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Living on the (Network) Edge:

A TELECOMMUNICATION PROVIDER'S GUIDE TO MAKING THE MOVE

The Internet of Things (IoT) is not new. Neither is the rapid rise of connected devices or customers' demands for instantaneous service. These are realities of digitalization. While they have become normalized, they are by no means the final destination on the journey to digital transformation. They are merely the first wave of the transformation process. In their wake, the next round of changes is brewing. These changes will require providers turn their focus to the periphery of their networks and get closer to their customers. This next frontier for providers to conquer? The Edge.

Gartner predicts that by 2022, as a result of digital business projects, 75% of enterprise-generated data will be created and processed outside the traditional, centralized data center or cloud, which is an increase from today's less than 10%.

"Technology Insight: Edge Computing in Support of the Internet of Things.", Gartner

Providers continually strive to provide the best customer experience possible. That means uninterrupted service and low latency. The problem is, geographically distributed resources make delivering this level of quality difficult. Storage and computing processes are simply too far away from devices for data-heavy applications like streaming video, augmented reality and artificial intelligence. The smart city concept, for example, can only work if it's internet-connected and IoT-enabled.

Hence the rise of edge computing, which addresses this problem by collecting and analyzing IoT data locally to alleviate the dependence on cloud and internet connectivity. This makes a huge difference in situations where information needs to be processed quickly and reliably. When compute, storage and network connectivity are all at the edge—either on the IoT device itself or in a local gateway—and data is processed there, the barriers of distance and sub-par connectivity are removed.

That makes edge data centers critical. And telecom companies, which are ideally suited to fill this emerging need, will figure large in the IoT and edge computing. They can provide an alternative to hyperscale data centers, which centralize large blocks of infrastructure. Telecoms are primed to own the edge, a much larger and highly distributed united set of smaller data centers that are closer to where content is being created. These smaller data centers are remote from a company's major data centers, and near its customers.

Edge computing has been around for a while as an IT solution. The idea of moving resources to the edge became inevitable as the amount and complexity of data exploded. Large content delivery networks such as Google and Netflix have already adopted edge centers. They cache their content and services at the network edge through 3rd party colocation data centers and specialized edge data center service providers. This makes it possible to reach customers in tier 2 and tier 3 markets and deliver a user experience on par with that of a tier 1 market where the original content servers are located. The fact that tier 2/3 markets are far away from these servers no longer matters.

Several factors are driving telecoms to the edge

Edge computing, and telecoms' position as a key player in this emerging architecture, is an important paradigm shift. Centralized cloud simply cannot deliver on modern applications, so the need for edge computing will continue to grow. Our changing economy and way of life fuels this growth.

IoT.

From increased adoption of wearable technology to remote education, food delivery services, virtual assistants and so on, the volume of data generated and accessed by mobile devices continues to grow exponentially. The equipment that communicates with these devices needs to live closer to users of them to be most effective. Therefore, compute intensive and latency sensitive applications are best hosted at the edge of the network. It makes sense to shift mobile compute power there as well.

Users' increasing reliance on mobile devices to carry out compute and storage intensive operations requires service providers offload to clouds to achieve adequate performance. This would be difficult and expensive to realize without bringing the cloud closer to the edge of the network.

Edge computing provides a highly distributed computing environment that can be used to deploy applications and services as well as to store and process content in close proximity to mobile users. It eliminates the need to backhaul traffic generated by applications to a data center. By setting up

data centers on the edge of their networks, service providers can provide interactive experiences with real-time applications that they would not be able to otherwise provide.

The need for low latency.

Latency, IoT and 5G are irrevocably interconnected. Factor in the next evolution of IoT - the Tactile Internet – and the latency requirement will become even more critical. Tactile Internet interconnects smart devices with how people and machines interact with the environment and makes it possible to do so in real time (low/no latency), while on the move (mobility) and within a certain spatial communication range (connectivity).

Tactile refers to human senses, all of which can theoretically interact with machines – provided there's enabling technology. For technical systems to match human touch, sight, hearing and movement with the environment, they must meet the speed of natural reaction times. You can imagine the latency and the reliability of the underlying networks that will be needed for these types of applications. Since the critical tasks will be executed remotely (think telesurgery), they will need edge infrastructure and a 5G network to transmit content and data to users, wherever they may be.

5G wireless networks allow for faster transfer of data to and from devices in the field over to edge data centers. The rise of 5G coincides with the explosion of connected devices and systems associated with IoT, in all its forms. The influx of additional data caused by IoT needs to be processed in real-time and is driving the need for edge computing.

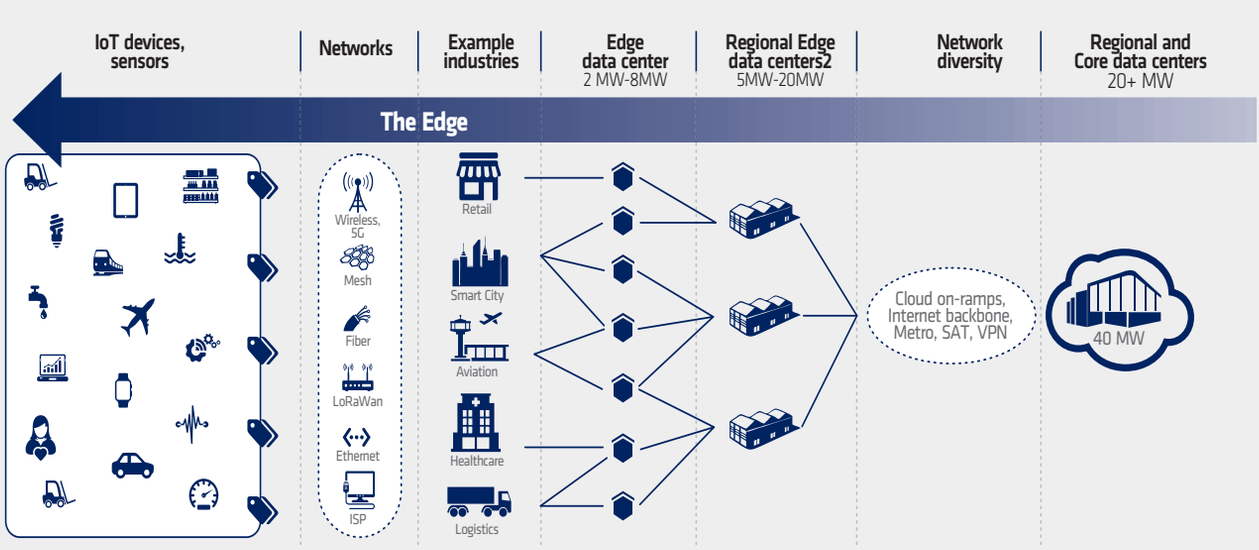
The buildout of next-gen 5G cellular networks by telecommunication companies is one of the most important use cases for edge computing. Some 5G applications require latency to be at levels where it currently does not exist. The edge is about being able to deliver on the kinds of services and applications that require very low latency so that you don't have delays that occur by going to a cloud that could be hundreds of miles away. Adoption of 5G and edge computing will drive new expectations for an always-on, high performing network and services.

Revenue and Cost Concerns.

Telecoms need to reduce costs and increase revenues. These two fundamental economic drivers relate to efforts to reduce network capex and opex by shifting from proprietary boxes to standardized servers. This increases programmability of the network to host new functions and services, and allows them to be deployed, updated and scaled rapidly. Edge computing plays a key role in realizing these outcomes.

In regards to revenue, edge computing offers significant commercial opportunities. This is critical as the whole industry is trying to uncover new sources of revenue, ideally where operators may be able to build a sustainable advantage. The biggest driver of edge computing, from an IoT perspective, is not coming from the consumer. It's coming from business customers in industries such as water utilities, power stations, oil and gas, pharmaceuticals and factories. These industries are putting IoT devices in place, so they can better monitor and manage what is going on in their infrastructure. Their goal is to use that intelligence to make rapid decisions.

For business customers, computing closer to the edge of the network lets them analyze important data in near real-time. Business customers can own or rent space in edge micro-data centers, giving them direct access to a gateway into the telecom provider's broader network, which could connect to a public IaaS cloud provider. Telco operators can leverage the free space within their central offices and take advantage of the growing demand for edge computing to expand their service offering and diversify their sources of revenue.



The global edge computing market is expected to reach $6.72 billion by 2022.

"Edge Computing Market by Component (Hardware, Platform, Solutions), Application (Smart Cities, Location Services, Analytics, Augmented Reality), Organization Size (SME, Large Enterprises), Vertical, and Region - Global Forecast to 2022", MarketsandMarkets

On the other side of the profitability equation, edge computing has significant cost benefits for telecoms. It reduces backhaul traffic, which reduces costs dramatically. It further reduces costs by decomposing and disaggregating the access function and optimizing central office infrastructure. The lower-latency, higher-speed connection afforded by edge data centers drives data exchange delays and costs out of the connection.

Competitiveness.

Consumers are becoming more demanding when it comes to the immediacy of data and information access. If they can't get what they want fast enough from one provider, they simply switch to another. Edge computing addresses this by making compute and storage capabilities available to customers at the edge of communications networks. Moving workloads and applications closer to customers enhances experiences and enables new services and offers. Edge computing allows data produced by IoT devices to be processed closer to where it is created instead of sending it across long routes to central data centers or clouds, making it possible to give customers the level of service they want.

Edge can be used as part of the LTE network and assets, and it is also part of the evolution to 5G. It enables telecom providers to improve their network reliability by distributing content between the edge and centralized data centers. Whether it's autonomous driving, AR/VR-type applications or a myriad of data-intensive smart city initiatives, moving compute, storage and processing power closer to the network edge will be key.

Best practices for a successful move

Telecoms are well placed to take advantage of the IoT and edge computing. There's a huge amount of data generated over the internet and telecoms will be a vital enabler in making the data useful and actionable. Telecoms can increase the likelihood of thriving on the edge by focusing on these four key areas:

1. Infrastructure

For these kinds of workloads, it's not optimal to take data back to the center, process it and then send it all the way back to the edge. It's much more useful to do the processing in local loops. This requires local infrastructure and is a strong play for telecoms.

Telecoms have infrastructure that is trusted, secure and reliable. But it is not necessarily the right infrastructure to support an ICT workload. They will have to go through their own infrastructure modernization to move from a traditional network-switching driven environment to a much more converged ICT environment. Even though they have some work to do, telecoms are still well-placed to leverage what they already have and modernize it. They have an advantage because the cost of building that kind of infrastructure from scratch is huge and prohibitive.

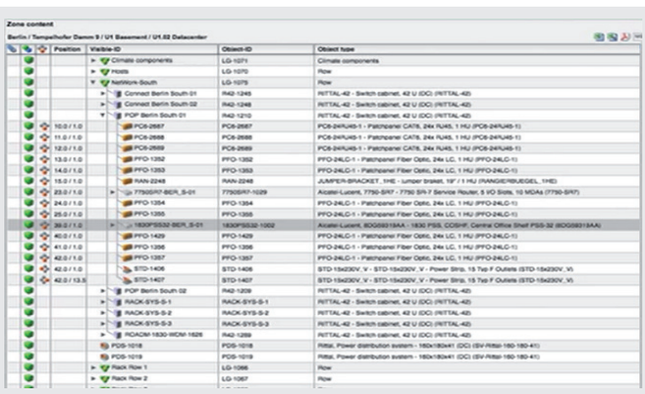


Fig. 1: FNT Command's integrated data model keeps an accurate and up-to-date inventory of all physical, logical and virtual assets across telecommunications, IT and data center infrastructures. From this inventory you can access detailed information about the asset including how it is connected to your network, where it's located and what services are running on it.

To modernize infrastructure, telecoms should seek to centralize all information about IT and telecommunication assets and connections, the central data center and edge data centers. This data should be housed in a single repository that dynamically updates as change occurs, so users across the organization are accessing the same accurate, up-to-date data at all times.

The introduction of edge computing, which meshes edge and core data center infrastructure, will add another level of complexity to infrastructure management. Now we're talking about managing a hybrid environment of network, IT and data center infrastructure. Delivering high quality services and applications based on and produced by such an infrastructure requires visibility into all dependencies, across all resources, to ensure high quality service that is still affordable. A unified resource repository that encompasses all physical, logical and virtual resources of such a hybrid infrastructure lays the proper foundation to manage this challenge.

Such a central data repository provides complete visibility and transparency throughout the IT, telecommunications and data center network infrastructure. It effectively eliminates the barriers that prevent the sharing of this critical information and enables a single, holistic view of the infrastructure. When this information is made actionable by a management system, the infrastructure management team is able to more effectively operate, analyze, plan, implement, change, document and monitor all technology activity, irrespective of geographic location or corporate silo.

2. Data Centers

It's more difficult to deliver a good user experience on the edge than in a central data center, where you have high-availability connectivity and power systems. Building out an edge network means changing the way you manage and run your data centers. Your systems are no longer in large, easy-to-access buildings with on-site operations teams. You're building something that's more like a cellular network, with hardware deployed in modular housings on remote sites.

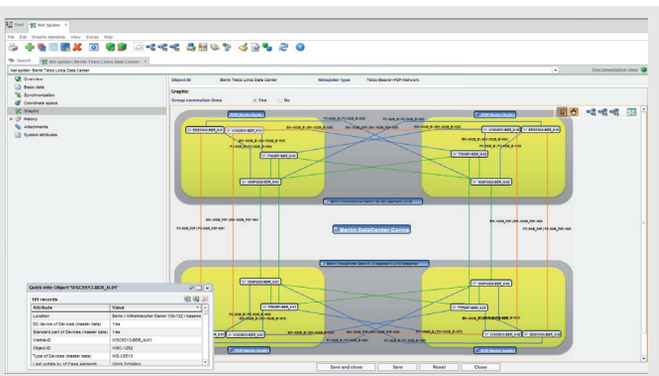


Fig. 2: FNT Command's Netspider displays a graphical representation of all connections between multiple data center sites.

The central offices of telecom companies – which boast a ton of free space - are being converted to computing rooms and used as edge data centers to make their networks more dynamic. As telecoms transform their networks to support virtual network services and automate network management using software, a telco network becomes a cloud, while the central office becomes a cloud edge node. As telecom providers build 5G into their wireless networks they will increasingly add micro-data centers that are either integrated into or located adjacent to 5G towers.

There are many factors that give telecoms an advantage over data center providers when it comes to setting up the distributed edge data center networks required to enable wide scale availability of 5G applications. An edge data center is a collection of IT assets that has been moved closer to the end user, but it is ultimately served from a large data center somewhere. Edge computing is part of the central data center, just on the end of a network connection. Service providers have a massive infrastructure already available. Their infrastructure assets are already well distributed and spread out, which means they can fairly quickly turn their tower sites and regional / local offices into edge data centers while building more of them.

An edge network is more than just connections and cabling. Edge computing is a mesh network of micro data centers that process and store critical data locally and push all received data to a central data center or cloud storage repository. If your edge deployment is going to succeed, you need to manage it alongside your existing data center, with the same processes, and take the same care planning its deployment. With more of these smaller edge data centers scattered around, if you're not good at remotely monitoring your equipment, resolving problems and moving load from one IT asset to another, it will be difficult to manage the large amount of geographically dispersed IT assets..

Of course, there are software tools available to manage the distribution and configuration of virtualized resources for an application across the relevant edge and core data centers. But there will be many applications, and there will be many different supplier or application specific software platforms and tools managing the configuration of the virtualized layers. All these virtualized resources are ultimately based on, and dependent on, the same underlying server and storage capacity within the data centers and connectivity capacity in between.

To set up and manage edge data centers, providers should look for a centralized solution to manage and optimize the entire data center infrastructure. That includes the central data center and all edge data centers. The solution should support capacity planning and change management with a comprehensive and integrated view of data center resources, including building infrastructure (power, cooling, floorspace); IT infrastructure (networks, servers, storage); and services (software, applications).

Since providers need to manage a large number of remote sites, it's important to emphasize that remote monitoring should not be limited to the application and IT infrastructure level. It must also encompass remote power and temperature monitoring, just as is done for central data center sites.

3. Connectivity

Service providers have the infrastructure in place to connect with IoT devices, other data centers in the edge network, regional facilities, as well as with the core data centers far away. In addition to providing compute and local storage, edge data center networks leverage their backend transport infrastructure to also backhaul the data from the edge to a centralized cloud server for user analytics and reporting.

Network connectivity will become more important. In the data center design world, people sometimes look at the network as a second thought. But you need a rock-solid network for edge data centers. You'll need to use multiple connectivity points and redundant connections between edge data centers and from edge data center to core data centers, capable of supporting the traffic load required for the business needs out of that edge data center. This is important because if there is a failure or a connection loss, you will still be able to deliver the same high-quality service. That may also mean mixing wired and wireless connectivity to ensure access even when one route is down.

Using the automated management benefits of SDN, service providers can manage connectivity requests to these remote edge data center networks much more efficiently and cost effectively. One of the compelling reason telecoms make ideal edge micro data centers is that they can leverage their existing network infrastructure to interconnect all these micro edge data center sites and backhaul the traffic to the core sites.

To ensure reliable connectivity, telecoms will need to implement an infrastructure management solution that centrally manages all cable and telecommunications network and service resources, both inside and outside of the plant. The solution must be able to encompass passive infrastructure all the way up the stack to active inventory, across all technologies. Such a repository will provide processes and tools with accurate information, streamline operations and increase service quality tremendously.

When such a system is powered by comprehensive and detailed telecommunications resource information, providers are able to easily operationalize their connectivity strategy by standardizing and harmonizing network operations and ensuring revision-secure documentation of all physical, logical and virtual assets. This is important because the structure of processes in the operation of the network must change to accommodate the move to the edge and all that it entails.

Before telecoms can move closer to their customers, they must first modernize and transform their networks. There is increasing complexity from new technologies, coupled with the task of integrating these new technologies with a variety of existing ones at sites throughout the network. There are three fundamental preconditions for successfully executing a network transformation that providers must be cognizant of:

1) **Make sure you have a clear view of the as-is situation in your network.** That means knowing precisely what your resources, services, capacities, redundancies, etc., are.

2) **Carefully plan your individual transformation steps** by analyzing the impact on services and customers, including tracing execution in the field, before you implement.

3) **Ensure all network changes are directly reflected in your information base.** This is the only way to ensure data consistency and accuracy, which is critically important for planning, operation and fulfilment teams who rely on that information to make business decisions. This approach ensures the greatest level of data accuracy for the upcoming transformation steps.

A central resource repository creates the preconditions for these three necessary steps. It also provides the transparency across this complex fabric of diverse technologies. Without transparency, such diversity makes service assurance and provisioning difficult, and service quality is one thing you want to protect at all costs. A provider's top priority, therefore, must be to ensure a reliable foundation of documented assets and connectivity resources. Only then will they be able to keep reaction times for incidents short and customer satisfaction high.

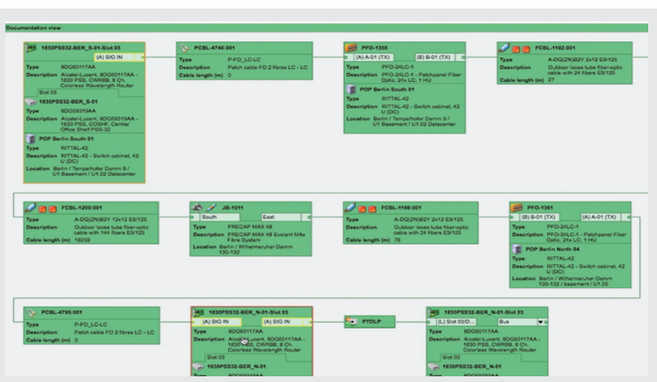


Fig. 3: Signal tracing in FNT Command shows the complete path a signal takes, from starting point to termination node. Easily navigate to other views and functionality from the signal trace to efficiently manage your network connections.

4. Virtualization

Edge computing enables IT, NFV and cloud-computing capabilities within the access network, in close proximity to subscribers. Service providers will need to leverage software-defined wide area networks (SD-WANs) and network function virtualization (NFV) software to deliver services. Edge computing fits nicely with telcos' 5G and SDN/NFV deployments, which will run certain virtualized network functions in a distributed way, including at the edge of networks. In turn, edge computing potentially benefits from the capabilities of a virtualized network to extract the full potential of distributed computing.

Not all virtual functions can be hosted centrally. While some things can be centralized (e.g. border/gateway functions between core network and public Internet, virtual IMS, virtual EPC), others make more sense to distribute. For example, Virtual CPE (customer premises equipment) and CDN caches need to be nearer to the edge of the network, as do some 5G functions such as mobility management. No telco wants to transport millions of separate video streams to homes, all the way from one central facility.

Since edge computing puts compute resources at the edge of telco networks, these servers can be used for distributing internal network functions. Edge computing extends virtualized infrastructure into the radio access network (RAN) and uses a lot of NFV infrastructure to create a small cloud at the edge.

While most virtualization focus in telecoms goes into developments in the core network, or routers/switches, various other relevant changes are taking place. In particular with the concept of C-RAN (Centralized-RAN / Cloud-RAN) in mobile Radio Access Networks, the traditional mobile base stations, composed of baseband units (BBUs) and radio units, which were typically located at the bottom of a cell tower, can now be split geographically. The radio unit is moved to the tower top alongside the antennas, and multiple BBUs can be centralized at a BBU pool location. Clustering BBUs at one site, with fiber front-haul connecting the radio units, improves the efficiency of both power and space utilization. It also means the BBUs can be combined and virtualized to make use of commodity hardware – and perhaps have extra compute functions added.

To maximize the benefits of virtualization in your networks, look for a solution that can manage a hybrid network infrastructure comprised of both traditional resources and virtualized ones. Introducing NFV (Network Function Virtualization)-based solutions into a telecommunications network requires providers to centrally control and optimize the server and software infrastructure, the Virtual Network Functions (VNFs), the NFV Infrastructure (NFVI) and their interaction with Physical Network Functions (PNFs) and the network.

This requirement can be met by introducing a hybrid resource management solution that centrally manages, plans and documents all relevant physical, logical and virtual resources, capacities and assets across the telecommunications network, IT and data center infrastructure - regardless of where they are located. Since the products and services that are ultimately delivered to customers are comprised of both traditional network services and virtualized components, the seamless navigation throughout these different types of resources will be a crucial success factor.

There will be many VNFs, from several suppliers, executed on the different NFVI platforms dispersed across the whole network. You can imagine the resulting complexity. So, from a resource and capacity management perspective, it's pivotal to implement a vendor agnostic resource and capacity management solution. It's the only way to ensure you have all relevant information available for both operation and planning. Such a solution will also deliver the transparency and visibility into your multi-vendor VNF deployments and allocated physical and virtual resources for operational analysis. Launching and releasing virtual resources make an operator's job more challenging. If there's a failure, for example, it's entirely possible for the configuration of virtual resources to be automatically changed before the operator begins fault analysis. Without a centralized database that historicizes the configuration data in the hybrid resource management database, the operator would be unable to analyze the configuration at the time the failure occurred and address any underlying issues that need to be resolved.

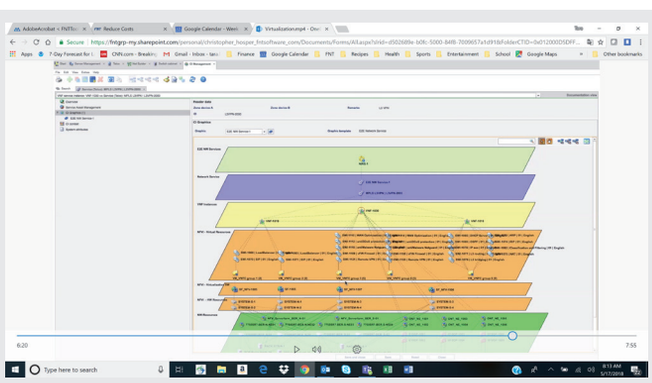
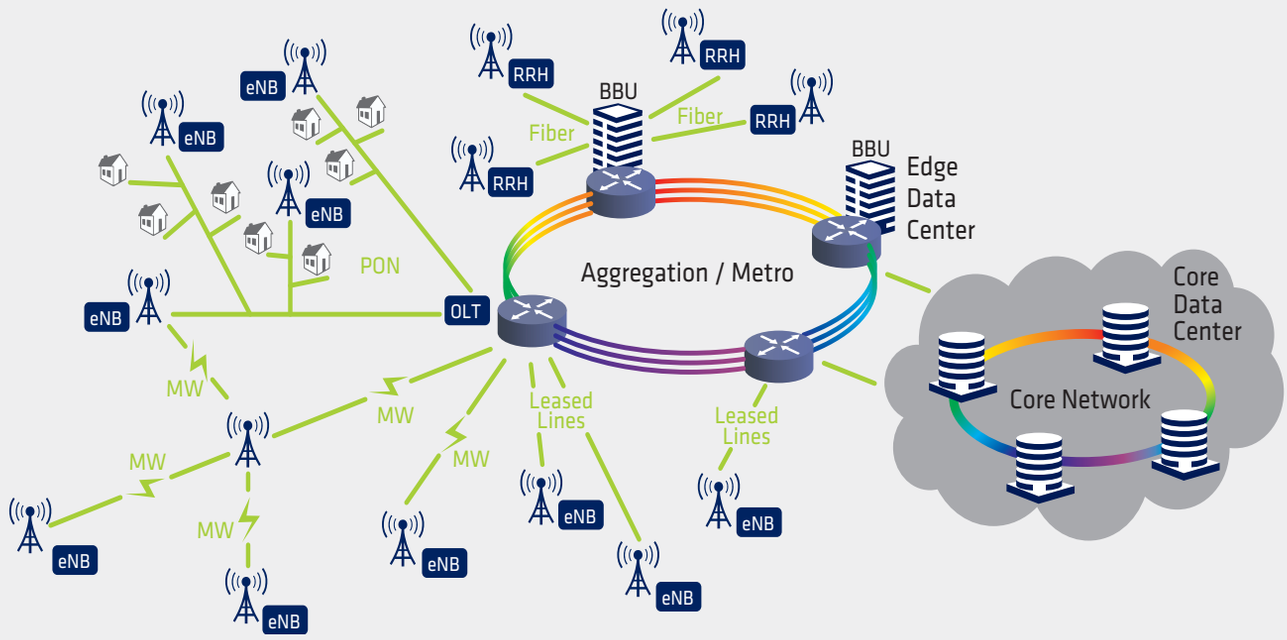


Fig. 4: FNT Command graphically displays a comprehensive overview of network services and assigned VNFs in a hierarchy, across all layers. This shows the network service assigned to the VNFs, the decomposition of the VNFC components, the relation to the server farms, and the underlying service hardware and network resources.

It's also important to have accurate information on server and storage capacity across the relevant edge and core data centers available from the planning perspective. For example, having access to this information enables the operator to analyze the impact of new VNF rollouts, and to manage data center capacity extensions according to the appropriate MAC (Move, Add, Change) processes.



One other important consequence of virtualization for service providers worth mentioning is the move from hardware-dominated services to more software-focused solutions. The impact of this move is an increase in the requirements for software and application lifecycle and license management. These must also be addressed by the hybrid resource management solution, in order to achieve a unified information repository to inform all assurance, fulfillment and planning processes.

Telecoms are leading the way

Telecoms are bringing cloud capabilities to the edge of the network, removing latency and reducing network and compute load back to centralized data centers. Providers need to invest in management and orchestration frameworks to successfully play in this new paradigm. Access to backend IT infrastructure in the cloud will be pivotal. Cloud infrastructure is a commodity. Creating the network fabric that leverages that backend infrastructure will be the differentiating factor.

To be successful, telecoms must place more intelligence at the edge of the network using gateways that host applications and provide access to local storage as close as possible to the point of application consumption by the end user. Those applications in turn can then leverage back-end cloud resources to access data as needed. To ensure high quality of service at affordable cost, telecoms must keep an eye on how to get transparency and visibility across such a hybrid infrastructure to efficiently manage this increased complexity.

New telco services will be inherently edge-oriented, driven by IoT, Tactile Internet, 5G and vertical enterprise applications. They will also depend on virtualization for distributed capabilities, so they can live on the edge of networks. The writing is on the wall for telecom service providers, and the message is clear: it's time to begin - or step up - your journey to the edge.

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FNT is a leading innovator in the field of integrated software solutions for IT management, data center infrastructure management and telecommunication infrastructure management. FNT's market-leading software suite FNT Command is used worldwide as an OSS / IT management application for communications service providers, enterprises and government organizations by more than 25,000 users since 1994. To learn more about FNT's solutions for the telecommunications industry,

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FNT GmbH

Roehlinger Strasse 11 // 73479 Ellwangen // Germany // Phone + 49 7961 9039-0 // contact@fntsoftware.com // **www.fntsoftware.com**