

10 Gigabit Ethernet: Scaling across LAN, MAN, WAN

By

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Overview

Ethernet is one of the few protocols that has increased its bandwidth, while retaining its basic functional characteristics such as Layer 2 protocol, frame format, packet oriented, non-guaranteed delivery. As the capability to drive signals faster over both copper and fiber media has increased due to advances in circuit design and process technology, Ethernet too has seen its capabilities extend beyond the ubiquitous triple speed (10/100/1000 Mb/s) MAC to 10 Gb/s and beyond.

The 10 Gigabit Ethernet standard is specified in IEEE 802.3ae 2002 and its most recent amendments (2008). With rapidly changing patterns of computing shifting between “thick” to “thin” clients, powerful workstations to centralized servers, and advancing regulatory requirements for data backup, Ethernet has been extended to support many applications.

The increase in affordable computing and multimedia processing in both home and enterprise systems has resulted in the explosion of data generated and consumed in public and private networks. Ethernet plays a vital role in delivering this data end-to-end and providing a common backhaul for interconnect and data backup as shown in Figure 1.

In this whitepaper, we present some of the market drivers for the next generation of higher speed Ethernet - 10 Gigabit Ethernet.

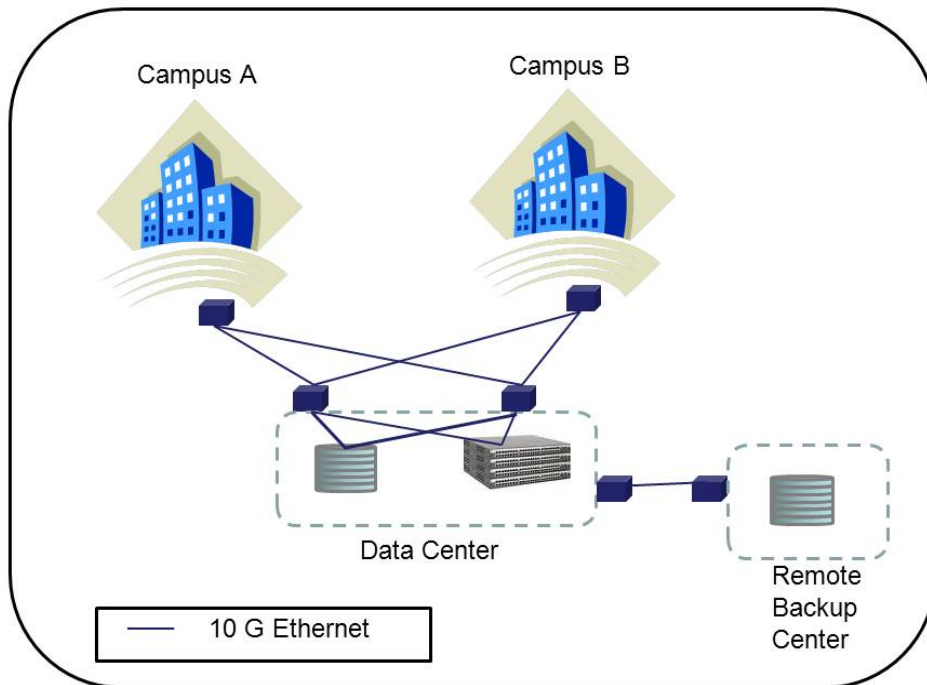


Figure 1: 10 Gigabit Ethernet deployment beyond traditional LAN environment

Trends Driving 10 Gb/s Ethernet Adoption

The rapid digitization of multi-media has resulted in more packet-oriented data traffic than ever on networks. While consolidation of multiple networks onto the ubiquitous Ethernet platform has been forecasted for a while, 10 Gigabit Ethernet offers the first opportunity for such networks can be cost-effectively realized. The convergence of multiple applications onto Ethernet, coupled with its increasing bandwidth and transportable distance make 10 Gb/s Ethernet the ideal choice for a common backhaul infrastructure.

Enterprise network managers can use 10 Gigabit Ethernet to scale across building, campus and remote offices (within 40 km radius) – without the need to translate Ethernet frames along the way. This helps them preserve their investment in Ethernet technologies while reducing the cost of deploying the network. 10 Gigabit Ethernet is the first networking technology that encompasses LAN, MAN and now even WAN links. The versatility simplifies campus wide networking – permitting a single standard to serve workgroup, intra-building, inter-building and campus-wide secure networks.

The increase in network traffic is also driven by the rapid adoption of 1 Gb/s Ethernet, further fueling the deployment of 10 Gb/s Ethernet for traffic aggregation and storage applications. The increase in client / server computational loads necessitates the bulk transfer of data across a network. Enterprise-wide operations such as backup, recovery and remote data management can be deployed using 10 Gb/s Ethernet, with minimal impact to network latencies. All of these network uses strain the current 1 Gb/s Ethernet connectivity and hence greatly benefit from the upgrade to 10 Gb/s Ethernet.

10 Gigabit Ethernet preserves many of the characteristics of the original Ethernet protocol and many vendors offer interoperable equipment. This compatibility reduces the cost of the necessary infrastructure – from cabling to host bus adapter cards and active network components lowering the cost of deploying 10 Gb/s Ethernet. Enterprise and service providers are assured of multiple, inter-operable sources of 10 Gb/s Ethernet infrastructure, eliminating any potential lock-in with equipment provider.

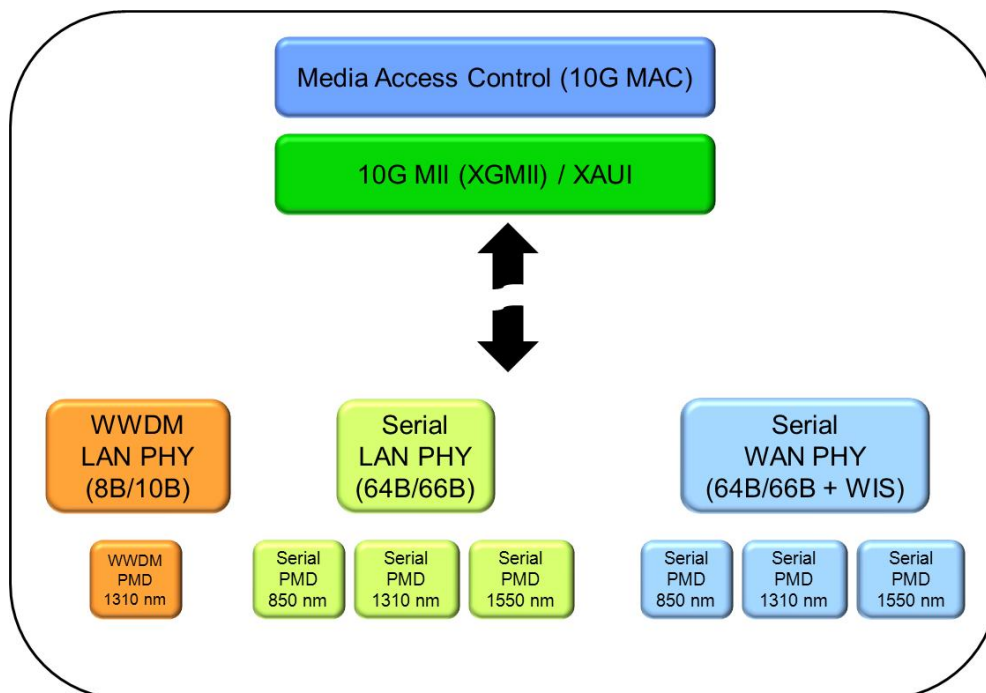


Figure 2: 10 Gigabit Ethernet Protocol

The key aspects of 10 Gigabit Ethernet protocol as shown in Figure 2 are:

- Increased bandwidth up to 10 Gbps
- Full-duplex operation
- No CSMA-CD needed
- Packet format are backwards compatible
- Increased physical network range

10 Gigabit Ethernet also permits Internet Service Providers (ISPs) and Network Service Providers (NSPs) to easily connect equipment using a short, high-speed interface between co-located carrier grade switches and routers. The interface enables ISPs to provide faster access without the latencies associated with format translations.

10 Gigabit Ethernet is thus the first technology that enables the convergence of different traffic types – data, voice, multi-media onto an all-IP and Ethernet platform.

10 Gb/s Ethernet Protocol

The 10 Gigabit Ethernet protocol was first ratified in June 2002, as the IEEE 802.3ae-2002. This standard extends the basic behavior of Ethernet to a bandwidth of 10 Gb/s in Full duplex mode. In full-duplex there are no packet collisions that can occur. Packet formats are unchanged in 10 Gb/s Ethernet.

Ethernet is a Layer 2 protocol in the networking stack as defined by the Open Systems Interconnection (OSI) model. 10 Gigabit Ethernet uses the same IEEE 802.3 Ethernet MAC protocol, frame format, frame sizes, and is a connection-less, non-guaranteed packet delivery protocol.

Several physical media are available – that extend all the way to WAN type of links. 10 Gb/s Ethernet defines two types of PHYs: a LAN PHY and a WAN PHY. The latter permits connections to SONET STS-192c/SHD VC-4-64c networks. Both copper and fiber PHY media are supported.

10 Gigabit Ethernet MAC defines a 74 signal, parallel XGMII bus to interface with a PHY. To ease system design, a new interface called XAUI has also been specified. This serves as an alternative to the parallel XGMII bus which is difficult to place and route on a PCB. XAUI is a high-speed, low-pin count differential interface, which eases PCB layout and component location.

The features and benefits are summarized in Table 1.

10 Gb/s Feature	Enables
10 Gbps peak bandwidth	Scale to meet bandwidth needs of next generation Enterprise Apps and Storage
Full-duplex operation only	Faster sync and two-way communication
No CSMA-CD function	Simplifies protocol, reduces overhead and eliminates re-transmissions due to collisions
Packet format backward compatibility	Maintain application layer interface and investment in network software stacks
Increased physical network range	Extend Ethernet into campus, metro and wide area networks

Table 1: Overview of new features in 10 Gigabit Ethernet and their benefits

A variety of media types are supported for physically transporting 10 Gigabit Ethernet frames over the PHY (Layer 1) layer. Due to the full duplex nature of traffic, the range of 10 Gb/s is extended significantly in this standard (refer to Table 2).

PHY Media	Range
10GBASE-CX4	15m
10GBASE-SR	26m
10GBASE-LX4	300m
10GBASE-LR	10km
10GBASE-ER	40km

Table 2: Physical network reach for 10 Gigabit Ethernet

Traffic Consolidation on 10 Gb/s Ethernet

Enterprise and service provider network architects so far had to rely on a complex set of networking technologies to provide end-to-end services to their customers. Ethernet, OC-12, OC-48, SONET, SDH, and packet over SONET/SDH are some of the technologies that these providers had relied on.

With Ethernet being the de-facto standard inside the Enterprise, an entire range of devices from simple switches to intelligent Ethernet based multi-layer switches have proliferated. Service providers would like to extend this network architecture to cover intra-campus and ultimately inter-campus internetworking.

Ethernet has scaled both in bandwidth (10 Gb/s) as well as physical range (over 40 km), while preserving the frame formats and other features of the protocol. Hence, Enterprises can continue to benefit from their investments in Ethernet such as – operator training, higher layer processing such as routing, caching, server load balancing and policy based intranets. Now, with 10 Gb/s Ethernet, these same functions can be supported for traffic in LAN, MAN and even WAN.

The convergence of both media (voice, video) and data onto packet switched networks using TCP/IP running over Ethernet is now a reality, with all parts of this ecosystem in place. The promise of convergence can finally be realized with 10 Gigabit Ethernet.

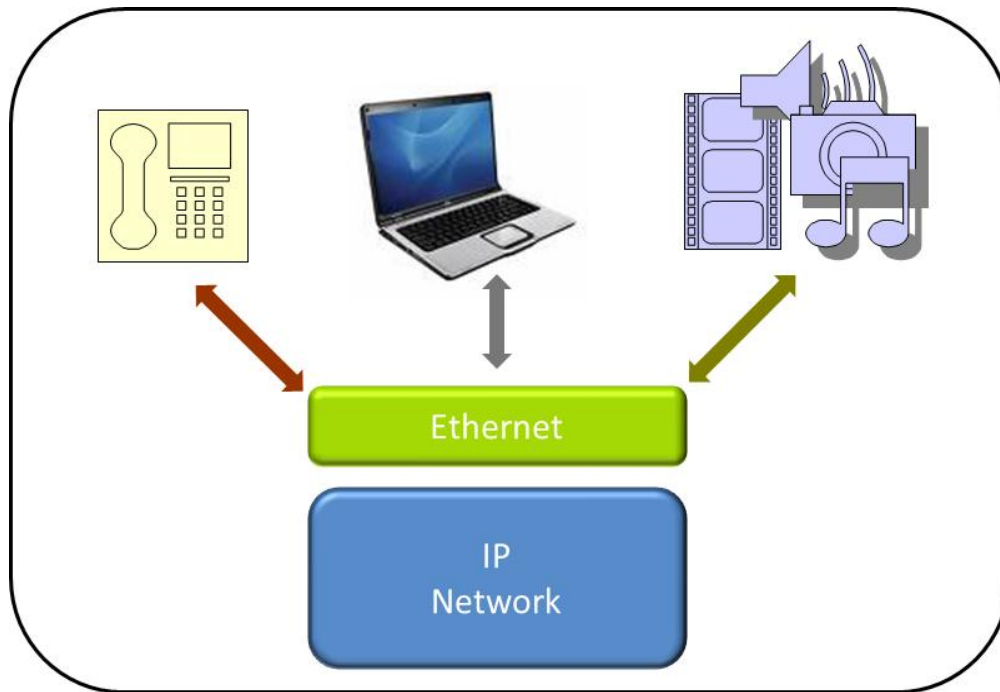


Figure 3: Convergence of Voice, Data, Multi-media onto a common IP / Ethernet platform

Arasan's Ethernet IP Portfolio

Arasan Chip Systems, Inc has been a leading developer of Ethernet IP offering comprehensive solution from 10, 100 Mb/s, 1000 Mb/s up to 10 Gb/s. The total solutions have been used in diverse applications ranging from custom networking ASICs to high-performance Ethernet systems. Ethernet cores enhanced to support IEEE 1588 Real-time Transport protocol are also available. For 10 Gb/s Ethernet, Arasan has also developed a XAUI IP and a 64B/66B PCS IP that can be separately licensed. Arasan provides a Total IP Solution for Ethernet consisting of fully-compliant, silicon-verified IP cores, verification IP, portable software stacks and hardware development platforms, backed by our World-class customer support.

Summary

10 Gigabit Ethernet provides the necessary performance at the right cost point to facilitate the convergence of diverse network traffic onto a common IP / Ethernet platform.

The ten-fold increase from 1 Gb/s Ethernet, allows it to support next generation Enterprise applications with ease. Network operators benefit from economies of scale by having to manage a single network protocol that can handle diverse types of network traffic.

The increase in its range, supported by fiber media, allows this ubiquitous interface to scale across small to mid-size campuses. The higher bandwidth permits storage access and backup operations to be supported on the same network.

With its portfolio of Total IP Solutions for Ethernet, Arasan eases the integration of this high-performance interface in complex networking ASICs and chipsets.



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