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Analysis of Ethernet connectivity by using ARP and UDP protocol

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ABSTRACT

Ethernet connectivity focuses on the priorities and necessities of requirements such as flexibility, cost, and area etc that varies for each system, but no extra functionality is desired than required. This paper mainly focuses on the Ethernet frame analysis in Xilinx by using UDP protocol and ARP Protocol. Ethernet frame consists of source and destination MAC addresses. To find out the next hop IP address that has a particular MAC address ARP Protocol is used. And also Ethernet frames payload will be either IPv6 or IPv4. Hence, the IPv4 packet header of UDP protocol is used. The analysis of Ethernet frame is performed by implementing the work on Xilinx FPGA - Spartan 6 as it offers driving network highlights of industry and Wireshark is used to get the traces of Ethernet frames.

Keywords: *ARP (Address Resolution Protocol), Ethernet, Ethernet frames, FPGA (Field-Programmable Gate Array), IP (Internet Protocol), IP addresses, IPv4 (Internet Protocol version 4), IPv6 (Internet Protocol version 6), MAC (Media Access Control), MAC addresses, Spartan 6, UDP(User Datagram Protocol), Wireshark, Xilinx.*

1. INTRODUCTION

Ethernet is a most commonly used standard in the network while connecting to the internet or LAN (Local Area Network). Earlier, for just simple point to point connection between an embedded system and LAN would require additional network circuits which added more than required functionality and high cost. Moreover, a processor was required for network stack implementation. At present, with the help of FPGA technology, it is convenient to implement UDP stack as it is the uncomplicated and budget-friendly network connection.

In this paper, basic information regarding Ethernet and its frames is provided in section 2 which is required for the implementation of Ethernet communication. Then theoretical information about FPGA can be observed in section 3. Section 4 describes the way how it is implemented by using protocols. Finally in section 5 conclusion is presented.

2. ETHERNET AND ETHERNET FRAMES

2.1 Ethernet

An array of systems and networking technologies in LAN is Ethernet. Data streams are divided into packets by the systems which use Ethernet for communication and these are known as frames. Frames consist of addresses of source and destination, mechanisms that are used in transmitted and re-transmitted data requests to detect errors.

Ethernet operates in the Data Link layer and the Physical layer. The below figure 1 shows the relationship of Ethernet with the OSI Reference model.

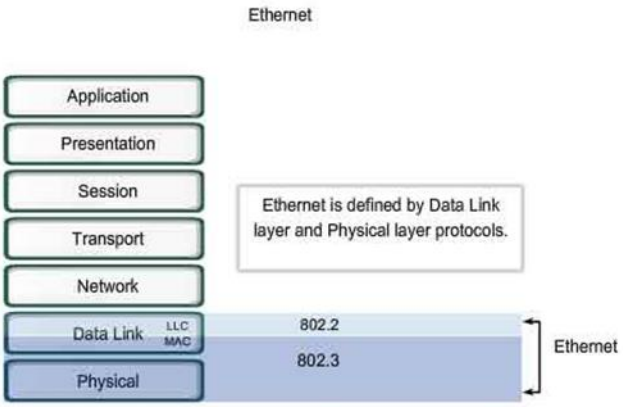

Fig 1: Ethernet in OSI Reference model

Data encapsulation and Media access control are present in MAC sublayer. Assembly of the frame before transmission of data, detecting an error during and after data reception is done by Data encapsulation. The MAC consists initiation of frame transmission and recovery of frames from transmission failure.Three types of transmission speeds can be observed in Ethernet systems.

1) 10Base-T: provides transmission speed upto 10 Mbps

2) 100Base-T: provides transmission speed upto 100 Mbps

3) Giga Bit Ethernet: provides transmission speed upto 1000 Mbps (1 Giga bit) and also 10 Gigabit Ethernet that provides transmission speed upto 10 billion bits per second.

Data transfer in Ethernet is provided by topology where topology is the shape of LAN or the communication system. Ethernet uses ring, star, bus and tree topology.

2.2 Ethernet Frames

Ethernet frame is transmitted through a data packet and is known as Ethernet packet. Ethernet frame is as shown in the below figure no.2.

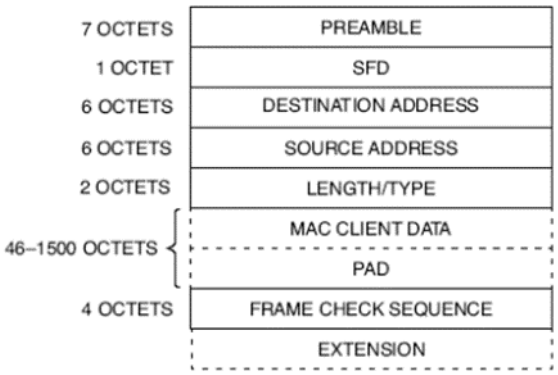

Fig 2: Ethernet Frame

The comparison of Ethernet frame and IEEE 802.3 is as shown in the below figure no.3.

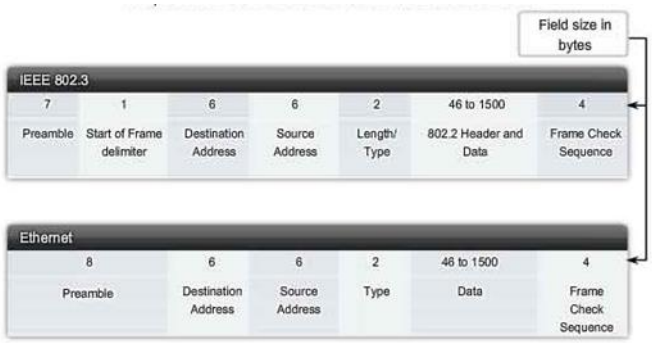

Fig 3: Comparison of Ethernet frame and IEEE 802.3

Synchronization between the sending devices and receiving devices are done by the Preamble of 7 bytes and SFD(Start Frame Delimiter) of 1-byte fields. To get the receiving nodes attention these 8 bytes are used. To identify the recipient the destination MAC address field of 6 bytes is used by the Layer 2 to help devices in determining the addressed frame. In the same way source, MAC address is used to identify the frame's origin.

The length of the frame's data field is defined by the Length or Type field which is of 2 bytes. This field is used by FCS to verify the message was properly received or not. Not only length this field can be used to designate type. The type field defines the implementation of the protocol. If the 2 octet value is greater than or equal to 0x0600 (hexadecimal) or 1536 (decimal) then the content is considered to indicate protocol.

From 46 to 1500 bytes of Data and Pad Fields are present and it contains higher level encapsulated data which is more commonly a packet of IPv4. All frames should be minimum 64 bytes long. If not, the pad is applied to increase the frame size to 64 bytes.

The 4 byte long FCS (Frame Check Sequence) field is used to detect errors in the frame by using CRC (cyclic redundancy check). At the source, CRC results are included in the FCS field. In the same way at the destination after receiving the frame the device generates CRC results to look for errors. If both the calculations matches, then no error occurred or else it indicates that the data has been modified and the frame will be dropped.

Mainly this paper focuses on Network level protocol ARP and transport level protocol UDP. ARP allows MAC address requests from other nodes if and only if the IP address is known. UDP which is an interface for the packets that are sent by IP network protocol provides an unreliable and connectionless service for communication.

3. FPGA (FIELD-PROGRAMMABLE GATE ARRAY)

Highly parallel and customisable platform is provided by FPGA which is used to perform control and advanced processing tasks at different hardware speeds. FPGA is a programmable chip and is composed of three basic components such as

1) Logic blocks: Slices (Contain combinatorial logic and register resources), Memory, Multipliers

2) Programmable interconnects

3) I/O blocks: Interface between the FPGA and the outside world

Other Resources like Global clock buffers, Boundary scan logic can also be obtained.

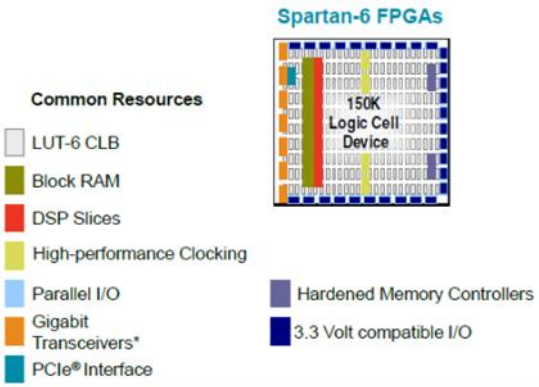

Fig 4: Spartan 6 Architecture Resources

Spartan 6 FPGA SP605 Evaluation kit implements many features such as PCIe(PCI Express), high-speed serial transceivers, DVI, FMC(FPGA Mezzanine Card) connector etc. The below figure no. 5 shows the SP605 Evaluation Kit.

4. IMPLEMENTATION

Fig 5: Spartan-6 FPGA SP605 Evaluation Kit

4.1 ARP (Address Resolution Protocol)

Ethernet frame carries a destination and sources MAC address. And if IP layer determines the destination IP address of next hop then the link layer can deliver the datagram to the hosting IP address. The ARP module is used to find out the MAC addresses associated with a particular IP address. In simple words, ARP can be considered as sitting between the Link and Network layers.

The Ethernet frame is implemented in Xilinx ISE and the simulation is as shown in the below figure no. 6(a) and figure no. 6(b)

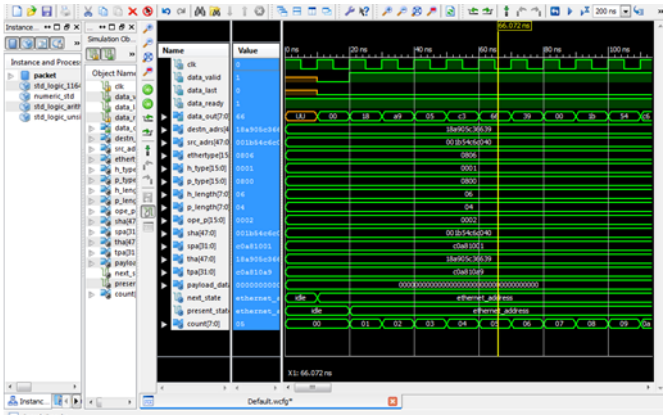

Fig 6(a): ARP in Ethernet frame

Authentication is not provided by ARP replies on a network. ARP replies can be obtained from many systems other than the one with the required Layer 2 address. ARP request is answered by ARP proxy on behalf of another system so that the traffic is forwarded.

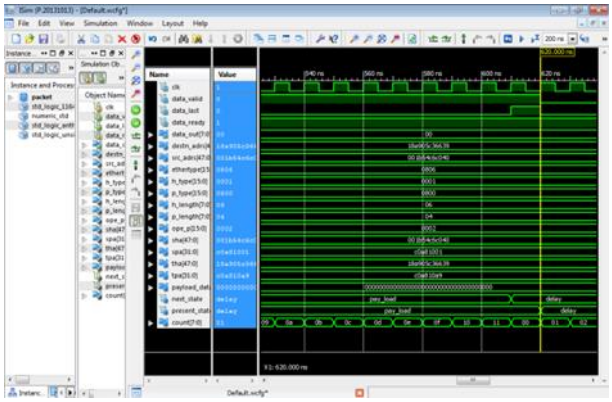

Fig 6(b): ARP in Ethernet frame

The IPv4 over Ethernet ARP packet has been recorded and the traces are displayed in Wireshark as shown in below figure no. 7.

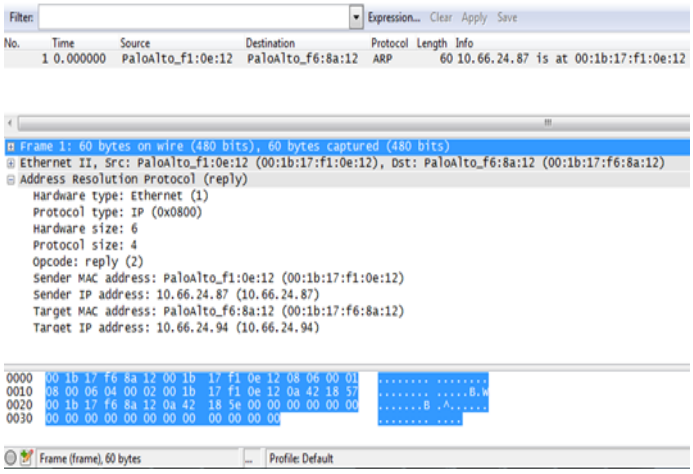

Fig 7: IPv4 over Ethernet ARP packet

4.2 UDP (User Datagram Protocol)

UDP is a connectionless communication protocol. It is unreliable as it does not bother about the reception of data the at the destination. For transferring important documents UDP is not considered. But UDP is faster than other protocol and is still preferred.

The Ethernet frame is implemented in Xilinx ISE and the simulation is as shown in the below figure no. 8(a) and figure no. 8(b)

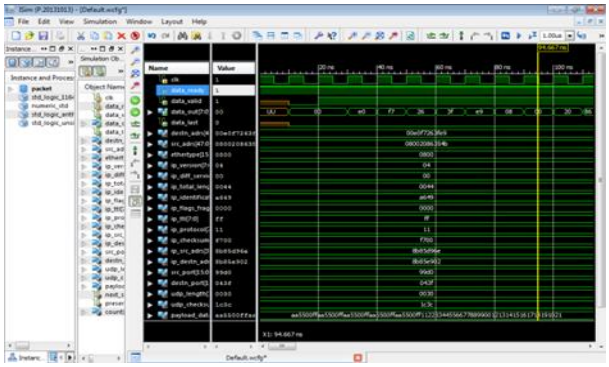

Fig 8(a): UDP in Ethernet frame

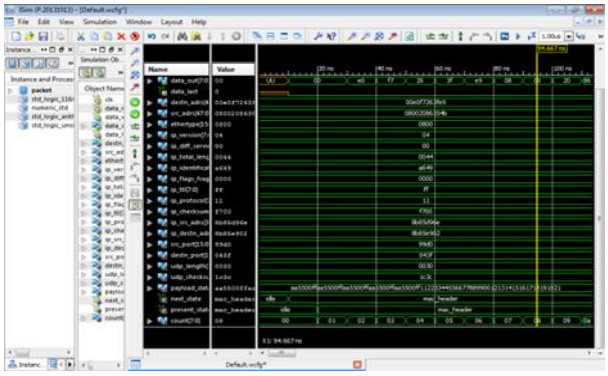

Fig 8(b): UDP in Ethernet frame

The IPv4 over Ethernet UDP packet has been recorded and the traces are displayed in Wireshark as shown in below figure no. 9.

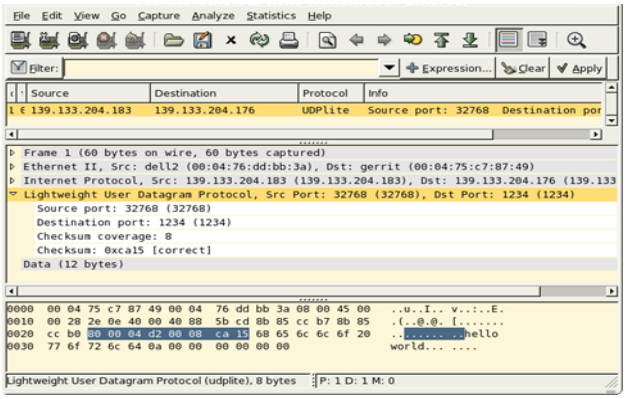

Fig 9: IPv4 over Ethernet UDP packet

5. CONCLUSION

This paper explains the Ethernet connectivity by using ARP and UDP protocols. Ethernet communication is faster and most feasible for different systems. How IPv4 over Ethernet ARP frame and over Ethernet UDP frame transfers the data is observed. By using this the reliability and also the speed is observed in ARP and UDP protocols respectively. It is implemented on FPGA technology as it is not much costlier and supports advanced features for Ethernet connectivity. In future, the Ethernet connectivity can be enhanced by using TCP Protocol.

6. REFERENCES

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