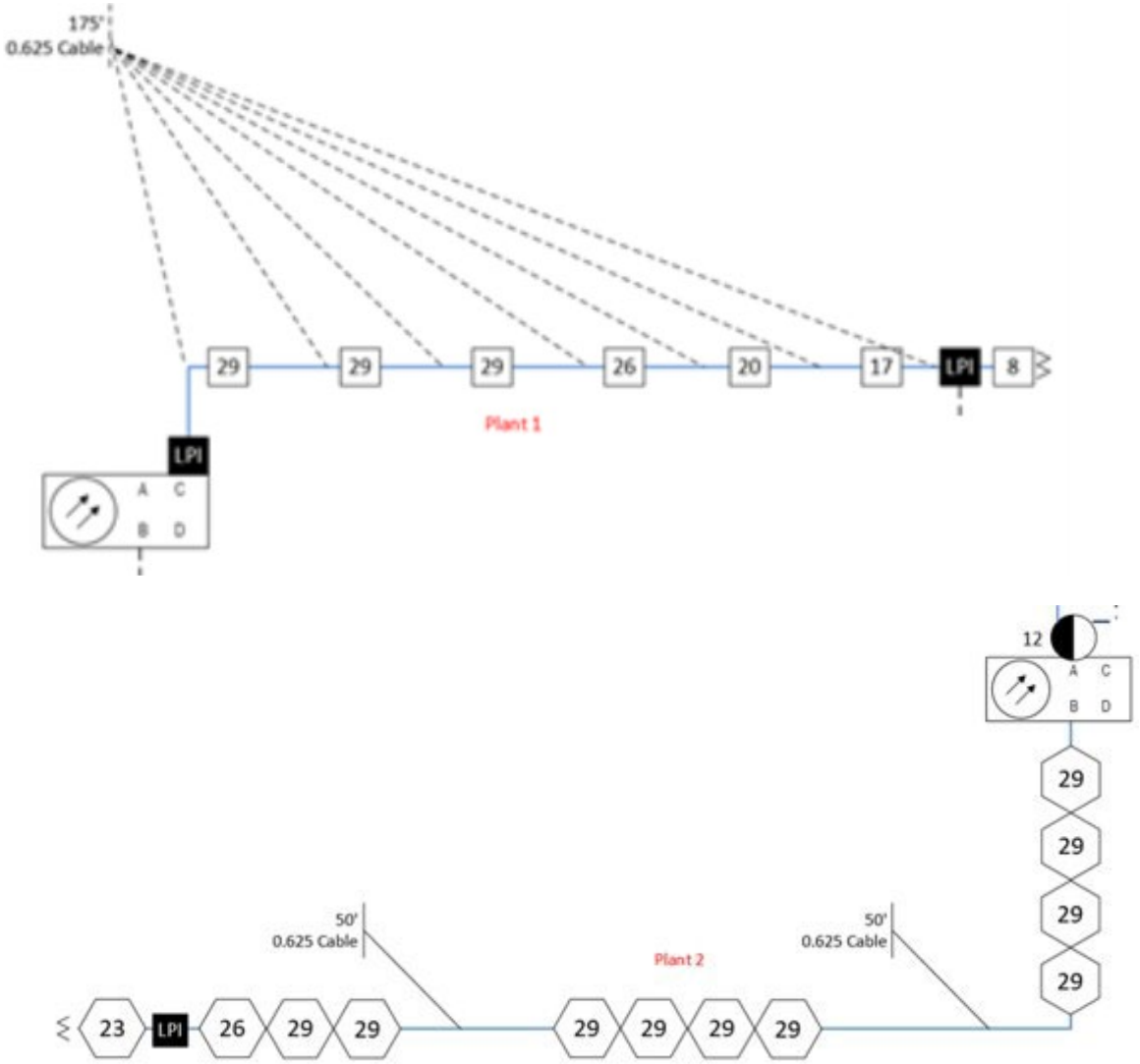


Typical Plant Models

Rural - low density

Residential – typical density

Dense MDU - high density

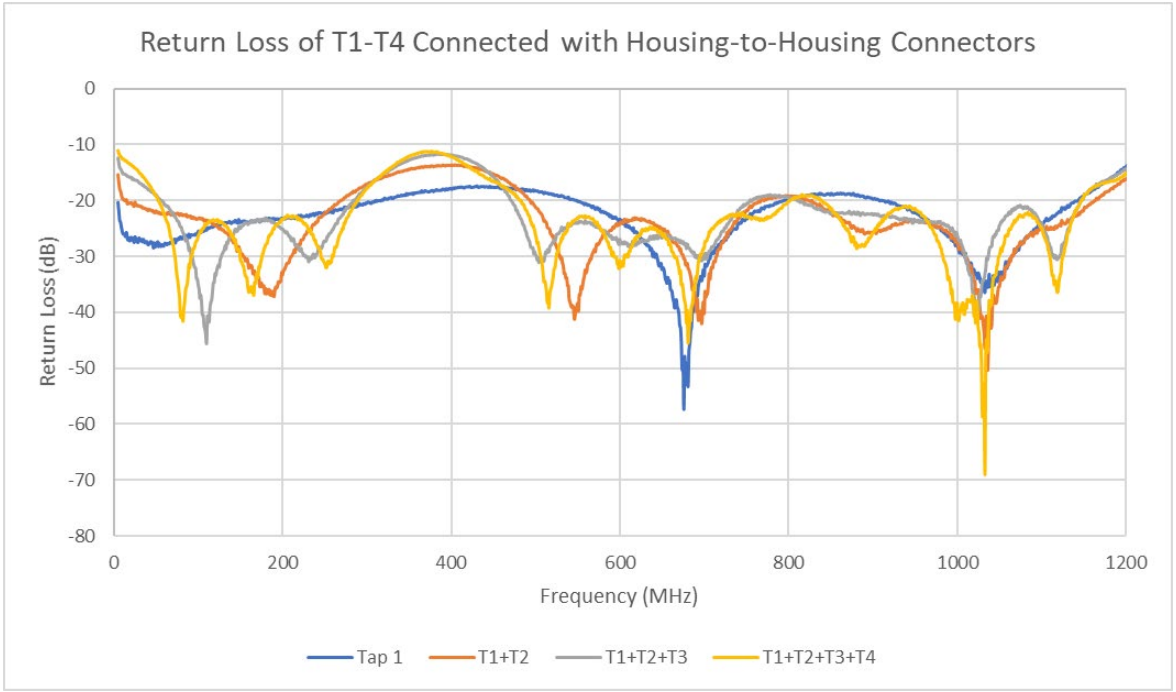


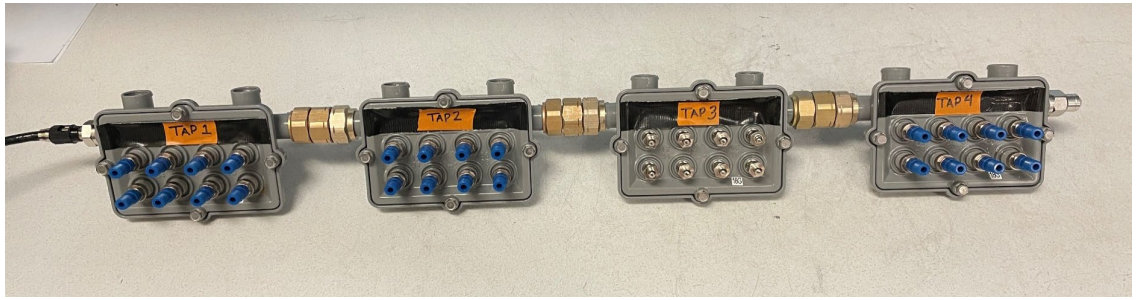
Dense MDU

Frequency Domain - Single Tap

Frequency domain measurement shows return loss degrades as taps are added

Time element needs to be measured differently



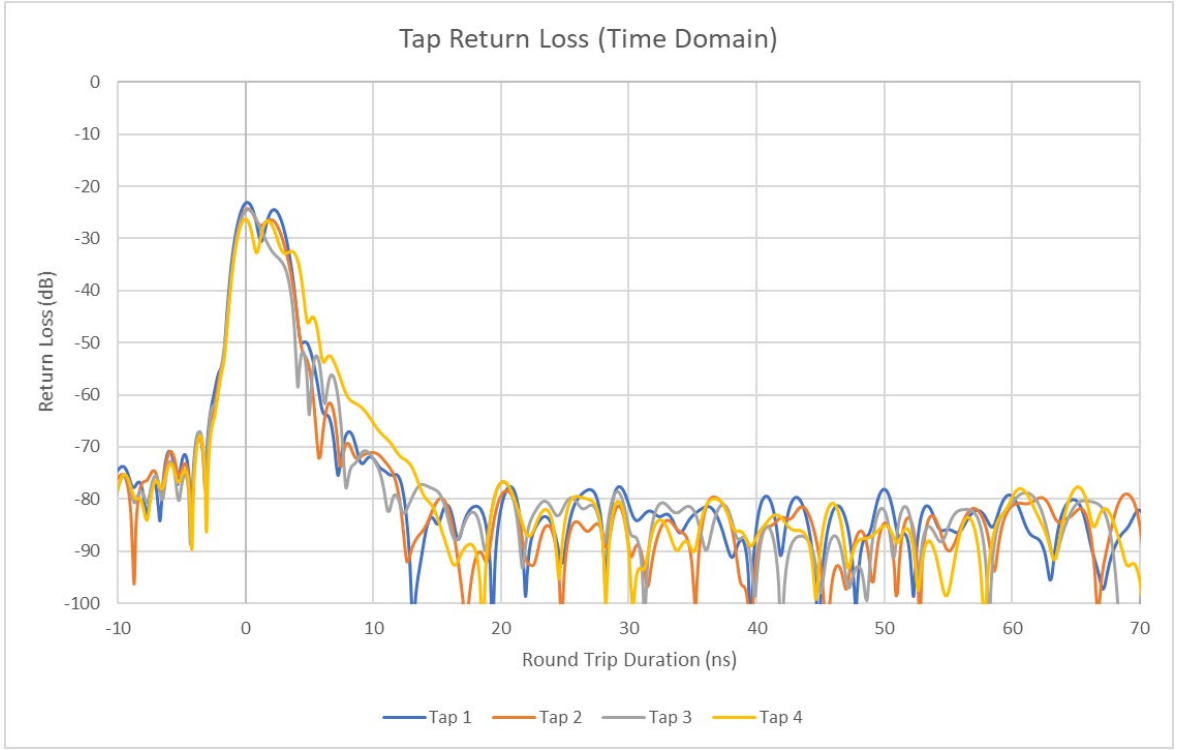


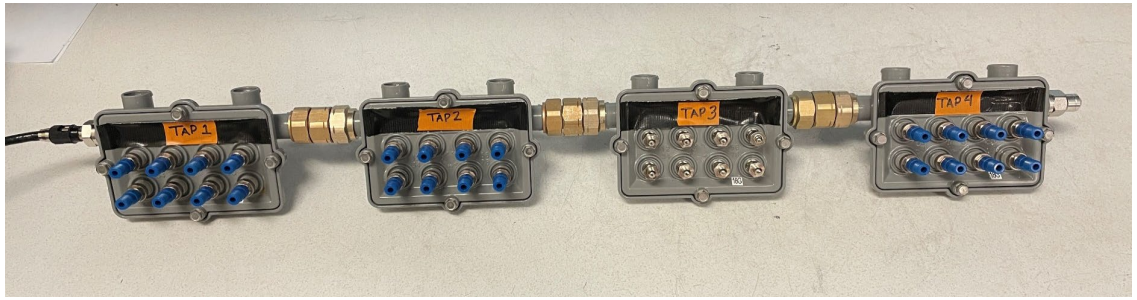
Dense MDU

Time Domain – Individual Taps

Time domain measurement shows 2 reflections from each tap, corresponding to the interface between the connector and the input and output ports of the tap

Each tap was the same body style, resulting in the same travel time for the reflected signal from each interface



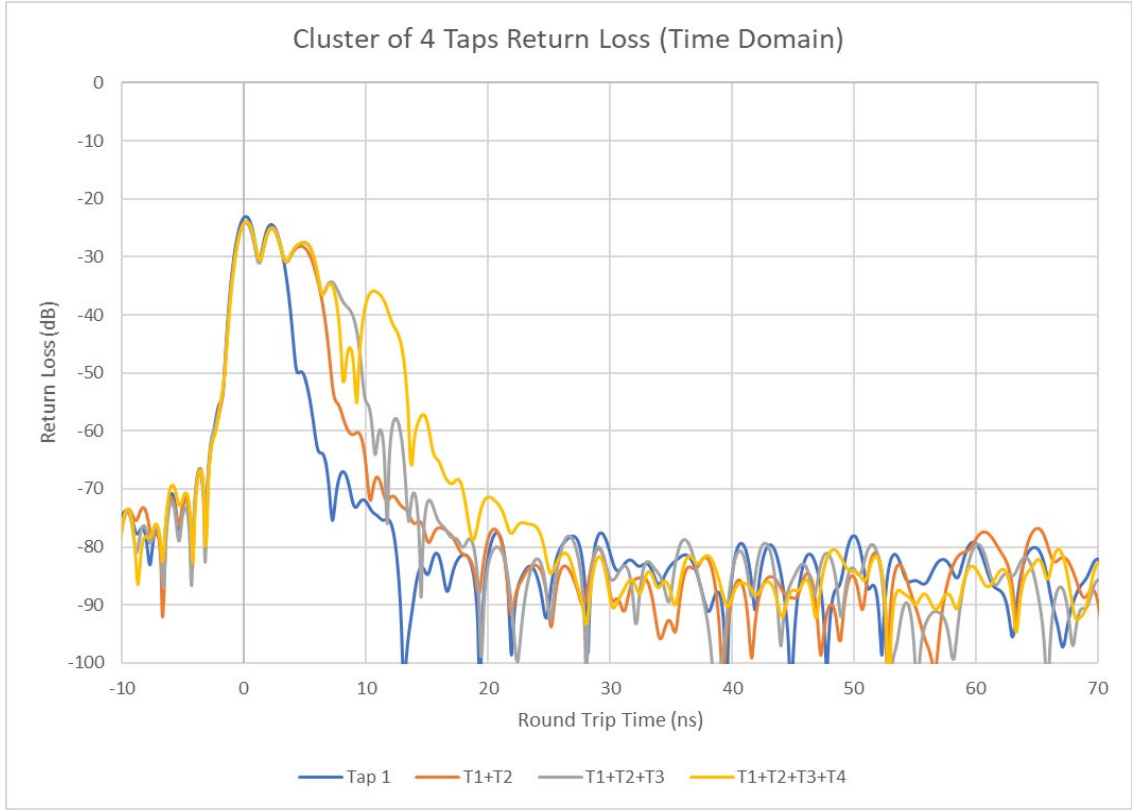


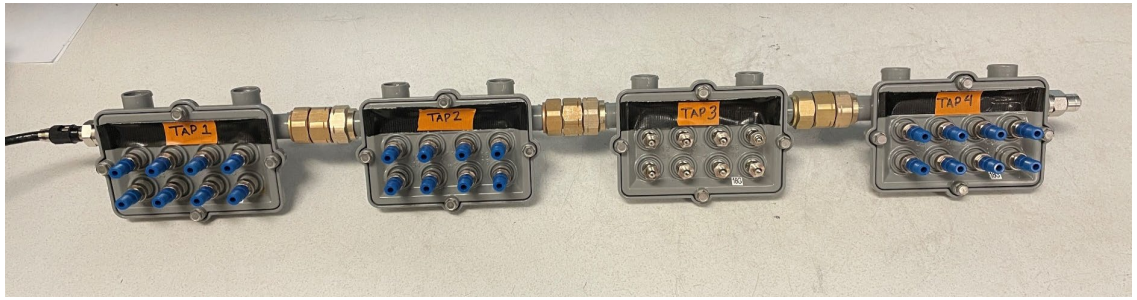
Dense MDU

Time Domain –Cluster of 4 Taps

Time domain measurement shows additional reflections at longer times as taps are added.

The added reflection times correlate to the extra path lengths for the reflected signal to travel.



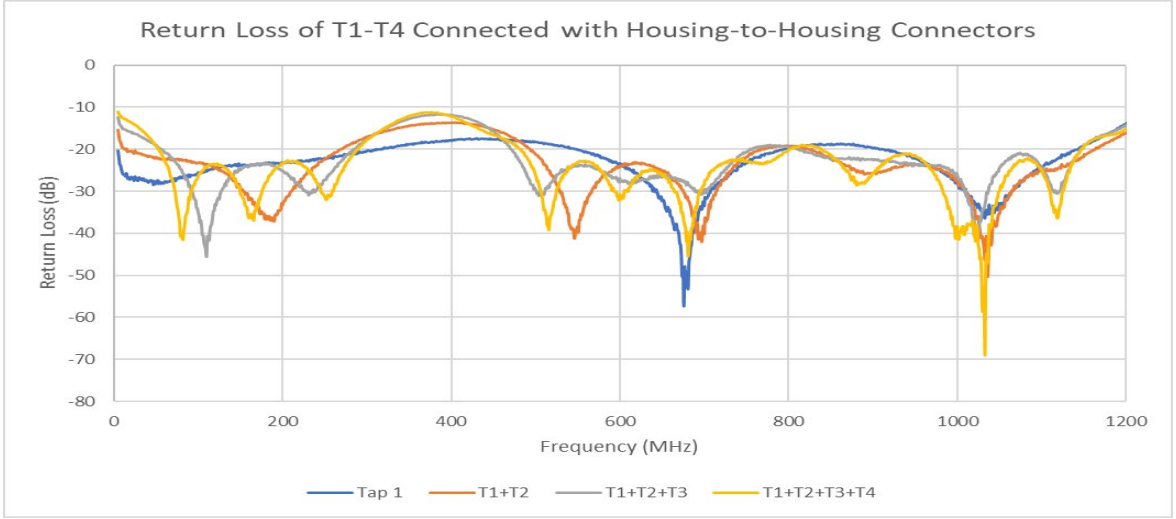


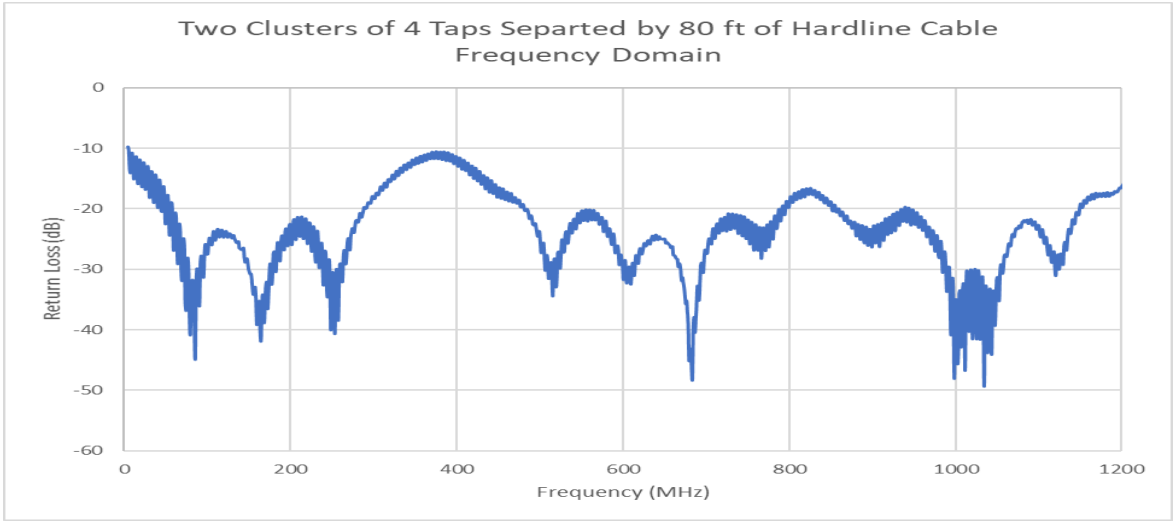
Dense MDU

Frequency Domain - Multiple Tap Clusters

Frequency domain measurement shows return loss degrades as taps are added

Time element needs to be measured differently





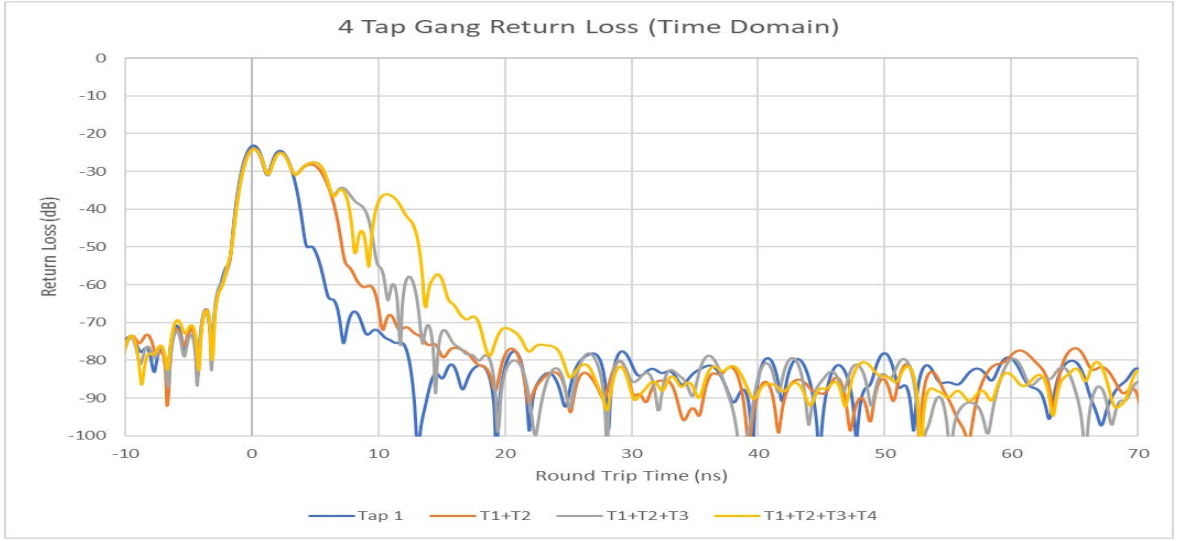
Dense MDU

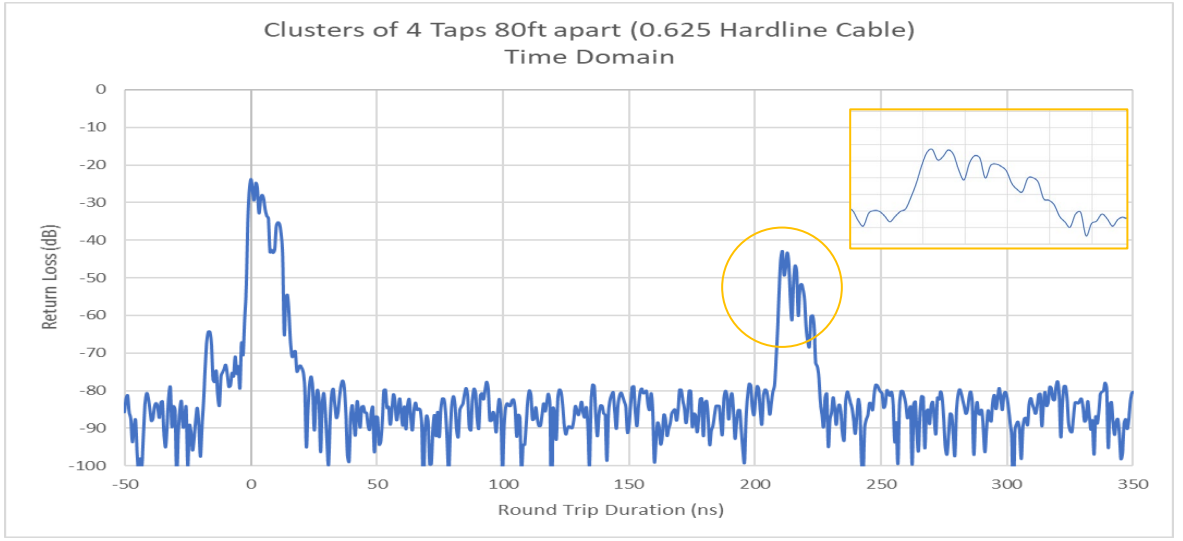
Time Domain – Multiple Tap Clusters

Second cluster of taps added with ~80 feet of hardline cable in between tap clusters.

Calculated round trip delay based on RF signal propagation over 80 feet of cable is 187 nanoseconds.

Return loss of the second cluster of taps is attenuated by coaxial cable as well as tap's through port loss.



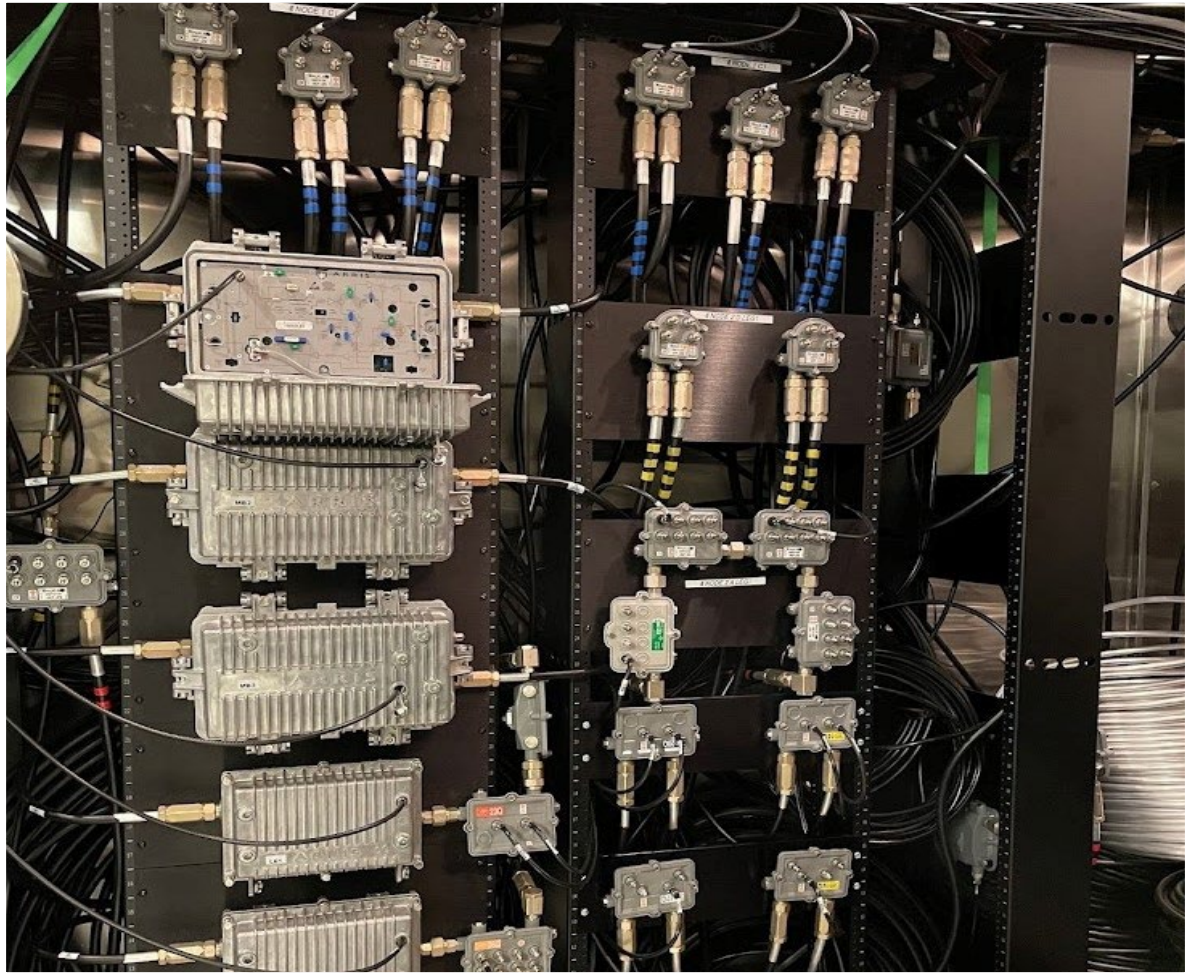


Summary

Most contribution to reflection amplitude is from the closest tap cluster

Time domain analysis shows that reflections from multiple taps in a cluster, and from multiple clusters are important and must be recreated

Complete plant models can be recreated in environmental chambers for testing to outside plant conditions



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Thank You!

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