

Beyond Speed:

ELEVATING SUBSCRIBER EXPERIENCE WITH UNIFIED DOCSIS 4.0, LOW-LATENCY SERVICES AND FIBRE OPTIONALITY

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BROADBAND CONNECTIVITY REQUIREMENTS ARE CHANGING RAPIDLY AS NEW APPLICATIONS AND USAGE PATTERNS PLACE GREATER DEMANDS ON SERVICE PROVIDERS. THE ABILITY TO DELIVER CONSISTENT, HIGH-QUALITY BROADBAND SERVICE HAS BECOME INCREASINGLY IMPORTANT, ESPECIALLY AS INTERNET USAGE EXPANDS TO INCLUDE HIGH-BANDWIDTH APPLICATIONS LIKE REAL-TIME GAMING, LIVE STREAMING AND EMERGING AI-DRIVEN SERVICES THAT DEPEND ON LOW LATENCY AND RESPONSIVE CONNECTIONS.

Broadband connectivity requirements are changing rapidly as new applications and usage patterns place greater demands on service providers. The ability to deliver consistent, high-quality broadband service has become increasingly important, especially as internet usage expands to include high-bandwidth applications like real-time gaming, live streaming and emerging AI-driven services that depend on low latency and responsive connections.

DOCSIS 4.0 was defined with two technology options, Full Duplex DOCSIS (FDX) and Frequency Division Duplex DOCSIS (FDD). With Unified DOCSIS 4.0, both FDD and FDX are combined into a single solution that delivers symmetrical multigigabit speeds and provides operators with a toolbox of capabilities.

FDX makes it possible to send data in both downstream and upstream directions across the same spectrum, optimising bandwidth efficiency. FDD uses dedicated frequency ranges for upstream and downstream data. Unified DOCSIS 4.0 is also available in a new operating mode — Flex-FDD, enabled by the amalgamation of the two DOCSIS 4.0 technology options. By supporting these methods, Unified DOCSIS 4.0 gives operators flexibility to match service configurations to real-world conditions, plant capabilities and subscriber profiles.

UNIFIED DOCSIS 4.0: BRIDGING FDX AND FDD FOR NETWORK AGILITY

Unified DOCSIS 4.0 introduces capabilities that extend broadband's potential to symmetrical multigigabit speeds and downstream speeds beyond 10Gbps. Unified FDX supports upstream and downstream communication sharing the same spectrum, with extended downstream capability, now accessing a full 1.8GHz spectrum. FDD, by contrast, designates separate frequency bands for data moving in each direction. The new Flex-FDD mode uses FDX techniques such as echo cancellation to minimise interference, eliminating the need for a diplexer guard band between upstream and downstream frequency allocations and maximising bandwidth utilisation.

The latest Unified DOCSIS 4.0 silicon and devices integrate both FDX and FDD in a single platform on the Remote-PHY device, amplifier or cable modem. This flexibility allows operators to deploy unified devices and software across their network knowing they can choose between FDX and FDD based on their current footprint and future demands. As a result, network design can align closely with specific service requirements and growth projections. The silicon for all devices includes additional AI capabilities to enhance reporting and operations visibility, leading to more

intelligent devices that contribute to better performing networks with higher reliability.

FLEXIBLE DEPLOYMENT AND ENHANCED SUBSCRIBER EXPERIENCE

A key advantage of Unified DOCSIS 4.0 is the ability to align deployment strategies with real operational needs. Operators can determine whether FDX, FDD, Flex-FDD or a combination is best suited for each service area. As demands shift, such as increased need for symmetrical bandwidth, networks can be reconfigured. This adaptability is valuable for supporting a range of emerging applications, from live sports streaming to cloud gaming and remote work platforms that demand stable, high-speed connections.

Unified DOCSIS 4.0 also supports more granular spectrum management. Operators can dynamically allocate upstream and downstream spectrum segments, choosing split configurations that reflect current usage patterns or plant capabilities. This optimises network performance and resource utilisation, enabling more consistent and reliable subscriber experience.

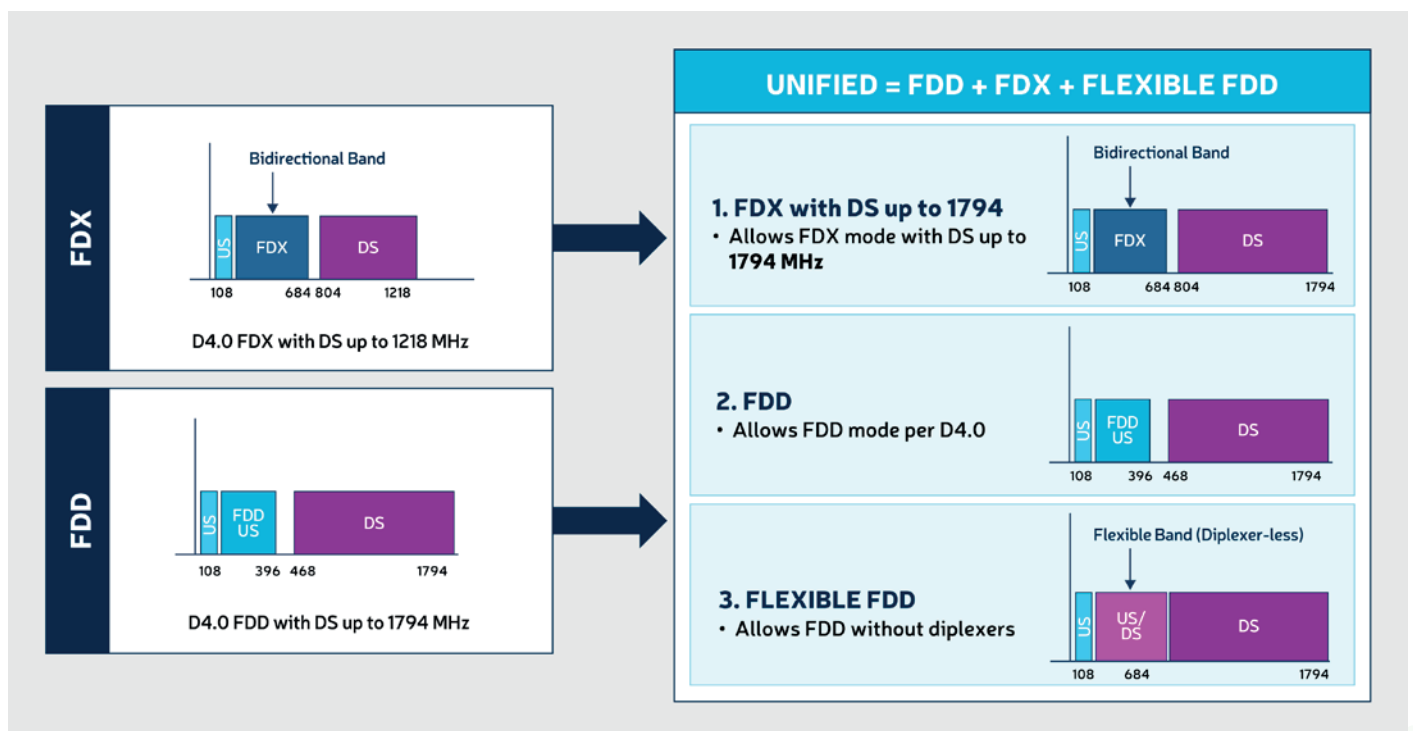


Figure 1: A Unified DOCSIS approach enables operators to support FDX, FDD and Flex-FDD through a single, software-defined platform — simplifying operations and accelerating network evolution.

FROM THE INDUSTRY

INTELLIGENT NETWORKS THROUGH EDGE AND CLOUD INTEGRATION

The transition to a unified and virtualised broadband platform brings further benefits, such as integration with edge computing and cloud-native management and operational tools. Artificial intelligence and machine learning enhance real-time monitoring, allowing networks to self-adjust to traffic variations or address emerging issues before they affect end users. Predictive analytics support proactive maintenance, reducing the likelihood of outages and limiting operational interruptions.

Centralised web-based management tools facilitate oversight of both DOCSIS and fibre assets. Operators can analyse network health, adjust configurations and implement changes from a single interface. This consolidation streamlines operations and reduces the need for specialised training or multiple systems.

Ultimately, AI-based monitoring and centralised management tools enable operators to maintain high-quality subscriber experiences. This leads to improved subscriber satisfaction and reduced churn.

EFFICIENT AND SUSTAINABLE NETWORK TRANSFORMATION

A Unified DOCSIS 4.0 approach emphasises incremental upgrades that leverage existing infrastructure, reducing both capital and operational costs. By adopting a software-defined architecture,

the need for frequent hardware replacements is minimised. Resource optimisation translates to decreased demands for space, power and cooling in network facilities.

From an environmental perspective, fewer hardware changes and energy-efficient components help reduce electronic waste and the carbon footprint of ongoing operations. Virtualised network elements allow for faster deployment cycles, enabling upgrades to roll out over weeks instead of months and supporting business goals with greater agility.

FOCUS ON LOW LATENCY TO PROVIDE LOW LAG SERVICES FOR OPTIMAL SUBSCRIBER EXPERIENCE

The capabilities of advanced cloud-native infrastructure allow operators to build on the introduction of Low Latency DOCSIS (LLD) capabilities to truly provide end-to-end network connectivity with techniques such as L4S (Low Latency, Low Loss, Scalable Throughput).

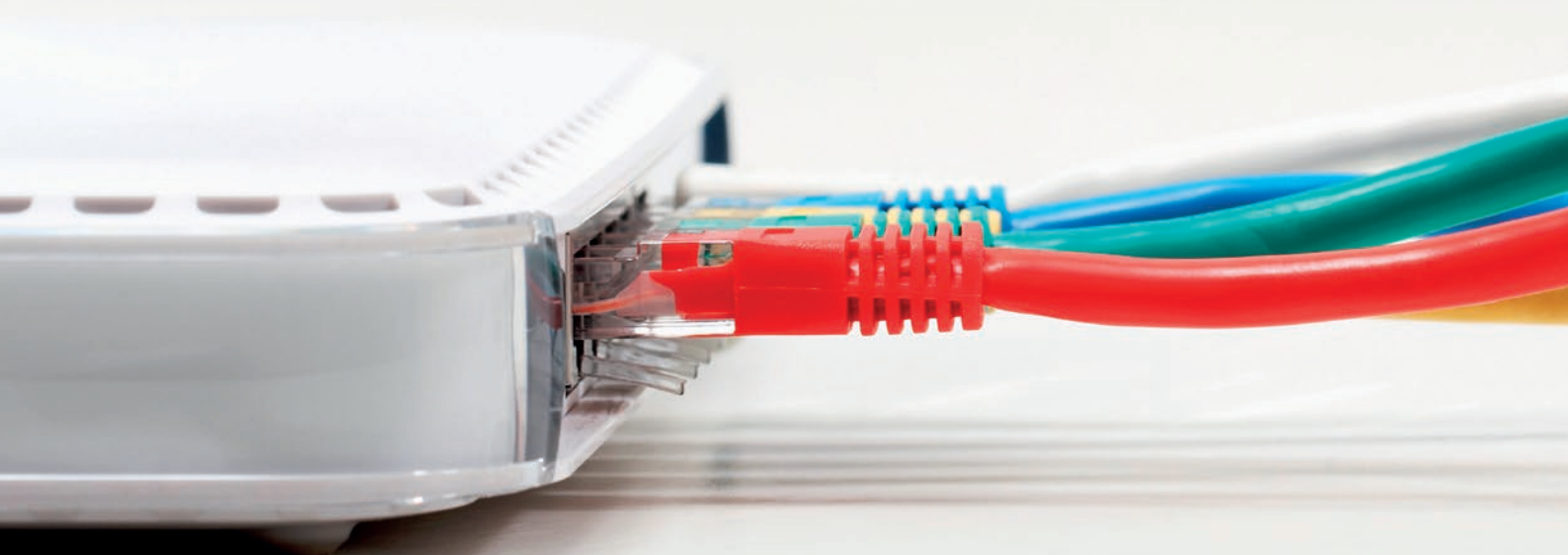
L4S allows for packet marking within subscriber applications to ensure priority for low-latency data, thereby enabling premium quality of experience. This is done by ensuring that data packets are marked for low-latency treatment not just between the cable modem and vCMTS (as LLD allows). But this treatment extends from

the subscriber's application — whether gaming, video messaging or virtual reality headset — through the CMTS and the operator's network, all the way to the gaming server. This approach provides a genuinely differentiated subscriber experience with consistent low lag service performance.

PATHWAYS TO PRACTICAL IMPLEMENTATION

The process of modernising broadband networks involves several practical steps. Operators have the option of deploying distributed access architecture (DAA) nodes that house one or multiple Remote-PHY devices or adapting existing DOCSIS nodes using retrofit solutions. Ensuring Remote-PHY devices can support both FDX and FDD is essential for a unified approach, providing operators with maximum flexibility.

Transitioning to virtualised broadband platforms supports more scalable network management. Maintaining backward compatibility with prior DOCSIS versions protects previous investments and allows for smoother operational transitions. Many operators benefit from phased deployment strategies, prioritising high-traffic areas and refining configurations as new segments come online.



UNIFYING DOCSIS AND FIBRE FOR NEXT-GENERATION BROADBAND

By embracing a Unified DOCSIS 4.0 strategy, broadband service providers can adapt to changing usage patterns and new application demands. As the expansion of fibre deployments continues, aligning management of DOCSIS and fibre services becomes increasingly valuable.

Edge compute, artificial intelligence and cloud-based management further enhance the adaptability and responsiveness of modern networks, enabling operators to offer reliable, high-quality broadband experiences across diverse technologies without making extensive infrastructure changes.

Virtualised broadband platforms allow operators to support DOCSIS, fibre and a hybrid combination of both deployment technologies from a single operational interface, facilitating resource allocation and simplifying operational processes. This integration makes it possible to maintain a consistent level of service quality for subscribers, regardless of the underlying network medium.

Moreover, combining DOCSIS FDX and FDD capabilities as well as fibre technologies such as GPON, XGSPON and future 25G and 50G PON in a single, virtualised broadband platform enables operators to meet evolving subscriber expectations by allowing for flexible deployment, efficient network upgrades and improved use of both DOCSIS and fibre assets.

With integrated AI and cloud tools, networks can adapt to real-time demands, ensuring resilient performance for modern broadband applications. A Unified DOCSIS 4.0 strategy supports sustainable growth and positions networks for future requirements, making it a practical solution for ongoing broadband evolution.

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