# TRANSFORMING THE NETWORK EDGE IN THE CABLE HUB

harmonic

Alcatel·Lucent

# PREFACE

Cable operators today are seeing their network capacity requirements double approximately every 24 months to keep up with customer demand and the launch of new services. Maintaining this high growth rate while managing costs has become a primary focus. Unfortunately, capacity growth and the launch of new services are often delayed because operators must wait for cable modem termination system (CMTS) vendors to add routing features and/or services on platforms that are not optimized to support them.

Reducing costs at the edge of the network is one fundamental approach all cable operators are driving. Two areas garnering the bulk of the attention are the CMTS and edge routing platforms. The Converged Cable Access Platform (CCAP), an industry-wide effort led by CableLabs that combines CMTS capabilities and the delivery of QAM channels on a single platform, addresses the first issue. CCAP is expected to significantly drive down per-channel costs, enable higher speed tiers, and facilitate rapid deployment of new services with deployments starting this year. Cable operators are also looking closely at the layers of routers present in the network and trying to optimize their infrastructures by eliminating routing where it makes sense to do so. In hubs today, there is likely a pair of full routers aggregating numerous CMTS that also have full routing capabilities. These redundant layers of routing, especially in a part of the network that generally only has a choice between two routes (east or west), is ripe for optimization.

The launch of new services frequently involves balancing routing and service roadmap development time across multiple vendors and access technologies. This essential development work must be completed while tempering senior management's expectations for speedy deployments. Historically, new services are often bolted onto existing networks. This approach assures an expedient launch by avoiding the expenditure of time required to fully develop and integrate the features. While this approach is acceptable for one-off scenarios to meet business needs, longer term it creates problems and ultimately delays future feature release and support. There is another approach — one that will likely improve service deployment times and provide a more reliable and maintainable solution. Cable operators can consolidate development efforts on fewer platforms when those platforms are designed from the beginning to accommodate growth and are better suited for advanced routing environments.

This paper explores one proposed architecture that leverages the new benefits of CCAP, is extensible to other access technologies, and eliminates redundant layers of routing. By combining these approaches, this architecture holds the promise of greater cost reductions than could be achieved by addressing each in isolation. It also enables faster deployment of new services and future access technologies by moving highly complex and costly routing technologies higher into the network, and onto equipment purpose-built to support routing and advanced network services.

**Michael S. Kelsen**
Senior Director and Chief Network Architect
Time Warner Cable

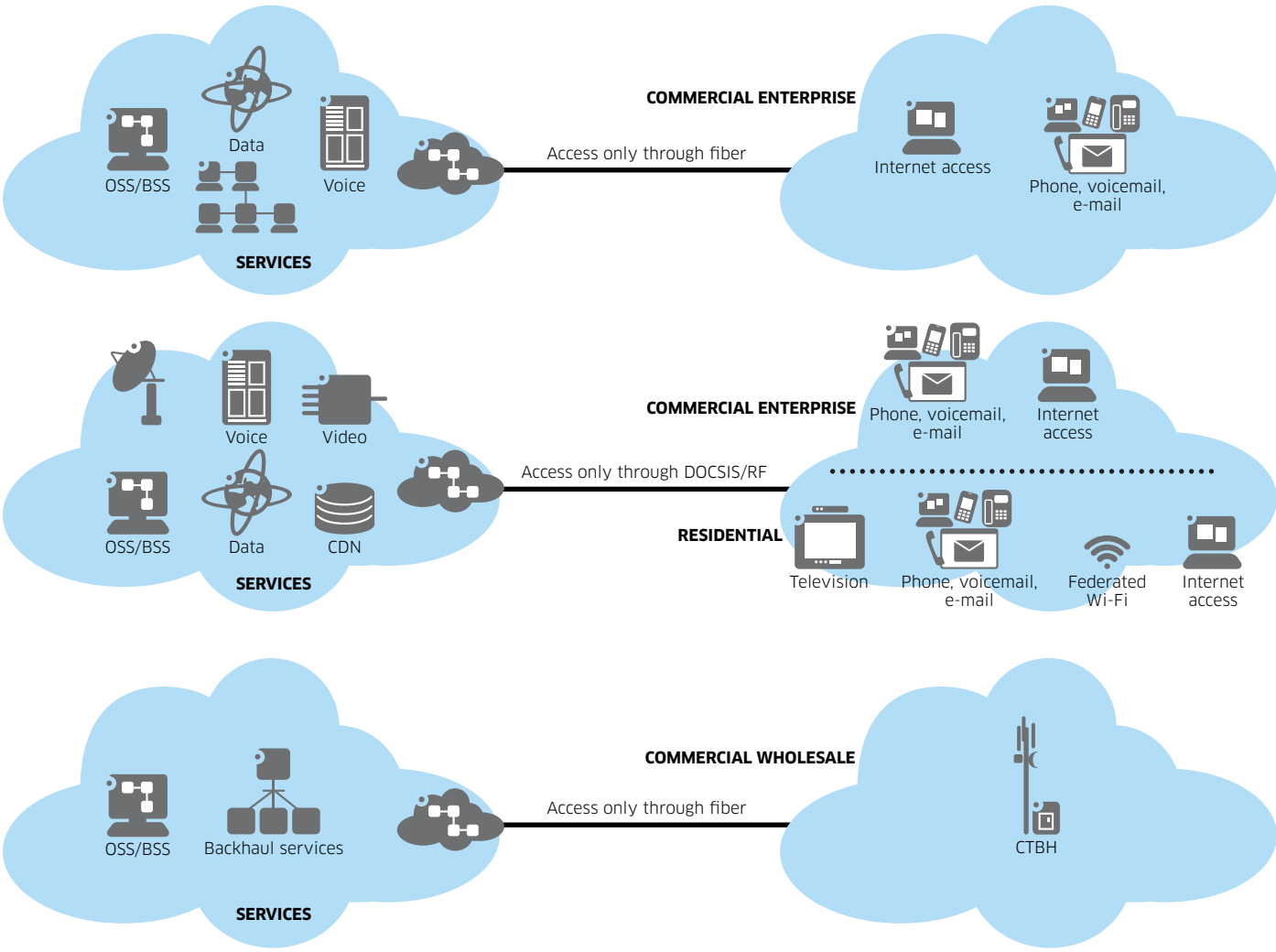
# TABLE OF CONTENTS

# INTRODUCTION

It's no exaggeration to say the cable industry has undergone a radical transformation in recent years, as it has evolved to meet the needs of commercial and residential customers. While in the past it was possible for cable operators to run a sustainable business by offering a handful of linear video channels to residential subscribers, increased competition and heightened subscriber expectations mean this is no longer the case. As cable operators increase their video offerings, add voice and data services, and begin to address commercial and carrier Wi-Fi® opportunities, they have taken an additive (bolt on) approach to these new service deployments.

This bolt-on method is placing cable operators in the untenable situation of needing to accommodate exponential growth in capacity by operating multiple parallel networks (Figure 1). As a result, cable operators are faced with the challenge of managing increasingly complex networks that hinder their ability to quickly and efficiently deploy new services.

**Figure 1. The multiple parallel networks managed by today's Cable Operators**



An increasing tension between scaling, the cost of cable access and the requirement to increase functionality is occurring at the edge of the cable network. Today's cable edge offerings simply do not possess the scalability and flexibility required to effectively address market requirements, and do not deliver the cost, space and power efficiencies required by cable operators.

# THE CHANGING MARKET LANDSCAPE

The pace of change in the industry is only growing faster. The number of smartphones and other video-capable portable devices is growing at an unprecedented pace. This growth, along with the constant introduction of new and compelling over-the-top (OTT) content sources, is impacting traditional cable operator's revenue streams, requiring an adjustment in business strategy.

Customers are becoming increasingly accustomed to the rapid new service introductions typical with the OTT model. They expect to have their service bundles available at all locations and on all devices. Commercial services are also growing in importance to the top and bottom line, while mobile services are becoming increasingly embedded in customers' mobile broadband-driven lifestyles.

## Meeting the challenge

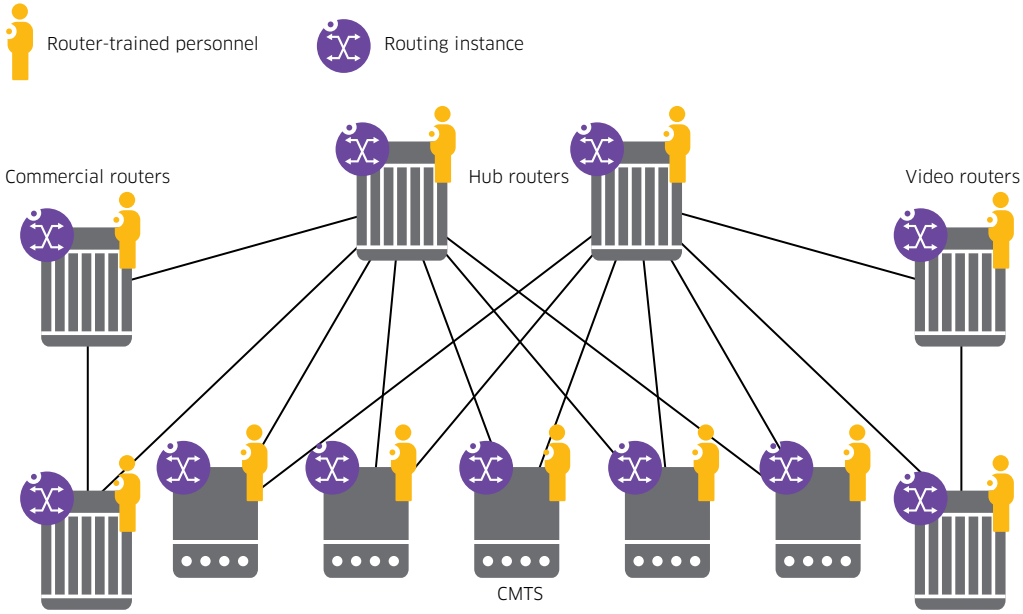
The new market landscape is driving transformation in the cable network at many levels, as cable operators adapt to the demands of new service offerings that were unheard of just a few years ago.

Video consumption no longer centers on traditional broadcast models with schedules defined by service providers and broadcasters. Today, it has become an on-demand experience where the user decides what to watch, when to watch, and where and how to watch. Video on demand (VoD) itself continues to evolve. Linear VoD came first, followed by the widespread deployment of set-top boxes (STBs) with integrated digital video recorders (DVR). In the not-too-distant future, cloud-based DVR services (cDVR) will take the video recorder out of the home and put it back in the cable operator's headend.

Commercial services provide a rich opportunity for cable operators to leverage their reach and footprint. Cable operators can diversify revenues and grow the business by going beyond basic voice and Internet to offer differentiated commercial services. These include service level agreement (SLA)-based Carrier Ethernet, virtual private networks (VPNs), managed cloud services with application awareness and security, and wholesale cellular or mobile backhaul.

Mobility must also be part of the solution. Cable operators are turning their attention to carrier Wi-Fi® technologies to remain competitive and to generate revenue as part of their mobile broadband strategies. Cable operators are contemplating community Wi-Fi, venue coverage and extended hotspot strategies — each of which has unique business and network implications — to meet business objectives. Carrier Wi-Fi can be a real game changer for cable operators, who can use it to make their service offerings available to subscribers not only when they are at home or their place of business, but also on the go.

**Figure 2. Routing complexity in current hub deployments**




To address multiscreen video, commercial services and mobility, cable operators have generally built and operated specialized silos, but this approach is not cost-effective. Multiple routers and routing protocols combined with inflexible access mediums have created a situation that makes deploying new services more complex, harder to implement and difficult to troubleshoot (Figure 2). Dependence on less-capable routing platforms, like today's cable modem termination system (CMTS), limits routing, scaling and service functionality at the cable edge. Also, this complexity requires large, specialized groups to support each function, meaning resources cannot be efficiently leveraged across the organization.

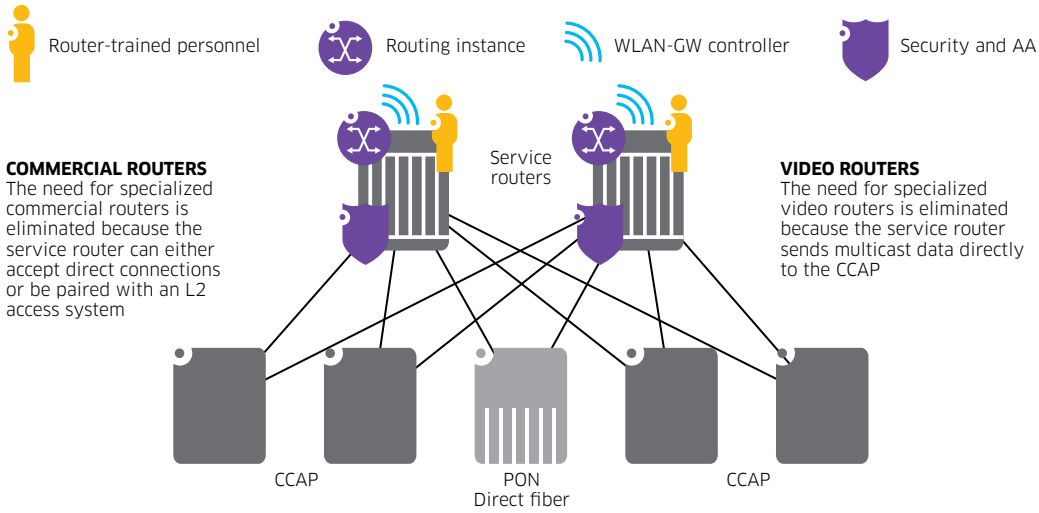
# THE SOLUTION: TRANSFORM THE CABLE NETWORK EDGE

## Adopt a flexible network edge

Network complexity can be alleviated by cable operators adopting a common flexible edge that separates the IP service router edge from the access technology (Figure 3).

The IP service router edge can eliminate one or more network IP aggregation layers. This approach delivers cost savings today and provides an access-agnostic service delivery foundation that can be used with current and future technologies.

**Figure 3. Flexible cable edge hub architecture**




A flexible cable edge hub architecture allows cable operators to deliver residential, commercial, wireless and network services with service awareness and differentiation (Figure 3) that can be connected across any access medium, including:

- DOCSIS
- PON
- Direct fiber
- EPoC
- Carrier Wi-Fi

A flexible edge architecture extends the reduced cost, reduced space and reduced power approach of the CCAP framework for cable access networks. It is designed to simplify overall network design and operation, enable service flexibility, and reduce overall network costs.

## Simplify cable access

Simplified cable access is rooted in the idea that cable operators need to increase their ability to deploy new products, features and services — and increase capacity — quickly. The CMTS products of the past have performed well enough to deploy initial high-speed data (HSD) and Voice over IP (VoIP) product offerings, but they are now strained to match current and future cable operators' demands.

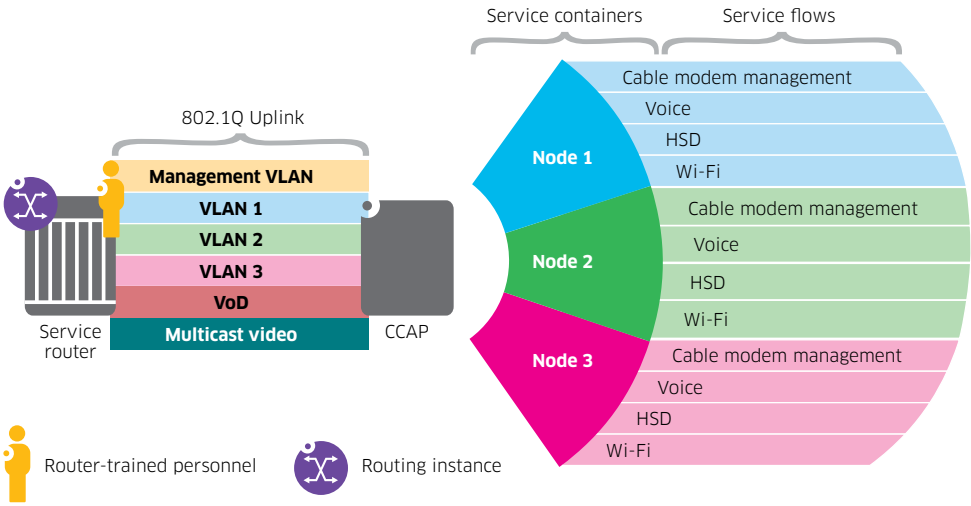
CCAP theoretically resolves plant and environmental limitations by defining specific minimum bandwidth and RF port capacity, and maximum power consumption, within specific physical sizing boundaries. That is a good start, but it does not address cable operators' requirements for flexibility, expanded services and optimized costs.

DOCSIS specifies the data-over-cable access protocols, providing interoperability of cable modems. CCAP defines the scale, performance and requirements of converged DOCSIS and edge QAM systems. In the more flexible cable hub, simplified cable access with Layer 2 forwarding allows cable operators to focus on delivering their services by leveraging the performance and scalability of the network devices that exist today, letting each network element excel functionally and cost-effectively.

Effective technology evolution can only occur when network elements are allowed to perform their intended function. In the simplified cable access network, each device can evolve based on the latest technology, specification and silicon. Example of domains that have orthogonal technology curves are IP routing and DOCSIS, where advancements in each domain are independent of each other. Simplified cable access decouples such technologies and localizes them in the intended network devices, which are feature-complete and scalable.

Simplified cable access leverages the superior service and routing capabilities of modern service routers while offloading routing functionality from the CCAP device. This approach enables cable operators to optimize the performance of their cable access and routing systems, and take advantage of independent yet complementary technology development curves. Decoupling significantly simplifies the development, testing and configuration of the CCAP device. This in turn increases overall system affordability and reliability, as well as the potential for network-wide simplification.

**Figure 4. CCAP deployment architecture**




Leveraging the superior routing features available in service routers, a Layer 2 (L2)-forwarding CCAP works with the service router to support all products and protocols in the cable hub. Moreover, the integration of the two is transparent to observers north of the service router and south of the CCAP (Figure 4).

By using Ethernet transport between the CCAP and a service router, the customer's service can be supported on the service router. If another access medium is chosen later, it simply needs to be connected to the service router.

An L2-forwarding CCAP provides the following high-level functionality:

- DOCSIS-compliant CMTS
- L2 DHCP Relay
- DHCP Lease Query
- PacketCable™ and PCMM
- DOCSIS Set-top Gateway
- EQAM functionality for M-CMTS, VoD, Switched Digital Video and linear broadcast applications

A CCAP device is always deployed with a defined northbound connection to one or two service routers. Therefore routing tables are not required for forwarding in a CCAP device. The service router attached to an L2-forwarding CCAP provides complete routing functionality, typically based on adaptive-routing algorithms (for example, BGP, IS-IS, OSPF). The service router terminates all routing protocols and contains all IP-layer configurations (subnets).

The service router provides the following high-level functionality typically performed by a routing CMTS:

- Manages all IP-layer configuration (for example, subnets)
- Configures DHCP Layer 3 relay agent (for example, insertion of giaddr)
- Populates ARP table via DHCP for all cable modems and customer premises equipment
- Terminates routing protocols
- Terminates commercial and enterprise VPN services

The video router and hub transport functions can also be consolidated onto the service router platforms. This helps to simplify the complexity of the cable access network by reducing the number of routers and routing instances within the edge hub, which in turn delivers OPEX and CAPEX savings.

Simplified cable access addresses the cable operator's requirements around flexibility, service and cost.

## Introduce next-generation access capabilities

Because a service router can feed any sort of access network (including, for example, carrier Wi-Fi, HFC and PON), cable operators can embrace different access types and introduce next-generation, high-bandwidth technologies. Support for smart and flexible scaling enables cable operators to respond quickly to business requirements. Cable operators can implement a completely IP-based fiber infrastructure and offer multiple services to multiple segments.

Commercial services can be consolidated onto the same service router platforms independent of the access technology used to connect them. For example, a cable operator could choose to offer fiber service to commercial customers in high-density areas and EPoC-based services to more remote businesses, all without disrupting the existing hub serving residential services.

Mobile carrier Wi-Fi services can also be consolidated onto the service router platforms enabling cable operators to leverage their footprint to address a range of carrier Wi-Fi market applications, such as hotspot, homespot and enterprise.

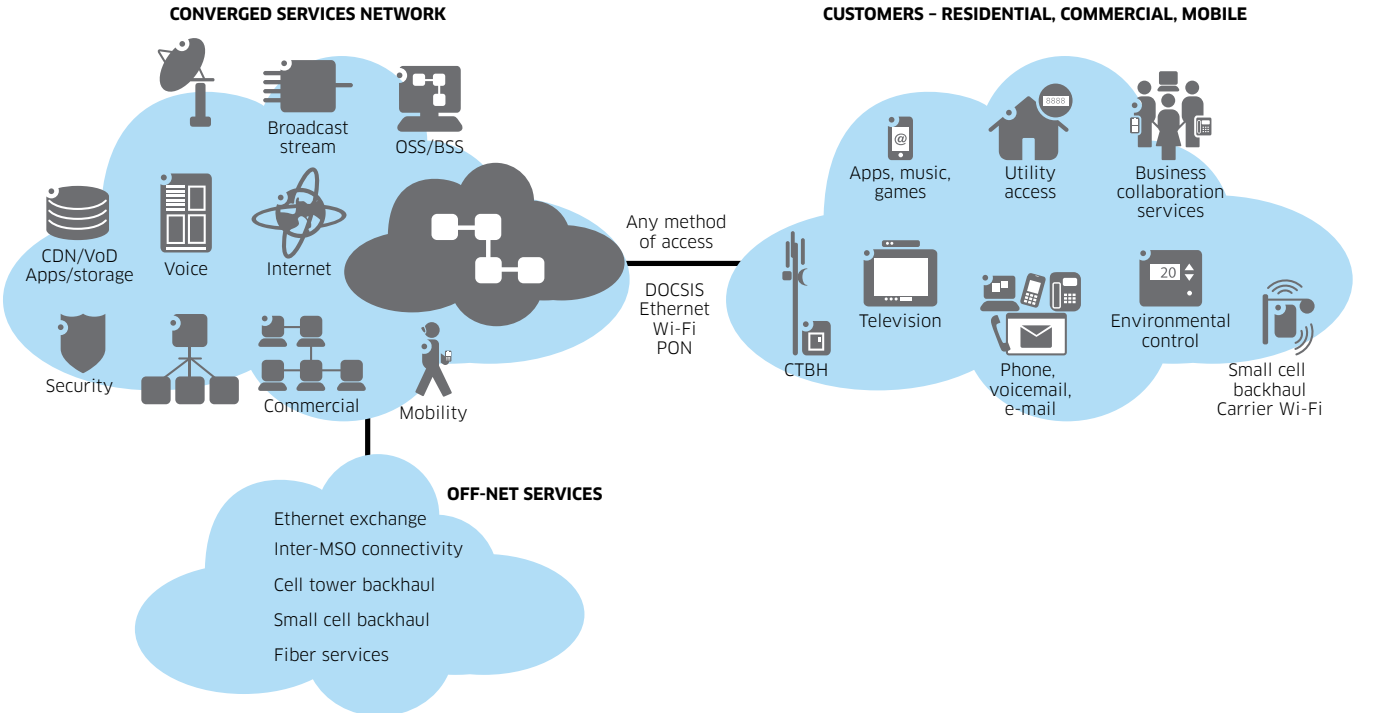
The next-generation network offers incomparable speed and quality of services to attract and retain high-margin customers, while providing efficient use of power and space within a simplified operating environment.

# CONCLUSION

The challenges currently facing cable operators are real, but so are the opportunities. Not only can Pay TV remain a compelling offering, multiple new revenue streams are available to cable operators that possess the ability to launch new services and enter new markets by leveraging their network.

A flexible cable edge hub architecture supports the evolution of residential, commercial and mobile services through service awareness, enabling the operator to differentiate its offerings from competitors. The simplified architecture will help cable operators reduce CAPEX and OPEX.

**Figure 5. Converged services network**




In this highly flexible architecture (Figure 5), the IP service routing plane is separated from the access technology. This IP service routing plane can be deployed behind multiple technology access networks (including current and future DOCSIS, Direct Fiber, PON and Carrier Wi-Fi), enabling cable operators to transition their access networks to leverage new and innovative technologies to match their business requirements.

Linking a CCAP system to the service router further transforms the cable access network. Edge QAM channels and CMTS capabilities are combined on a common platform, helping to simplify the network. With the routing functionality decoupled from the CMTS, cable access and service routing system performance can be independently optimized, improving reliability, and providing the ability for cable operators to more quickly take advantage of technology developments. Network capacity is also more scalable, making it easier and less expensive to launch new cable access based services.

The flexible cable edge hub architecture:

- Simplifies the cable hub while enabling migration from the existing network architecture to a future mode of operation
- Enables introduction of new technologies where network elements can evolve independently, leveraging industry technology development curves
- Delivers common personalized and differentiated services consistently across multiple access technologies
- Accelerates service innovation and deployment
- Provides a platform for future migration towards new network paradigms such as network personal video recorder, virtual customer premises equipment and cloud applications

The result of this simplified cable edge architecture is optimized performance, flexibility and scalability; reduced infrastructure costs; faster deployment of new services; and investment protection.

## ABBREVIATIONS

| | |
|---|---|
| AA | Application Assurance |
| ARP | Address Resolution Protocol |
| BGP | Border Gateway Protocol |
| BSS | Business Support System |
| CCAP | Converged Cable Access Platform |
| CDN | Content delivery network |
| CMTS | Cable Modem Termination System |
| CTBH | Cell tower backhaul |
| DHCP | Dynamic Host Configuration Protocol |
| DOCSIS | Data Over Cable Service Interface Specification |
| DSG | DOCSIS Set-top Gateway |
| EPoC | EPON Protocol over Coax |
| EPON | Ethernet Passive Optical Network |
| giaddr | Gateway IP address |
| GW | Gateway |
| HFC | Hybrid Fiber Coax |
| HSD | High Speed Data |
| I-CCAP | Integrated Converged Cable Access Platform |
| IP | Internet Protocol |
| IS-IS | Intermediate System to Intermediate System |
| L2 | Layer 2 |
| MSO | Multiple System Operator |
| OSS | Operations Support System |
| OTT | Over The Top |
| PCMM | PacketCable Multimedia |
| PON | Passive Optical Network |
| QAM | Quadrature Amplitude Modulator |
| RF | Radio Frequency |
| STB | Set-Top Box |
| VLAN | Virtual Local Area Network |
| VoD | Video on Demand |
| VoIP | Voice over Internet Protocol |
| WLAN | Wireless Local Area Network |

# ACKNOWLEDGEMENTS

**Editors**
Nick Cadwgan, Alcatel-Lucent
Keith Lissak, Harmonic

**Contributors**
Michael Kelsen, Time Warner Cable
Peyton Maynard-Koran, Alcatel-Lucent
Asaf Matatyaou, Harmonic


# CONTACTS


For more information please contact the editors by email at:
Nick Cadwgan, Alcatel-Lucent, n.cadwgan@alcatel-lucent.com
Keith Lissak, Harmonic, keith.lissak@harmonicinc.com

www.harmonicinc.com

www.alcatel-lucent.com