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The Edge Transformation of the Cable Hub

New Video Consumption Models Driving IP Data Traffic

A Technical Paper prepared for the Society of Cable Telecommunications Engineers
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Overview

PayTV service, the long-time MSO core business, has seen more change in the past two years than in the previous 40. Online Subscription Video on Demand (SVoD) services such as Netflix, Lovefilm and Amazon Instant Video have grown significantly, particularly in North America, providing new options for people to consume content. Internet and consumer device companies such as Apple and Google are experimenting with new user interfaces, and “new kids on the block” such as Netflix and YouTube are funding premium content initiatives, intending to develop original video content to compete with mainstream broadcast channels. Additionally, consumer expectations have fundamentally shifted; they expect to consume content when, where, and how they want it.

The proliferation of new IP-connected devices from tablets to gaming consoles to smart TVs points to the eventual obsolescence of the long-standing vertically integrated Conditional Access (CA) systems used to deliver premium TV service. Companion screens, new types of search, social, and content viewing apps, and app stores on smart TVs are fundamentally altering the premium video ecosystem, altering existing relationships and introducing a number of new players. Emerging web technologies such as HTML5 and WebRTC will continue to drive new players in the industry in the years to come.

The above trends will continue to fuel the growth of IP video consumption over the next several years and threaten to overwhelm existing cable data networks. Cable is at an inflection point. Our industry recognizes that it has to move faster, and it has to do so more affordably. Brian Roberts, CEO of Comcast, recently said: Cable is “now clearly in the cross-section, maybe uniquely, of media and technology. We're no longer a cable company or a broadcaster. We're right at a cusp of change in media and technology.”

To help drive this and future change more quickly, MSO edge networks have to become much more flexible to deliver the capabilities and scale required to effectively address the market requirements and deliver the operational and capital cost efficiencies required by MSOs.

MSO edge scaling challenge

Largely due to the way that the cable industry has evolved, MSO's find themselves in the difficult situation of operating multiple parallel networks as they have embraced new market opportunities. However, with data usage doubling every 2-3 years and market pressures on the MSOs to launch new residential and business services much faster than ever before, the access network must evolve to sustainably support the growth in capacity and the launch of new services. Expansion of service flexibility at the edge will be vitally important.

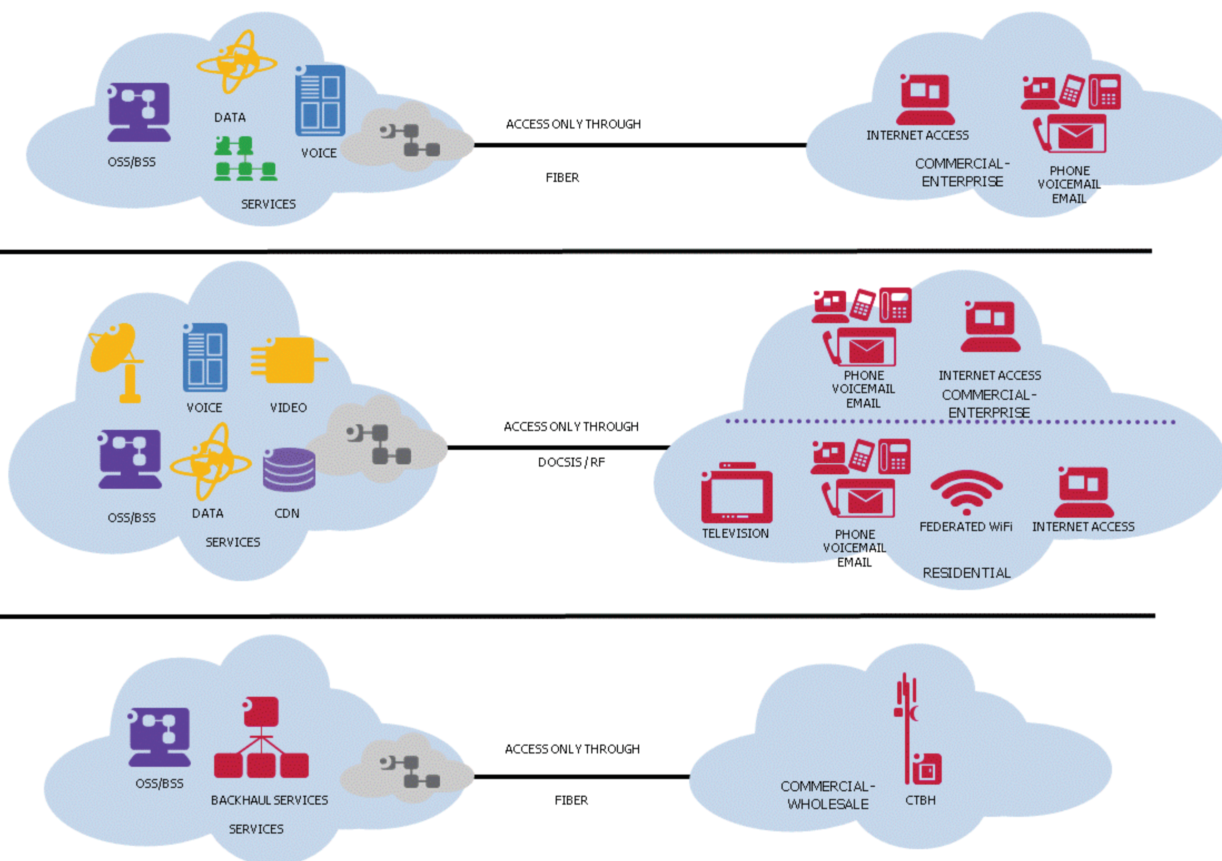


Figure 1: The current MSO

There is a real and growing tension between the scalability and cost of cable access versus the increasing features and functionality requirements of the edge. Cable hubs have become complex. The number of routers and routing protocols, coupled with the inflexibility of access mediums has led to a hub architecture that makes deploying new services harder to implement and troubleshoot. The complexity in the network also requires large specialized teams to support each function, often making it difficult to redeploy resources due to the specialty needed for each functional area.

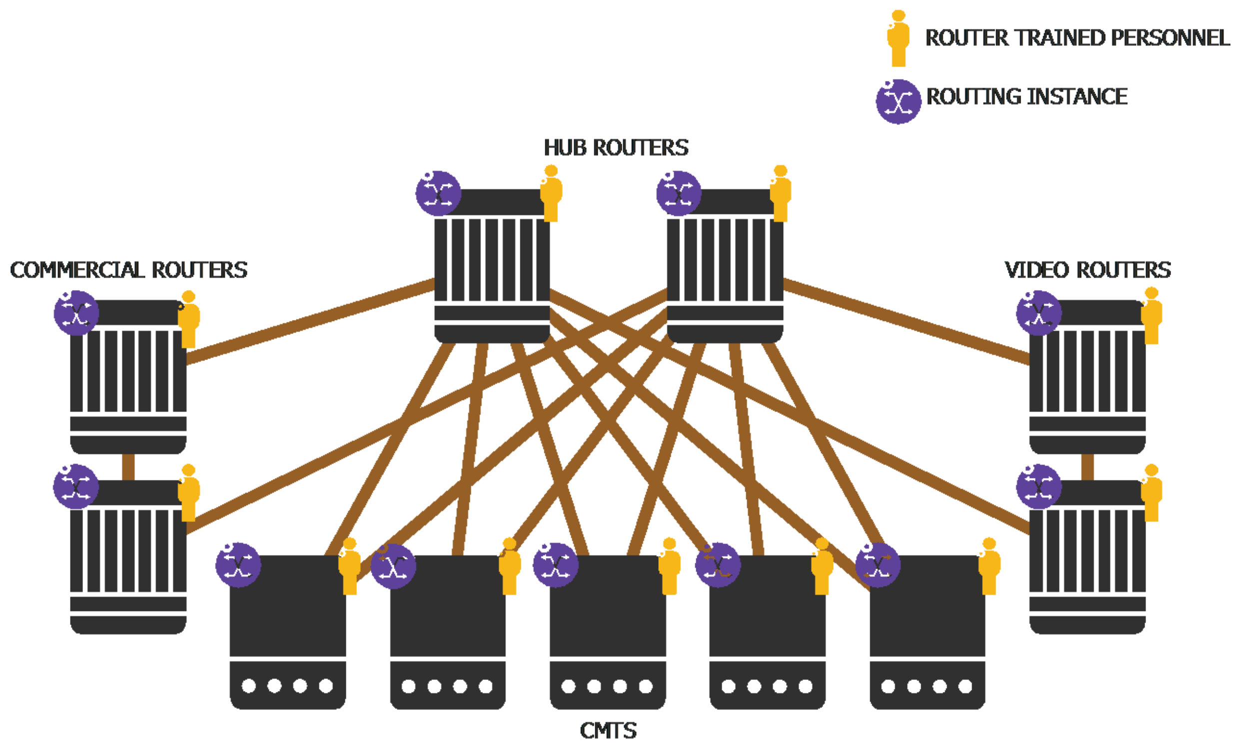


Figure 2: Current MSO Hub Deployments

MSOs have had to constantly deploy additional routers in their standard hub architecture because specific services were tied to access, and as they work to connect with more customers using an expanding set of access technologies this situation compounds the underlying issue. Access technologies, like DOCSIS®, are embedded inside the CMTS, and the customer's services are supported in the embedded routers. But those routers are not designed to support other access mediums, and cannot support the requirements of areas like commercial services, where MSOs are looking to expand their services and revenues, or video distribution because of their limited features and capabilities.

So parallel video and commercial networks were deployed to support these different services. Commercial customers that required Fiber or PON (passive optical network) access had to be supported on yet another router, here described as the Commercial Router while additional routers, here described as video routers, were deployed to support video distribution. Then all these had to be aggregated into a hub router for consolidated transport over the Optical network.

Cable access

Growing consumer high speed data and video service demand has MSOs upgrading Hybrid Fiber/Coax (HFC) access and DOCSIS® data networks by driving fiber deeper, deploying DOCSIS 3.0, and reclaiming analog video channels for other services. But upgrades require additional Cable Modem Termination Systems (CMTS) and Video Quadrature Amplitude Modulators (QAM) and routers in cable equipment hubs. Digital broadcast video and narrowcast video services such as Video on Demand (VOD) use QAMs to modulate and distribute signals across the HFC network. CMTS use DOCSIS technology to transport IP packets on HFC for high-speed data, voice and IP video including Over-The-Top (OTT) and user-generated video. CMTS also contain sophisticated Layer 3 (L3) routing functions, acting as integrated routers as well as DOCSIS access platforms, bridging IP in the access network to/from IP in the core network.

CMTS have also had a large impact on how cable hubs have to be physically engineered, including cabling, power and cooling requirements. The limited number of channels per port, or single channel per port, on a CMTS made RF combining a major task that required additional equipment and required additional room in the hub. It also made RF power balancing a much larger issue.

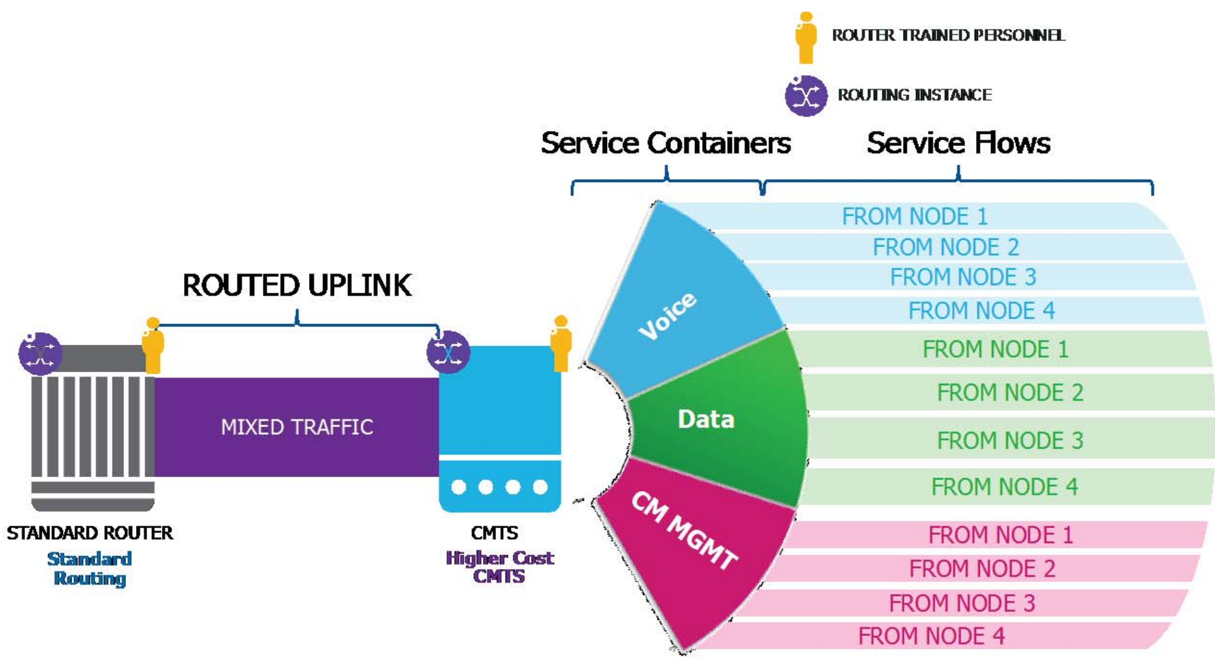


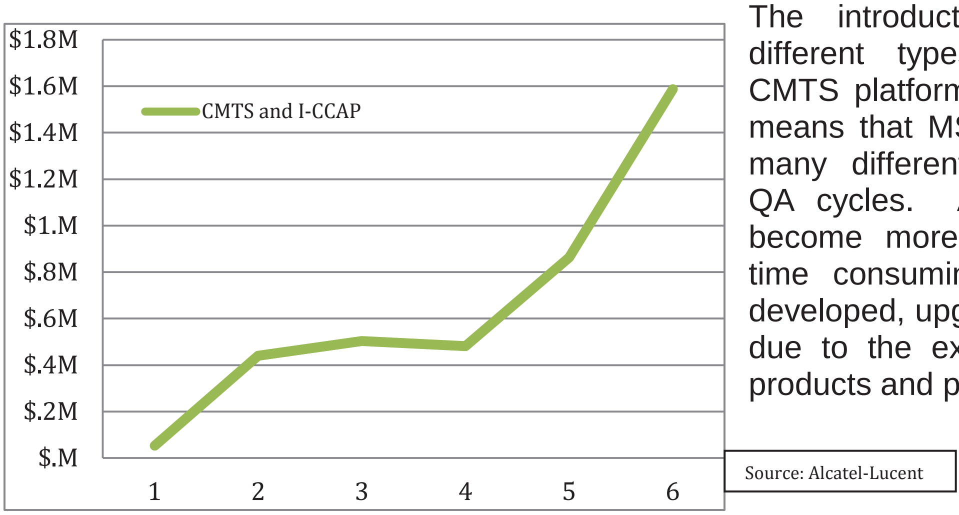
Figure 3: CMTS or I-CCAP Architectures

To address these issues and to achieve the scale required, the industry has defined the Converged Cable Access Platform (CCAP) specification. There are two approaches to

CCAP; I-CCAP (Integrated Converged Cable Access Platform) where routing functions are integrated into the same platform as the access functions, and a traditional, or modular, CCAP where the routing functions are handled separately from the access technology platform.

However, most existing CCAP options in the market today limit the number of RF channels per port, or the number of ports that can be utilized on the external QAM shelf, thereby limiting the flexibility and scalability required by the MSOs in their edge networks.

Hub complexity drives costs



The introduction of the many different types of routers and CMTS platforms into the hub also means that MSOs have to handle many different development and QA cycles. As a result, it has become more difficult and more time consuming to get products developed, upgraded and deployed due to the expanding number of products and platforms.

Figure 4: **Yearly Costs for a Hub with CMTS and I-CCAP Deployments**

This is driving more complexity into the hub architecture. In a typical small-medium sized hub that serves 48,000 homes passed, there could be up to 11 routers deployed, each requiring capital and operational support costs on an ongoing basis.

Reduce complexity, improve service velocity with Flexible Edge

There is an opportunity for MSOs to consolidate the dedicated infrastructure that is currently tied to supporting specific applications and services such as residential (multi-screen video), commercial and new emerging mobile (such as carrier Wi-Fi) services. We believe that MSOs can alleviate much of this complexity by adopting a common ‘flexible edge’ that separates the IP Service Routing plane from the underlying access technology. A ‘flexible edge’ is rooted in the premise that MSOs need to increase speed and deploy products quickly to meet the business requirements.

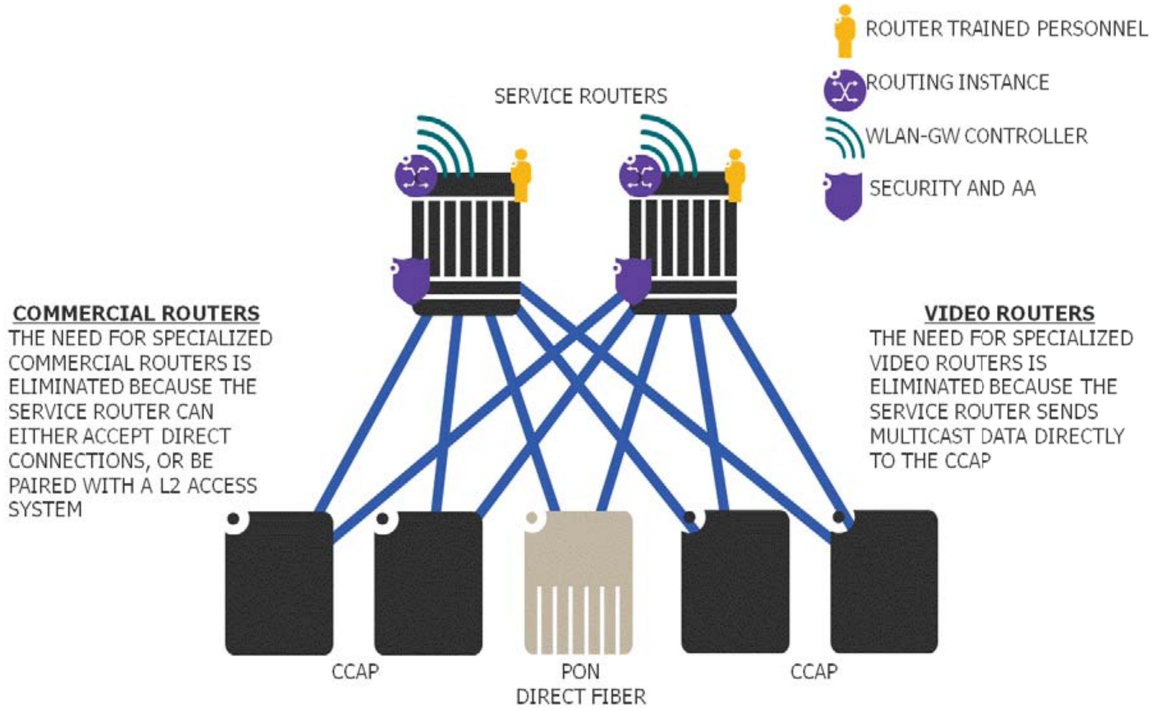


Figure 5: Flexible Edge

The IP Service Routing plane can eliminate one or more network IP aggregation layers. This would drive cost savings today and provide an access independent service delivery foundation that can be used with current and future access technologies.

The service-specific routers and hub aggregation functions can also be consolidated onto the flexible edge Service Router helping to simplify the complexity of cable access by reducing the number of routers and routing instances within the edge hub.

This transformational hub architecture allows MSOs to deliver residential, commercial, mobile and network services with service awareness and differentiation that can be connected across any access medium, including DOCSIS, Ethernet passive optical network (EPON), direct fiber, EPON protocol over coax (EPoC), and carrier Wi-Fi.

The flexible edge expands on the same reduced cost, reduced space, and reduced power approach of the Converged Cable Access Platform (CCAP) framework for hybrid fiber-coaxial networks, and shows tremendous potential to simplify overall network design and operation, to enable service flexibility, and to reduce overall network costs.

Simplifying cable access

Simplified cable access leverages the superior service and routing capabilities of modern Service Routers while offloading routing functionality from the CCAP platform. This enables MSOs to optimize the performance of their cable access and routing systems and take advantage of independent yet complementary technology development curves. This results in significant simplifications to CCAP development, testing, and configuration. In turn it increases overall system affordability and reliability, and provides network simplification that can deliver operational expense reductions.

Leveraging superior routing features available in Service Routers, a L2-forwarding CCAP connects to the Service Router in a way such that the combination of the two can support all MSO products and protocols. Moreover, the integration of the two is transparent to network elements north of the Service Router and south of the CCAP.

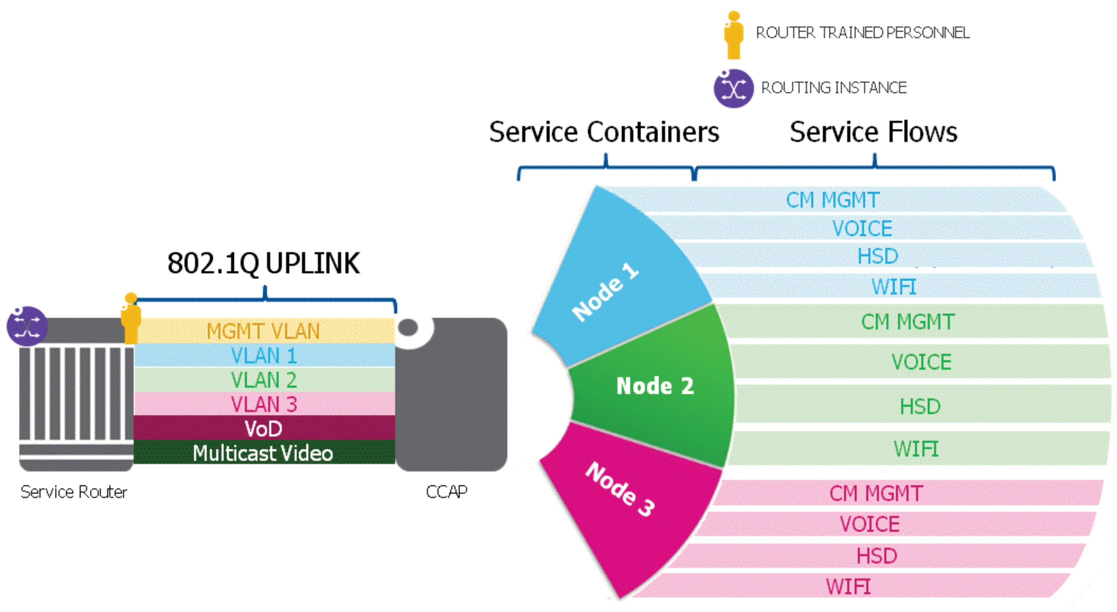


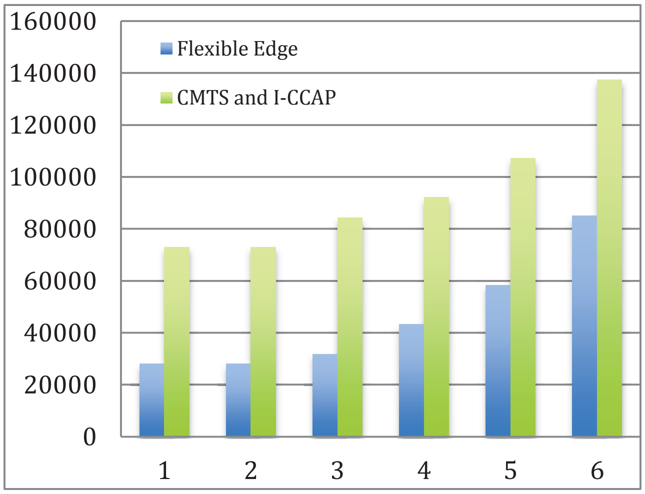
Figure 6: CCAP Deployment Architecture

Using Ethernet transport between the CCAP and a Service Router, the customer's service can be supported on the Service Router. With services supported on the Service Router, if another access medium is chosen later it simply needs to be connected to the Service Router.

Using this evolved cable access architecture within hub locations, we can extend and enhance DOCSIS architectures, delivering increased bandwidth to customers while delivering CAPEX (Capital Expense) and OPEX (Operational Expense) savings to the MSO.

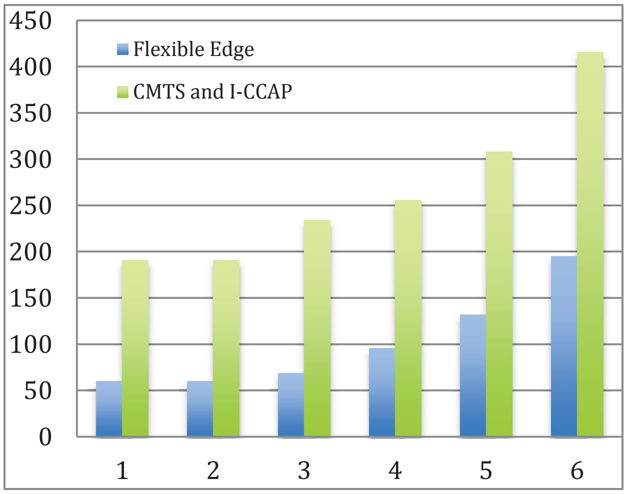
Realizing cost efficiencies

By employing the Flexible Edge architecture, cable operators can reduce the CAPEX costs and OPEX costs required to support their portfolio of commercial and residential service offerings in comparison to an Integrated CCAP approach. If we look at the power and space savings in the hub, we find that a Flexible Edge can reduce the total rack space and power for the whole solution. Working in partnership with several Tier-1 cable operators, our analysis shows that supporting 48,000 homes passed using Flexible Edge requires 51 rack units (RU) versus nearly 200 RU using an Integrated CCAP. This means that including all other devices such as optical transport, combiners, VoD Servers, fiber trays, etc; the new hub could be deployed in less than 5 racks using a Flexible Edge architecture.



Source: Alcatel-Lucent

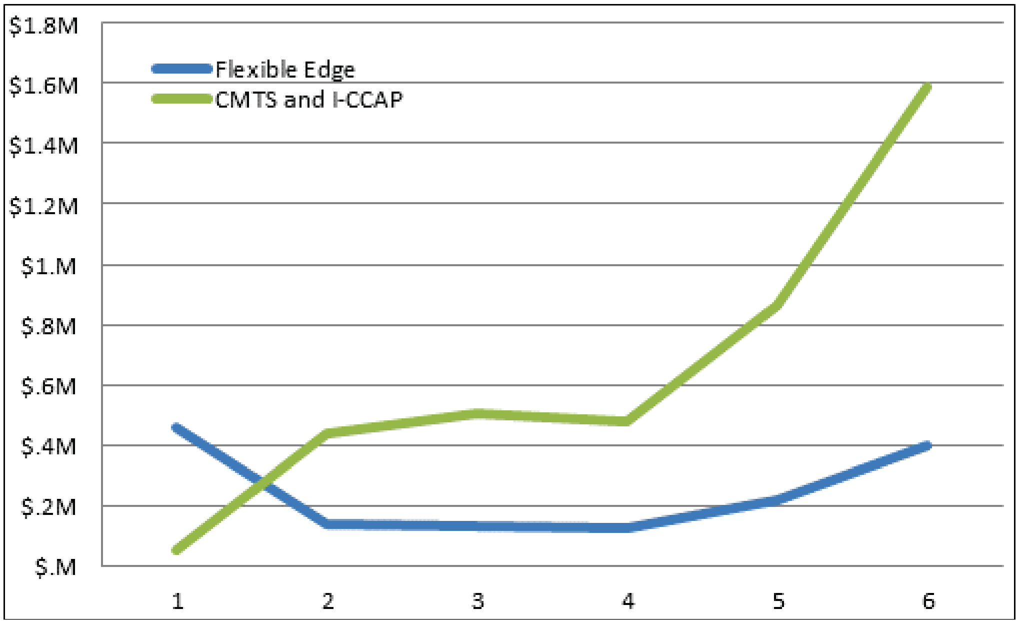
Figure 7: Max Watts Per Hub



Source: Alcatel-Lucent

Figure 8: RU per Hub

Extrapolating this architecture across all the hub locations in North America, we see that the potential savings are pronounced; while also providing a more flexible edge for MSO to rapidly deploy services and addressing the MSO requirements around scale, flexibility, functionality and cost.



Source: Alcatel-Lucent

Figure 9: Flexible Edge vs CMTS & I-CCAP Costs per hub per year over 5 years

Looking beyond cable access

Because a flexible edge Service Router can support any sort of access network (e.g., carrier Wi-Fi, HFC, PON), MSOs can embrace different access types and introduce next-generation, high-bandwidth technologies quickly and easily using this architecture. This enables smart and flexible scaling that can be driven by the business requirements of the MSO. MSOs can fully embrace a full IP-based fiber infrastructure offering multiple services to multiple segments using a flexible, common service edge.

Commercial services can be consolidated onto the same Service Router platforms independent of the access technology used to connect them. For example, an MSO could choose to offer direct fiber service to commercial customers in high-density areas and EPoC-based services to more remote businesses, all without disrupting the existing HFC plant serving residential services.

Mobile carrier Wi-Fi services can also be consolidated onto the Service Router platforms while leveraging the MSO footprint to address a range of carrier Wi-Fi market applications such as Hotspot, Homespot and Enterprise.

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

Conclusions

In this paper we have proposed a transformational cable edge hub architecture that can support MSO's residential, commercial, and mobile service evolution with service awareness and differentiation, while lowering CAPEX and OPEX.

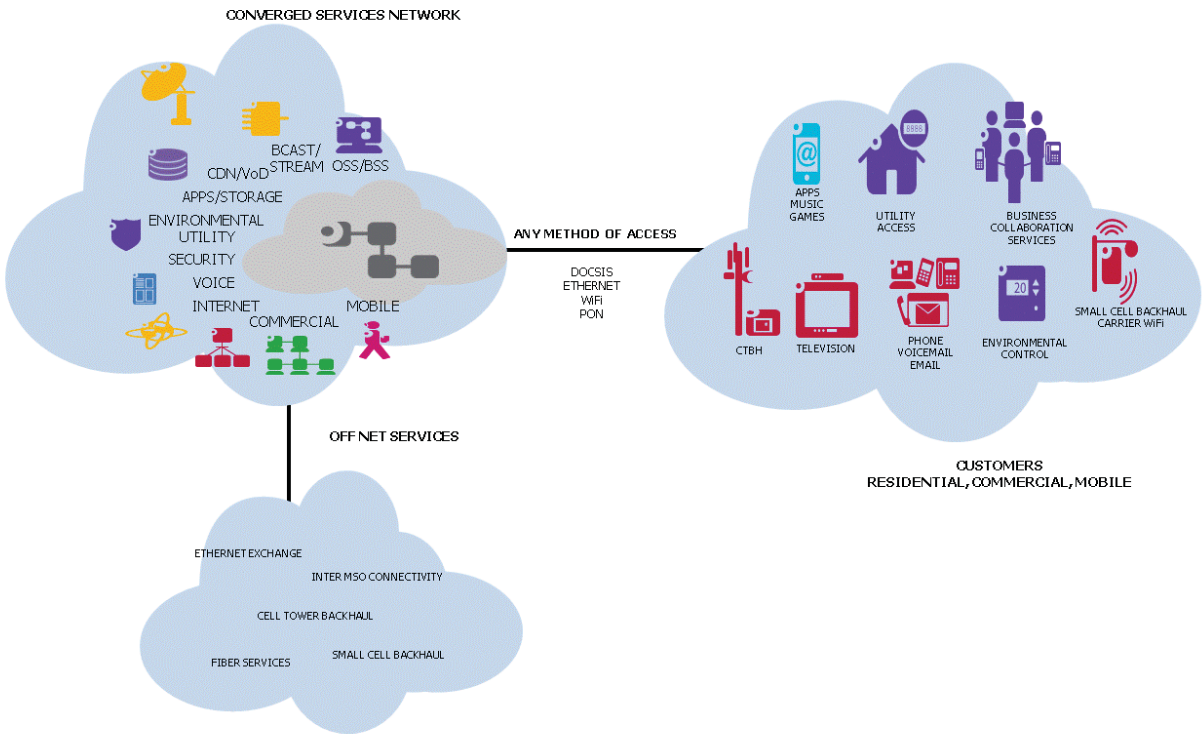


Figure 10: Converged Services Network

The architecture includes a flexible edge, which separates the IP Service Routing plane from the access technology. The IP Service Routing plane can be deployed behind multi-technology access networks (CMTS, CCAP, Direct Fiber, PON, carrier Wi-Fi, …) enabling MSOs to transition their access networks to leverage new and innovative technologies to match their business requirements as required without disruption and undue expense.

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

Bibliography

Interview with Brian Roberts CEO Comcast Article URL:
http://management.fortune.cnn.com/2012/12/13/comcast-brian-roberts/

Abbreviations and Acronyms

802.1Q	IEEE standard for support of Virtual LANs
CA	Conditional Access
CCAP	Converged Cable Access Platform
CDN	Content Delivery Network
CEO	Chief Executive Officer
CMTS	Cable Modem Termination System
CTBH	Cell Tower Backhaul
DHCP	Dynamic Host Configuration Protocol
DOCSIS	Data Over Cable Service Interface Specification
EPOC	EPON Protocol Over Coax
EPON	Ethernet Passive Optical Network
HFC	Hybrid Fiber Coax
HSD	High Speed Data
HTML5	Hypertext Markup Language 5
I-CCAP	Integrated Converged Cable Access Platform
IP	Internet Protocol
L2	Layer 2
L3	Layer 3
MSO	Multiple System Operator
OSS/BSS	Operational Support System/Billing Support System
OTT	Over The Top
PON	Passive Optical Network
QA	Quality Assurance
QAM	Quadrature Amplitude Modulator
RU	Rack Unit
SVOD	Subscription Video on Demand
VoD	Video on Demand
VLAN	Virtual LAN
WebRTC	Web Real Time Communication