INFOBRIEF

An Edge Data Center Approach

For the first three decades of the internet, applications primarily focused on automating the sharing of content between the cloud and end-users. We are now entering the next era of the internet, which will include automating physical and human tasks. This will involve cloud-native applications emerging in categories such as manufacturing, retail, automotive, and entertainment where in many cases, these applications will be compute-intensive and latency-sensitive. Traditional centralized cloud architectures do not meet the stringent latency requirements of this new generation of applications, defined as less than 20 ms roundtrip, and will require a more adaptive and distributed cloud model. As a result, compute and storage cloud resources must move physically closer to the edge of the network, where content is created and consumed, to meet the expected Service Level Agreements (SLAs). This new approach is referred to as Edge Cloud.

Internet Content Providers (ICPs), Data Center Operators (DCOs), and Communications Services Providers (CSPs) will all implement and leverage the Edge Cloud in various ways. As the race to build out the Edge Cloud expands, this ecosystem of different providers must work together and build new business relationships to ensure its commercial success. Partnerships are already emerging and will continue to play out in the coming years.

CSPs will be front and center in this shift to the edge as they already possess the valuable 'beach-front' real-estate where the Edge Cloud will geographically reside. To succeed in this new market, CSPs must convert their existing central office and cable headends into edge data centers. Analysts forecast that there will be three to five times as many data centers at the edge than centralized data centers that exist today[1]. A traditional data center may house tens of thousands of servers and deploy up to eight layers of networking equipment. Data centers at the edge will likely house hundreds of servers but without the luxury of space and power available in traditional centralized data centers. With this many data centers at the edge, automating both cloud and network resources across these many locations is expected to

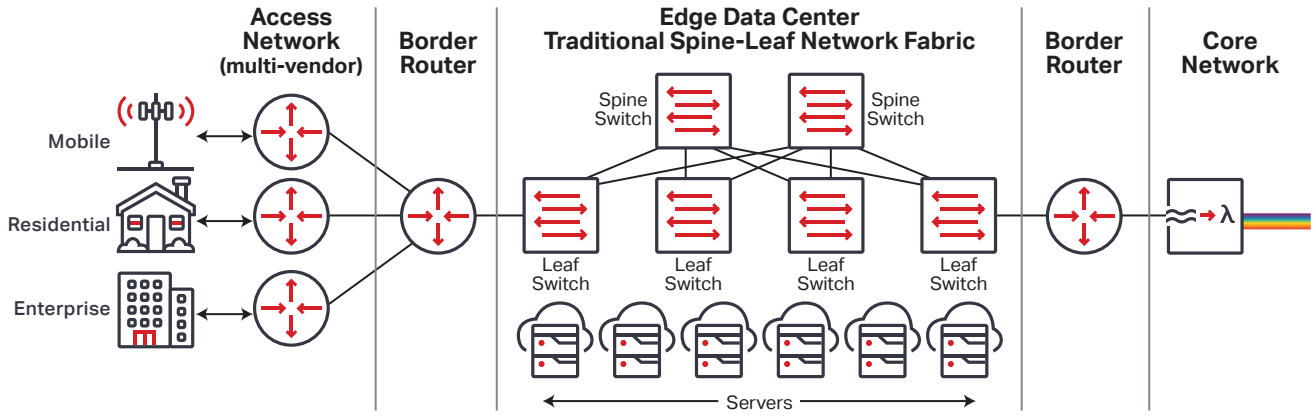

Figure 1. Present mode of operation: Edge data centers

1 Mobile Experts, "Edge Computing for Enterprises 2019", July 2019

be a significant challenge to overcome. A new converged architecture approach is needed for data centers at the edge to meet the new space, power, and automation requirements.

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Challenges for the edge data center

The highly dynamic nature of Edge Cloud services requires the various ecosystem players to think differently about their networks, unlike the traditional data center architecture of the centralized cloud model as shown in Figure 1. The key challenges of the traditional data center architecture are summarized below.

- **Space and power optimization:** Each edge data center will have much less space and power available compared to centralized data centers and cannot support the typical eight layers of networking equipment usually deployed at a centralized data center, as shown in Figure 1. Convergence of these network layers at the edge data center will be required to accommodate the limited availability of space and power.
- **Data center fabric and Data Center Interconnect (DCI) scalability:** The edge is not a one-size-fits-all proposition. Some edge data centers will be close to end-users—humans and machines—and others will cover a wider metro area. More traffic will be carried east-west between edge data centers than north-south back to the core. The architecture for the edge data center must be scalable from a spine-leaf network fabric (n x Tb/s) and DCI perspective (100G/400G) to cover this range of locations.
- **End-to-end service lifecycle automation:** To optimize the utilization of network and cloud resources while satisfying the demand for and requirements of dynamic applications at the edge, intelligent data-driven automation—with a bird's-eye view of the network and edge data center—is required. Unlike the centralized cloud that delivers to many customers, each edge application is specific to a much smaller subset of customers and must dynamically and automatically respond instantaneously to local customers' requirements in an environment with limited resources.
- **Timing and synchronization:** Distribution of accurate timing and synchronization to both edge data center, enterprise, and mobile sites will be key to delivering sub 20 ms latency performance as required by this new generation of edge applications.
- **Analytics and closed-loop automation:** This is required to maintain latency performance of the network of less than 20 ms from end-users to cloud resources in the edge data center, as well as ensure that cloud resources are positioned appropriately to meet the performance metrics of the end-user's application. Intelligent closed-loop automation is required to dynamically identify cloud resources in an alternative data center and/or route to an alternative path in the existing edge data center should that path not meet the required latency SLA of the edge application.

The Adaptive Network approach to the edge data center

The key challenge for Edge Cloud providers is to manage the network and cloud resources efficiently and intelligently for edge data centers during peak periods of usage. Ciena's Adaptive Network™ vision provides a uniform framework for

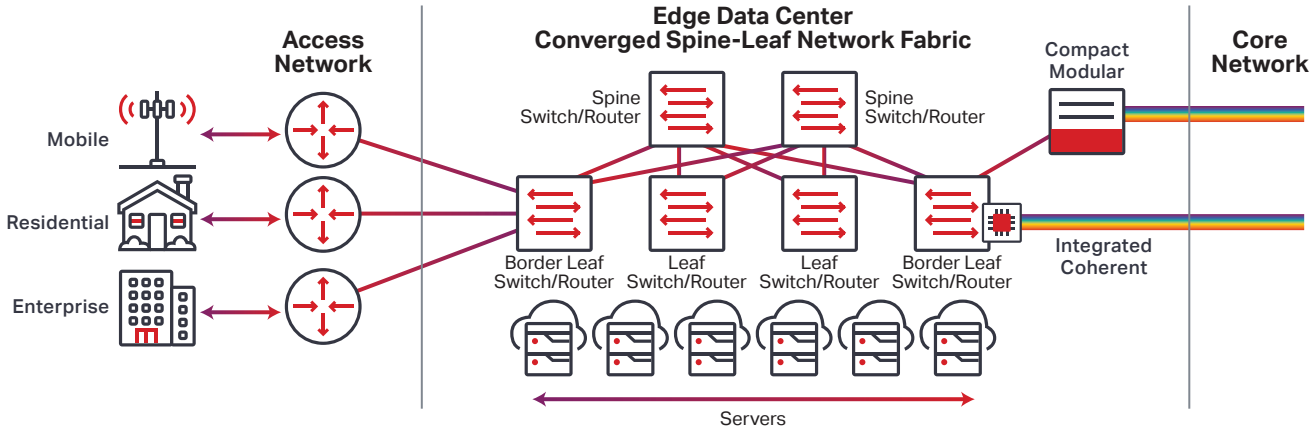

Figure 2. The Adaptive Network™ approach for the edge data center

the edge data center, allowing providers to collectively achieve an end-to-end network that grows smarter and more agile every day with the scale required to respond dynamically to pressures placed upon it.

The Adaptive Network is built on four key foundational elements—Programmable Infrastructure, Analytics and Intelligence, Software Control and Automation, and Services—that enhance network and business outcomes independently but are a force multiplier when working together.

Ciena's approach to the edge data center addresses the challenges identified above by incorporating the following values, as shown in Figure 2.

Programmable Infrastructure

A programmable edge spine-leaf data center network fabric is one that can be accessed and configured via common open interfaces, is highly scalable and instrumented with the ability to export real-time network performance data to the application layer of the Edge Cloud and can adjust its resources as needed to meet the demands of the application layer. This will be key for enabling an application-aware network and providing scalability for interconnection between and within edge data centers. Network slicing at the infrastructure layer will be essential for providers to enable Edge Cloud multi-tenancy services to different cloud providers and application overlays.

Business value

- **Convergence:** Opportunity to optimize space and power by collapsing layers by up to 50 percent, consolidating functions into the edge data center spine-leaf network fabric.
- **Lean:** With the sheer quantity of IoT devices to be deployed at the edge, there will be a huge increase in the amount of edge-to-edge connectivity required. Overly complex, proprietary, and monolithic legacy IP infrastructures are not flexible enough for agile, on-demand services at the edge. What is needed is an automated, open, and lean IP network approach, leveraging such protocols as Segment Routing (SR) that are best optimized for the any-to-any edge data center traffic flows versus traditional flows back to the core.
- **Flexible and scalable DCI:** One of the approaches to converge data center network layers is to consolidate the traditional dedicated optical transponder into the data center spine-leaf network fabric via integrated coherent pluggable optics, such as 400ZR. This is a new approach for the edge that delivers scalability while meeting the space and power requirements of edge data centers.
- **Timing and synchronization:** This approach includes full IEEE 1588v2 capability to all edge data center network elements, allowing centralized network timing sources to be distributed seamlessly to the edge data center, and mobile and enterprises sites over a packet-optical network; it will be key to ensuring sub 20 ms latency performance.

Analytics and Intelligence

Edge Cloud is an extension of cloud computing and operation practices, which rely heavily on automation informed through the interpretation of substantial telemetry and Key Performance Indicator (KPI) data streamed from underlying infrastructure resources to provide real-time visibility into how routing behavior at the edge of the network affects low-latency service delivery. The captured real-time telemetry from network devices in the edge data center, as well as from domain controllers and service orchestrators, provides network forensic capabilities. Leveraging these insights enables an application-aware network that can sense and adapt to edge application needs securely—and in near real time.

Software Control and Automation

Automating the placement of edge network and cloud resources to meet the demands of applications in near real time will be critical to meeting the key constraints and goals of the Edge Cloud. Through the implementation of SDN, NFV, and open APIs, providers can simplify the act of managing, securing, and automating their networks end to end for delivering Edge Cloud services across multi-vendor, multi-domain hybrid networks.

Business value:

- **Automated:** Allows for the rapid creation, deployment, and automation of end-to-end network slices across both physical and virtual domains. The associated complexity of the edge makes intelligent automation a critical network requirement. Separate instances of orchestration will work across cloud/edge virtualization, platform, infrastructure, and application to place and interconnect the application components in suitable edge data center hosts based on end-user location—namely application resource, Quality of Service (QoS), and service specifications.
- **Open:** Facilitates a multi-vendor, hybrid network environment, making it easy for any network operator to successfully evolve from a box-centric, legacy IP approach, to a simpler, automated network design that efficiently supports legacy services as well as the next wave of new edge application requirements.

- **Analytics-driven:** Leverages actionable insights from analytics and streaming telemetry data to identify areas where SLA policies, such as latency, are not being met due to congestion to create an alternative path that does meet SLA conditions and reroutes traffic accordingly. This ensures that low-latency services are maintained, as this will be a key requirement in the Edge Cloud.

Services

Technical and professional services are required to help providers determine their best strategy and architecture for the Edge Cloud, and to build, operate, and continually improve their networks. To do so requires key approaches provided by Ciena's professional services.

Business value:

- **Reduces risk** by leveraging Ciena's field-proven expertise gained from real-world deployments backed by decades of experience in hardware and software.
- **Accelerates time to market** of new services through simplified processes and the availability of proven and tested capabilities ready for use in new deployments.

The Adaptive Network: A Framework for Understanding the Networking Implications of the Edge Cloud Download

Meeting the demands of the network edge

We are still the early phases of the evolution to a distributed Edge Cloud architecture, with resulting deployments of edge data centers. The edge should not be thought of as a specific data center location, but will reside at any number of locations, depending on QoE expectations, resource requirements, and availability of a given cloud application. The location of an application could shift to different edge data centers during its lifecycle, driving the need to intelligently scale infrastructure both within and between edge data centers and to the central cloud while automating network and cloud resources between locations at the edge of the network.

While ICPs have successfully demonstrated their ability to scale within a centralized public and hybrid cloud model, moving to a distributed Edge Cloud model will require partnerships with DCOs and CSPs to take advantage of their extensive infrastructure and footprint closer to end-users. For a distributed Edge Cloud model to reach its full potential, new networking requirements at the edge data center must be addressed. Most notably, the application layers of the cloud stack must be dynamically aware of the resources across network layers, while the network layers must maintain awareness of the changing dynamics at the application layer.

Win the edge with an Adaptive Network approach

Ciena's Adaptive Network approach plays a critical role in some of the largest inter–data center and cloud architectures in the world today. With the number one market share in both global DCI and metro DCI, Ciena is well-positioned to bring its depth of experience and leadership in the cloud and DCI markets to the edge. The Adaptive Network also provides a framework for all edge ecosystem providers to follow by addressing the challenges of the dynamic Edge Cloud model and leveraging highly programmable and scalable infrastructure, analytics, and automation to rapidly scale both network and application cloud resources as required to meet end-user expectations. Following the Adaptive Network framework can help ensure that the performance of an Edge Cloud model can scale and adapt to meet the ever-changing demands of the network edge.

Edge Cloud insight
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