PDF Document

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"title": "Optical Access Architecture Reference Document: High-Tech Park Optical Fiber Access Network",

"content": "TECHNOLOGY OVERVIEW\n\nThe modern high-tech park represents a concentrated ecosystem of data-intensive enterprises, research institutions, and cloud service providers, all of which demand guaranteed bandwidth, sub-millisecond latency, and carrier-grade reliability from their network infrastructure. The High-Tech Park Optical Fiber Access Network is purpose-built to address these stringent requirements, offering a future-proof, scalable, and highly secure foundation for next-generation digital services. This reference document details the architecture, hardware components, and performance specifications of this comprehensive solution, which leverages the unparalleled bandwidth and low-loss characteristics of optical fiber to deliver symmetric multi-gigabit services directly to the tenant premises.\n\n[IMAGE_1]\n\nSYSTEM HARDWARE TOPOLOGY\n\nThe physical architecture of the solution is structured around a hierarchical, fully redundant topology designed for maximum resilience and deterministic performance. At the core of the park, a high-density Optical Line Terminal (OLT) chassis serves as the central aggregation point. This chassis, housed in a secure, environmentally controlled datacenter facility, terminates up to 128 subscriber fibers via
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modular line cards, each equipped with advanced physical-layer chipsets. From the OLT, a dual-homed Gigabit-capable Passive Optical Network (GPON) or 10-Gigabit-capable Symmetric Passive Optical Network (XGS-PON) distribution network extends outward through a series of hardened Optical Distribution Frames (ODFs) and passive optical splitters. This point-to-multipoint (P2MP) topology minimizes active electronics in the field, significantly enhancing reliability and reducing operational expenditures (OPEX). At the edge, Optical Network Terminals (ONTs) or Optical Network Units (ONUs) are deployed at each tenant demarcation point, providing a range of user-network interfaces (UNIs) including 1G/10G Ethernet and legacy TDM ports for seamless integration into existing enterprise local area networks (LANs). The system's non-blocking backplane ensures that all aggregated traffic is forwarded to the core network at wire speed, without contention.\n\nDATA & CONTROL PLANE CAPABILITIES\n\nThe solution's intelligence is distributed across a sophisticated dual-plane architecture. The high-speed data plane handles all subscriber traffic, utilizing a centralized switching fabric with a capacity of up to 3.2 Tbps, enabling line-rate forwarding of all packets, regardless of size. Advanced features such as hierarchical quality of service (HQoS), traffic shaping, and policy-based routing are implemented in hardware to ensure that service-level agreements (SLAs) are met without impacting throughput. The control plane, managed by a redundant pair of advanced CPU modules, is responsible for system management, protocol processing, and network orchestration. It

supports a comprehensive suite of networking protocols, including but not limited to: IGMP/MLD snooping for multicast traffic, dynamic bandwidth assignment (DBA) for optimizing upstream bandwidth utilization, and robust routing protocols (OSPF, BGP) for seamless integration with the wider IP/MPLS network. The separation of data and control planes ensures that even during periods of high traffic, network control and management functions remain responsive, enabling stable and predictable network operations.\n\nOPTICAL TRANSCEIVER INTERFACES\n\nA critical component of the system's performance lies in its standardized, high-performance optical interfaces. The OLT line cards are equipped with Small Form-factor Pluggable (SFP) and SFP+ transceiver ports, supporting a wide array of physical media depending on the required reach and application. For standard distribution (up to 20 km), Class B+ GPON optics are utilized, operating at 1490 nm downstream and 1310 nm upstream. For higher bandwidth needs or longer reach (up to 40 km), XGS-PON interfaces employing Class C+ optics are supported, delivering symmetric 10 Gbps capacity. In addition to PON interfaces, the OLT and aggregation switches feature SFP+ and QSFP+ ports for 10/25/40 Gigabit Ethernet uplink connectivity to the core layer, ensuring that the access network does not become a bottleneck. All transceivers are compliant with the SFF-8472 digital diagnostic monitoring interface, allowing for real-time monitoring of optical power, temperature, and bias current, which is essential for proactive maintenance and fault prediction.\n\nREDUNDANT SUBSYSTEMS\n\nTo meet

the high-availability demands of a commercial high-tech park, the system is engineered with full hardware redundancy at every critical point. The OLT chassis is designed with dual, hot-swappable power supply units (AC or DC) and a redundant fan tray module, ensuring continuous operation even in the event of a component failure. The control plane is safeguarded by 1+1 active/standby CPU module redundancy, with automatic failover switching in under 50 milliseconds. For fiber protection, the system supports Type B protection topologies, where each ONU is connected to two separate PON ports on the same OLT, providing a secondary path in case of a fiber cut or PON port failure. This comprehensive redundancy strategy ensures 99.999% service availability, protecting tenants against network downtime and the associated financial losses.\n\nCAPABILITY METRICS\n\nPARAMETER SPECIFICATION PERFORMANCE\n\n- PORT DENSITY: Up to 128 GPON / XGS-PON ports per chassis; 16 user-facing Ethernet ports per ONT. High-density design to support large campus deployments with future expansion capacity.\n- SWITCHING CAPACITY: 3.2 Tbps non-blocking backplane. Enables concurrent wire-speed forwarding across all interfaces, ensuring zero packet loss under full load.\n- FORWARDING RATE: 2,400 Mpps (million packets per second). Based on 64-byte packet processing capability, meeting the demands of high-frequency trading and real-time analytics.\n- MAXIMUM SPLIT RATIO: 1:64 (GPON) / 1:128 (XGS-PON), supporting a large number of tenants per OLT port and maximizing fiber utilization in the distribution network.\n- LATENCY: < 5 microseconds for

store-and-forward switching, ensuring high responsiveness for interactive applications and cloud-hosted services.\n- MTBF: > 300,000 hours for OLT core components, underscoring the carrier-grade reliability and long operational life of the deployed hardware.\n\n[TABLE_1]\n\nCOMPLIANCE AUDIT\n\nThe High-Tech Park Optical Fiber Access Network is designed and verified to meet the most stringent international telecommunications and safety standards, ensuring a future-proof investment and facilitating regulatory acceptance. The hardware and software have undergone extensive testing to achieve compliance with all applicable directives. The system holds CE marking, confirming it meets the essential requirements of the applicable European Directives, and is fully compliant with FCC Part 15 Class A for electromagnetic interference. For safety, the equipment adheres to UL / CSA 60950-1 and IEC 60825-1 for laser safety. In the telecommunications domain, the system is compliant with the full suite of ITU-T G.984 (GPON) and G.987 (XG-PON) standards, ensuring interoperability with a wide range of standard-compliant ONUs and third-party equipment. Additionally, the management and control interfaces are fully compliant with the TR-069 protocol, allowing for remote, automated device provisioning and management.\n\nSCALING STRATEGY\n\nThe architecture is inherently scalable, offering a flexible investment model that permits capacity upgrades without requiring a costly "forklift" upgrade of the entire infrastructure. As bandwidth requirements grow, the system can be seamlessly scaled in two primary dimensions. The first

dimension is vertical scaling: individual PON cards can be upgraded to higher-density or higher-bandwidth versions (e.g., from GPON to XGS-PON) to augment the capacity of an existing OLT chassis. The second is horizontal scaling: additional OLT chassis can be added to the central hub and interconnected via the high-speed uplinks, effectively creating a cluster to support a larger number of tenants. Furthermore, the adoption of next-generation technologies, such as 50G-PON, is considered in the chassis backplane design, ensuring that future network upgrades are possible via simple line card replacements. This modular approach protects the operator's investment and ensures that the network can evolve to meet the demands of the next decade.\n\n[IMAGE_2]",

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"A high-quality 4K realistic promotional image showing a modern datacenter rack with high-tech park optical fiber access network equipment, cool blue lighting, high tech vibe, professional generic aesthetics, no text.",

"A high-quality 4K realistic close-up image showing the hardware details, fiber optic ports, or interfaces of the high-tech park optical fiber access network, professional studio lighting, generic industrial components, no text."

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          ["Port Density (OLT)", "Up to 128 GPON/XGS-PON ports; 16 x 10GE uplinks"],
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