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TRANSITIONING TO 100GB NETWORKING

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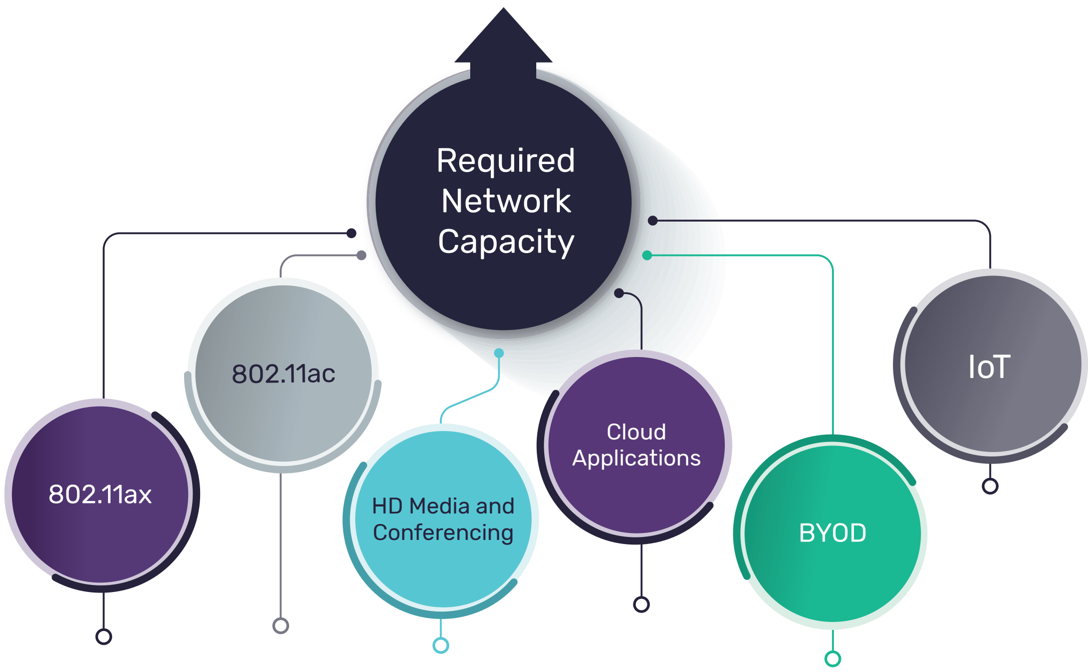
The demand for more network capacity in the campus, distribution, and core layers is a key challenge for many organizations, a result of an ever-increasing set of business objectives pushing networks to their limit.

Amid the growing prominence of cloud computing in IT operations – or perhaps partly because of it – the physical network infrastructure is as important as ever. Network infrastructure enables IT to cost-effectively deliver valuable services such as productivity applications and high definition unified communications to the business. In turn, when a network is near full capacity, the per-employee costs in lost productivity can range into the thousands of dollars per year. Additionally, an underperforming network can result in the loss of interactivity, disruption to phone and other live media services, and the associated opportunity costs that are accumulated while waiting for slow transactions to complete.

Network capacity demands will only grow as the network is pressed to carry more data. In coming years, advances in Wi-Fi, specifically the 802.11ac Wave 2 and 802.11ax protocols, will bust the 1Gb per AP Ethernet barrier. Applications intolerant of network congestion, especially growing use of high-definition videoconferencing and other streaming video, will further tax the network. And in the 3-5 year timeframe, mobile data from small-cell and femtocell 5G wireless will begin to traverse enterprise networks, demanding faster connectivity. At the same time, employee, guest, and customer expectations for fast, responsive application performance continue to grow.

In the context of these issues, it becomes clear that today's 1 and 10 Gbps core and distribution networks can no longer sustain increasing demand. It is against this backdrop that enterprises should begin planning for 100Gb Ethernet in the near future.



BABY STEPS OR GIANT STEPS

The transition to 100Gb in the data center is already underway with the introduction of standards-based 25Gb and 100Gb interfaces on server and storage systems coming to market. In the campus, the situation is different because the demand for higher capacity wireless networking is growing, and support for 2.5Gb and 5Gb multi-rate ports in access points and switching platforms will fuel higher consumption. In addition, per-user network consumption demands are increasing with the advent of cloud storage and applications and other high-bandwidth applications.

Efforts to improve performance on today's existing enterprise networks is somewhat hindered by standard design paradigms. Campus LANs tend to be built in tiers with the access layer aggregating to a distribution layer, and the distribution layer aggregating to a core. Flatter architectures, like leaf/spine, are difficult to achieve because of distance limitations between floors and buildings are measured in 100's of meters which may exceed the distances for fiber and copper cables, and because of how buildings are laid out.

The N-Tier architecture referenced in Figure 1 naturally means increasing inter-switch capacity requirements from the access layer through the distribution layer and up to the core. Having a 1:1 ratio from access to core bandwidth is prohibitively expensive and, in most enterprises, has historically resulted in unused capacity between tiers. Enterprise workstations and network devices rarely ever consume 100% capacity for prolonged periods, so enterprises typically strive to balance available capacity against the cost of high-speed network connectivity. Oversubscription - with a common target access-to-uplink ratio of 3:1 - is common in enterprise architectures due, in part, to the static configuration of network ports. With contemporary multi-gig Ethernet capacities ranging from 10 to 100Gb, enterprises have more flexible options in managing total network capacity as demand grows.

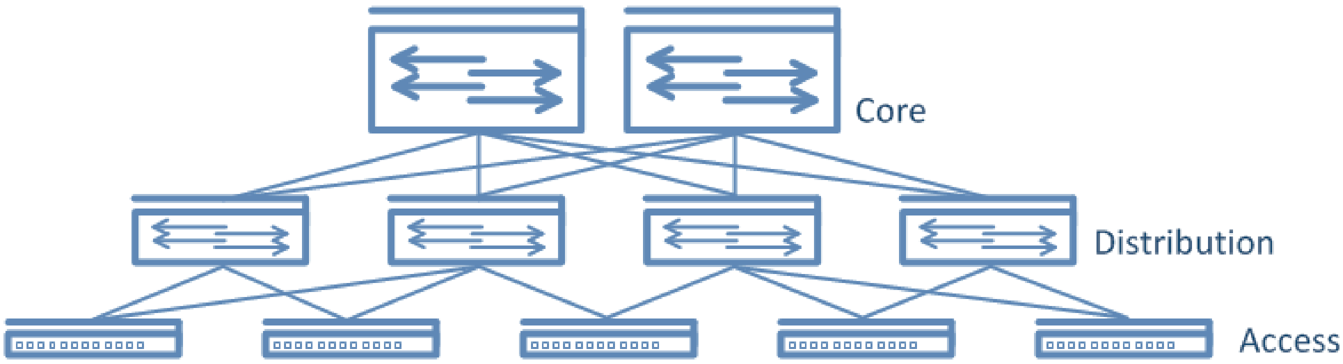


Figure 1

48 Port Access Layer Switch		
Access Port Speed in Gbps	Gbps Uplink demand for 1:1	Gbps Uplink demand for 3:1
1	48	16
2.5	120	40
5	240	80

Table 1

Table 1 shows the 1:1 and 3:1 uplink capacity for a 48-port multi-gig access layer switch. Assuming a single uplink connection, a single 40Gb port or 4 x 10Gb ports would achieve 1.2:1 over subscription while 2 x 25Gb ports would create a 1:1 relationship. At 2.5Gbps or 5Gbps, access ports for the same switch significantly increase the uplink capacity for a 1:1 and moderately increase the required uplink capacity for 3:1 over-subscription. In either case, it would be advantageous to 25 or 40Gb to reach the required uplink capacity.

GREATER VERSATILITY

Unlike prior capacity shifts networking, the standards bodies increased in port speeds from 10Gb to 40Gb versus 10Gb to 100Gb. The interim 40Gbps standard was developed to meet the demand of cloud-scale companies and Internet Exchanges that needed more capacity than was offered with 10Gb. The 40Gb standard was created using four 10Gb lanes that were bonded together to create a single 40Gb interface, or broken out to four 10Gb lanes using a breakout cable. Similarly, the first jump to 100Gb, 100GBase-CR10, was essentially 10 x 10Gb, which offered either a 1 x 100Gb interface or 10 x 10Gb. Today, 100GBase-SR4 features four lanes of 25Gb, which can be broken out to 4 x 25Gb or combined to a single 100Gb link.

Starting in the data center but soon moving to campus switches and routers, multi-rate ports supporting capacities from 1Gb, 10Gb, 25Gb, 40Gb, and 100Gb by simply replacing the interface modules will become the norm for switches and has created a unique opportunity for enterprises to future proof network purchases. These changes reflect the reality that network equipment in-service lifetimes have extended from 2-3 years to 5 years or more. Multi-rate ports protect investments in network infrastructure by increasing capacity in a switch or router at a much lower cost, and allow enterprises to add capacity on their own timeline.

MIND THE GAP

When the time comes, the decision to increase network capacity shouldn't occur in a vacuum. As capacity grows, the ability to monitor the network becomes more difficult, and minimizing downtime due to an outage becomes more important. With the transition from 1Gb to 10Gb Ethernet, it took two-plus years for network equipment -- including firewalls, IDS/IPSes, and load balancers -- to catch up with the capacity change, and that history is repeating itself with 100Gb. Advanced capabilities in routers and switches that can match traffic and forward to a particular network device, or limit access without impacting network performance, is increasingly common and an important consideration. In addition, network, application, and security performance monitoring must not only support the higher raw-data rates, but also the increase in packets and flow volume.

As capacity in the access layer grows, the demand for increased capacity in the core and distribution tiers also grows. The capacity overflow caused by over-subscription can often be addressed at the access layer with switch stacking. This creates a virtual backplane between access layer switches, expanding the management domain as well as taking traffic between clients and servers on the same stack off the uplinks which simplifies management and increases resiliency and capacity. Advanced stacking features also increase network resiliency with in-service hardware insertion without disrupting the entire stack, as well as distributing uplinks across stack members. Should a stack member fail, network traffic can be forwarded uninterrupted to other members. Backplane stacking using ribbon cables is common, but with front-side 40Gb and 100Gb ports, overall stack capacity is increasing. New switches are removing the access port/uplink port split, allowing any port to be an access or uplink port. This allows for more versatility and inter-stack capacity, which is particularly useful as network speeds rise.

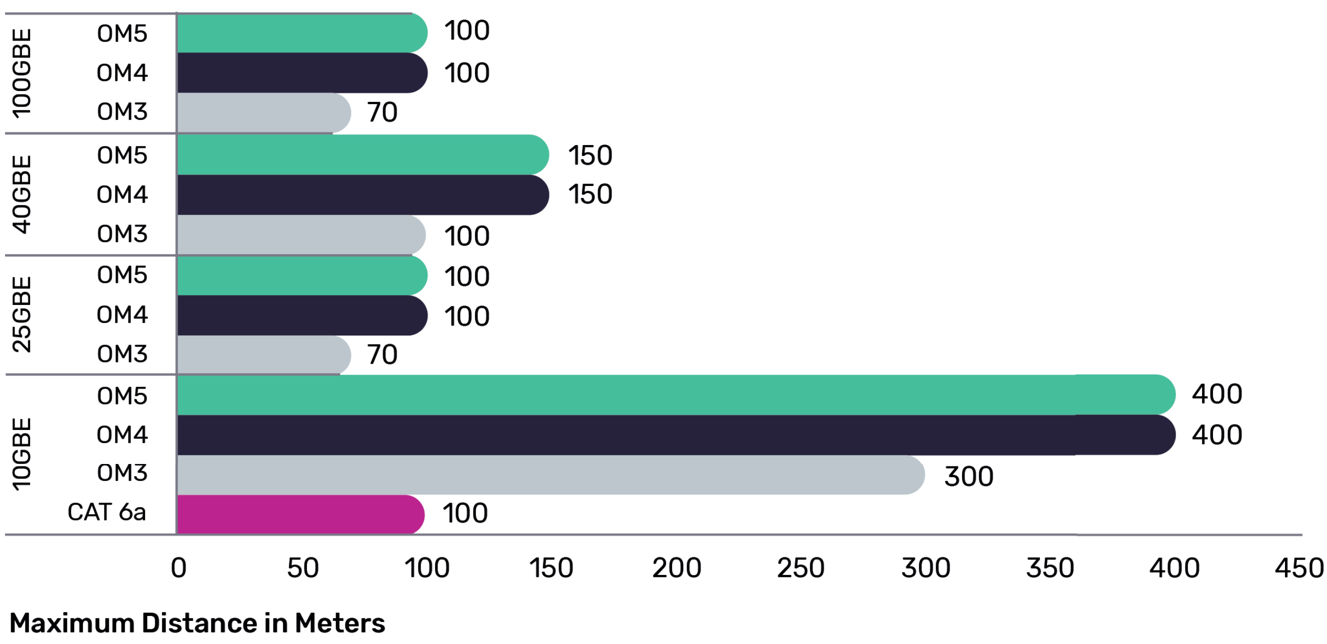
COST VS DISTANCE

As organizations plan the migration to 100Gb Ethernet, a critical consideration is the cabling plant. This is because the media beyond 10Gb network devices must be fiber; the distances between network tiers are simply too great for copper. The choices made today will have a significant impact on network costs and limitations in the next 10 to 15 years.

A prudent starting point is to evaluate the total price of the cabling plant and the optical modules. A single-mode fiber plant is often less expensive than a multi-mode fiber plant, while single-mode optical modules are usually far more expensive than multi-mode optical modules. The cost difference between single- and multi-mode cable and optical modules isn't negligible, but any effort to pull new fiber is expensive. Future-proofing the physical plant well beyond expected short-term capacity demands will pay off in future savings, especially with 200Gb and 400Gb standards efforts already underway.

Any fiber plant with multi-mode OM1 or OM2 fiber will likely need new fiber to support increased capacities beyond 10Gb. In most cases, this will mean a jump right to OM4 or OM5 multi-mode fiber. While 25Gb and 100Gb will run over OM3 fiber, it's clear from the distance limitations that OM3 is reaching the end of its useful life for new installations.

Comparison of Distance for Multi-Mode Fiber for 10/25/40/100Gb Ethernet



100Gb and 25Gb relies on the same underlying technology and both suffer the same distance limitations: 70 meters over OM3 and 100 meters on OM4 and OM5. While 40Gb has a slightly longer reach, the costs of 40Gb optics are higher than either 25Gb and comparable to 100Gb. The decision to push toward 100Gb becomes even more sound when considering a 100Gb module in a multi-rate switch provides 2.5 times more capacity than a 40Gb module for roughly the same cost.

The same price-to-performance relationship holds true in the campus. If the interconnecting switches are within 70 meters over OM3 fiber or 100 meters over OM4 or OM5 fiber, 100Gb-SR is more cost effective than 40Gb for the interconnection. For distances up to 150 meters, using 40Gb optical modules on OM4 or OM5 fiber may be a *short-term* solution - if, for example, existing switches only support 40Gb - but most organizations will want to abandon it at the earliest opportunity. With no place to go past 40Gb other than link aggregation, 40Gb represents an evolutionary dead end. Going beyond 100 meters in distance means it's time evaluate single-mode fiber.

The timing for such a purchase is one more important consideration. The price of a single-mode optical module can be shocking and may put it out of reach of most enterprises. Eventually production runs will increase and prices will drop, but this won't happen overnight. However, there are non-standard multi-vendor interoperable options available today, such as the Open Compute Project's coarse wave division multiplexing (CWDM4-OCP) or the parallel single-mode 4 lane (PMS4) interfaces, which offer 500 meter reach for 100Gb and 25Gb over single-mode fiber. The module prices are comparable to standards-based multi-mode 100Gb and 25Gb and are a reliable and cost-effective alternative to much more expensive long reach—2km or more—single-mode for distances up to 500 meters in length. Better still, with a single-mode fiber plant, enterprises would be future-proofed for 200Gb and 400Gb transitions in the years to come.

TAKE THE PLUNGE

There's a strong case to be made that enterprises should skip the transition to 40Gb in the campus, and instead go right to 100Gb. While 40Gb is indeed more affordable than 100Gb in the near term, those savings will be short lived. Because of the aforementioned increases in demand for bandwidth, enterprises must replace aging OM1, OM2, and OM3 fiber sooner rather than later.

Fortunately, enterprises can defray the added cost of choosing 100Gb by taking a phased approach to their infrastructure upgrades. OM4 and OM5 fiber is fully backwards compatible with OM3 modules, so the fiber and optical modules can be upgraded independently at different times based on budget constraints and business requirements. The cost of 100Gb multi-mode modules are comparable to 40Gb modules and provide far more capacity. For moderately longer distances, 100Gb over single-mode fiber is well below the cost of 40Gb.

No one wants to spend on infrastructure but poorly performing networks will significantly impact the ability of the business to execute. Enterprises can maximize its IT budget by building a network that will have the capacity for the next 10-15 years. 100Gb Ethernet is the way to go with 2.5 times the capacity for the same cost as 40Gb.

ABOUT THE AUTHOR

Mike Fratto
Research Manager

Mike is a Research Manager on the Business Technology and Software team covering the Enterprise Networking and Data Center Technology markets. He has extensive experience reviewing and writing about enterprise remote access, security and network infrastructure products.

Prior to GlobalData, Mike was with TechWeb for over 15 years finishing as Editor of Network Computing. He was Lead Analyst with InformationWeek Analytics, Senior Technology Editor with Network Computing and Executive Editor for Secure Enterprise. He has spoken at several conferences including Interop, MISTI, the Internet Security Conference, as well as to local groups. He served as the chair for Interop's Data Center and Storage tracks. He also teaches a network security graduate course at Syracuse University. Prior to Network Computing, Mike was an independent consultant.

Mike graduated from Syracuse University with a Bachelors of Information Science and Technology.

GlobalData.

info@globaldata.com
www.globaldata.com
+1 646-395-5460
www.linkedin.com/company/globaldataplc
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