www.pipelinepub.com
Volume 21, Issue 4

Solving Pervasive Mobility's Latency Puzzle by Fusing Telecommunications Legacy with Edge Innovation

By: Marc Cram

The telecommunications and data center industries are at an inflection point. Users expect uninterrupted access to digital services wherever they are, at all times. This requirement of pervasive mobility comes as more and more devices are coming online and connectivity becomes increasingly integrated into everyday life. This confluence leads to a fundamental question: how can networks be reimagined to seamlessly connect mobile fronthaul, edge, and core?

The new age of ubiquitous computing demands an unconventional, imaginative approach. It's not enough to build bigger data centers or deploy 400, 800, or even 1.6 Tb/s networks. Data processing must be embedded closer to end users in a way that successfully bridges connected devices on home Wi-Fi networks, cellular systems, and public/private connections with the facilities where data is stored and processed.

The challenge, as always, is latency. Delivering on the promise of pervasive mobility will require solutions that address connectivity, power distribution, operational intelligence, and environmental adaptability at every layer of the network. Success depends on rearchitecting networks in a way that fuses cutting-edge innovation with existing infrastructure.

Constant Contact

Today, 98 percent of Americans own a mobile phone of some kind, and 9 in 10 own a smartphone, up from 35 percent in 2011. That doesn't account for other connected devices, such as smart home appliances, smart speakers, smartwatches and wearables, or connected vehicles.

Although users have become accustomed to being able to, for example, transition from home Wi-Fi to LTE while streaming content, there's another element at play here putting pressure on networks to deliver ubiquitous connectivity: products and applications that are designed with the expectation of pervasive mobility.

Peridot, an augmented reality game, makes an excellent use case. Users are encouraged to visit real world locations, hopping from network to network to play with their AI-generated pets. The platform communicates with all the different networks in a geographic region and can direct users to specific locations to interact with the game. This dynamic and evolving virtual world is not possible without pervasive mobility. The same concept can be applied to a growing number of devices and applications. For example, an electric vehicle which can identify nearby charging stations based on its geographic location.

This demands networks that can handle ever-changing environments without any perceptible delay. Latency is a critical factor in ensuring these seamless experiences. Data processing must be embedded closer to end users in a way that successfully bridges the connected devices on home Wi-Fi networks, cellular systems, and public/private connections with the facilities where data is stored and processed.

Additionally, the telecommunications and data center industries must reimagine how all layers — mobile fronthaul, edge, and core — interact to create a cohesive ecosystem. This requires addressing challenges across connectivity, power, and operational intelligence.

New Era of Data Center Connectivity

Tackling the latency issue starts at the data center level. The acceptable level of optical losses grows smaller as data rates grow larger. High-capacity optics, such as Very Small Form Factor (VSFF) connectors, allow data center operators to increase the density of fiber optic connections within a limited space, maximizing performance and efficiency. By leveraging the channelization and distribution capabilities of VSFF optics, operators can reduce dependencies on conventional spine-leaf architectures, thereby improving latency through more direct routing paths. That said, with greater fiber optic connections, comes another challenge: managing fiber cables and their connectivity. Much like with VSFF optics, the closer the connections, the better the performance and the lower the

latency. Using direct mating fiber cabling connections, such as those of the Alignment Independent Multifiber (AIM) variety, can help reduce losses compared to traditional cassette-based systems, which bring increased complexity and inefficiencies into high-density deployments.

These solutions simplify cable management, enable faster installations and reconfigurations, and support the higher density needed for hyperscale and edge environments. By reducing physical-layer complexities and streamlining fiber connections, these innovations improve operational efficiency, reduce downtime, and minimize latency.

Power Distribution: The Legacy Advantage

The same characteristics needed to advance network connectivity — efficiency, reliability, scalability — are equally important for the underlying power infrastructure. A significant opportunity lies in leveraging legacy 48V DC power networks, a mainstay of telephone systems. These networks, once the backbone of Central Office (CO) power distribution, can be repurposed to support modern equipment at edge nodes, neighborhood remote terminals, and cell towers.

Through this process — Central Office Rearchitected as a Data Center (CORD) — network operators can repurpose these spaces to run a small data center, rent out as an edge data center, or install a cloud-based content delivery network sitting on regular data center servers.

Modern 48V switch power distribution units (PDUs) enhance this legacy infrastructure with advanced features. They allow operators to remotely manage power distribution, reboot unresponsive servers without on-site intervention, and monitor environmental conditions via integrated sensors.

A major advantage of CORD in pervasive mobility is the ubiquity of its infrastructure. It is already located where the end users are, enabling low-latency operations. By integrating legacy 48V DC power systems with these advanced PDUs, operators can rapidly deploy edge data centers without expensive infrastructure overhauls.

Similarly, open radio access networks (ORAN) transform an industry standard into a new application, offering a more flexible and cost-effective approach to network deployment. Traditional RAN systems rely on proprietary hardware and software from a single vendor, limiting interoperability and innovation. With ORAN, meanwhile, operators can take a white box server, turn it into a telecommunications switch and deliver an open interface that anybody can build upon.

Additionally, ORAN facilitates edge integration by supporting distributed network architectures. With ORAN, processing can be virtualized and moved closer to the network edge, reducing latency and improving the performance of real-time applications. This capability is particularly important for emerging use cases such as autonomous vehicles, smart cities, and industrial IoT, where low-latency connectivity is essential.

Operational Intelligence

If connectivity and power are the backbone of pervasive mobility, operational intelligence is the central nervous system. Operators can track the health of their networks in real-time with sensors that monitor numerous variables, such as temperature, humidity, air quality and moisture. These insights can bring attention to unfavorable operating conditions, allowing for potential issues to be addressed before problems arise.

Remote power monitoring solutions further refine the network management process. Centralized control over power distribution and monitoring give operators the tools they need to optimize their operations, as well as the data needed to perform predictive maintenance. This translates to fewer on-site interventions, or truck rolls, which reduces costs and ensures faster response times, all of which leads to lower downtime and greater reliability.

A Fully Interconnected Network

The way to achieve pervasive mobility is clear. It requires a fully interconnected ecosystem where fronthaul, edge, and core work in unison to deliver seamless, low-latency experiences.

While fiber and copper networks remain critical, the path forward requires creative solutions — for example, reimagining the legacy 48-volt telephone infrastructure in many existing buildings throughout the world. Supporting pervasive mobility also means integrating advanced connectivity solutions such as transceivers and fiber cable connections with supporting infrastructure, including racks, PDUs and track busway systems, designed to support both hyperscale and edge environments.