

Comments
for
The Definition
of an
Open Access Architecture



Acknowledgement and Disclaimer

These comments are a result of the request for comments by the National Telecommunications and Information Administration (NTIA), U.S. Department of Commerce; and the Rural Utilities Service (RUS), U.S. Department of Agriculture in regards to the American Recovery and Reinvestment Act of 2009 Broadband Initiatives, [Docket No. 090309298-9299-01]

These comments are afforded by Broadband Wizards, LLC. Broadband Wizards provides telecommunications consulting services to communities, municipalities and service providers by assisting in the development a “Broadband Community Network” from conception to implementation and operation through a six-step Community-wide Network Planning Process: 1.) Community Network Planning Task Force Development. 2.) Network Assessment and Vision. 3.) Network Applications and Priorities. 4.) Network Planning and Engineering. 5.) Community Network Services, Administration and Funding. 6.) Community Network Implementation and Operation.

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Preface

In 2006, a study on “Local Open Access Networks For Communities and Municipalities” was commissioned by infoDev and jointly developed by infoDev and The Oplan Foundation for The International Bank for Reconstruction and Development². One of the key findings of the study was that access to the internet was considered as a prerequisite for improving any country’s economic and social welfare, because it may provide a conduit to enable open and accessible government, enhance business competitiveness, and improve the quality of their citizens’ lives, through the improved delivery of specialized services, telemedicine, and education.

As a potential solution, the Study specifically considered the provision of “*local open access networks*”, to include certain key features:

- They have in most instances *true broadband capacity*. This capacity is likely to be constrained only by the physical capability of the digital hardware and software that is deployed, rather than by some artificially imposed business model.
- They serve a *local geographic community* ranging from a street or business park or housing block right up to an entire town or city. Such networks do not encroach upon the trunk and international networks of the conventional telecommunications sector, nor do they subsume local area networks within homes and office buildings.
- These networks are, in one sense, a *public utility for the information society*. They are intended to be used by any party located within the community it serves - public and private, business and residential.
- They are *operated on an open basis*. These networks are owned and controlled independently of any service or content which runs over it. This affords anyone connected to the network to take or provide content or service from or to anyone they choose. They facilitate market entry by removing the high fixed costs associated with the need for each competitor to deploy its own infrastructure.
- Finally, the key feature of the legal structure of these local open access networks is that they have a *corporate governance culture and structure* that places emphasis on serving the “common good”.

The “Broadband Highway will become as important to a cities economic vitality as the rivers, railways, highways and interstates have been over the last 150 years”.



1800's - Rivers



Late 1800's – Early 1900's
Railways



Mid 1900's – Today
Highways/Interstates

Exhibit 1. History of Access

Open access – Maximizing Service Innovation vs. Network Neutrality

To further enjoin the Broadband Highway, let’s say that you owned the Highways and Interstates, and you wanted to maximize the number of goods and services sold on your road, which would be the fastest and most efficient way to do so; close the road to other businesses and invent all the goods and services on your own, or open the road for use by as many entrepreneurs as possible? Which way would create the most jobs? Which way would create the most economic stimulus? If you answered to open up the road, you might be right. If you want to maximize innovation in services, open access is one way to go. However, while the technologies and business models to support open access are available, for broadband, this has not been the case. While we have the solutions based upon Internet Protocols (IP), the networks cannot handle the complexities of efficiently managing triple play services for one company over one network, never mind support the efficient delivery of hundreds of services from hundreds of different companies, all over many different types of connections. The world has neither the business models nor the technologies needed to support open access broadband networks or network neutrality. They have to be invented.

Executive Summary

Next Generation Networking (NGN) is a broad term to describe some key architectural evolutions in the telecommunications core and access networks that will be deployed over the next 5-10 years. The general idea behind NGN is that one network transports all information and services such as voice, data, video and all sorts of applications by encapsulating these into packets, using techniques that are similar to the techniques used to access the Internet. NGNs are commonly built around the Internet Protocol, and therefore the term "all-IP" is also sometimes used to describe the transformation towards NGN. For the "Next Generation Architectures," the International Telecommunications Union (ITU) definition states that, "a Next Generation Network (NGN) is a packet based network able to provide services including Telecommunication Services or telephony, and able to make use of multiple broadband, Quality-of-Service (QoS) enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies." The NGA will offer unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

From a practical perspective, NGN involves three main architectural changes that need to be looked at separately:

1. In the core network, NGN implies a consolidation of several (dedicated or overlay) transport networks each historically built for a different service into one core transport network (often based on IP and Ethernet).
2. It implies amongst others that the migration of voice from a switched architecture "Public Switched Telephone Network (PSTN) to Voice over IP (VOIP).
3. It is also the migration of legacy services to either commercial migration of the customer to a new service like IP VPN, or technical emigration by emulation of the "legacy service" on the NGN.

In telecommunications, the traditional definition of **Open Access Networks (OANs)**, refer to horizontally layered network architectures and business models that separate the physical access of networks from service provisioning. The same OAN will be used by a number of different providers that may or may not share the investment or the maintenance costs. The term was coined by Roberto Battiti on 2003 in his article "**Global growth of open access networks: from warchalking and connection sharing to sustainable business.**"¹

The OAN concept had its origins in the deployment of the metropolitan Wireless Internet (WiFi) Access Networks where exclusivity is typically not allowed. Open access networks are also viewed as feasible way of deploying next-generation broadband networks in low population density areas where service providers cannot obtain a sufficient Return on Investment (ROI) to cover the high costs associated with trenching, right-of-way encroachment permits, and the requisite network infrastructure. In contrast to traditional municipal networks where the municipality owns the network and there is only one service provider, the open access model allows multiple service providers to compete over the same network at wholesale prices. In theory, this allows service providers to make money in the short-term and the municipality, cooperative or community to recoup its costs over the long-term. The build-out and infrastructure has typically been financed through low-cost bonds, but today, these costs will be financed in part or wholly by the Broadband Technologies Opportunity Program, Docket No. 090309298-9299-01.

These comments regarding the definition of Open Access Networks are primarily aimed at leaders and local policy makers that will fully define the process and steps that are to be used to grant financial assistance to service providers, municipalities, cooperatives or communities. Broadband Services Providers throughout the United States in these unserved and underserved communities, are faced with the complex and daunting task of facilitating and delivering to citizens, businesses and government the benefits accrued from accessing the internet. It also serves as a useful source for donors and development agencies, who may wish to understand the dynamics of emerging markets, when considering the provision of grants and loans specifically for local communications projects. National policy and regulation, as tools of 'public interest', should also, of course, be scrutinized to identify if alternative approaches can at least complement, if not challenge, current strategies to bridge this digital divide. Furthermore incumbents' views on, commercial viability of networks in rural and remote regions, local public sector engagement and attitudes towards potential competition, should also be part of the debate, as if resolved, these issues would further reduce the enormity of this challenge. The argument for Open Access Architectures should not be one of IP and Network Neutrality issues alone.

One key consideration for many services providers is to recognize the value of their existing copper infrastructure; the second school of thought, Fiber-to-the-node (FTTN) architectures. FTTN may also be called fiber to the neighborhood or fiber to the cabinet (FTTCab), is a telecommunication architecture based on fiber optic cables that are run to a cabinet serving a neighborhood. Customers connect to this cabinet using traditional twisted pair wiring. FTTN offers operating companies an alternative solution to providing the necessary bandwidth required by today's voice, data, and some limited video services while taking advantage of existing infrastructure. In many cases, FTTN can actually complement or lead to FTTH/P deployments.

Finally, there is a fiber-to-the-curb (FTTC) solution that extends fiber deeper into the serving area (SA) while taking advantage of the existing copper infrastructure similar to FTTN. FTTC boasts 24 Mbps over Asymmetric Digital Subscriber Line 2+ (ADSL2+), while Very High Speed Digital Subscriber Line (VDSL) and Very High Speed Digital Subscriber Line 2 (VDSL2) boasts 50 Mbps and 100 Mbps to the home respectfully. Certainly the question surrounding this architecture is whether the 50 to 100 Mbps will be adequate and for how long.

At the end of the day, the key consideration in choosing which architecture will work best for any provider boils down to bandwidth – now, and more importantly, in the future. This paper addresses several key considerations in helping service providers decide if FTTN or FTTC makes sense for all or part of their network. A subsequent follow-up to this paper will address the infrastructure costs by region.

For example, if a high percentage of a provider's network is already designed using digital loop carrier (DLC) remote terminals, it may make more sense to deploy FTTN from an economic standpoint. Traditional telephone service providers seeking to offer additional broadband services over an existing copper-based voice network may find FTTN more advantageous and less costly than building a new network that takes fiber all the way to the customer. However, with every advantage, there are trade-offs, or disadvantages.

The Business Case

Every operating company must consider its own business case in relation to the capabilities of the existing network. Since FTTN and FTTC both strategically seek to leverage existing facilities as much as possible, it will ultimately come down to what each individual carrier sees as the real demand for customer bandwidth – and possibly, where that demand will be five to ten years from now. Additionally, whether you choose the FTTN or FTTC strategy as an early alternative to FTTP for rapidly providing broadband services to customers, it's important to ensure network longevity.

Any solution should include an easy migration path to FTTP if future bandwidth demands exhaust the bandwidth capabilities of the current infrastructure. Installation cost is always the primary concern in making a business case for the network architecture. The FTTN architecture may be less expensive to install than FTTP because it re-uses legacy infrastructure for the final 3000 to 5000 feet. But, as stated earlier, installation costs alone should not necessarily dictate choosing FTTN over FTTP, particularly if the FTTN overbuild network will only provide a five-year life in terms of bandwidth demand. With FTTC, we are serving less homes, and take the fiber even deeper into the SA; typically between 1000 and 3000 feet. With FTTC, operating companies may find that the transition to FTTP is even easier.

Service providers may find themselves in the position of deciding which course of action is more prudent in the long run – reaching customers ahead of competitors with either an FTTN or FTTC overbuild that may require upgrades in a few years, or spending more money for a new FTTP network that will provide all the necessary bandwidth for years to come. In other words, FTTN and FTTC may have the potential for faster return on investment, yet it may require a complete overhaul at some point – possibly sooner than later, depending on consumer bandwidth demand.

One other consideration in choosing FTTN/FTTC vs. FTTP depends on how much of the network is rural and how much is metro. An operating company can leverage FTTN in areas with limited customers and lower entry costs in rural areas, making broadband services available to customers more quickly.

Bandwidth – How much is enough?

Why do we need so much bandwidth? While the Internet is expanding, video appears to be the biggest draw on the competition front. With any DSL service, the only way to deliver video is over an IP transport mechanism. With Video over IP, one key unknown in the broadband services equation is how much bandwidth will be enough to support video into the next decade. Will 50 Mbits/sec be enough? 80 Mbits/sec? 100 Mbits/sec?

It is not the intent of this paper to discuss the key differences between video coding techniques, but for the moment, the Motion Picture Experts Group or MPEG have determined that content provided to the consumer must adhere to certain standards where quality is a key concern. There are two encoding schemes that provide video content at various levels of bandwidth requirements. MPEG2 where Standard-Definition Television (STV) is delivered at a rate of 2.5 to 3.5 Mbps per channel while High-Definition Television (HDTV) is delivered at a rate of 12 to 20 Mbps per channel. MPEG4 encoding schemes typically cut the bandwidth requirements in half, where a High-Definition Television (HDTV) delivery requires about 9-10 Mbps, enabling consumers to receive at least two HDTV signals from a 24-Mbps Asynchronous Digital Subscriber Line2+ (ADSL2+) service. Without knowing content requirements of the future or how much bandwidth will be required to deliver new applications and services, ADSL2+ could easily come up short in just a few years.

Pair bonding can be used to produce higher bandwidth capability from FTTN build-outs that use copper-based “last mile” architectures, and VDSL over FTTC architectures may delay the inevitable, but there are other issues that must be considered to successfully implement FTTC. For example, FTTC may require using more of the Remote DSLAMs to serve fewer customers. If the distribution area requires re-distribution due to distances exceeding 3000 feet, deploying a VDSL network will require more cabinets to be deployed within the SA. Furthermore, if existing cross boxes do not have the necessary binding posts to support them, pair bonding can quickly become very complicated and expensive. Another wildcard in making a decision between FTTN or FTTC and FTTP is in knowing what changes will occur in active components over the next few years. As these components improve, the bandwidth guessing game gets more and more complicated. Where does this leave the network architect?

Business cases must be determined by customer needs today and the best determination of what they will need in the future. An increasing demand for additional bandwidth for cutting-edge broadband services seems like the one thing everyone agrees on. But will the network upgrades to provide that additional bandwidth be a simple matter of swapping out a card at each end of the network? Will it require a higher quality fiber plant to support high-end services? Will factors like better forward error correction techniques enable longer use of existing infrastructure?

The Long and Short of FTTN/FTTC

For “Brown-Field” architectures, FTTN and FTTC offer several advantages over the short term to operating companies that want to be first in reaching customers with today’s broadband services. Because it re-uses existing infrastructure to the customer, turn-up can be achieved faster to meet immediate consumer demand. For the same reason, FTTN/FTTC may be less expensive in an overbuild deployment and may provide a faster return on their investment.

However, there are still many unanswered questions about bandwidth demand over the long term that can not be ignored. Both the FTTN and FTTC architectures may continue to have bandwidth limits that may be exceeded; perhaps in five years or less. On the other hand, FTTP is certainly a more future-proof network design. In green-field models, there is no question it is the architecture of choice. It cannot be overstated that any decision to deploy an FTTN or FTTC overbuild network should include a solution that provides a relatively easy migration to FTTP.

In the end, the final decision for FTTN and FTTC networks boils down to current architecture needs and several considerations that each operating company must resolve. Is it more advantageous to opt for an initial cost savings model with faster return on investment? Can we depend on technology improvements that will allow us to avoid the need to upgrade in the near future? Or is it more important, despite additional costs, to upgrade directly to FTTP to ensure future-proofing the network against any future bandwidth demand?

There is no “one size fits all” solution when transforming the traditional switched approach network into a high-speed, high-capacity broadband network. These are challenging days for any service provider – but making decisions based on today’s information coupled with a concern for future events will help network architects develop a solid business plan that meets each unique situation.

The Open Access Definition

Exhibit 3 below is a simplified block diagram of how the Open Access Concept may look. The model of the “modern” open access architecture is one where we may have separate and possible multiple owners of the active components that would be located in the Central Office or Head End, separate or multiple owners of the passive components which would include the outside plant (OSP) infrastructures of copper/fiber, connectivity, couplers, closures and access, and a separate set of service providers for triple play or quadruple services of voice, data, video and other services. Historically, in the United States, a single service provider owned most or all of the network and services as depicted in Model 1 of Exhibit 3.

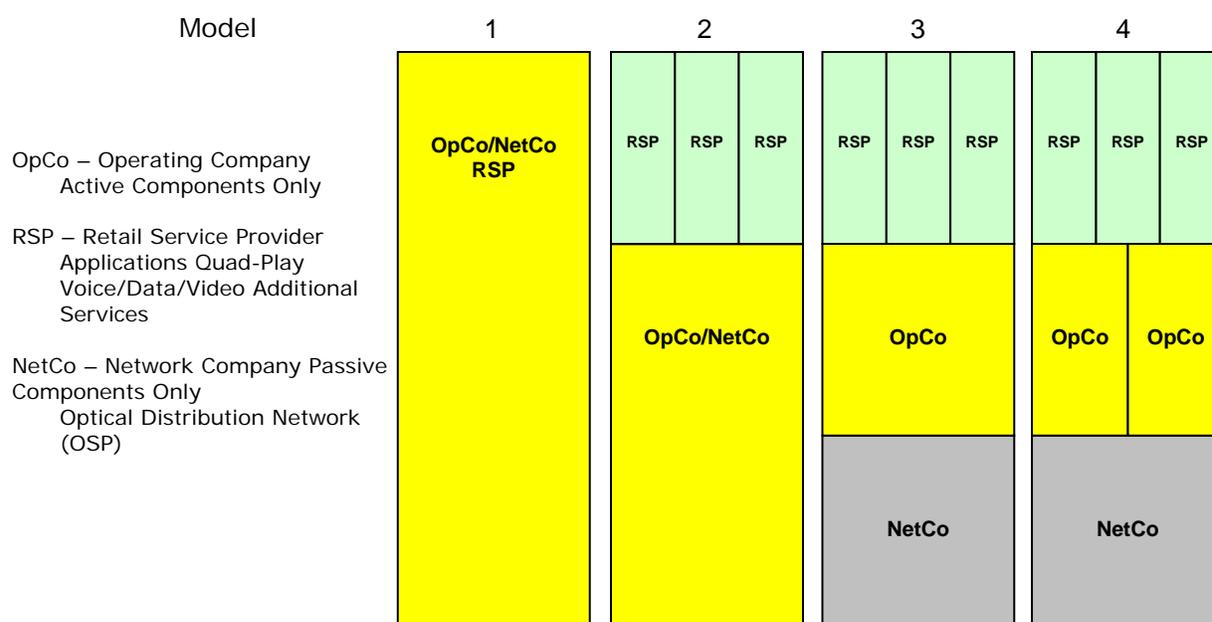


Exhibit 3. Open Access Block Diagram

In Model 2 of Exhibit 3 we see that the Operating and Network Company may provide all transport connections between the Central Office/Head End and the end user, while there may be multiple retail service providers that will interface directly with the end user for voice, data, and video services. This is the second most popular access technique use in the United States.

When we look at Model 3 and Model 4 of Exhibit 3, the network starts to get a little more complicated. We have multiple sets of transport equipment and a single physical topology. This will require separate feeder plant, either copper or fiber to a single cabinet or hub from each Operating Company owner providing the transport services. There will be separate interface equipment configured for each transport or operating company owner. This will only work well with a centralized architecture where each end user location will require multiple copper/fiber terminations.

Today, in the copper world, we typically have multiple copper cables placed from the end user location to an access point, and from the access point to the copper cross connect cabinet location. This works well in the ADSL2+ and VDSL networks where we require bonded pairs to increase the rate or reach. In the fiber world, with either P2MP or P2P Architectures, typically a single distribution fiber is allocated for each end user. This technique should be revisited to include a second fiber in the event that both IP and analog services are warranted.

Open Access Questions and Considerations

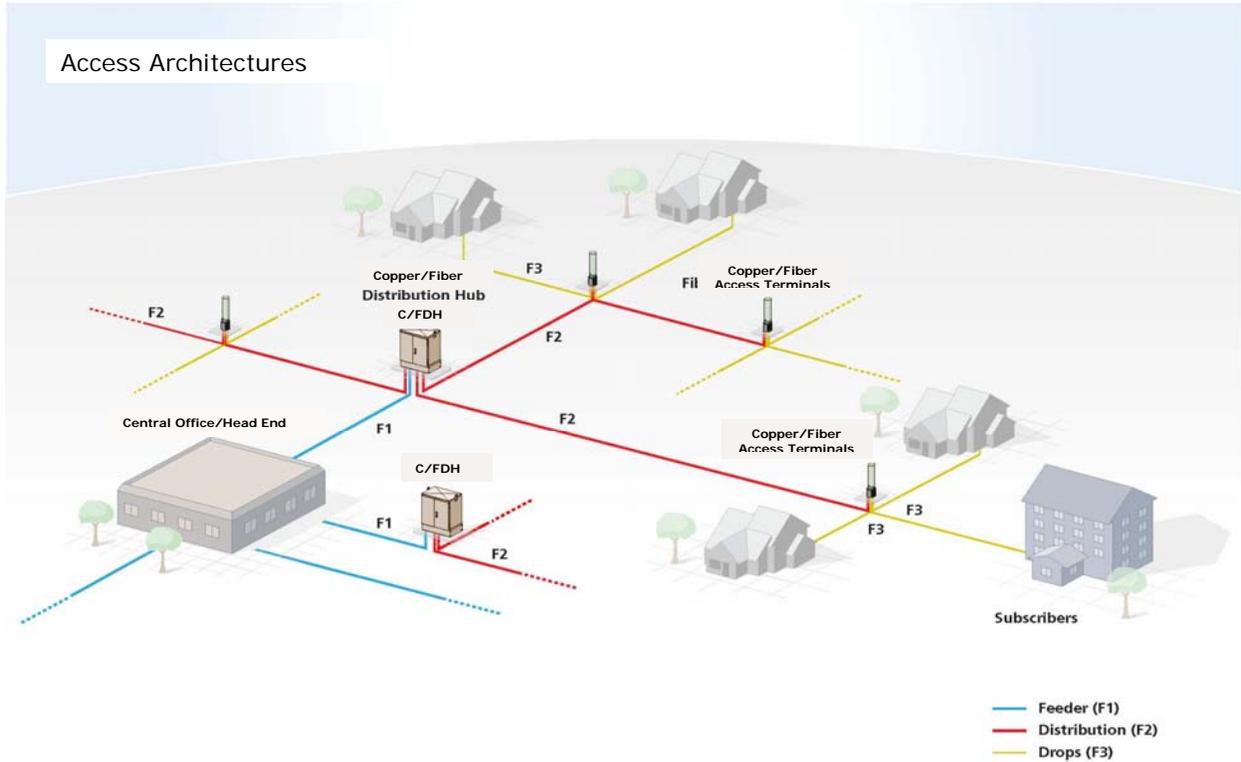


Exhibit 4. Access Architecture

Exhibit 4 is the generic model of the Access Architecture. Included within most Service Areas (SA) of the access architecture, there is a Feeder Copper/Fiber Cable (F1), a Distribution Copper/Fiber (F2), and the Drop Cables (F3). In the Open Access Architecture Model, we will need to provide enough fiber for point-to-multi-point architectures, point-to-point architectures, active Ethernet, and xDSL.

For Open Access Architectures, a number of question arise, the first being; 1.) Is it possible to split the OpCo and NetCo functions technically in a clean manner? If the answer is yes, what would the OpCo own.....



Exhibit 5. Operating Company Architecture

The Operating Company would own the active electronics located within the Central Office or Head End, as well as the network interface device (NID) or electronics at the end user location, and possibly the drop cables.

And what would the Network Company Own.....

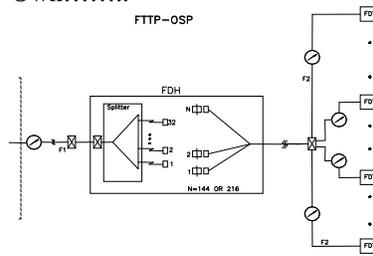


Exhibit 6. Network Company Architecture

The Network Company would own all of the outside plant (OSP) infrastructure to include all cable, Copper and Fiber, as well as all connectivity and cross connect equipment within the OSP. Exhibit 7 shows how both infrastructures are connected.

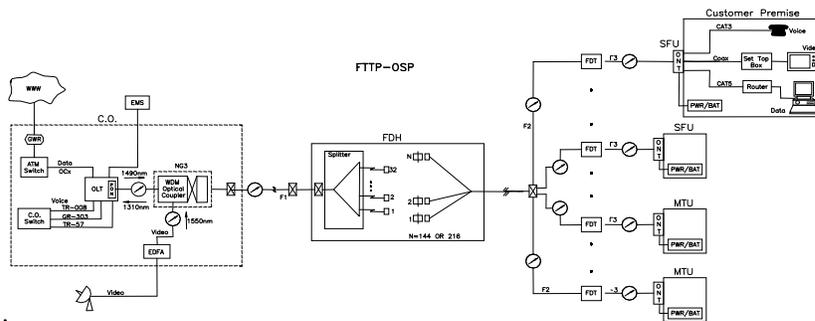


Exhibit 7. Operating/Network Company Architectures

If there are multiple Operating Companies and a single Network Company, would your answer be different.....

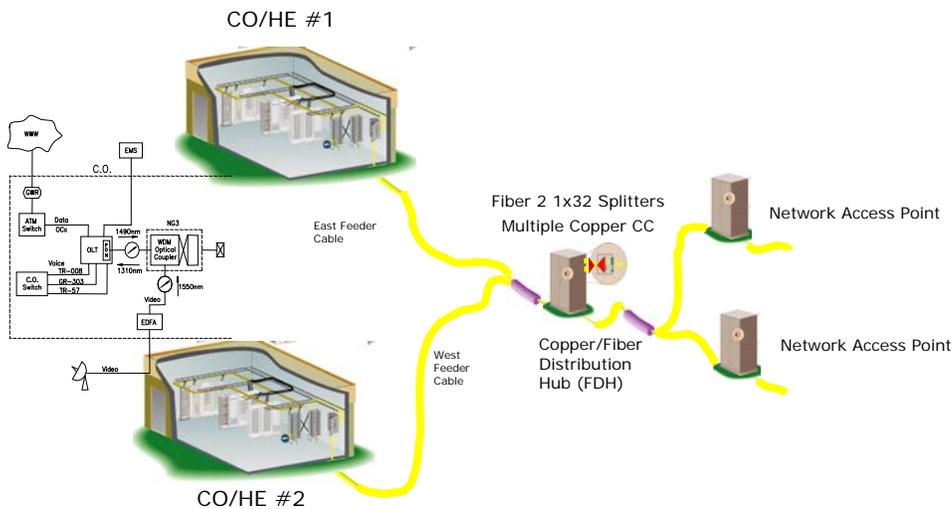


Exhibit 8. Operating/Network Company Architectures

In Exhibit 8 on page 10, there are multiple Operating Companies, and a single Network Company. In this instance, both Operating Companies will be required to pull their own Feeder Fiber (F1) from their respective Central Offices or Head-Ends to the Network Company's Fiber/Copper Cross-connect Cabinet. The Network and Operating Company will be required to jointly place all terminations at the cross-connect.

In Exhibit 9 below, here we have multiple Operating Companies, and multiple Network Companies. In this instance, both Operating Companies will be required to pull their own Feeder Fiber (F1) from their respective Central Offices or Head-Ends to each Network Company's Fiber/Copper Cross-connect Cabinet. The Network and Operating Company will be required to jointly place all terminations at the cross-connect.

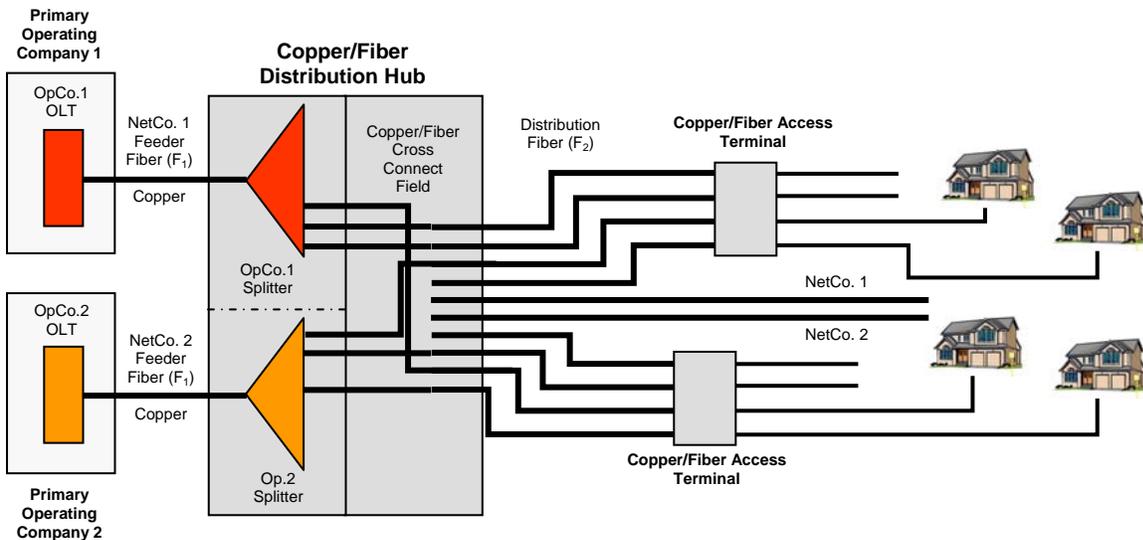


Exhibit 9. Multiple Operating/Network Company Architectures

Key Findings

In providing the requirements to build a total Open Access Architecture, The Broadband Technologies Opportunity Program (BTOP) will stimulate “job creation” within the State-designated economic zone, the Economic Development District designated by the Department of Commerce, the Renewal Community or Empowerment Zone designated by the Department of Housing and Urban Development, or Enterprise Community designated by the Department of Agriculture. True Open Access Architectures at the physical layer will improve access to, and use, of broadband service by public safety and educational agencies, and stimulate the demand for broadband.

References

1. “Global growth of open access networks: from warchalking and connection sharing to sustainable business “
by: [Roberto Battiti](#), [Renato Lo Cigno](#), [Fredrik Orava](#), [Bjorn Pehrson](#)

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