Access network convergence - Deep in the trenches

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Executive Summary

Network operators are investing a significant amount of their capital in upgrading broadband access networks to keep up with subscriber demand. Many operators run their business with separate teams managing different parts of their networks such as residential brownfield, residential greenfield, business etc.

When networks are built and operated independently in silos, they only focus on their own needs and capabilities which is maintained independently. As such, there is often duplication of infrastructure, resources, and effort. In an environment where capital availability is constrained and demand for advanced services is constantly rising, operators can ill afford such waste.

In this paper we discuss some of the challenges and benefits of integrating key elements of the outside plant (OSP) infrastructure to effectively reap the benefits of network convergence. Especially, we focus on OSP related areas such as – architectural optimization (fiber backbone, fiber distribution, OSP enclosures, OSP powering) and resource optimization (design optimization, right-of-way planning, permitting) etc.

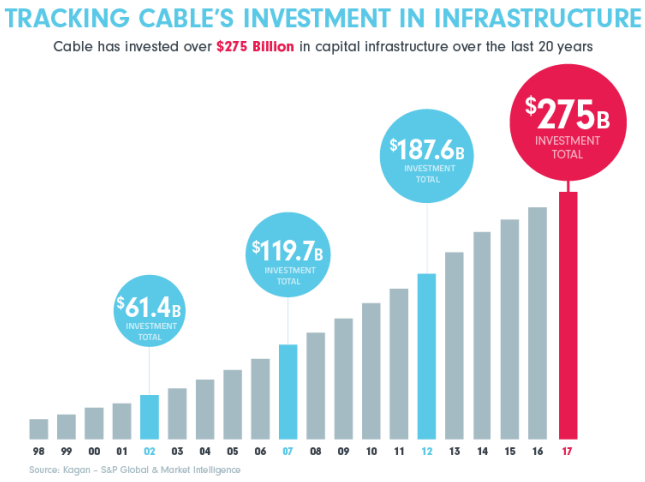
WHAT IS THE PROBLEM?

Many operators operate multiple access networks dedicated for different type of services and customers. While this simplifies business, it is operationally inefficient and wasteful – particularly now that operators are investing large amounts of capital to upgrade their networks.

Key Words: Broadband Access Network, Convergence, Planning, Outside Plant, Fiber Backbone, Network Optimization

Keeping up with access network upgrades

Internet users are consuming data at a rapidly growing rate. New applications like video streaming, 4k television, and augmented reality video games are driving this need. To keep up with this growing demand, network operators are having to spend large amounts of their capital budget on upgrading their access networks as shown in the chart below [1].



KEY TAKEAWAYS

- ✓ A large portion of most operator's capital investment goes towards upgrading the access network – particularly the outside plant (OSP).
- ✓ In order to effectively utilize OSP resources, operators need to carefully plan and coordinate operations across the various lines of business.
- ✓ Following key areas in the outside plant should be prioritized:
  Architectural:
  - Fiber backbone
  - Fiber distribution
  - OSP Enclosures
  - OSP Powering

  Operational Resources:
  - Right-of-way Planning
  - Construction Optimization
- ✓ By implementing these strategies, operators can realize 1%-5% savings on their annual CAPEX spending in the OSP.

Network operator's need for network convergence

Network operators have traditionally built and operated multiple access networks to serve the needs of different customers or for offering different services. Some examples of the different networks include residential versus business networks for serving needs of residential and business customers, fixed access versus wireless networks for offering land-line and mobile services, greenfield versus brownfield upgrades etc.

Quite often the different networks are architected, built and managed as separate independent businesses for ease of operation. This results in each business operating in a silo, with little or no coordination. Unfortunately, this often results in wasteful duplication of resources and effort.

With the need to frequently upgrade their access network, operators are having to make significant capital investments. This is quite challenging given their limited budgets. As a result, many operators are looking at ways to optimize their investments by trying to converge their separate networks. Most of the effort to converge the networks thus far has focused on the core network as it is a logical and easier convergence point for all access networks. Also, access networks typically use different technologies and have different requirements that make them harder to converge.

OSP Architectural alignment

While it is hard to converge disparate access networks, there is one area where significant benefits can be derived from convergence - the outside plant (OSP) infrastructure. A large part of the access network investment is in the outside plant infrastructure. It is also the area most costly and difficult to upgrade. Any convergence here is likely to result in very significant cost savings.

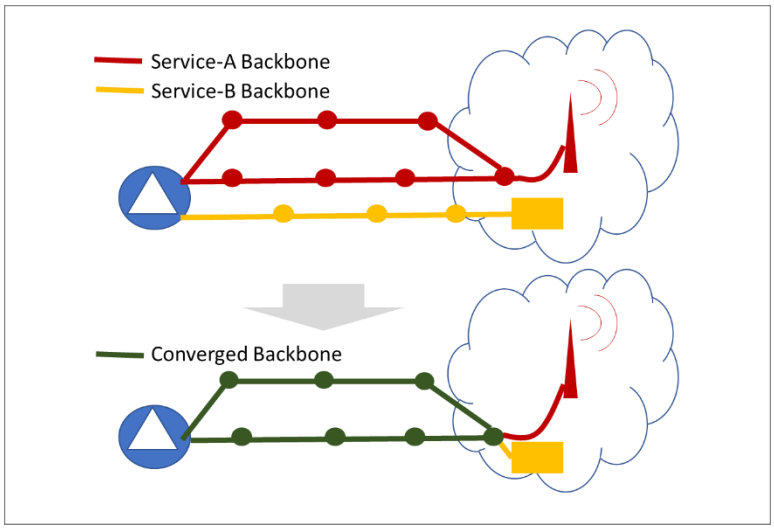
In this section we highlight some of the major elements of the outside plant that network operators should focus on and provide some guidelines about key factors to consider.

Fiber Backbone

Most access networks require an optical fiber backbone. Building and upgrading the fiber backbone is extremely costly and labor intensive. It is therefore essential to effectively plan and manage this critical resource.

Fiber is a long-term asset – plan for the long haul

The fiber backbone is a long-term asset. Therefore, it needs to be planned for the long term. In many ways, this is quite similar to planning and building a road network for a city. Planners need to take into consideration not just the current network requirements, but also future network needs in the next 10-20 years. Given the many unknowns about future planning, the design of the fiber backbone should be made sufficiently flexible to enable easy upgrades in the future.



Access networks typically require access nodes to be located close to the subscriber. The distribution of these access nodes will normally determine the route of the fiber backbone. In order to effectively optimize the fiber backbone, it's route should be planned with the needs for all the different networks taken into account in a collective way as illustrated in the figure on the left.

There is never enough fiber in the fiber backbone as many operators have learnt while upgrading their access networks. Whether it is node splits or fiber-deep, there is always need for more and more fiber backhaul. The cost of fiber itself is not much compared to the cost of labor to install new fiber. It is therefore prudent to install additional spare fibers while building or upgrading the fiber backbone. At the very least, operators should consider installing spare conduits to make it easier to install additional fibers in the future.

Fiber Planning Considerations

New fiber deployments should plan for all current and potential future fiber needs:

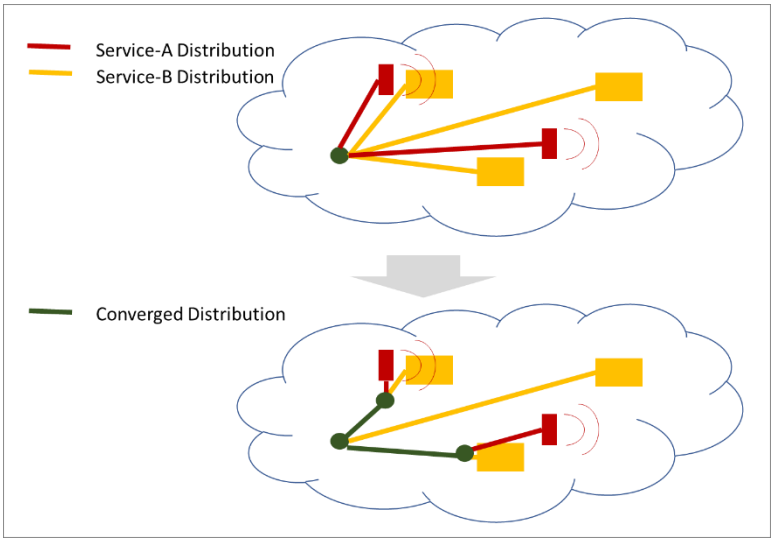
- Future FTTx Deployment: 1-2 fibers per HHP
- Future small-cell need: 4-24 fibers per cell site [7]
- Fiber to serve potential future small business and enterprise subscribers

When building a converged fiber backbone, it is important to account for the need of critical services that may require fiber route diversity for higher reliability. With the shared infrastructure, the benefit of route diversity can also be available to all other services at minimal additional cost.

In cases where a fiber backbone is already in place with limited spare fibers, operators should consider using optical multiplexing mechanisms to support multiple networks or services over the same fiber [2]. As

more and more networks move towards a digital optical backbone, it may become easier to use a truly converged optical backbone [3].

Fiber Distribution



In order to meet the increasing subscriber demand in the access networks operators are having to push fiber much deeper in the network than ever before. Whether it is fiber-deep for HFC networks or small cells for mobile networks, fiber is being extended in the traditional distribution portion of the outside plant. This presents yet another opportunity for convergence as shown in the figure on the left.

Plan for future fiber needs

It is important to coordinate planning of plant extension projects in order to maximize the benefits of convergence. Quite often fiber has to be placed ahead of time for future services in order to optimize the build.

Outside Plant Enclosures

Outside plant enclosures are another key resource to optimize. Access networks often need to place sensitive electronic equipment in the outside plant. These are typically housed in environmentally hardened enclosures that range in size from small pedestals to large cabinets or huts. Most larger enclosures like cabinets or huts are quite costly to build and operate – especially when they require active cooling.

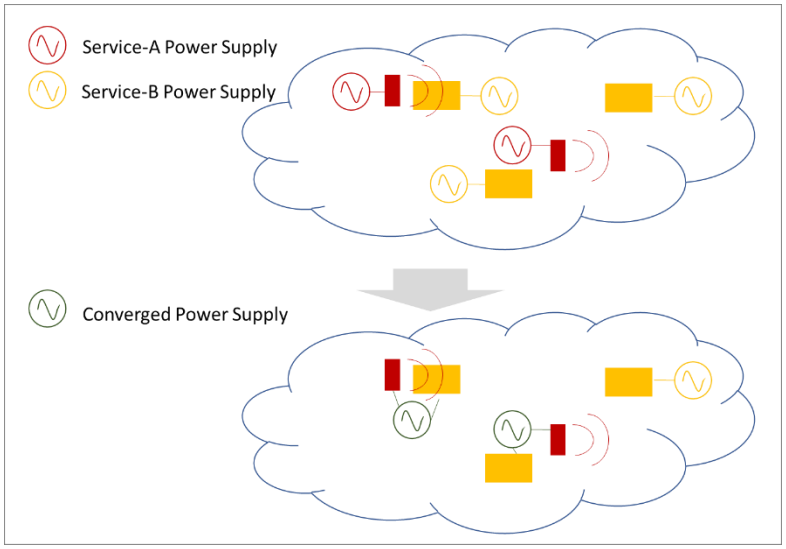
Consolidate needs for multiple OSP enclosures

Operators can achieve significant cost savings by sharing outside plant enclosures among various networks. Quite often, it is much cheaper to build and operate one large enclosure rather that multiple smaller ones as shown in the picture on the left.

Outside Plant Powering

All active devices in the outside plant need to be powered. Traditional access networks used many active devices in the outside plant including repeaters and amplifiers. These were typically fed power from the network with a well-defined powering architecture.

As networks have evolved with increasing use of fiber, the need for powering has gone down substantially. The centrally fed network powering has therefore been replaced by distributed metered power supplies in many networks. However, the need for powering is not going away. In fact, with the advent of fiber-deep architecture, increasing number of power-hungry active nodes are being installed deeper in the network than ever before.



Implement a comprehensive OSP Powering strategy

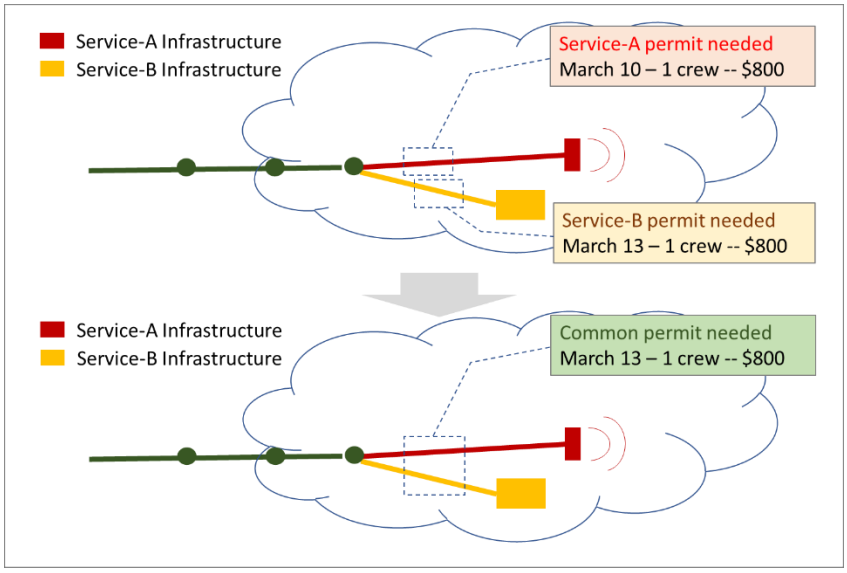
Powering is also a critical need for wireless. Increasing number of small cell nodes are also being installed deep in the network. A comprehensive outside plant common powering infrastructure can best address the needs of all the networks in an optimum way as illustrated in the figure above.

OSP Resource Alignment

In addition to optimizing the access infrastructure as described above, operators can derive significant benefits by coordinating operations across various lines of business. We have outlined two key areas below that can have a significant impact – right-of-way planning and project clustering.

Right-of-way Planning and Permitting

One area where multiple networks can gain significant operational benefits of convergence is in right-of-way planning and permitting. Network operators spend significant time and resources when they need to obtain necessary right-of-way permits from various permitting agencies. Quite often this is a tedious and time-consuming process that is outside the control of the network operator.



Plan for future fiber needs

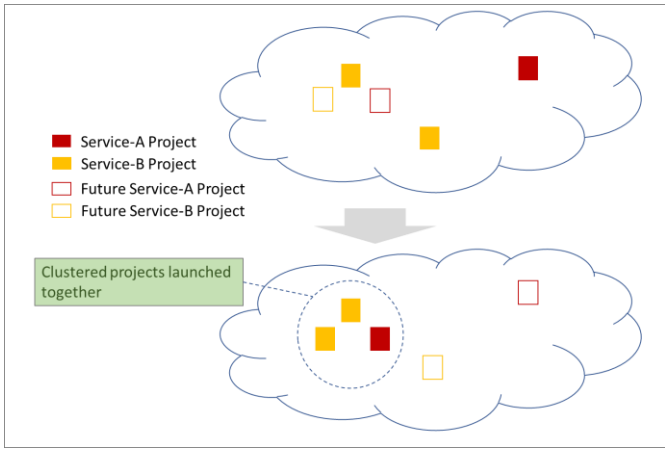
When multiple network construction projects are planned in a given area, it is highly recommended to plan and coordinate these projects with the permitting agencies. The coordination can often result in following potential benefits as illustrated in the figure on the left:

- Reduced Permits: Multiple projects can be combined under a single permitting application which will reduce the total cost and processing time.
- Reduced delays and construction resources: When construction projects are properly coordinated, they are less likely to interfere with each other, and can potentially leverage the same resources to do the work.

Project Clustering

Another area where OSP operations can be optimized is in project planning. When multiple lines of business plan their projects there is little or no coordination. Multiple projects can be launched anywhere in the operator's footprint at the same time. This can lead to operational challenges requiring resources to be pulled in various directions wasting a lot of time traveling between locations.

The idea behind project clustering involves coordinating projects across various lines of business and try to group together projects in the same geographic area. This way resources can be co-located and better shared. While this is not always possible due to specific project constraints, it is at least worth aligning projects with some flexibility in terms of their timing as illustrated in the figure.



Strategies for Convergence

Sharing resources in the outside plant is not a new thing. One place where this strategy has been widely used is in mobile networks where the cost of deploying cell towers is extremely high. Many governments are encouraging infrastructure sharing by putting in place appropriate rules and policies [7]. Even competitors like AT&T and Verizon are working jointly to build hundreds of shared cell towers [4]. In South Korea SK Telecom Co., KT Corp., LG Uplus Inc. and SK Broadband Inc. expect to save over a billion dollars over next 10 years by sharing cellular infrastructure [5].

Here are some scenarios where infrastructure sharing should be carefully looked at:

Future Planning (Greenfield)

As shown in the examples above, it makes a lot of sense to carefully evaluate sharing opportunities when planning for new (Greenfield) infrastructure deployments. This is the best time to optimize the infrastructure.

Brownfield Upgrades

Operators are constantly having to upgrade their existing brownfield network. Any time a major upgrade is planned, a careful evaluation of potential infrastructure sharing opportunities should be done.

OPEX Saving

Most of the times it makes little sense to rebuild existing infrastructure so that it can be shared. However, in cases where there is potential for significant OPEX cost savings, this can make a lot of sense. A few such cases to consider include ones using leased resources like fiber or real estate. In such cases the OPEX savings could more than pay for the cost of rebuilding the infrastructure in the long run.

Conclusions

Many network operators have traditionally operated multiple access networks for different services as separate lines of businesses. While this clearly simplifies business operation, it leads to operational inefficiencies. The rapid growth in access networks is driving a lot of investment in the access networks – particularly in the outside plant. With so much investment, it is critical to avoid this inefficiency.

In this paper we have outlined following key areas of the outside plant where operators can achieve substantial cost savings by converging or closely coordinating operations of various lines of business:

- Access Fiber Backbone
- Distribution Fiber
- Outside plant enclosures
- Outside plant powering
- Right-of-way planning and permitting
- Project clustering

We have also provided some guidance regarding strategies for implementing convergence.

We estimate that by implementing these convergence strategies operators can easily achieve savings ranging from 1% - 5% of their annual CAPEX expenditure in the OSP. For an operator spending over a billion dollars of CAPEX in the OSP, this could amount to over $50 million in savings.

The DTS team has had a lot of experience helping clients realize substantial cost savings and operational efficiencies in their businesses. Feel free to reach out to us to learn more about how we can help you do the same.

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About the Author

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Rajesh Abbi has over 25 years of experience in the telecom and networking industry, covering strategy consulting, product management, system architecture, and software development roles. Rajesh earned a master's degree in computer engineering from North Carolina State University and an MSc in physics and BE in electrical and electronics engineering from BITS Pilani, India.

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