ISSN 2348-8565

Volume 10 Issue 1 | March 2022 ISSN: 2320-9984 (Online)

International Journal of Modern Engineering & Management Research

Website: www.ijmemr.org

# A Novel Method for Implementation and Optimization of UDP/IP Stack

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***Abstract—*** *UDP/IP (user datagram protocol / internet protocol) stack protocol in FPGA (field programmable gate array), which is widely used in VoIP (voice over internet protocol), video conference, Ethernet connectivity and LAN network applications. 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. 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 UDP (User Datagram Protocol) is an OSI transport layer protocol that had been defined in 1980 by RFC 768 as a response to the need for an alternative to the TCP protocol. It belongs to the TCP/IP family, and thus, it is commonly used in conjunction with the IP protocol, replacing the TCP features of the suite. The TCP protocol allowed stability and had many mechanisms for ensuring data integrity, but the additional checks and communication rules added to the cost of bandwidth. On the other hand, the UDP protocol was designed to be a lot less reliable and relieved from most TCP communication rules which gave the software and hardware engineers more freedom with how they could approach their objectives.

## 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.

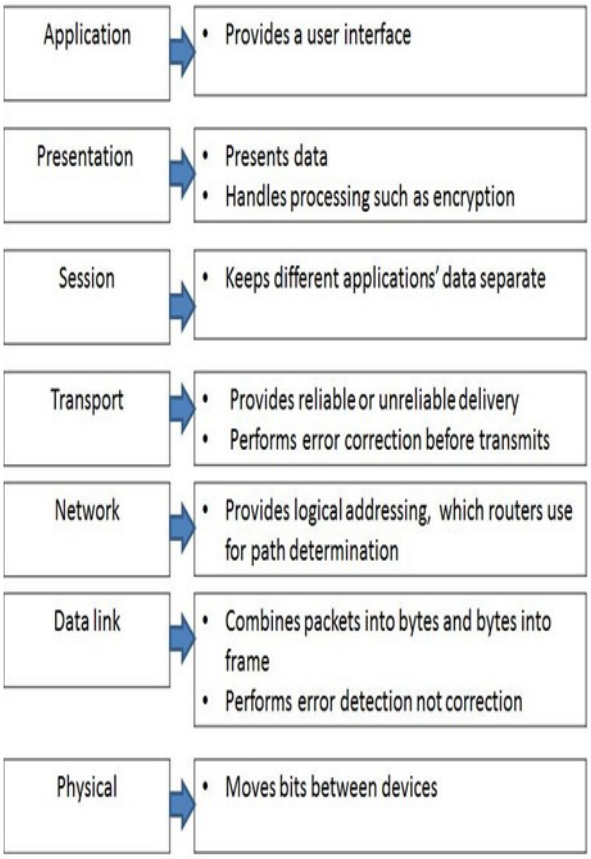


*Figure 1. Layers of OSI model*

### *3.1 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.

### *3.2 Data link layer*

It transforms the physical layerto 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.

### *3.3 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.

### *3.4 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 a unreliable and connectionless communication service.

### *3.5 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.

### *3.6 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.

### *3.7 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 member of internet protocol. It provides checksum for data integrity and port number for addressing different functions.

### *4.1 Uses*

- Suitable for the process that requires simple request response communication.
- Used for multicasting and management process.
- Used for some route updating protocols.

## 5. IMPLEMENTATION

The proper block diagram of UDP/IP stack is as shown in the figure 2.vThe layers, transport, network, data link in UDP/IP stack are designed using VHDL.

### *5.1 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]

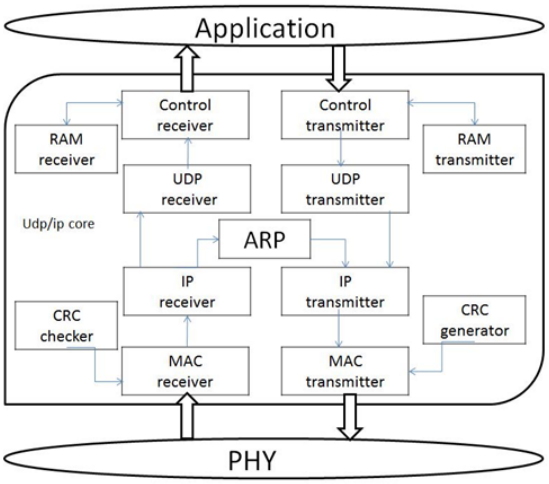


*Figure 2: Block diagram of UDP/IP core*

### *5.2 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]

### *5.3 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]

### *5.4 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.

### *5.5 ARP*

ARP(address resolution protocol) block is used to convert network address to physical address and manages ARP packets. It allows the MAC address from other node when only IP address of its neighbors is known. It uses simple message format that contains one address resolution request.

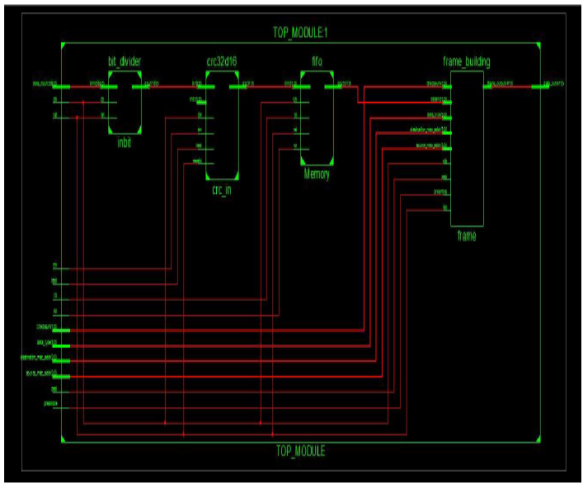


*Figure 3: Top module RTL Schematic diagram*

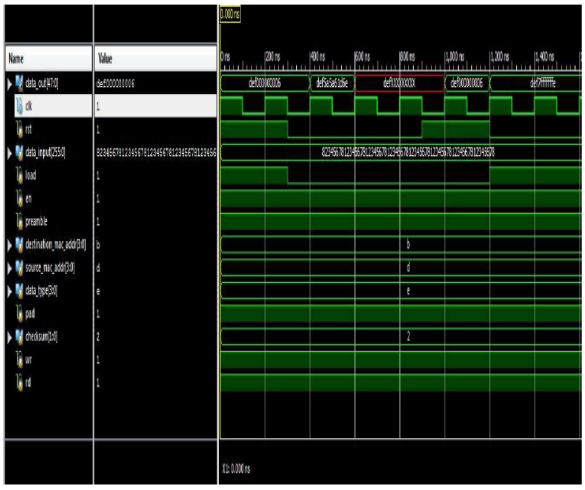

*Figure 4:Transmitter module simulation results*

## 6. COMPARATIVE RESULT

Proposed module has been compared against different modules with same target FPGA on which previous has been implemented and then showcased comparison on the basis of availability of results.

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.

**Table 1: Comparison from Pervious work**

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

## 7. FUTURE SCOPE

We propose to improve UDP protocol so that the physical frame error indication is forwarded to the application for better error control. Various optimization techniques can be implemented to reduce area, increase speed. Timing constrains can be and data integrity. We can also implement different types of UDP like CUDP, UDP-Lite for real time multimedia applications over wireless networks.

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