

**Synopsis**

In response to the insatiable need for speed, and hot on the heels of 10 Gigabit Ethernet, an industry study group has been formed to investigate the market requirements and feasibility of even higher speeds. Multiple approaches will be necessary to address the future traffic needs of metropolitan core networks, supercomputing, data centres and corporate backbones. Products are expected by 2010, with 40 Gigabit and 100 Gigabit solutions operating over a range of different media, including copper.

**1. Higher Speed Study Group Formed**

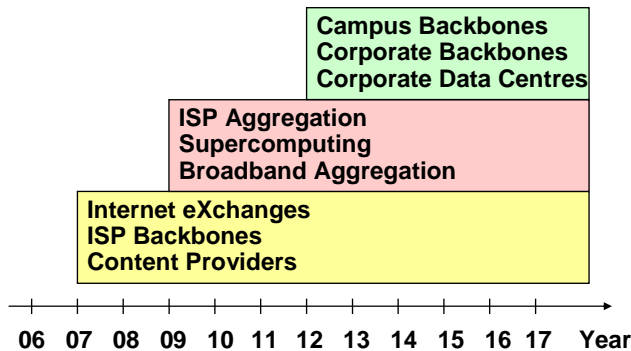
An IEEE 802.3 study group was established in July 2006 to explore the feasibility of higher speed Ethernet for LAN, MAN and WAN use. The study group is targeting speeds well in excess of 10 Gigabit but has been cautious about choosing a particular number. Champions Cisco Systems, IBM, HP Procurve, Quake Technologies and Force 10 Networks provided the following rationale to support this new project:

*Rising volumes of data are causing congestion to occur at various aggregation points, such as within internet exchanges, data centres, cluster computing, and the enterprise. 10 Gigabit Ethernet links in combination with 802.3ad Link Aggregation are being deployed at these aggregation points; however, projected bandwidth requirements indicate that in the future this will be insufficient. It is time to study the effort, scope the task, and start towards the development of a standards-based solution to bring relief to these congestion points.*

Study group recommendations were presented in July 2007.

**2. The Market Need for 100 Gigabit Ethernet**

The early adopters for higher speed Ethernet are mapped chronologically in figure 1. The earliest markets are anticipated to be metropolitan core networks, Internet exchanges, High Performance Computing (HPC), data centres and corporate backbones.



**Figure 1: Early Adopters of Higher Speed Ethernet**

One of the main drivers for higher speed is anticipated to be IP-rich media applications, primarily video. Broadband access and the future digital home will require growing support of TV + Internet + telephony, with the capacity required for 30 minutes of TV viewing equivalent to 30 days of typical Internet surfing. Interactive HDTV Video on Demand (VoD) is expected to be main driver for metropolitan aggregation networks. 100 Gigabits will be needed for the metropolitan core network in the 2008-2010 timeframe. Compatibility with the telecommunications network hierarchy will be prerequisite. Estimated bandwidth requirements are listed for residential applications. Forecast growth in global subscriber access traffic is also shown in figure 2, assuming 50 million IPTV subscribers in 2011, each viewing 4 hours/day from 2007.

| Application        | Bandwidth   |
|--------------------|-------------|
| VoIP               | 100k        |
| Video-conferencing | 0.7 to 1.5M |
| Internet           | 0.2 to 5.0M |
| Gaming             | 0.2 to 0.5M |
| SDTV (MPEG-2)      | 6M          |
| SDTV (MPEG-4)      | 3M          |
| HDTV (MPEG-2)      | 20M         |
| HDTV (MPEG-4)      | 10M         |

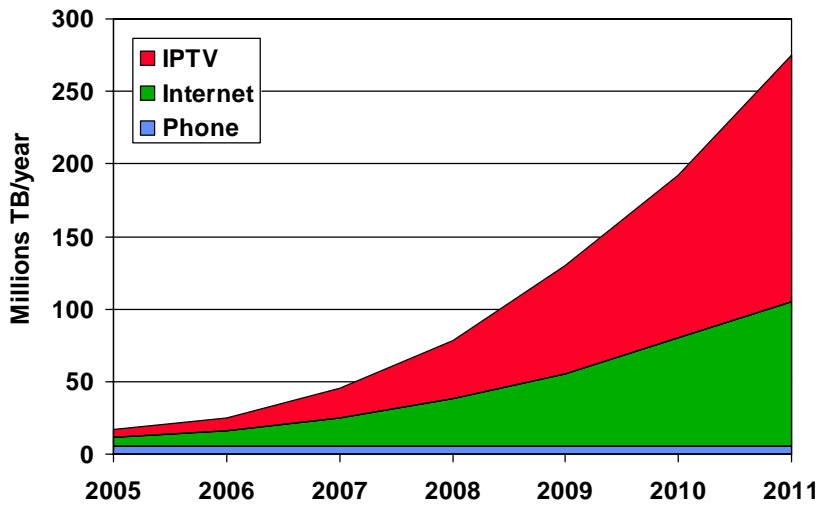


Figure 2: Global Subscriber Access Traffic

The majority of applications in the 10 Gigabit Ethernet early adopter market are supported by singlemode fibre (SMF), as its deployment started in the network core (SMF was 85% in 2004 reducing to 50% in 2006). The main early adopters of 10 Gigabit Ethernet have been service providers and large corporates.

It's quite plausible that the early adopter phase for higher speed Ethernet will last several years and service providers/large enterprise customers will drive initial volumes. It's therefore important to prioritise different solutions for the needs of early adopters.

### 3. The Market Need for 40 Gigabit Ethernet

It took 2 generations of server to catch up with 10G Ethernet, and the costs associated with its early adoption were too high. Server throughput doubles roughly every 2 years, so increasing network speed by a factor of 10x creates a huge mismatch with server requirements. This trend is illustrated in figure 3, which shows a period of almost 8 years for 10G Ethernet to match CPU performance.

It is important to match the processor speed and bus bandwidth of server systems with the speed of the network (Amdahl's Law), hence 40G is much more desirable for next generation servers. According to Intel and Sun Microsystems, the market window for 40G in the server environment spans from 2012 to beyond 2020.

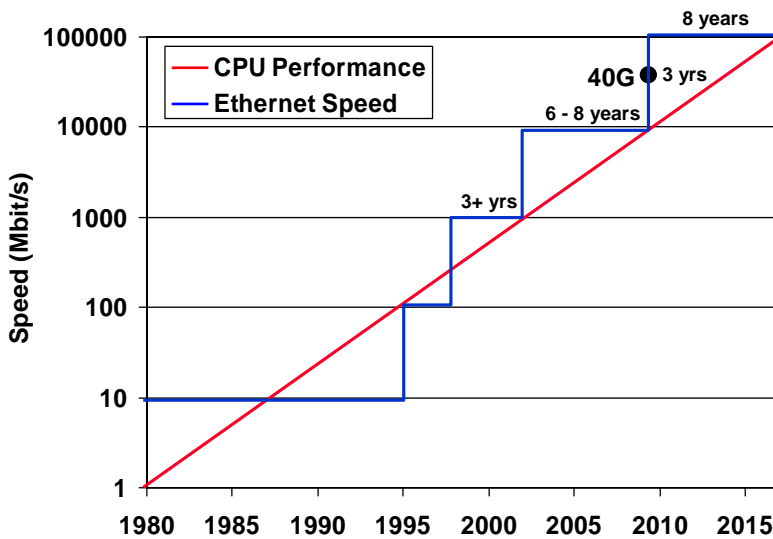


Figure 3: Trends in CPU Performance & Evolution of Ethernet

#### 4. The Need for a Multi-lane Solution

In the absence of very high speed lasers, the design approach for higher speed Ethernet will need to use multiple lanes. Figure 4 shows some implementation options for 80, 100 and 120 Gigabit channels. Telecom-grade 40 Gigabit lasers exist however these are too expensive for LAN applications. 10 Gigabit devices are preferred as they are available as lower-cost VCSELs (Vertical Cavity Surface Emitting Lasers). Multi-lane solutions may use either WDM (Wavelength Division Multiplexing) techniques or parallel optics.

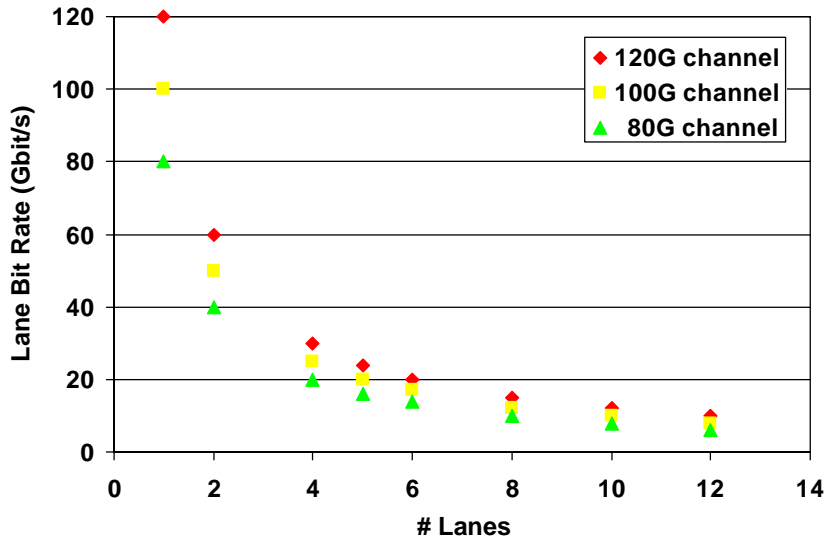


Figure 4: Number of Lanes vs. Lane Bit Rate

#### 5. Higher Speed Long Haul Approaches

Approximately 80% of 10 Gigabit Ethernet metropolitan links today are between 5km and 40km. A reach objective of at least 10km is therefore considered to be a critical success factor.

10-lane 1310nm DWDM (Dense Wavelength Division Multiplexing) transceivers operating at 10 Gigabits per lane are available today, and Layer 2 CMOS implementations are expected to be feasible in the near future. 10-lane DWDM is a very appealing solution for long haul SMF applications. 10x10G DWDM Photonic Integrated Circuits (PICs) are illustrated in figure 5.

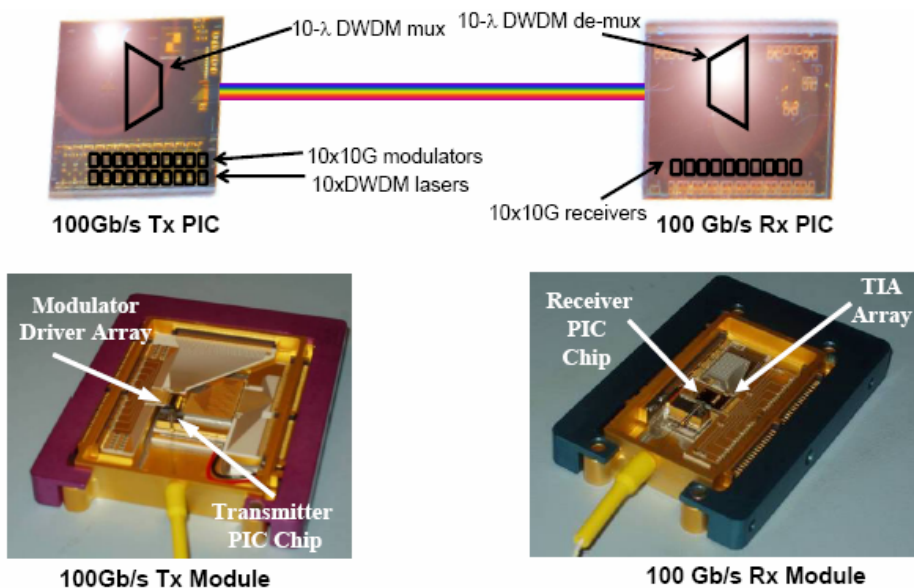


Figure 5: 100G DWDM Photonic Integrated Circuits

## 6. Higher Speed Short Haul Approaches

A survey of installed data centre links indicated that 96% of all lengths were less than 200m. 90% of data centre links use MMF today. High performance computing requires only 100m reach and the majority of corporate backbones need up to 300m reach. Another recent survey also identified 70-80% links in these 3 market sectors to be less than 100m.

10 Gigabit VCSELs are much less expensive than conventional 10 Gigabit lasers. 850nm VCSEL arrays are built in 4-lane and 10/12-lane format to support parallel optics, and are also available in CWDM (Course Wavelength Division Multiplexing) solutions.

A reach objective of 100m could therefore represent a low-cost approach for short haul MMF applications.

Multimode Fibre (MMF) solutions are being considered for data centre applications, although data centre managers also have a lot of flexibility in choosing cable type. An SMF solution may therefore represent a viable option for data centres, particularly for early adopters.

## 7. Project Objectives

The following set of objectives are proposed by the higher speed study group. These will be considered for adoption by IEEE 802 in November 2007

1. support full-duplex operation only
2. preserve the Ethernet frame format
3. preserve min and max frame sizes specified for Ethernet
4. support a BER better than  $10^{-12}$  at the MAC/PLS interface
5. support a MAC data rate of 40G
6. provide PHY specifications to support:
  - at least 100m on OM3
  - at least 10m on a copper cable assembly
  - at least 1m over a backplane
7. support a MAC data rate of 100G
8. provide PHY specifications to support:
  - at least 40km on SMF
  - at least 10km on SMF
  - at least 100m on OM3
  - at least 10m on a copper cable assembly
9. provide appropriate support for ITU-T OTN (Optical Transport Network)

## 8. Development Plan

A formal standards project is expected soon, with the earliest date for an approved standard of May 2010. This is a 3-year gestation period, which is ambitious for a project of this complexity.

### About Brand-Rex

Brand-Rex is a designer and manufacturer of copper and fibre based cabling systems, headquartered in Glenrothes, Scotland with facilities across Europe. Brand-Rex has two primary businesses: Connectivity and Speciality. Its Connectivity division designs and manufactures cabling systems (both copper and fibre) for data communications and is the No.2 player in Europe. The Speciality division exclusively produces cables that are used for control, communications, power and instrumentation within hostile environments.