Buyers guide

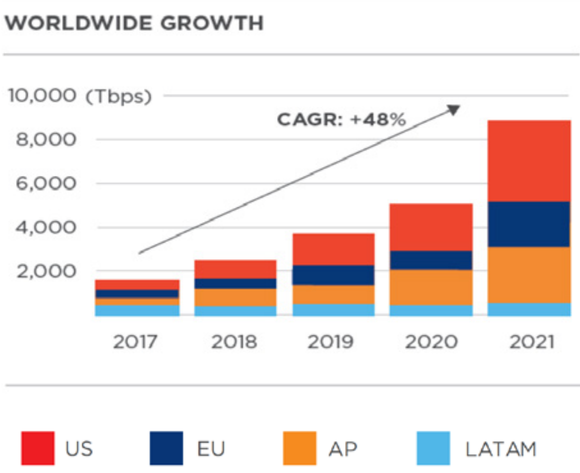
The tangible benefits of multi-Gigabit Ethernet networks

The need for organisations of all shapes and sizes to transmit ever increasing amounts of data across their networks shows no sign of abating. The massive volumes of information that are being transmitted across both fixed and mobile networks are driving the need for huge performance increases. This is driven in part by the widespread adoption of cloud hosting and server virtualisation, the sheer size and scale of modern data centres and by the deployment of larger Wi-Fi networks, creating significant demand for ultra-high-speed uplinks.

Coupled with this is the desire for ever faster network performance with low latency due to the growing use of video and complex graphics applications and the need for high-speed backbone connections between LANs.

It is generally accepted that Internet traffic is growing at around 20% per year and by 2021 global IP traffic will reach mind-boggling levels of around 3 Zettabytes. More interestingly, the bandwidth needs of enterprises are growing even faster than this. In its Global Interconnection Study, data centre company Equinix predicts that private data exchange between enterprises will be nearly six times the volume of global IP traffic by the end of the decade and that global interconnection bandwidth across all industries is growing at a CAGR of 48%.

These factors mean that multi-Gigabit networks are very much on the agenda for those organisations looking to boost the speed of their networks to keep up with rapidly increasing demand and to avoid bottlenecks in critical areas.



Worldwide Interconnect Bandwith Growth IMAGE FROM EQUINIX REPORT

Where is multi-Gigabit needed?

Supporting large scale, robust Wi-Fi networks

Providing Wi-Fi connectivity in a relatively small environment, like a small office or a café, is a fairly straightforward undertaking. However, as demands for increased mobility continue to expand, there are more and more environments where large scale Wi-Fi networks are being used. For example, across university campuses, in stadiums, large co-working facilities, an increasing number of public areas and in making up a more significant portion of company networks (driven by more flexible working environments as more and more users opt for laptops and tablets as their devices of choice).
Clearly, the need in all of these environments is for robust, reliable and fast Wi-Fi networks. In other words, business-grade Wi-Fi connectivity is essential.

Today, business-class APs (Access Points) typically have Gigabit speed LAN ports in order to give the AP the raw bandwidth needed to support multiple, simultaneous wireless device connections with no performance degradation. Larger Wi-Fi networks obviously need multiple APs and it is clear that, as a Wi-Fi network is scaled up, there quickly becomes the need for multi-Gigabit interconnectivity to meet the significant bandwidth demands of the combined load. Furthermore, the speeds at which APs connect back to the LAN are getting faster, moving into the multi-Gigabit range.

Predictions are that growth in Wi-Fi networks will not only come from demand for increased mobility (in the use of laptops, tablets and smartphones). Industrial Wi-Fi is already seeing a huge uptake with the need to support rapid growth in areas such as IoT, video surveillance and M2M communication. This will further increase network traffic and the need for multi-Gigabit infrastructures.

The bottom line is that Wi-Fi traffic levels are booming as the convenience and flexibility of unmetered wireless access continue to drive increased deployments. The massive amount of Wi-Fi traffic being fed back into wired networks is driving demand for switches that offer the performance of 10 Gig and beyond.

High-speed LAN backbones

Demand for high-speed LAN connections is higher than ever for both wired and wireless users. With office PCs now coming with Gigabit Ethernet ports as standard, simple arithmetic dictates that, in order to support a number of Gigabit connections, a backbone needs to provide more than Gigabit connectivity otherwise bottlenecks can soon appear.

In any reasonably sized network, it is sensible to monitor performance and determine where bottlenecks are so that higher speed, multi-Gigabit switches can be strategically used to improve overall performance. Upgrading core servers to use multi-Gigabit Ethernet can alleviate server problems and increase connection speeds for all users.

As an example, if there were 100 PCs simultaneously connected to a single 1 Gigabit LAN backbone, sharing the bandwidth between them, their connection speed would average only 10 Megabits per second each. Throw in some intensive users or bandwidth-hungry applications and network performance will quickly deteriorate to the point where a boost to the backbone is needed.

It is true that computers with Gigabit ports often do not use their full connectivity speed (depending upon the applications they are running) so moving from network clients with Fast Ethernet to network clients with Gigabit Ethernet won't necessarily provide a ten-fold increase in network traffic. However, upgrading to Gigabit Ethernet clients will increase network traffic significantly and can result in problems with backbone performance. In such cases, it is possible to use VLANs to segment traffic or aggregate existing Gigabit links to boost bandwidth. However, moving to a multi-Gigabit backbone will provide a more significant performance increase and a longer-term solution.

As well as backbones that have enough bandwidth to support the sheer number of both wired and wireless network users, real-time applications that make use of voice and video running concurrently, and other business-critical processes that require fast transactional responses and low latency, drive the need for higher network performance. No competent network manager would want to run a network at near capacity and in any well-designed network, it is important that spare bandwidth is available in the core and at the server, from where most traffic emanates.

As a result, upgrades to LAN backbones to support multi-Gigabit speeds have been taking place for a few years as standards have evolved and gained widespread industry support and costs per port have continued to fall. Although many of the largest organisations have already upgraded their LAN backbones, there are many more organisations that are now realising that a move to multi-Gigabit is a realistic and sensible route to take.

Computational-intensive environments

Organisations with high-performance computing needs such as video production, animation, scientific research, CAD simulation, and geological modelling need high-performance network infrastructures. These environments involve the processing of gigantic amounts of data involving advanced high-speed networks capable of transporting multimedia traffic, including real-time visualization, high-resolution graphics, and scientific data. Multi-Gigabit switches are now being used in such environments to build reliable, scalable, high-speed networks.

The performance of multi-Gigabit switches with speeds of 25, 40, 50, and 100 Gigabits per second, lossless transmission and traffic prioritisation, means that storage traffic has been moving away from storage specific Fibre Channel networks. Ethernet's widespread industry support and adoption make lossless multi-Gigabit Ethernet switches a more cost-effective solution both in terms of purchase costs (CapEx) and operating costs (OpEx).

Multi-Gigabit Ethernet switches have overcome the problems that previously prevented converged compute and storage networks to the extent that Fibre Channel is becoming obsolete. Even organisations with legacy Fibre Channel Storage Area Networks (SANs) may be better served deploying multi-Gigabit Ethernet switches alongside what they have rather than upgrading the existing Fibre Channel network itself because of significant cost savings.

Fibre Channel over Ethernet (FCoE) was a first step towards converging previously separate LAN and SAN networks by implementing Fibre Channel as a network protocol running over Ethernet but even FCoE is now considered by many to be an outdated approach. Advancements in multi-Gigabit Ethernet (and features such as RDMA over Converged Ethernet (RoCE) and TCP/IP offload engine (TOE) technology) mean optimised throughput with lower latency, traffic prioritisation and support for multiple storage protocols, allowing LAN and SAN traffic to share the same network.

Data center fabric

For a number of years, data centers have been migrating to multi-Gigabit Ethernet speeds to support the increasing number of virtualised servers that are used to host more applications and huge volumes of data that need to be accessed, transmitted and stored.

The scale, complexity and performance requirements of data centres put them at the forefront of high-speed networking and there has been accelerated take-up of 100 Gigabit Ethernet switches in data centre environments over the past year driven by the reduction in per port cost as volumes have grown.

The data center fabric provides the connection between servers and switches, consolidating thousands of storage devices and servers in the network and supporting networking requirements such as network expansion and performance.

Major drivers for the use of 100 Gigabit Ethernet switches in the data center fabric are the ability to consolidate cabling and save space and, of course, the raw speed needed to meet ever-increasing performance demands.

According to research firm IDC, last year 100 Gigabit Ethernet shipments accounted for 13.6% of Ethernet switching revenue compared to 8.5% in 2017. This growth is across data centres and large enterprises.

Keeping up with the increased rate of change

The business case for multi-Gigabit Ethernet is compelling. The relentless demand for ever more network performance means that organisations must not only decide how they are going to meet current demands but also how they are going to build an infrastructure that can adapt to meet future requirements.

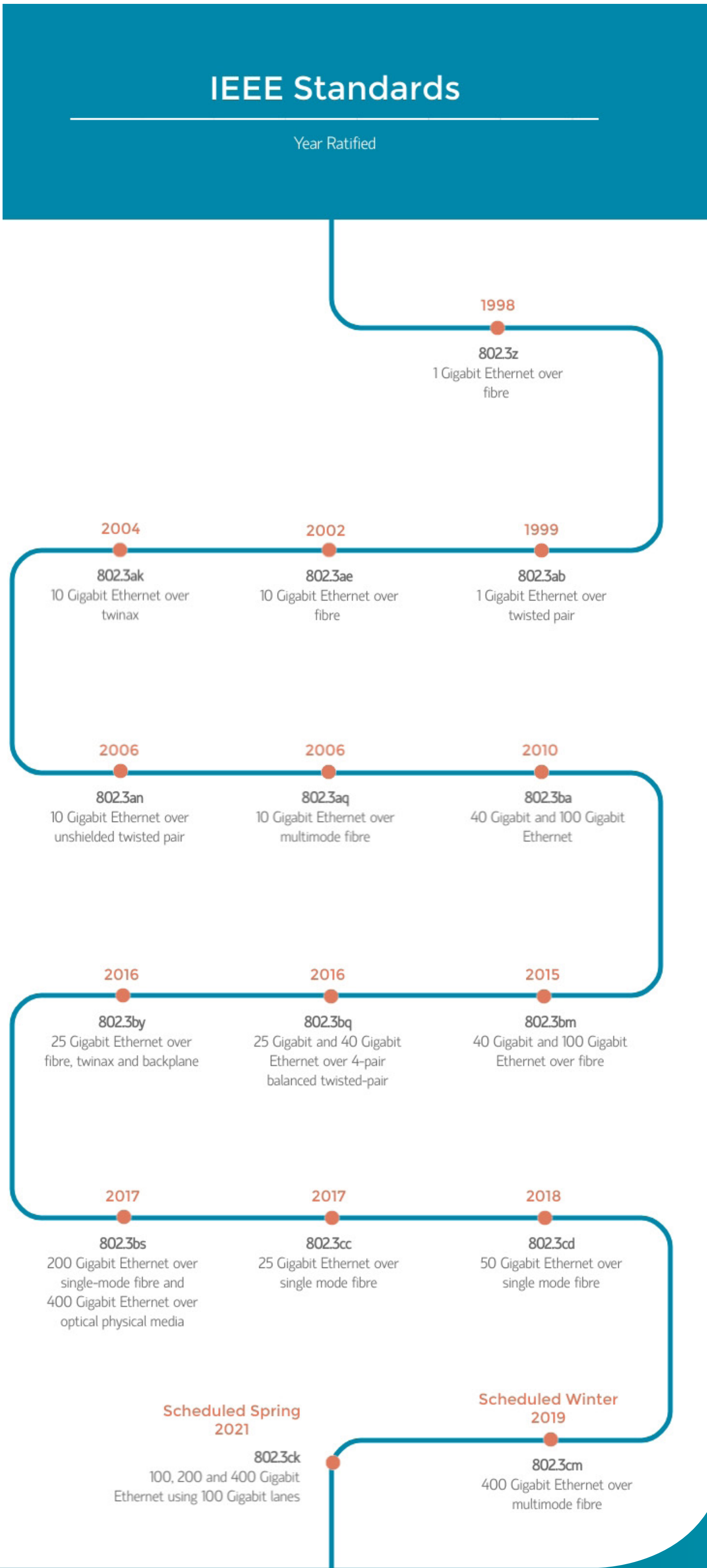
The evolution of the various multi-Gigabit IEEE standards sheds some light on how demand for multi-Gigabit networks is increasing. The first multi-Gigabit IEEE standard, IEEE 802.3ae for 10 Gigabit Ethernet, was ratified way back in 2002. At the time it was seen as the natural next major step up in network performance albeit one that, at the time, had limited appeal at the top end of the market with the standard only covering transmission over fibre.

A major breakthrough in bringing multi-Gigabit speeds to a wider market came in 2006 with ratification of the 802.3an standard for 10 Gigabit Ethernet over copper twisted pair cable (the IEEE 10GBASE-T standard). This made 10 Gigabit Ethernet switches much more affordable to deploy, using copper cabling (Cat 6 or 6a) without the need for a more expensive fibre infrastructure.

It was also in 2006 that the IEEE's 802.3 High-Speed Study Group started work on even higher speed Ethernet standards that, ultimately, lead to 40 Gigabit and 100 Gigabit Ethernet standards being ratified in 2010.

Odd though it may seem, the 25 Gigabit Ethernet standard came later. This is because it is a derivative of 100 Gigabit Ethernet and is based on 100 Gig technology implemented as four separate 25 Gig lanes. It wasn't until 2014 that an IEEE 802.3 task force was formed to start work on the single-lane 25 Gig standard and the resulting IEEE 802.3by standard was ratified in 2016. In May 2016, an IEEE 802.3 task force was formed to develop a single-lane 50 Gigabit Ethernet standard.

Of course, it does not end there. To meet these seemingly never-ending performance demands, the IEEE already has approved standards for 200 and 400 Gigabit Ethernet (in December 2017) and there will be more, higher speed standards to follow.



How to future-proof your network

With the proliferation of multi-Gigabit Ethernet standards and the endless demand for more speed the decision often boils down to which multi-Gigabit technology is right for your network. The good news is that price per port costs on multi-Gigabit switches continue to fall, in fact, they've never been lower, driven by the stellar work of the IEEE in developing industry standards. Although there is pressure to deploy future-proofed solutions, fast enough to meet demands in the foreseeable future, this needs to be offset against cost and practicalities.

A major consideration is the 'moving target' nature of network performance demands. What fits the bill today may well be unsuitable in the future so the key to future-proofing your network is getting the balance right between performance and cost while building an infrastructure that can evolve with changing needs. Here are some tips on how to future proof your network:

Deploy multi-Gig where needed today to avoid bottlenecks with a clear upgrade path

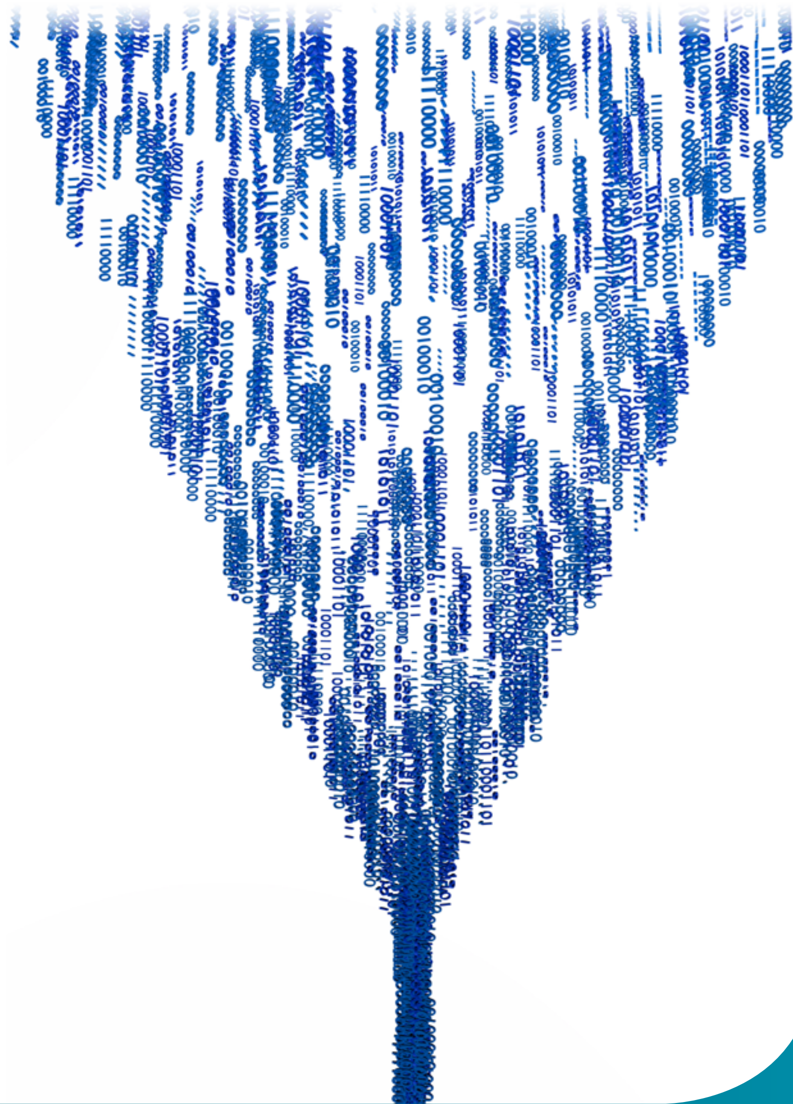
There is no indication that the demand for higher Ethernet speed and performance will stop any time soon. As servers are increasingly connected using 25, 40 or 100 Gigabit Ethernet this impacts on the network infrastructure needed to handle the load now and in the future. It is more important than ever to plan for future network evolution to accommodate technology advances and changing.

When looking at the upgrade path beyond 10 Gigabit Ethernet the decision is generally whether the next step should be to go to 25 Gigabit or 40 Gigabit. Although on the face of it, 40 Gigabit may seem like the better (i.e. faster) option, factors such as cost per bit, power consumption and server rack density need to be considered.

For example, when upgrading the top-of-rack switches in data centres from 10 Gigabit Ethernet the step up to 40 Gigabit is now generally not cost effective or power efficient. Instead, a move to 25 Gigabit with its single lane format, as opposed to 40 Gigabit with four lanes, is the better option. Upgrading from 10 Gigabit Ethernet to 25 Gigabit Ethernet delivers cost savings for data centre operators via backwards compatibility, reduced power consumption and a lower cost per gigabit. The power savings mean reduced cooling and by using the existing cabling, 25 Gigabit Ethernet switches provide a quick, easy performance upgrade.

In other circumstances, however, the best option may be to upgrade to 40 Gigabit Ethernet (4 x 10 Gigabit lanes) or even switches that support the newer 50 Gigabit Ethernet standard (2 x 25 Gigabit lanes).

The way that the standards have evolved, with an eye on networking infrastructures with 25 Gigabit, 50 Gigabit and 100 Gigabit capabilities, is to provide flexibility with a clear path for future upgrades to 200 Gigabit and 400 Gigabit when the need arises.



SDN delivers more flexibility using industry standard high-performance switches

The Software Defined Networking (SDN) market is showing healthy growth with adoption across both data centres and enterprises. SDN separates the control of the network from network hardware by overlaying a control plane that is implemented in software.

This provides a far more flexible and efficient network, controlled and configured from a central console, allowing a move away from closed vendor environments with proprietary features built into switches and network management platforms can only manage a specific vendor's own equipment.

With SDN a network administrator can, for example, change network rules, prioritize traffic and dynamically adjust traffic flow to meet changing needs across the entire network from a single control panel all without changing the settings of any physical switches. Of course, some of these functions can be automated through software with the aim of making the network intelligent enough to monitor traffic and automatically configure itself to handle changing traffic patterns.

In SDN parlance the network is divided into the data plane (implemented in networking hardware and responsible for forwarding network traffic) and the control plane (implemented in software and handling the management of the network as a whole).

By separating the data plane from the control plane in the network and implementing the control plane in software, network resources can be much more dynamically managed, making it ideal for high-bandwidth gigabit-Ethernet environments.

Furthermore, SDN allows the use of lower cost, industry standard hardware while, at the same time, giving better management and control of network traffic and configuration. It also simplifies network design because management is via SDN controllers instead of multiple, vendor-specific devices and protocols.

The separation of the control plane means that the switching fabric can be built using high-performance hardware from different vendors because much of the management functionality is implemented in the control plane software that overlays the entire network. This means that network managers can configure, manage, and allocate network resources quickly via the control pane freeing them from the proprietary features built into some switches.

Another important benefit of SDN is that it enables organisations to expand and upgrade their networks as they grow, adding new switches into the fabric to increase available bandwidth instead of making large step changes.

Bare Metal, multi-Gigabit switches increase choice and reduce costs

Another area where there is growing interest is Bare Metal network switches. Taking the SDN philosophy a step further, by separating networking hardware from software, Bare Metal switches come with no network operating system pre-installed. This gives the purchaser the choice to install and run whichever network operating system they choose. Initiatives like the Open Network Install Environment (ONIE), an open source installer, are now being incorporated by network switch vendors that supply Bare Metal switches to make it easier for the purchaser to install their chosen network operating system.

ONIE has been gaining traction in data centre, service provider and large enterprise networks because it allows the installation of the network operating system of choice as part of network provisioning, in a similar way that servers are provisioned with an operating system of choice.

Key advantages of the Bare Metal approach are that it delivers economies of scale in manufacturing, distribution and stocking of network switches and removes the cost of pre-installed operating systems and of the customer being locked into a specific switch vendor.

Plan ahead – what does the future hold?

To future-proof a network, it's not enough to just stay on top of port counts and protocols. Consideration needs to be taken about where the organisation is heading and what it means for future network requirements and a strategy followed that enables the network to grow and change accordingly.

It is also important to keep up to speed on vendors' future product strategies and ensure that there is clarity on where the technology is going.

With Wi-Fi already prevalent and playing an increasingly important role at the edge of the network, it is going to become even more significant. Plans need to be made for further growth in this area and in the use of multi-Gigabit Ethernet for backhaul and interconnect. With the new 802.11ax Wi-Fi standard expected to be ratified later this year (with its 10 Gigabit per second throughput), Wi-Fi will continue to drive increased levels of network traffic for many.

Deployments in SDN continue to build and these are likely to drive network automation and network orchestration - a policy-driven approach to automating the way network requests are carried out, removing, or reducing, the need for human intervention when delivering applications or services. This necessitates a high-performance network infrastructure built on multi-Gigabit switches that is managed and controlled centrally.

An emerging and growing area is Hyper-Converged Infrastructure (HCI). The concept of HCI is an almost completely software-defined IT infrastructure made up of virtualized computing, software-defined storage and SDN all running on commercial off-the-shelf servers. This combines computing, storage and networking into a single system running on a high-speed network fabric.

Conclusion

There is no end in sight to the relentless increase in demand for more network performance. Higher and higher volumes of data being transmitted, an explosion in the use of video, increased use of cloud computing and virtualisation, and more mobility will all continue to put growing pressure on the network infrastructure. With careful planning, the use of high-performance standards-based switches, effective infrastructure management and a considered approach the balance can be met between performance demands now and building an infrastructure that can evolve in a cost-effective way to meet demands for the future.

D-Link's is a global leader in network solutions offering a wide range of wired and wireless solutions including highly reliable multi-Gigabit switches for enterprise and data centre applications.

D-Link's product range includes managed switches, data centre and industrial switches supporting 10 Gigabit, 25 Gigabit, 40 Gigabit and 100 Gigabit Ethernet standards. D-Link also has a range of Bare Metal switches with ONIE support.