Energy Efficient Ethernet
Being Studied by IEEE

Synopsis

US energy consumption from electronic equipment is consuming 200 TWh of energy per year, costs an estimated $16 billion/year and generates nearly 150 million tonnes of CO_2 per year. Network equipment alone consumes an estimated 13 TWh/year. Gartner recently stated that *power hungry hardware and global fuel prices could lead to energy costs eating up more than one-third of IT budgets in the next 5 years*. With energy conservation being high on the political agenda, IEEE 802.3 has established a study group to investigate what it can do to reduce the overall energy demand from Ethernet equipment.

1. Energy Efficient Ethernet Study Group Formed

As in other parts of the world, the US government is introducing new policies and regulations to conserve electrical energy from electronic equipment. An IEEE 802.3 study group was established in November 2006 to explore the feasibility of reduced power consumption Ethernet. Project champions were Cisco, Broadcom and the Lawrence Berkeley US National Laboratory. The study group charter is to evaluate methods to reduce energy use by reduction of link speed during periods of low utilisation.

Study group recommendations are expected in July 2007.

2. The Case for Energy Efficient LAN Equipment

Desktop LAN utilisation is currently in the range 1-4%, with typical levels near the lower bound. Traffic analysis of busy PC users show 30% bursts with 1% overall utilisation using 100BASE-T. As the power consumption of switches and NICs increases significantly with link speed, it is proposed to match the link rate to its utilisation. To do this, a standard mechanism would be required to rapidly transition from low to high rate and vice versa. It is proposed to do this within the capabilities of auto negotiation.

Rapid PHY Selection (RPS) is being proposed as a control protocol and it is envisaged that the process could take approx 1ms. This would mostly benefit 1000BASE-T in terms of energy saving, with substantial benefits for home and offices and lower power consumption for laptops. Its deployment with 10GBASE-T could also reduce the power burden in data centres (where 1W cooling energy is required to cool 1W of heat generated).

Assuming 100% adoption in the US, the residential sector could save an estimated 1.73 to 2.60 TWh/year ($139-208 million/year). The commercial office sector could save an estimated 1.47 to 2.21 TWh/year ($118-177 million/year). Finally, the data centre sector could save an estimated 0.53 to 1.05 TWh/year ($42-84 million/year).

It is generally agreed that the scope should be limited to *edge* networks, as there may be severe transport level disruption in *core* networks due to speed change transitions.

It is also agreed that the main focus should be *high speed copper* networks, as they consumed more energy than high speed optical and low speed copper networks. The applicability to optical networks is to be confirmed after further study.

Broad Market Potential: Market pressure and legislative action world-wide is demanding improvements in energy efficiency of networked equipment. Energy Efficient Ethernet will be explicitly or implicitly required by a significant fraction of Ethernet edge connections in the future. Ethernet equipment vendors and customers are able to achieve an optimal cost balance between the network infrastructure components and the attached stations.

Technical Feasibility: the control mechanism will build on well known protocols that may be implemented in simple, low cost equipment. The PHY change will use existing capabilities of typical multi-speed PHY implementations. Energy saving effectiveness and system reliability will be demonstrated through simulation of typical installations and usage as well as detailed review by higher layer networking experts.

Economic Feasibility: the control mechanism will use similar functions to those already included in most Ethernet equipment and therefore will not add significant cost. The PHY speed change will use existing capabilities of typical multi-speed PHY implementations. The energy savings achieved will result in lower operating costs and increased system reliability.

White Paper

3. Rapid PHY Selection (RPS)

As many Ethernet NICs are idle for most of the time (especially desktop links), it is proposed to match the link rate with link utilisation for maximum energy efficiency; this would save an estimated 2-4W for 1G vs. 100M copper links, and 10-20W for 10G vs. 1G copper links.

Many existing laptop NICs drop power when entering sleep mode or operating on battery power. Auto-negotiation is used, but this requires 3-4 secs to switch link speed, which is not acceptable for real-time use. A faster method is required to switch the link rate for real-time use. A good control policy should be simple, responsive to changes in link utilisation, and does not cause any oscillation in link rate.

Different speed change policies are being investigated with low and bounded packet delay and maximum energy savings. Speed change times of the order of 1ms are understood to be feasible.

4. Project Objectives

The main project objectives are proposed to be:

- define a means to change between 1000BASE-T & 100BASE-TX without loss of link.
- define a means to change between 10GBASE-T & 1000BASE-T without loss of link.
- do not harm the support of full-duplex operation and star-wired structured cabling only.
- make no change to the operational mode of existing PHYs.
- support auto-negotiation.

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.

White Paper