Energy Efficient Ethernet

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Abstract

Energy consumption is nowadays a global source of connection for both economic & environmental reasons .The energy demand of Ethernet links have been an active focus of research in the recent years .The IEEE 802.3az Standard provides a new Idle mode of Ethernet physical interfaces .which needs a small fraction of the power used in normal operation, but no traffic can be transmitted nor received while the interface stays in the idle mode.

Key Terms:- *IEEE802.3az,Low Power Idle (IPL), Link layer Discovery Protocal (LLDP), etc.*

I. INTRODUCTION

Energy reduction by an Ethernet interface will be accomplished by facilitating transmissions to and from lower power consumption in response to changes in network demand .The premise for EEE is that Ethernet links have Idle time &thus opportunity to save energy. Networking equipment alone consumes 1.8% of the world's electricity and that number is currently increasing at a 10% rate annually.

Complying with the latest 802.3az Energy Efficient Ethernet standard and carrying green Ethernet technology ,the Gigabit switch adjust power consumption via cable length and auto power down when a port is inactive, thus utilizing energy more effectively.

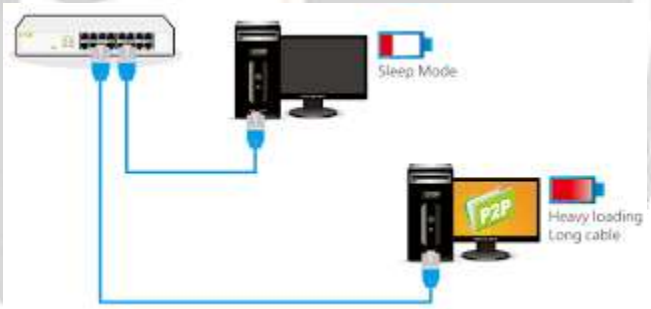

Figure :- Green Ethernet Technology

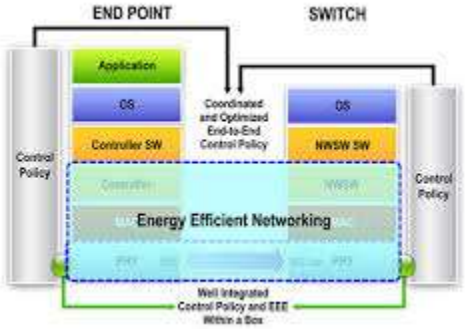

Figure: - Energy Efficient Networking

II] OVERVIEW:-

IEEE 802.3az / Energy Efficient Ethernet is a symmetric protocol that enables network ports to switch between higher power port to switch between higher power state (data mode)/lower power state (LPI Mode)in response to whether data is flowing through them (Active state)/Not(Idle state).
IEEE 802.3az/EEE uses a technology called LPI-Low Power Idle, which is actually a low energy consumption state that can be used during periods where there is no link utilization.
Each (Network switch Port, NIC, etc) advertises its EEE capability during auto negotiation when a link is established. If the device PHY at both sides of the link support EEE, then they operate in the EEE Mode. Even if one of them do not support the EEE Standard, they operate in the normal /legacy mode.
EEE complient devices use a modified static logic design in order to transcend to the Low Power Idle(LPI)Mode when no data is flowing through them.LPI signaling protocol is used to convey that a particular link needs to go idle as there is no data transfer during a certain period. But once data flow is initiated through the link , LPI enables the link to resume to its normal operation(Data Mode).
When there is no data flow, the link is kept in the sleep mode so that the power consumption is minimized. But the transmitter sends periodic refresh signals to ensure that the link is functioning and higher level systems (NMS) can see through them.

For 1000 Base –T and 10 G Base –T transceivers new LPI modes have been defined. Key features are:

1) They allow powering down the transmitters and three of the four receivers in a link when there is no data to send.
2) They include a refresh cycle that requires transmission of short training sequences in LPI mode so the PHY parameters can be updated and kept current.
3) They include the definition of an alert signal that can be used to rapidly wake up a PHY from sleep in the LPI mode
4) They can be initiated either from the local system by signaling from the MAC or station management or from the remote system over the PHY link.

III] LOW POWER IDLE:-

The fundamental idea of EEE is that the communication link should need to consume power only when real data is being send. In order to save energy during times where there is a gap in the data stream, EEE uses a signaling protocol that allows a transmitter to indicate that there is a gap in the data and that the link can go idle. The signaling protocol is also used to indicate that the link needs to resume after a predefined delay.
The EEE protocol uses a signal that is a modification of the normal idle that is transmitted between data packets,this signal is termed low Power Idle(LPI)
The transmitter sends LPI in place of idle to indicate that the link can go to sleep. After sending LPI for a long period (Ts=time to sleep), the transmitter can stop signaling altogether so that the link become quiescent. Periodically, the transmitter sends some signals so that the link does not remain quiescent for too long without a refresh. Finally, when the transmitter wishes to resume the fully function link, it sends normal idle signals. After a predetermined time (Tw=time to wake) the link is active and data can be sent.
The EEE protocol allows the link to be re-awakened at any time; there is no minimum or maximum sleep interval.
Which allows EEE to function effectively in the presence of unpredictable traffic. The default wake time is defined.For each type of PHY and is generally aimed to be similar to the time taken to transmit a maximum length packet at the particular link speed. Following figure describes the different EEE States pictorially

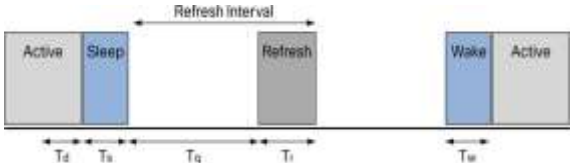

Fig LPI Diagram

IEEE 802 Standards process – Initial steps

IV] EEE SAVINGS –ISSUES:-

1) EEE includes LLDP Mechanism(Link Layer Discovery Protocol) that can enable longer latencies for increased savings beyond NIC.
2) Opportunities to coalesce packets to increase savings.
3) Does not cover cooling savings(data centers).
4) Industry Figures often DC(e.g. 3.3 V) so need to be inflated to account for AC/DC conversion losses.
5) Link speeds rising over time.
6) More IP –networked devices.
7) Some of these use Wi-Fi or MoCA, not Ethernet.

V] ADVANTAGES OF EEE:-

EEE is very effective in reducing the total power consumed per port and it saves a lot of energy on the long run for organizations having a large number of network devices.

1) EEE is very effective with edge devices like computers, edge switches, etc and can save a lot of power.
2) EEE standard does not transition to a lower bandwidth/throughput to achieve power savings.
3) EEE standard operates over standard Base T interfaces on twisted pair copper wiring and supports 10 Mbps/100Mbps/1000Mbps/10GE.
4) EEE is backward compatible with legacy interfaces.
5) The EEE standard gives room for some future improvements(without requiring hardware replacements)

VI] DISCUSSION:-

The EEE Standard addresses the enery consumption of the PHY devices but can also enable savings in other system components which would be achieved by putting those components in a low power mode when the ports are in LPI mode as in that case no packets can arrive until the PHYs are activated.

VII] CONCLUSION:-

The reduction of operational energy consumption alone will not be sufficient to enable and maintain sustainability.
Information and communication technologies are strong catalyst that can help boost productivity and efficiency in many sectors of the economy.

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Author Profile

Jyoti M. Giri Completed her Graduation in Electronics from AISSMS WCOE, Pune , MH, India in 2006. And also completed M.E. (E & TC) from PVPIT Bavdhan , Pune. She is having 3.10 years of industrial experience &5 years of teaching experience. Currently she is working as Assistant Professor in Dhole Patil College of Engineering wagholi, Pune.Her research area include Wireless sensor Network based on Zigbee.