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50G PON: Enabling scalable, intelligent, and reliable networks

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As global digital transformation accelerates, the demand for faster, more reliable, and scalable networks has never been greater. The early use of PON for networking was largely best effort and mainly supported the first fiber-to-the-home broadband deployments. However, the advent of next-generation PON is set to transform the way we connect, offering unparalleled bandwidth, reliability, and intelligence. This blog explores how 50G PON is a key driver in this evolution.

Applications transformed by 50G PON

50G PON networks are revolutionizing scenarios that were previously reliant or unfeasible over traditional LAN networks. In campus environments, 50G PON redefines how end users interact both onsite and remotely. High bandwidth and low latency improve the performance of virtual whiteboards and video conferencing. Multi-campuses or extended campus settings can now be better interconnected through intelligent cloud services, enabling enhanced applications such as live, remote collaboration; interactive lectures; and imitative training (e.g., robotics with enterprise-level performance). The dynamic capabilities of 50G PON, augmented with artificial intelligence (AI), also support 10G Wi-Fi access requirements. IoT devices can be more effectively deployed in smart campus applications, such as smart lighting, security systems, and energy management. Real-time data can be collected and analyzed to improve the campus environment. Additionally, 50G PON can connect advanced facility management systems, such as HVAC systems, to drive a more energy-efficient campus.

In smart manufacturing, fiber optic networks are making advanced capabilities a reality. According to Omdia, there is an increase in optical connectivity in industrial settings across the world as legacy copper connections are decommissioned. One notable use case enabled by 50G PON is smart optical inspection for automated quality control. In this scenario, high-resolution cameras and imaging systems driven by

AI replace inconsistent traditional methods like manual inspection. This application requires sustained connectivity of 3Gbps to deliver consistent and accurate results. A 50G PON network powered by AI management can also support predictive maintenance by continuously monitoring equipment conditions and performance. Advanced analytics can predict potential failures before they occur, reducing maintenance costs and improving uptime.

There is strong evidence in the mobile access network space that PON can effectively manage 5G network backhaul. Small cell backhaul remains a key area of interest because of the cost-effectiveness of using a single 50G PON to manage multiple small cells, reducing the operational and infrastructure costs of the network. Furthermore, 50G PON offers sufficient capacity to support growing 5G traffic levels without requiring extensive infrastructure changes. Numerous operators have tested and verified this capability. China Mobile has verified that a single 50G PON can handle traffic for forty small cells.

50G PON supports ubiquitous 10G service

50G PON also addresses broader network demands. Networks must support individualized sets of requirements and seamlessly provision a wide range of applications and end users to remain scalable and cost-effective. 50G PON meets this need with advanced technical features. One such feature is an ultra-short preamble (essentially the “handshake” before data transfer begins), significantly enhancing data transmission efficiency and thus increasing uplink bandwidth by 30% or more. Additionally, 50G PON enables time division multiplexing (TDM) multiburst mode, which supports continuous data transmission and decreased packet time, ensuring a smoother and more responsive network experience.

Migrating to 50G PON

Upgrading to 50G PON involves careful consideration of the existing network infrastructure and long-term planning. An example includes assessing the impact on the current PON technologies utilized and the impact on the optical distribution network (ODN) in place. 50G PON OLT platforms can provision multigenerational PON by deploying multimode ports that can support GPON, 10G PON, and 50G PON simultaneously. This flexibility allows the continued provisioning of lower-bandwidth applications with previous-generation PON technologies while introducing new bandwidth-intensive applications over 50G PON. This is without needing multiple OLT platforms, resulting in space and energy savings.

The ODN is often the costliest component of the access network. To address this, 50G PON enables a zero-change ODN through three technologies. The first, a tapered amplifier, supports an increase in the transmitting optical power. The second, a superlattice receiver, increases the receiving sensitivity. Together, these two technologies expand the power budget to 32dB, guaranteeing the network is upgrade-ready for 50G PON. The third technology, a micro-angle prism array, dramatically reduces the optical path size by upward of 90%. This array also enables the simultaneous operation of GPON, 10G PON, and 50G PON within the same optical module, eliminating the need for external multiplexers and demultiplexers. These advancements not only facilitate a zero-change ODN upgrade path to 50G PON but also lay the foundation for future upgrades to 200G PON.

More than bandwidth

A truly reliable and deterministic network experience relies on much more than bandwidth capability. 50G PON offers advanced features beyond just capacity, such as providing hard network slicing. This

capability allows for service-level agreements (SLAs) tailored to different applications and end-user profiles, ensuring consistent and predictable performance across various scenarios.

Another noted function enabled by 50G PON is dual-plane forwarding support across TDM and Ethernet. Traditional Ethernet queue scheduling causes high jitter and delay, which cannot meet the requirements of services with deterministic delay. With TDM forwarding, the system will allocate dedicated resources for high-value services to guarantee millisecond-level latency and nanosecond-level jitter, ensuring a deterministic experience.

Embracing native intelligence

The 50G PON network is significantly enhanced by AI-driven management, powered by hardware and network technology advancements. More powerful AEC edge computing boards enable AI-based application sensing, experience sensing, and intelligent closed-loop management. Diagnosis can be conducted at the application level for key applications that demand high bandwidth and optimized performance. Issues with quality of experience (QoE) can be identified and automatically corrected, complete with a diagnosis report. In an FTTR network scenario, the OLT can work in tandem with access points to implement real-time control of the Wi-Fi network.

These enhancements are most effective when integrated with a cloud-based management system like Huawei's Network Cloud Engine. In this environment, service automation is transformed to a quality on demand (QoD)-based NaaS capability supported by an open, interoperable gateway with a standard API interface. This setup, backed by a built-in AI core, opens up opportunities for third-party monetization across numerous high-bandwidth applications and diverse end-user profiles.

50G PON is much more than a residential, fiber-to-the-home technology; it showcases the evolution of fiber access networks to a level where they can provision even the most sophisticated of applications. As new applications emerge—ones that legacy networks cannot keep pace with—and wireless deployments require more robust backhaul support, PON technology is no longer just for service providers. It is now a versatile solution that can be dynamically deployed and managed across a wide range of industries and verticals. Now is the time for organizations to embrace this technology, unlocking new opportunities and ensuring they can remain competitive in an increasingly digital world.

Appendix

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Omdia Commissioned Research
This piece of research was commissioned by Huawei.

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