BTR
BROADBAND TECHNOLOGY REPORT

EXECUTIVE SUMMARY

Possibilities and Limitations of the ESD Return Path

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KEY TAKEAWAYS

- The DOCSIS 4.0 upgrade significantly increases the upstream spectrum capability.
- Operators must plan for increased total composite power (TCP) as they move up the spectrum.
- Intelligent amplifiers simplify implementation and reduce power consumption.
- Changes in outdoor temperature can impact upstream performance with DOCSIS 4.0.
- Moving to DOCSIS 4.0 is a slow and methodological change offering huge improvements.

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OVERVIEW

The pandemic, consumer trends toward 4K television, and significant competition from fiber network companies is driving the cable access television (CATV) industry to rapidly increase upstream capacity.

The latest version of the Data Over Cable Service Interface Specification (DOCSIS), DOCSIS 4.0, includes support for a significant increase in upstream capabilities, offering operators new possibilities. Extended Spectrum DOCSIS (ESD) technology, which enables use of higher upstream and downstream frequencies, introduces new challenges, which Teleste Intercept solutions are built to overcome.

CONTEXT

In a discussion with BTR/Lightwave editorial director and associate publisher Stephen Hardy, Steven Condra, director of product management/engineering at Teleste Intercept, shared the benefits and challenges of an upgrade to DOCSIS 4.0.

KEY TAKEAWAYS

The DOCSIS 4.0 upgrade significantly increases the upstream spectrum capability.

The DOCSIS 4.0 upgrade increases the capability of the upstream spectrum, helping cable businesses meet the bandwidth challenges they have seen over the past several years from fiber network competitors and as a result of the COVID-19 pandemic.

> The pandemic put a lot more pressure on the upstream bandwidth with a lot of videoconferencing, not just for business, but for schools and everyday use.
>
> *Steven Condra, Teleste Intercept*

Moving beyond 42-megahertz (MHz) frequency commonly used by DOCSIS 3.1 is necessary to meet modern bandwidth needs. Along with ESD extending the highest plant frequency to 1.8 gigahertz (GHz) and later to 3.0 GHz, operators can change the upstream/downstream split to 85 MHz, 204 MHz, 396 MHz, 492 MHz, or 684 MHz.

Downstream is also migrating to a higher frequency, but with no appreciable increase in the actual spectrum due to the higher split frequency.

Operators must plan for increased total composite power (TCP) as they move up the spectrum.

Active devices need to support the entire selection of diplex filters that can be changed in the field. While most multiple-system operators (MSOs) are likely to start at a lower split frequency, and not at 684 MHz, they need to make sure their amplifier can support that split in the future.

Following ESD, approximately 62 decibel millivolts (dBmV) of TCP in the upstream is available to the amplifier. It won't all be used, especially as today's 42 MHz system in the upstream has approximately 18 dB of gain, and a high-split 204 MHz system will need 26 dB of gain. In the future, when that same system moves to an ultra-high split for 684 MHz, it will require 34 dB of gain. These upstream signals also require us to more closely consider both slope control and level control over temperature.

Additionally, 70 dBmV of TCP is needed in the downstream to support the 1.8 GHz of downstream capability.

Intelligent amplifiers simplify implementation and reduce power consumption.

All outdoor active devices available from Teleste, both the amplifiers and the nodes, include intelligent

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features. These offerings simplify implementation, even allowing remote configuration, reduce power consumption by as much as 30%, and detect and protect against ingresses.

Intelligent features in Teleste Intercept's amplifiers and nodes

Feature	What it does
Electrical pads and equalizers (EQs)	No plug-ins necessary, as the amplifier auto-selects right integrated electrical pads and EQs based on the two carriers—high and low—selected.
Radio frequency (RF) level measurement on each port	Detects ingress in the upstream and monitors signal levels in the downstream, detecting and reporting on each port individually. – Downstream read capability sets up the levels in the amplifier and uses two carriers to make corrections for changes in temperature post-installation. – Ingress-switching is available on each port, improving ingress detection. The signal on the impacted port can be attenuated or the port can be shut off to prevent the event from affecting other customers.
Adjusts the amount of RF spectrum in use to save power	Detects the spectrum being used and adjusts accordingly, saving 20% to 30% power consumption over the life of the amplifier. For example, if the MSO is using a 1.8 GHz amplifier, but is only loading channels up to 1.2 GHz, the amplifier detects the amount of RF spectrum in use and adjusts the bias level on the gain blocks to support the spectrum actually in use. Changes made at a later time are automatically detected and the bias level on the gain blocks is automatically readjusted.

Changes in outdoor temperature can impact upstream performance with DOCSIS 4.0.

Although the industry has been using temperature compensation on amplifiers on downstream signals for many years, the compensation was not necessary on upstream signals as there wasn't much change on the attenuation at 42 MHz or lower frequencies. The significant increase in upstream signal frequency now makes temperature compensation a necessity on downstream and upstream signals.

The closed-loop feedback system used for downstream temperature compensation can't be used for upstream, because, unlike downstream, the DOCSIS upstream signals are sporadic. Teleste has solved this problem for upstream signals by using the downstream signal as a predefined pilot and by using changes that occurred in the downstream to calculate what they would be for upstream through the same piece of coaxial cable at lower frequencies. This Teleste's technology is called reverse follows forward automatic level and slope control (RFF-ALSC).

The downstream ALSC can use any downstream signal as a pilot. Changes in the downstream signal are used to adjust the downstream slope and gain to maintain signal integrity.

Moving to DOCSIS 4.0 is a slow and methodological change offering huge improvements.

The move to DOCSIS 4.0 requires changes in almost all parts of the network, including a move to a next generation distributed access architecture (DAA), as well as changing both active and passive equipment. MSOs are taking this shift slowly but recognize that DOCSIS 4.0 will offer significant network improvements.

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> The move to DOCSIS 4.0 is a slow, methodological change in the network with huge impacts for improvements in the network.
>
> *Steven Condra, Teleste Intercept*

Most operators today are focusing on changing the passives, but changes to active devices will come soon after, followed by the shift to DOCSIS 4.0.

BIOGRAPHY

Steven Condra

Director of Product Management/Engineering, Teleste Intercept

Steve Condra is the Director of Product Management/Engineering for Teleste Intercept. He has been leading the effort for Teleste to grow the North American market in HFC architectures. Prior to his present position, Steve led the Cable Access Business Unit at Cisco in numerous positions including the General Manager for the Access Optics Center of Excellence located in Naperville, Illinois. For more than 12 years Steve was instrumental in leading the growth and profitability of the world-wide Access businesses for Cisco. He joined Scientific Atlanta in 2000 (later became Cisco in 2006) after having spent sixteen years with Lucent Technologies in a variety of roles. Steve has a BS and an MS in Mechanical Engineering from the University of Missouri.

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