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A Novel Approach for Implementing of UDP/IP Stack in FPGA

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Abstract—*UDP (User Datagram Protocol) is an alternative communications protocol to Transmission Control Protocol (TCP) used primarily for establishing low-latency and loss tolerating connections between applications on the Internet. Both UDP and TCP run on top of the Internet Protocol (IP) and are sometimes referred to as UDP/IP or TCP/IP. Due to use of FPGA board the less number of resources are required. We are implementing UDP/IP in the three layers of OSI model those are data link layer, network layer and transport layer. This architecture is implemented using XILINX ISE (integrated synthesis environment) tool and synthesized to a SPARTEN-3E FPGA.*

Keywords:— *FPGA, Network Protocols, OSI Layer, UDP/IP.*

1. INTRODUCTION

The User Datagram Protocol (UDP) is a transport layer protocol defined for use with the IP network layer protocol. The service provided by UDP is an unreliable service that provides no guarantees for delivery and no protection from duplication (e.g. if this arises due to software errors within an Intermediate System (IS)). The simplicity of UDP reduces the overhead from using the protocol and the services may be adequate in many cases. UDP provides a minimal, unreliable, best-effort, message-passing transport to applications and upper-layer protocols. Compared to other transport protocols, UDP and its UDP-Lite variant are unique in that they do not establish end-to-end connections between communicating end systems. UDP communication consequently does not incur connection establishment and teardown overheads and there is minimal associated end system state. Because of these characteristics, UDP can offer a very efficient communication transport to some applications, but has no inherent congestion control or reliability.

2. NETWORK PROTOCOL

Protocol is a set of rules that govern data communications. A protocol defines what is communicated, how is communicated and when it is communicated. The key elements of protocols are syntax, semantics and timing [5]. There are various types of protocols like TELNET (Telecommunication Network), FTP (file transfer protocol), SMTP (simple mail transfer protocol) and DNS (domain name system) come under application layer of OSI (open system interconnection) model, UDP and TCP come under transport layer and IP and ARP come under network layer.

Usually Internet protocol delivers messages to destination which is selected by unique IP address. ICMP (Internet control message protocol) is used by network devices like routers to send error messages. It is nothing but a network diagnostics protocol and is used to report problems.

3. OSI MODEL

An open system is a set of protocols that allows any two systems to communicate without requiring changes to the logic of the underlying hardware and software. It is not a protocol it is just a theoretical model for understanding and designing a network architecture. It consists of seven layers which are related to each other, which defines a part of process of moving information across a network. Each layer serves the layer above it and served by the layer below it.

Physical Layer:

It deals with the mechanical and electrical specifications of the data connection. It also defines relationship between device and physical transmission medium. It establishes and terminates the connection between two directly connected nodes. it is flow controlling layer. It predicts transmission mode that is whether simplex, half duplex or full duplex.

Data link layer:

It transforms the physical layer to a reliable link and exchanges data within networks by detecting and possibly correcting errors which may occur in physical layer. Data link packet frame is the basic unit of data transfer for this layer. Frame carries the destination and source link address and other control information in the header.

Network layer:

It is responsible for source to destination delivery of the packet across multiple networks, whereas the data link layer oversees the delivery of packet within same networks. If two systems are connected to the same link, there is no need of network layer. IP is the most important protocol of this layer. It converts logical network address to physical machine address.

Transport layer

It is responsible for process to process delivery of the entire message. A process is an application program running on the host. It treats each packet independently. The transport layer ensures that the whole message arrives intact and in order, overseeing both error control and flow control from the source to destination. The TCP is the most used protocol of transport level which gives connection oriented communication. Another transport layer protocol is the UDP which provides an unreliable and connectionless communication service.

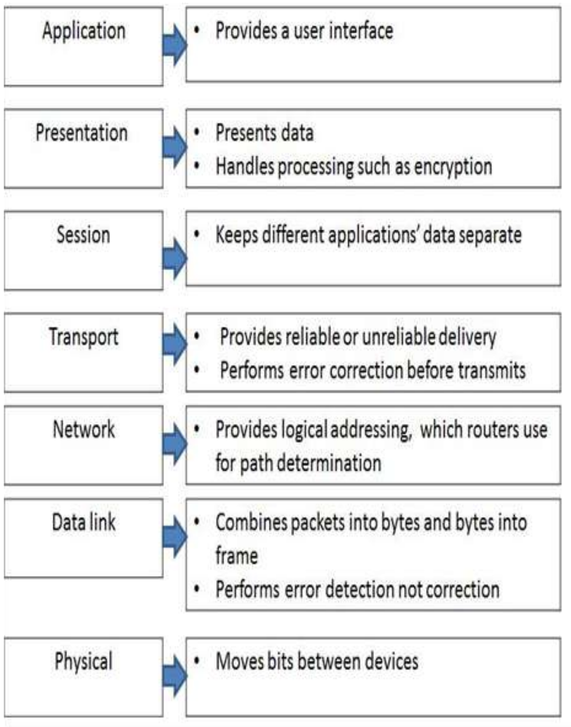

Figure -1: Layers of OSI model

Session layer

For some applications service provided by the first three layers (physical, data link and network) is not sufficient then we go foe session layer. It is the network dialog controller, establishes, maintains, and synchronizes the interaction among communicating systems.

Presentation layer

It deals with the syntax and semantics of the information which is going to exchange between two systems and also responsible for translation, compression, and encryption.

Application layer

The application layer is closest to end user and enables the user, whether the human or software to access the network. It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared data base management.

4. UDP over TCP:

TCP provides connection oriented, reliable, full-duplex while UDP provides connectionless, unreliable service. UDP offers minimal datagram delivery service. For sending small messages, UDP it takes much less interactions between sender and receiver than using TCP. It is simpler than TCP.UDP is one of the core members of internet protocol. It provides checksum for data integrity and port number for addressing different functions.

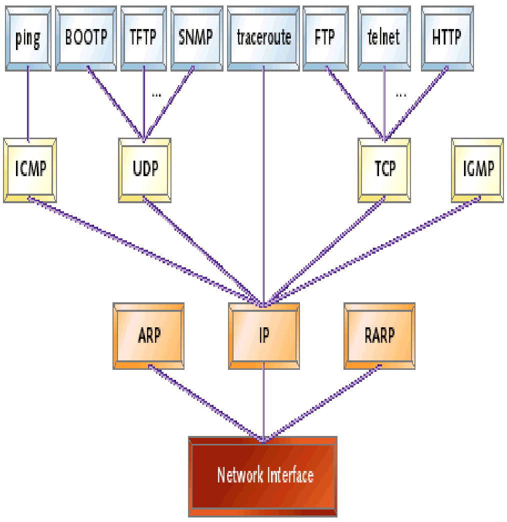

Figure 2: Block Diagram of UDP/IP Stack

5. METHODOLOGY

Control transmitter/ receiver

It receives the packet from application and stores it in the RAM transmitter. Control transmitter is for sending data to UDP transmitter block.

In RAM receiver control receiver writes the data in packets from UDP receiver and then sends to the application layer.[2]

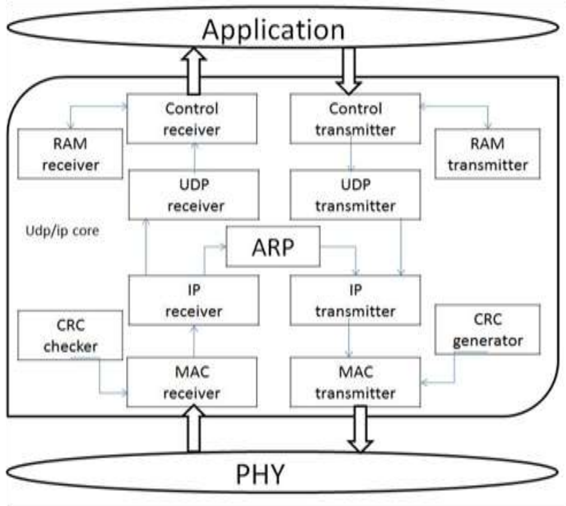

Figure -3: Block diagram of UDP/IP core

UDP transmitter/ receiver

It manages UDP packets and represents transport layer. UDP transmitter encapsulates the packet with the UDP header and sends out to the block IP transmitter. UDP receiver checks the packet and sends it to the control receiver without UDP header information. [2]

IP transmitter / receiver

IP transmitter represents the network layer and manages IPv4 packets. It calculates checksum and encapsulates packet with IP header. IP receiver verifies the checksum of the packet and the destination IP address. Only IP addresses that matches with the core's IP address and broadcast IP address are accepted and send to UDP receiver and others will get discarded. [2]

MAC transmitter / receiver

MAC transmitter represents the link layer and manages outgoing and incoming of the packets. It sends packet to the physical layer and preamble, where the last nibble is start of the frame delimiter is sent at the beginning. MAC transmitter sets the control signal high. Each byte is sent to the CRC (cyclic redundancy check) generator which progressively calculates the CRC. When packet end is reached the calculated 32-bit CRC is sent.

MAC receiver checks for new packet, when the new packet is detected it will be sent to the CRC checker which will progressively calculates the CRC checksum.

6. SYNTHESIS & SIMULATION

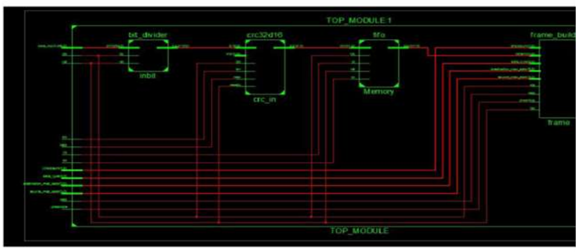

Figure-4: Top view of UDP transmitter

Figure- 5: Transmitter module simulation results

7. COMPARATIVE RESULT

Table-1: Comparative Result

Parameter	Nikolaos Alachiotis, Simon A. Berger[1]	Result obtained
Slice Registers	184	82
FMax(MHz)	128.8	161.91

8. CONCLUSION

We presented a significantly enhanced version of our widely-used open-source UDP/ IP core for efficient direct PC $ FPGA communication. The improved version allows for automatic configuration of the UDP/IP core. In addition, we introduce a light-weight communication protocol and provide an appropriate software/hardware interface and communication library implementation.

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