800G AND BEYOND

A look at the drivers and factors of building tomorrow's data centers

T1 NEXUS

Contents

INTRODUCTION

The world consumes a lot of data. According to the Technical University of Denmark in Copenhagen[1], just over a petabit is on the move every second. And that number is only set to grow. A convergence of several technologies such as the cloud, high-performance computing, and AI are just a few of the innovations leaning heavily on the data center and the race for 800Gbps transceiver capability has begun.

What would it take to become an organization capable of meeting these growing data transfer needs? And what should professionals spearheading these initiatives consider as they aim to future-proof their data centers?

What follows is a look at several key elements that you should consider on your journey to building a more capable data center. You'll get a closer view of the technology and innovations that enable faster transfer rates, what upgrading means for your current infrastructure, and what standards and interoperability considerations you must keep in mind.

GROWING DEMAND

Data centers across the globe looking to bolster their operations aren't strangers to conversations about operational efficiency. These conversations take place at every turn and today, they are growing in number.

Several technologies have gained enough momentum to drive the need for greater data transfer capabilities. IoT, for example, plays an integral part in enterprise operations, requiring large numbers of devices to transmit and receive data for mission-critical tasks. Connected cars and smart devices used by enterprises and consumers are online. In 2023 alone, there will be an estimated 15.14 billion IoT devices online[2].

A convergence of technologies has created the demand for faster data transfer rates.

The adoption of 5G has made it possible to transmit more data faster too, shaving time off previous transfer rates. Cloud computing has also reached its maturity phase, with highly mature organizations leveraging multi-cloud solutions[3] and hyperscalers expanding to meet growing enterprise needs.

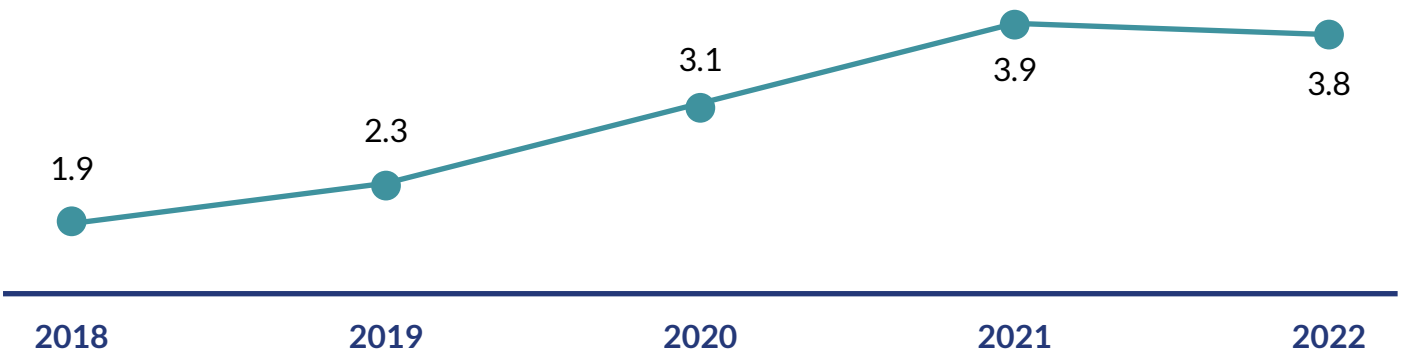
But these aren't the only fast data consumers. Streaming, high-performance computing and AI are also growing. Recent figures show that 38% of all TV usage is dedicated to streaming[4].

AI's unique data processing requirements necessitate faster data transfer rates. The need to process large data volumes and move this data to and from storage devices, manage large workloads, a dependence on cloud computing architecture, and the importance of interconnectivity and connectivity with other AI applications all draw on network resources.

It's clear that tomorrow's data centers have to be capable of handling the demands of these applications. Let's explore the technology designed to support these applications.

Responses show an increasing number of AI capabilities embedded inorganizations over the past five years.

Average number of AI capabilities that respondents' organizations have embedded within at least one function or business unit.



TECHNOLOGY AND INNOVATION

Technological advancements enabling 800Gbps operations offer data centers more than just greater speeds. Data is susceptible to degradation over longer distances, and when electronics are challenged to perform at higher rates, they are also prone to generating more heat. 800Gbps transceivers, however, have been designed to account for these and other challenges by leveraging the following technologies.

Higher-order modulation

Higher-order modulation (HOM) refers to the use of more complex modulation formats designed to transmit more data through the same amount of spectrum. This method is critical in enhancing the capacity and efficiency of communication systems, including 800Gbps optical transceivers.

In the context of 800Gbps optical transceivers, here's how higher-order modulation becomes particularly important:

Increased Data Transmission: HOM schemes, such as 16-QAM (Quadrature Amplitude Modulation), allow for the transmission of more bits per symbol. By doing so, they effectively increase the data rate transmitted over a single wavelength without needing additional bandwidth. This is crucial for 800Gbps transceivers that require high-throughput capabilities.

Spectral Efficiency: Higher-order modulation improves spectral efficiency, meaning more data can be packed into the same optical spectrum. This is particularly beneficial for 800Gbps transceivers as

it allows for denser information packing, making better use of available network resources and optimizing bandwidth.

Advanced Signal Processing: Implementing HOM requires advanced signal processing technologies to manage the complexity of the signals, especially in the optical space. For 800Gbps transceivers, this means sophisticated electronics are required to support the modulation, ensuring signal integrity and reducing transmission errors.

Innovations in transceiver design and functionality enable high-quality data transmission with faster data transfer rates.

Despite the value HOM offers, it's crucial to note that an increase in data capacity also contributes to a system that is more susceptible to noise and signal distortions. 800Gbps transceivers must be designed with enhanced features, such as forward error correction and improved signal-to-noise ratios, to counteract these challenges.

Advanced Digital Signal Processing

Data Signal Processing techniques have become more sophisticated to support 800Gbps technology. The more data you try to pack into each transmission (as higher-order modulation does), the more susceptible your signal becomes to interference and degradation. Advanced DSP mitigates these effects by employing techniques like error correction, signal reconstruction, and noise reduction, ensuring the integrity of data transmissions despite the increased throughput.

Coherent Optics Technology and Host FEC

Coherent optics technology involves the use of advanced modulation techniques to increase the capacity and sensitivity of optical communication systems. When combined with Host FEC, a technique used for controlling errors in data transmission over unreliable or noisy communication channels, coherent optics benefit from an additional layer of error correction. This layer enhances a system's ability to successfully recover and interpret signals that have degraded over long distances or through interference.

Silicon Photonics

Silicon photonics supports the high-speed, efficient transfer of data, helping meet the increasing bandwidth demands.

As a transformative technology, silicon photonics integrates photonic systems with electronics, using silicon as the structural material. It plays a crucial role in the production and design of 800Gbps optical transceivers due to several inherent advantages:

High Data Rate Capability: Silicon photonics enables the development of optical transceivers capable of handling extremely high data rates, such as 800Gbps. The technology supports higher bandwidth demands, ensuring rapid data transmission with lower power consumption compared to traditional electronic data transmission.

Integration and Scalability: Silicon photonic component design allows for the integration of different optical components (modulators, detectors, etc.) onto a single silicon chip. This integration is essential for 800Gbps transceivers, where space constraints and integration at the photonic level are critical for performance and scalability, particularly as data center interconnects continue to demand higher bandwidth.

Reduced Power Consumption and Heat: Silicon photonics components typically consume less power, which is important for 800Gbps transceivers that handle vast amounts of data. Lower power consumption means reduced operational costs and less heat generation, both of which are critical concerns in modern data centers.

Cost-effectiveness: Silicon is abundant and leverages the well-established CMOS (Complementary Metal-Oxide-Semiconductor) manufacturing infrastructure, which helps in reducing the costs associated with the production of photonic components. This economic efficiency is crucial for the commercial viability of high-performance transceivers.

Together, these technological advancements collectively contribute to the overall performance enhancement of 800Gbps transceivers. They make it possible to realize modern, high-bandwidth applications and the ever-growing demand for data-intensive services.

STANDARDS AND INTEROPERABILITY

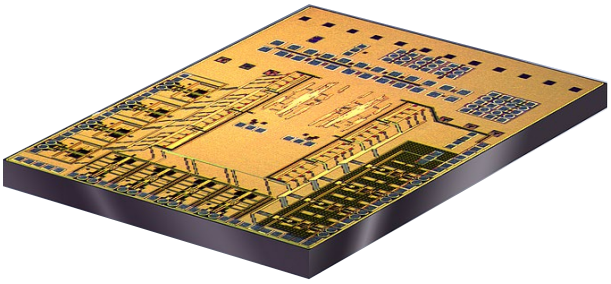
Industry standards ensure that 800Gbps transceivers are compatible across different equipment and vendors. While most larger and more prominent vendors often don't support interoperability, forward-thinking and innovative alternative OEM manufacturers have designed completely interoperable 800Gbps transceivers, enabling data centers to benefit from high-quality mission-critical hardware with competitive rates.

The standards and interoperability of 800Gbps transceivers are crucial aspects ensuring that these high-speed components efficiently and effectively communicate within and between networks. While the specific details related to the standards and interoperability of 800Gbps transceivers are continuously evolving, these are the most common considerations for 800Gbps-ready data centers:

Interoperability gives data centers access to high-quality next-generation transceivers with multi-vendor environment support at competitive rates.

Standards Compliance: The 800Gbps transceivers must comply with industry standards set by global organizations such as the Institute of Electrical and Electronics Engineers (IEEE), International Telecommunication Union (ITU), and others. These standards ensure the uniformity of performance specifications, enhancing compatibility, and interoperability across various network equipment and vendors.

Silicon Photonics Chip



Interoperability Testing: This involves rigorous testing procedures to ensure that 800Gbps transceivers perform optimally across different systems and protocols. Interoperability testing checks the data integrity, error rate, and the ability of transceivers to establish and maintain communication in diverse network setups.

Forward Compatibility: Given the rapid advancements in technology, 800Gbps transceivers should be designed with forward compatibility to accommodate future upgrades and standards. This flexibility ensures that current network investments remain viable and efficient as newer, faster technologies are introduced.

Multi-vendor Environment Support: The transceivers should work seamlessly in multi-vendor environments, a common scenario in complex modern networks. The ability to support various vendor equipment without performance degradation is crucial for operational efficiency and cost-effectiveness.

Protocol Agnosticism: 800Gbps transceivers should support various network protocols, including Infiniband, Ethernet, and others, without requiring different physical infrastructure. This versatility ensures that they can be deployed across various network architectures.

Data centers that adhere to these principles are positioned to ensure that 800Gbps transceivers can support the fast, reliable, and secure transfer of data needed in high-bandwidth applications and services.

NETWORK INFRASTRUCTURE UPGRADES

Integrating 800Gbps transceivers requires significant changes to existing network infrastructures and intricate planning. As expected, the cost of upgrading to 800Gbps transceivers is a crucial point, however, there is also the need to meet 800Gbps compatibility requirements such as the potential need for new cabling or amplification technologies, and the option of future scalability.

800Gbps transceiver and data center compatibility must be examined holistically for successful integration.

Here are critical considerations for network infrastructure upgrades with 800Gbps transceivers:

High-Bandwidth Backbone

Networks must have a high-bandwidth backbone to support 800Gbps speeds. This might necessitate upgrading core routers and switches, as well as the cabling infrastructure, to devices that can handle higher data rates without bottlenecks.

Power and Cooling

800Gbps transceivers may require more power and produce more heat. It's essential to ensure that data centers have sufficient power supply and efficient cooling systems to maintain optimal operating temperatures and reliability.

Distance Considerations

The reach of 800Gbps transceivers might be limited compared to lower-speed options. Infrastructure planning should consider the placement of data centers and the network design to accommodate these transceivers without signal degradation.

Interoperability

Upgraded components need to work seamlessly with existing equipment and those from different vendors. Comprehensive testing for compatibility and interoperability is crucial during and after upgrades.

Future-Proofing

Technology continues to evolve. Planning should include scalability and flexibility to adapt to future standards, potentially beyond 800Gbps, without requiring a complete infrastructure overhaul.

Cost Assessment

While 800Gbps transceivers offer superior performance, they also come at a higher cost. Organizations must balance the needs for speed and capacity with budget realities, possibly implementing phased upgrades.

Security Protocols

With increased capacity and speed, ensuring the security of data-in-transit becomes even more vital. Upgrades should include advanced encryption and security protocols without compromising performance.

By addressing these factors, organizations can effectively integrate 800Gbps transceivers into their networks, enhancing capacity, speed, and overall performance in their digital transformation journey.

BEYOND 800G

While 800Gbps technology is still being adopted, research into 1.6Tbps capabilities and beyond is ongoing. These developments are expected to leverage new innovative techniques in silicon photonics and advanced fiber optics to achieve faster data transfer rates. As with 800Gbps adoption, key considerations into the infrastructure upgrade costs, and interoperability will need to be addressed. Energy efficiency will be just as important as higher transmission rates are tested.

GET THE T1NEXUS ADVANTAGE

T1Nexus provides end-to-end interconnect solutions. Our product range includes optical transceivers, active optical cables, active copper cables, direct attached copper cables, fiber patch cables, and patch panels for the 800Gbps data center.

Our hands-on approach and supply of 800Gbps optical transceivers with interoperable vendor-neutral solutions give customers the freedom and flexibility to run and maintain a multi-vendor, multi-standard data center.

Transform your data center with us and realize the operational efficiency all world-class data centers experience.

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