Energy Efficient LAN

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Abstract— Ethernet is the leading wire line communications technology for LANs. In 2006 the IEEE 802.3 Working Group started an exertion to increase the energy efficiency of Ethernet. Ethernet is one of the first computer networking technologies for which a standard has been developed to improve its energy efficiency. A local area network (LAN) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building Simple LANs generally consist of cabling and one or more switches. A switch can be connected to a router, cable modem, or ADSL modem for Internet access. In this article, a new hardware design concept is to develop to reduce the energy consumption of Ethernet cable. The system is made possible by the use of Raspberry pi. The LAN is established by raspberry pi as a switch and it make the links On-off depending on the data traffic.

Key words: Ethernet Cable, Raspberry pi, Networking, Pi as a Switch, Pi as a controller, Local Area Network

I. INTRODUCTION

The Internet is quickly becoming a major consumer of electricity with measurable economic and environmental effect. The hubs, switches, and routers that include the core of the Internet consumed an estimated 6.15 TWh/yr. One TWh/yr corresponds to $85 million at $0.085 per kWh and about 0.75 million tons of CO2. In 2000, it was estimated that 9 percent of the commercial sector electricity consumption was due to electronic office and telecommunications equipment. In addition to this all of the desktop PCs and new commercial and residential devices are connected to the Internet via Ethernet links. All of the Ethernet links currently deployed operate with very low duty cycles; unfortunately their power consumption remains almost the same for all the time they are switched on. In other words, the power consumption of a link depends only slightly on the actual data traffic on the link itself. The power consumption, instead, strongly depends on the transmission rate and ranges, in general, from some hundreds of milliWatt for 100Mb/s links to some Watt for 10Gb/s links. Considering that the assessment carried out in both and revealed an average utilization of Ethernet links below 5%, the expected overall power saving that could be achieved reducing the power consumption of idle links is potentially enormous. Finally, it is worth highlighting that energy efficient communication systems are expected to play an important role in "green manufacturing", a driving concept for the design and implementation of innovative manufacturing systems, where priority is given to aspects like both reduction of the environmental impact and use of natural resources.

The objective of this research is to develop a system that reduces the energy consumption through Ethernet cable to satisfy the goal of energy saving. Even though there are various switches present in the world, this system introduces new easy, compact and economical hardware which reduces energy consumption of Ethernet cable.

II. RELATED WORK

A. *Energy Efficient Ethernet:*

In IEEE 802.3az-2010 Energy Efficient Ethernet concept is elaborated. The amendment to IEEE Standard 802.3-2008 (CSMA/CD) is explained.

B. *Energy Efficiency in Industrial Ethernet:*

J. A. Maestro and P. Reviriego, these authors analyze the application of appropriate EEE strategies to Ethernet POWERLINK, a popular RTE network. The results, obtained from theoretical analyses, are encouraging, since the achievable power saving demonstrated to be considerable. Focusing on the same RTE network, F. Tramarin and S. Vitturi, [6] provides a simulation study that investigates further EEE strategies aimed at harmonizing power savings and timing requirements. another contribution, although not officially published, is given in [7] In this case, J. W. Walewski, V. Kulkarni, and G. Steindl these authors provide a feasibility study about the possibility of adapting the EEE philosophy to RTE networks, proposing to incorporate them in the IEEE 802.3az amendment. Unfortunately, the proposal has not been further discussed, even if it represents a valuable attempt to address the topic from a standardization point-of view. In [8], S. Herreria-Alonso, M. Rodriguez-Perez, M. FernandezVeiga, and C.Lopez-Garcia these authors focus on sleeping algorithms as a way to provide high power saving, while ensuring the unavoidable delays that influence frame transmission are kept very low. Similarly, in [9], K. Christensen, P. Reviriego, B. Nordman, M. Bennett, M. Mostowfi, and J. Maestro specifies a technique called packet coalescing is proposed. Here, the authors concentrate on the transmission of large TCP frames and show the benefits, in terms of energy efficiency, of grouping acknowledgment frames before their actual transmission, instead of sending them one by one immediately. Another interesting contribution is given in [10]. In this case, M. A. Marsan, A. Anta, V. Mancuso, B. Rengarajan, P. Vasallo, and G.Rizzo these authors provide an analytical model to evaluate the time spent by a link in the various states defined by EEE.

III. METHODOLOGY

This system approach fulfills Energy Efficient LAN. The aim of system is energy saving of the existing computer network through switch by putting the serving links in off state for particular period of time.

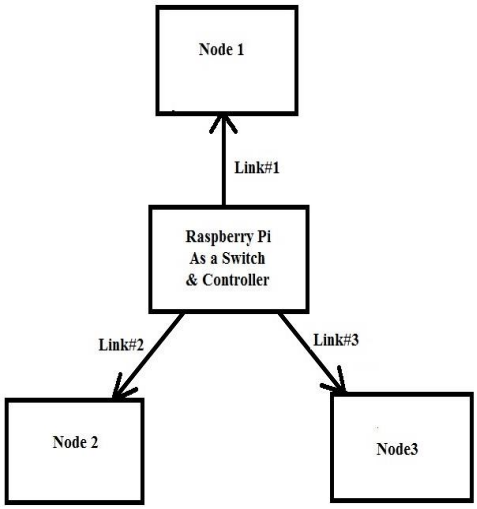

Fig. 1: Block diagram Energy Efficient LAN

A. Hardware Design

The system block diagram is as shown in figure 1. Each block will function as -

1) Raspberry Pi as a Switch & Controller:

Raspberry Pi 3 feature a Broadcom system on a chip (SoC), which includes an ARM compatible central processing unit (CPU) and an on-chip graphics processing unit (GPU, a Video Core IV). CPU speed ranges from 700 MHz to 1.2 GHz for the Pi 3 and on board memory range from 256 MB to 1 GB RAM. Secure Digital (SD) cards are used to store the operating system and program memory in either the SDHC or Micro SDHC sizes. Raspberry pi board has four USB slots, HDMI and composite video output, and a 3.5 mm phone jack for audio. Lower level output is provided by a number of GPIO pins which support common protocols like I²C. The B-models have an 8P8C Ethernet port and the Pi 3 has on board Wi-Fi 802.11n and Bluetooth connectivity 802.15. Out of four USB ports two USB ports are converted into Ethernet ports by using USB to Ethernet converter. The controller used here is also same raspberry pi which detects the Low traffic links in LAN and put that particular links in off state. The controller continuously checks nodes to find whether data traffic on the nodes of particular links are high or not after some predetermined period of time.

2) Node1,2,3:

These are typically intelligent devices like PLCs or PCs Implementing automation task. These systems are working in LAN. These nodes are connected in star topology. A network topology is the arrangement of a network, including its nodes and connecting lines. There are two ways of defining network geometry: the physical topology and the logical (or signal) topology. Therefore, in effect, each workstation is directly connected to every other workstation in the network. A star topology is a topology for a Local Area Network (LAN) in which all nodes are individually connected to a central connection point, like a hub or a switch. A star takes more cable than e.g. a bus, but the benefit is that if a cable fails, only one node will be brought down. In star topology, every host is connected to a central hub. Therefore, in effect, each workstation is directly connected to every other workstation in the network. A star topology is a topology for a Local Area Network (LAN) in which all nodes are individually connected to a central connection point, like a hub or a switch. A star takes more cable than e.g. a bus, but the benefit is that if a cable fails, only one node will be brought down. In star topology, every host is connected to a central hub. Data on a star network passes through the hub, switch, or concentrator before continuing to its destination. The hub, switch, or concentrator manages and controls all functions of the network. These nodes are connected using Ethernet cable. The static IP addresses are given to these nodes in network. A static IP address is a number (in the form of a dotted quad) that is assigned to a computer by us to be its permanent address. Difference between static and dynamic IPs is when a device is assigned a static IP address, the address does not change. Most devices use dynamic IP addresses, which are assigned by the network when they connect and change over time.

B. Software Design

Raspberry pi works on Linux system thus all the work is done on Linux operating system. Raspberry pi does not work as a switch by default thus it requires to configure as a switch. Raspberry pi as a switch configuration is done by using some commands in Linux which are needed to be studied. These commands used are related to networking commands in Linux. To configure raspberry pi as a switch it should be connected in LAN Condition means raspberry pi should be connected to all PC'S in LAN via Ethernet cable. The static IP address should be given to raspberry pi and same class static IP's should also given to the nodes connected in LAN. While configuring the raspberry pi as a switch the bridge get installed on pi. The hardware address of Ethernet port of raspberry pi and the bridge installed on raspberry pi needs to make same. It is also done by using some Linux commands. Then raspberry pi as a Switch connects all nodes in LAN. The algorithm is designed for checking low traffic nodes in network. This algorithm checks low traffic nodes in the network and then put the link of particular node in off state. Then it takes the sleep time of some count value. After sleep time it again checks the data traffic on all nodes in the network after continuous time of interval and if the data traffic on particular node is more then it will up that link and the data transfer get possible. Fig.2 shows the flowchart of software design of this paper.

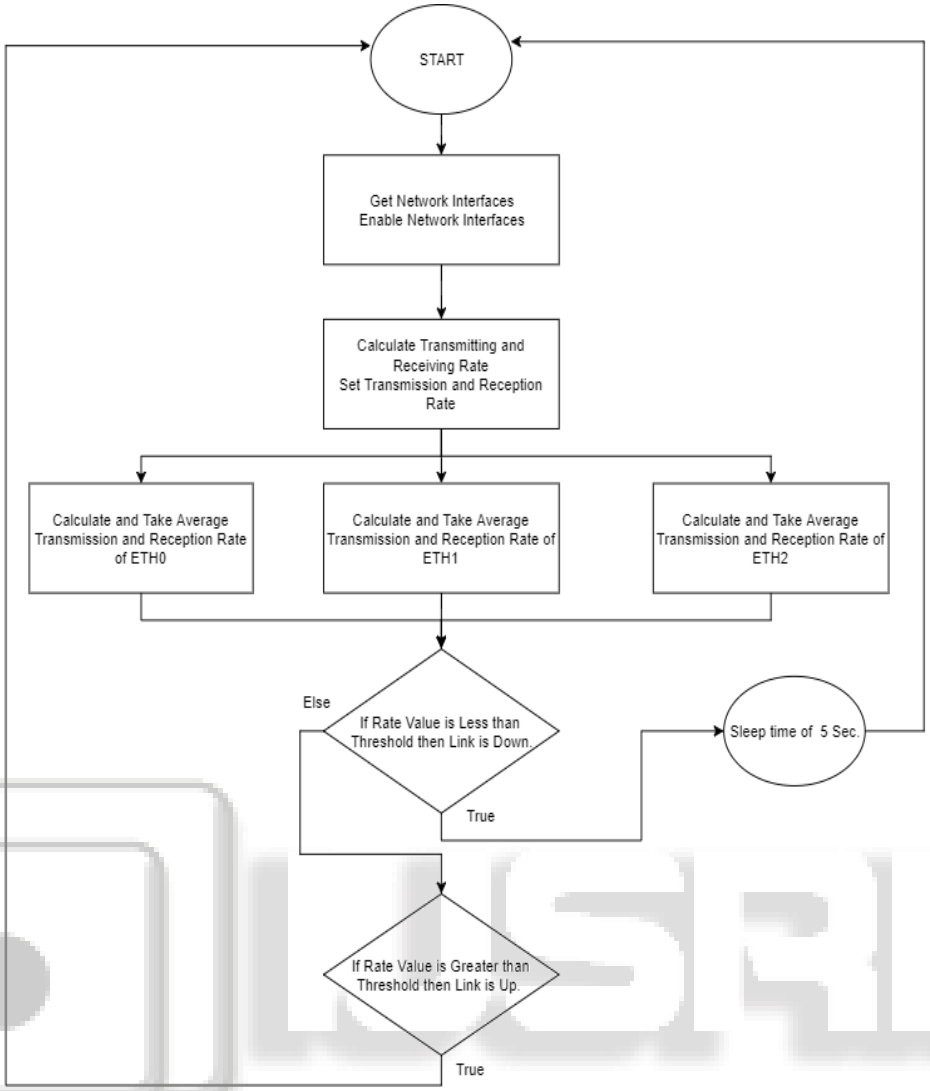

Fig. 2: Flow Chart

IV. CONCLUSION

In the proposed method controller is able detect low traffic links in the network and such indication is again send to the controller. Controller provides energy savings by putting the links in off state. This scheme provides low cost solution and can be implemented to existing LAN.

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