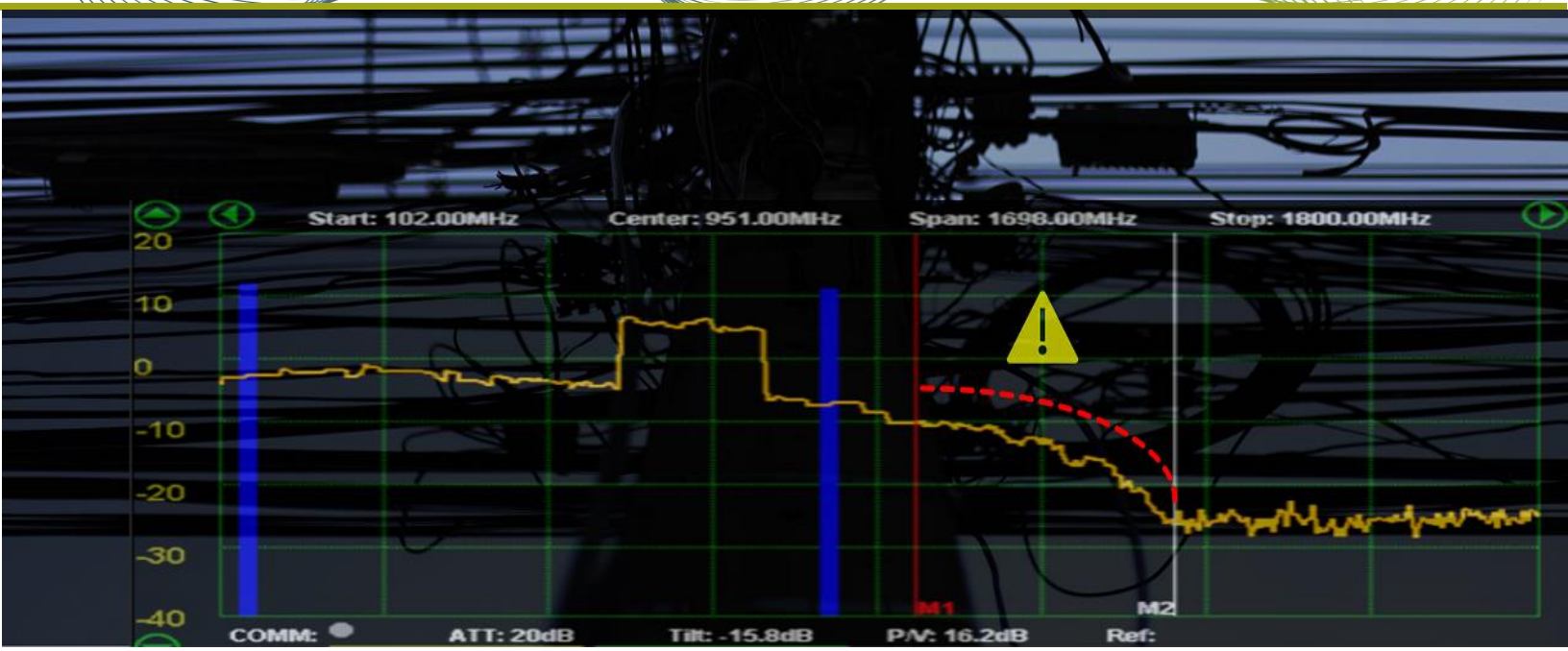
Extended Spectrum DOCSIS (ESD)

The Time Is Now!



Some people may correlate extended spectrum with DOCSIS 4.0 and since 4.0 capable chips still have a long way to go, it can be seen as another "*don't worry, we have plenty of time*" scenario. In reality, ESD also applies to DOCSIS 3.1 and can be used to significantly improve the current HFC plant and the Internet services it carries. Especially if coupled with ongoing deployments of R-PHY DAA and Node+0, which require updates and investment in the cable plant anyways. So, the journey towards extending the coaxial plant's spectrum has already started. Aren't you prepping your HFC network for ESD?

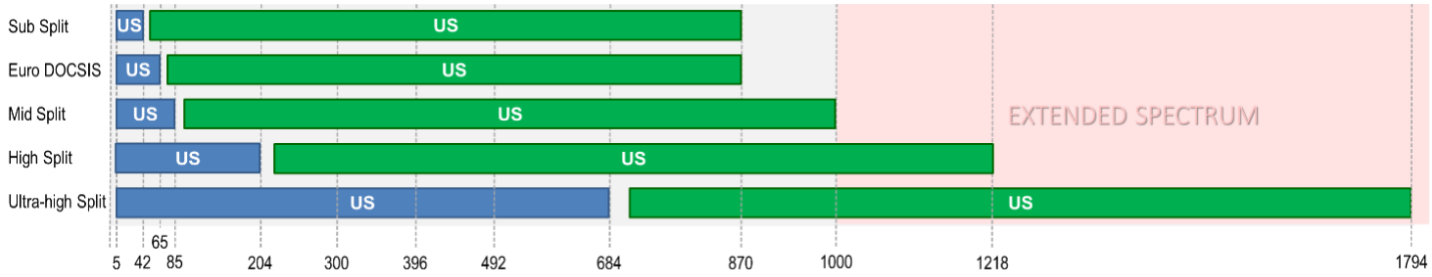


Figure 1. Examples of high-split and extended spectrum. ESD greatly improves the upstream and downstream performance.

Change in Market Dynamics

New Internet Consumer Behaviors

During the initial COVID-19 pandemic lockdown period (2020-2022), the statistic and probabilistic calculations and assumptions used by network engineers to calculate oversubscription, went down the drain. No one could have predicted that entire households, of around two to six people, would stay connected to the Internet all day, working and attending classes remotely. Not just using store-and-forward type of services like email, web browsing or streaming, but multiple concurrent sessions of real-time videoconferencing. Even though the restrictions may be ending, many employees are choosing (or demanding) to continue working remotely. The Internet access network will need to keep up with the demand.

Although there was higher stress in the forward/downstream bandwidth (which could be mitigated by provisioning more SC-QAM and/or OFDM data channels), the real bottleneck was in the return/upstream, which may not have a quick fix, besides long-term planning. Anyways, we can only hope that everyone learned their lessons and that MSOs are not only planning, but acting, on adding more bandwidth and flexibility to their HFC plan. The potential short and long-term solutions would depend on the region of the world and the types of subscribers being served. Here is where Extended Spectrum DOCSIS (ESD) comes into play, as a mid-long term enabler of high speed and high availability Internet services.

New and Stronger Competition

During the same period, DSL "broadband" Internet access technology finally showed its age and limitations, to the point that some large Telcos, still 'milking' it, finally decided that it was in their best interest to stop promoting them. That wakeup call led to increased interest and investment in next generation passive optical networks (PON) for business and residential Internet services.

With the introduction of C/DWDM co-existence, those passive networks can now also carry high speed x-haul traffic to feed 5G remote radio units, enabling 5G mobile and 5G home Internet services. Fixed wireless Internet is a competing access technology that was not there before, bringing at least two new residential service providers to most regional markets. Therefore, large cellular companies, which can quickly deliver wireless modems to consumers, get added to the mix.

So, whether it is an MSO or Telco, the incumbents' sales pitch most likely has to be based on a combination of (somewhat) guaranteed or expected Speed, Reliability, Quality of Service (QoS) and Quality of Experience (QoE). When it comes to fixed 5G residential Internet services, all bets seem to be placed on one major factor: Convenience, which may rank high in subscribers' perceived QoE. Remember, original cellular phones offered far worse voice quality than the land lines of the era, but convenience won that battle. Thus, MSOs must be vigilant and focus on making the most out of their current HFC plant to assure customer retention. Reliable and verifiable ESD readiness should be part of the current maintenance and deployments plans.

Competition, an Upstream Battle

Limited return (upstream) data throughput is one of DOCSIS' Achilles heel. Traditional DOCSIS deployment has been asymmetric in nature, oriented at sporadic or intermittent Internet content consumption behaviors, not to the generation of large upstream data flows. Pre-pandemic, multiple long video conferencing sessions or constant connection to remote desktops and servers may still have been considered in the realm of science fiction. Today, that is a reality which requires reliable upstream data throughput. Fortunately, mid-split, high-split and current DOCSIS 3.1 OFDMA offer help in that front, to provide better upstream rates and stay competitive.

But, what about Full-duplex DOCSIS 4.0? Well, its marketing machine is at full throttle and R&D teams are busy working at it. The reality is, MSOs still have to wait until this complex technology becomes available, and ready to be deployed. Full-duplex will not be a simple evolution or addition to the current coaxial plant, but a complete overhaul. So, while we wait for it, why not maximize the use of the current plant by introducing ESD? DOCSIS 3.1 still has quite a few years left.

Prepping Coax Plants for the Present and Near Future

With the ultimate goal of delivering 10G services, ESD was defined to enable the extension of the spectrum in both downstream and upstream directions, by updating the existing fiber and coax infrastructure, without the need of CAPEX-intensive investments. From the 10,000 ft view, implementing or getting ready for ESD doesn't seem to be that complicated. MSOs are already replacing and qualifying passive and active components all the time. Coax cables, taps, amplifiers, etc. can be specified and tested to higher frequencies, such as 1.2 or 1.8 GHz. They are also testing for ingress and egress, so procedures and equipment can also be updated to perform tests at the higher ESD frequencies. Keep in mind that higher frequencies require smaller antennas to radiate or receive, so cable faults that may not show significant issues in an 870 MHz plant, may show some significant problems at higher frequencies. Since technicians are already being dispatched to do the work, the additional cost for higher frequency components (passive or active) should not have a significant long term cost effect. (Compared to sending one technician today to replace 750, 860 or 1000 MHz feeders, drops, splitters, taps or amplifiers, plus sending another one a year later to replace it with 1.2 GHz versions and two years later to replace it again with one that is 1.8 GHz compliant.)

Depending on the country and region, MSOs may have different short term plans to prepare their plant for DOCSIS 3.1 ESD (1.2 GHz), or leap forward to the 1.8 GHz spectrum required for DOCSIS 4.0. Either way, test and measurement tools are available to qualify, verify and certify the coax plant's ESD readiness – all with significant economic advantages, whether the extended spectrum is immediately put into service or not.

What to Test When Preparing for 1.2 and 1.8 GHz Spectrums

- Coax cables' frequency response, up to 1.2 or 1.8 GHz
- Passive elements' frequency response (e.g., splitters and taps), up to 1.2 or 1.8 GHz
- Active elements' frequency response, up to 1.2 or 1.8 GHz
- Ingress at higher frequencies, up to 1.8 GHz

The use of portable extended spectrum signal generators and spectrum analyzers are key to qualify the frequency response of individual elements and networks, as well as to identify trouble sections using 'divide-and-conquer' troubleshooting segmentation methods. Many of those tests can be performed on live networks, using portable sweep systems, which are a combination of extended spectrum signal generators and spectrum analyzers.

The Need for Portable Sweep Systems

In traditional HFC plants, the analog nature of the physical transmission allowed the use of centralized sweep systems. With the introduction of R-PHY/DAA, the packetization of the content severed the direct connection between the coaxial plant and centralized locations. The smaller coax plants are now isolated behind nodes or RPDs, which are dispersed out in the field.

Another problem with stationary sweep systems is that they can't provide any more information past the frequency roll-off from the first fault, because the test "tones" get decimated. Portable sweep systems, on the other hand, can be easily moved close to the failure point to qualify the rest of the network and can also be used to perform qualification, verification and troubleshooting tests on specific sections of the coax plant.

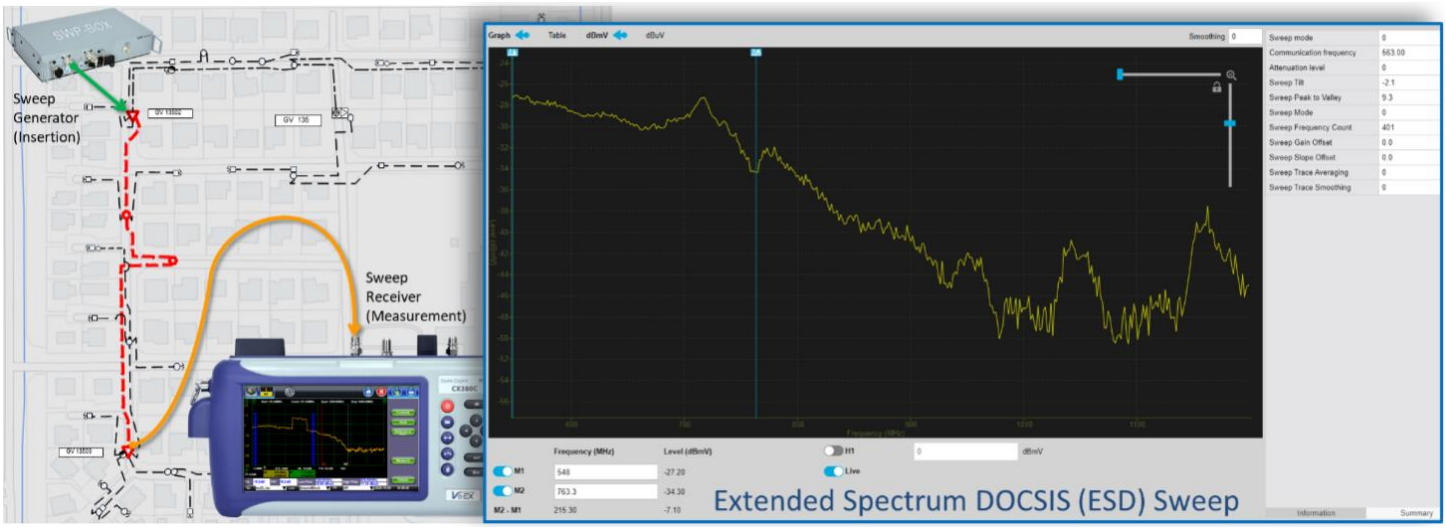


Figure 2. Example of sectionalized qualification and/or troubleshooting test scenario

Conclusion / Recommendation

Since MSOs are constantly maintaining their coaxial plant, and many are currently investing in DAA upgrades, why not adding a prep plan to leave the plant ready for 1.8 GHz ESD? It should include the selection of compliant (or at least upgradeable) passive and active components, as well as test plans to identify and resolve non-compliant elements and high-frequency faults, then qualify and verify the final spectral performance of each updated leg.

Related Information & Reference Materials

DOCSIS 4.0 Technology Poster

Getting Ready for DOCSIS 4.0 & ESD (recorded webinar)

SWP-BOX Generator Information

CX380C Meter (handheld sweep receiver)

SWP-BOX Quick Guide

SWP-BOX Introduction (teaser video)

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About VeEX

VeEX Inc., a customer-oriented communications Test and Measurement company, develops innovative test and monitoring solutions for next generation telecommunication networks and services. With a blend of advanced technologies and vast technical expertise, VeEX products address all stages of network deployment, maintenance, field service turn-up, and integrate service verification features across Copper, Fiber Optics, CATV/DOCSIS, Mobile 4G/5G backhaul and fronthaul, next generation Transport Network, Fibre Channel, Carrier & Metro Ethernet technologies, WLAN and Synchronization.

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