ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 7, Issue 4 , April 2020

# Network Layer Protocol of Protocols TCP / IP

**Vafayeva Zamira Sevindikovna, Nasilloev Sanjar Baxtiyor o'g'li.**

Assistant of Department " light industry machinery and equipment " of Bukhara engineering and technological Institute, Bukhara, Uzbekistan.
Student, Tashkent University of Information Technology named after Muhammad al-Khwarizmi, Tashkent, Uzbekistan.

**ABSTRACT:** This article provides detailed information about the network layers and networks that are often used for data exchange. At the same time the process of this layer and its associated protocols are listed.There are also comments on the supported protocols.

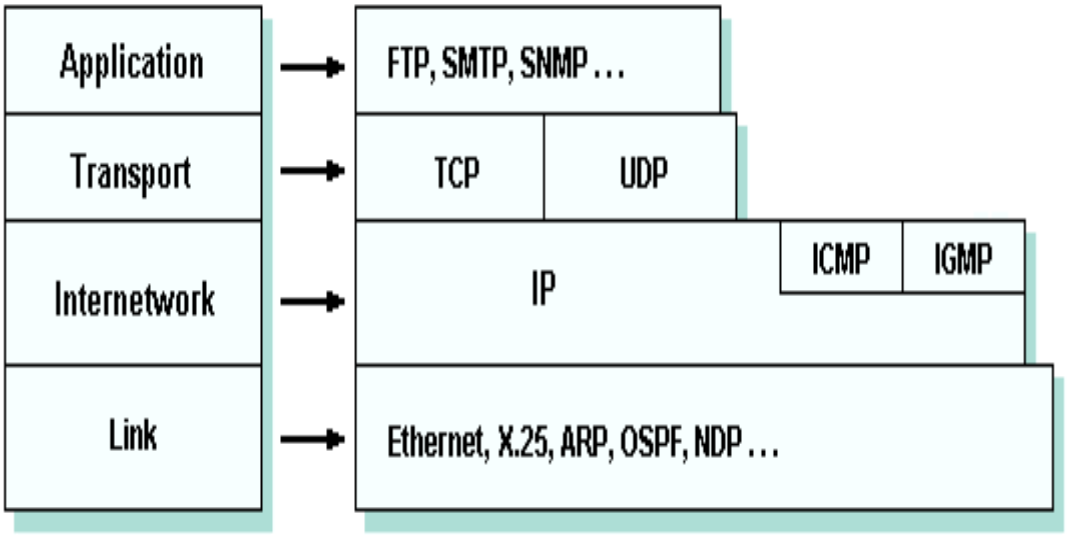
**KEY WORDS:** TCP, IP, protocol, layer, network, stack.

## I. INTRODUCTION

TCP/IP is the world's most widely-used non-proprietary protocol suite because it enables computers using diverse hardware and software platforms, on different types of networks, to communicate. The protocols work equally well in both LANs and WANs. TCP/IP is a collection of protocols named after its two best-known and most important protocols, the *Transmission Control Protocol* (TCP) and the *Internet Protocol* (IP). As well as these relatively low-level protocols, TCP/IP includes several higher level protocols that facilitate common applications such as electronic mail, terminal emulation, and file transfer. As we have seen, the Internet protocols used today were originally developed as part of the ARPANET research project which started in the 1960s and led to the emergence of the global network of networks we call the Internet. Each Internet protocol, together with any subsequent amendments, is described in a document known as a *Request For Comments* (RFC).

### TCP/IP layers

The TCP/IP protocol suite can be modelled as a layered protocol stack, allowing TCP/IP to be compared with other layered models such as the OSI Reference Model. The TCP/IP model has four layers. From lowest to highest, these are the *link layer*, the *Network Layer*, the *transport layer*, and the *application layer*, as shown below.



ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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The Internet Protocol is the building block of the Internet. Its functions include:

- Defining the datagram, which is the basic unit of transmission in the Internet
- Defining the Internet addressing scheme
- Moving data between the Network Access Layer and the Transport Layer
- Routing datagrams to remote hosts
- Performing fragmentation and re-assembly of datagrams

Before describing these functions in more detail, let's look at some of IP's characteristics. First, IP is a *connectionless protocol*. This means that it does not exchange control information (called a "handshake") to establish an end-to-end connection before transmitting data. In contrast, a *connection-oriented protocol* exchanges control information with the remote system to verify that it is ready to receive data before any data is sent. When the handshaking is successful, the systems are said to have established a *connection*. The Internet Protocol relies on protocols in other layers to establish the connection if they require connection-oriented service.

IP also relies on protocols in the other layers to provide error detection and error recovery. The Internet Protocol is sometimes called an *unreliable protocol* because it contains no error detection and recovery code. This is not to say that the protocol cannot be relied on—quite the contrary. IP can be relied upon to accurately deliver your data to the connected network, but it doesn't check whether that data was correctly received. Protocols in other layers of the TCP/IP architecture provide this checking when it is required.

The TCP/IP protocols were built to transmit data over the ARPAnet, which was a packet-switching network. A packet is a block of data that carries with it the information necessary to deliver it, similar to a postal letter, which has an address written on its envelope. A packet-switching network uses the addressing information in the packets to switch packets from one physical network to another, moving them toward their final destination. Each packet travels the network independently of any other packet.

The datagram is the packet format defined by the Internet Protocol. Figure 1-5 is a pictorial representation of an IP datagram. The first five or six 32-bit words of the datagram are control information called the header. By default, the header is five words long; the sixth word is optional. Because the header's length is variable, it includes a field called Internet Header Length (IHL) that indicates the header's length in words. The header contains all the information necessary to deliver the packet.

The Internet Protocol delivers the datagram by checking the Destination Address in word 5 of the header. The Destination Address is a standard 32-bit IP address that identifies the destination network and the specific host on that network. (The format of IP addresses is explained in Chapter 2.) If the Destination Address is the address of a host on the local network, the packet is delivered directly to the destination. If the Destination Address is not on the local network, the packet is passed to a gateway for delivery. Gateways are devices that switch packets between the different physical networks. Deciding which gateway to use is called routing. IP makes the routing decision for each individual packet.

## II. THE TCP/IP LAYERS AND PROTOCOL STACK

The ***internetwork layer*** provides *addressing* and *routing* functions that ensures messages are delivered to their destination. *Internet Protocol* (IP) is the most important protocol in this layer. It is a connectionless, unreliable protocol that does not provide flow control or error handling, and attempts to deliver datagrams (in the form of *IP packets*) on a best-effort basis. Network devices called *routers* forward incoming datagrams according to the destination IP address specified within the IP packet. The Network Layer corresponds more or less to the *network layer* of the OSI model. Other protocols at this layer include *Internet Control Messaging Protocol* (ICMP) and *Internet Group Management Protocol* (IGMP).

## III. DEVICES USED IN NETWORK LAYER OF TCP/IP MODEL

The network layer is responsible for creating routing table, and based on routing table, forwarding of the input request. Some of the Devices used in Network Layer are,

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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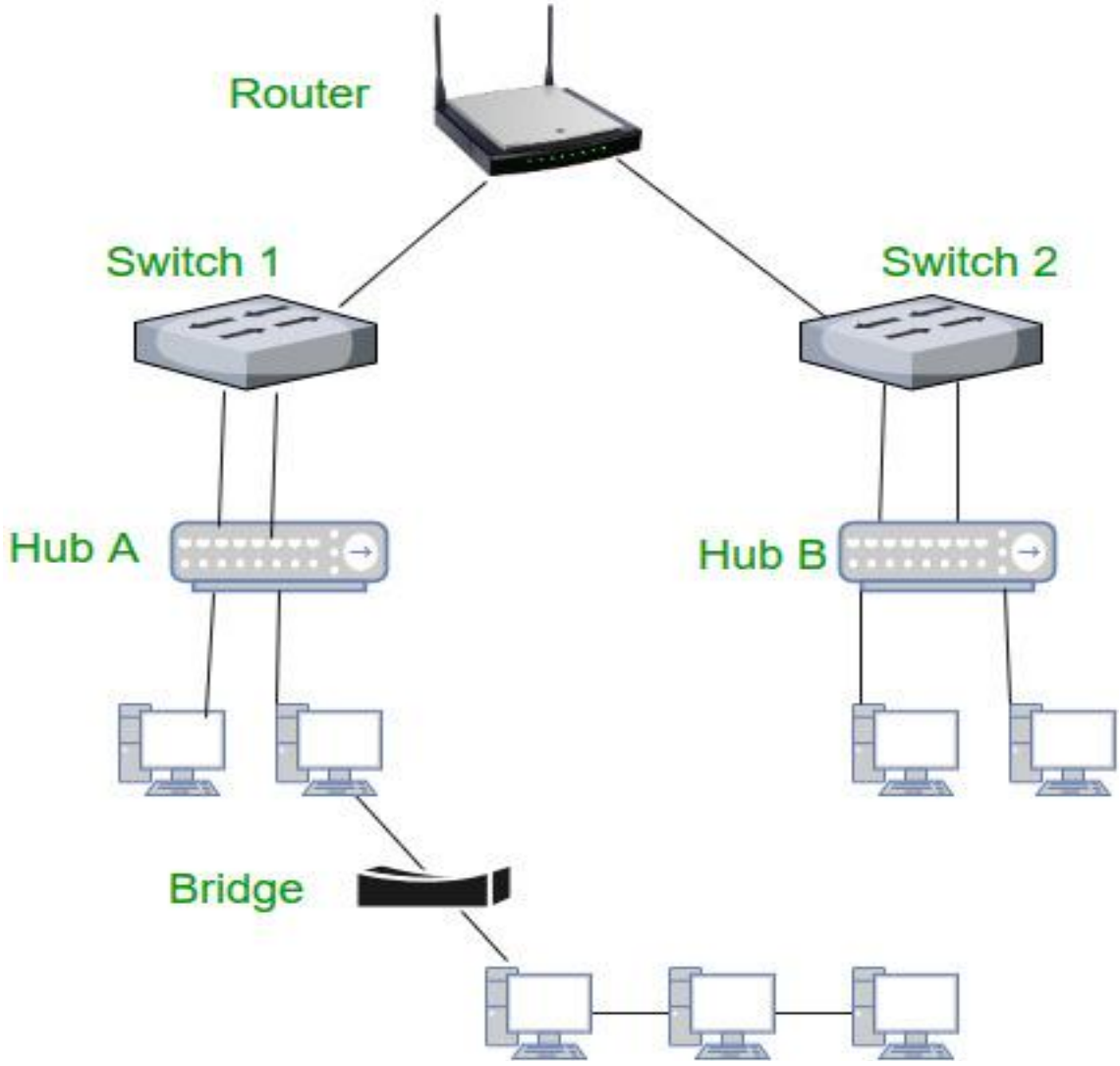
- **Routers:**
  A router is a switch like device that routes/forwards data packets based on their IP addresses. Routers normally connect Local Area Network (LANs) and Wide Are Network (WANs) together and have a dynamically updating routing table based on which they make decisions on routing the incoming packets.
- **Brouters:**
  A bridge router or brouter is a network device that works as a bridge and as a router. The brouter routes packets for known protocols and simply forwards all other packets as a bridge would. Brouters operate at both the network layer for routable protocols (or between network with different data link layer protocol ex. one is running on ethernet (802.3) and other network is running on Token ring (802.5)) and at the data link layer for non-routable protocols (or both network are using same data link layer protocol).




Network Layer

- An Network Layer is the second layer of the TCP/IP model.
- An Network Layer is also known as the network layer.
- The main responsibility of the Network Layer is to send the packets from any network, andthey arrive at the destination irrespective of the route they take.

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International Journal of Advanced Research in Science, Engineering and Technology
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## IV. THE PROTOCOLS USED IN NETWORK LAYER

The network layer protocols provide a connectionless packet delivery service. A packet is the unit of transfer for a physical network. "Connectionless" describes the packet treatment: all packets are treated as separate entities. Network layer protocols provide efficient packet delivery by managing the addressing and routing of packets. The Internet Protocol (IP) provides the network layer protocol for TCP/IP.

**IP Protocol:**

IP protocol is used in this layer, and it is the most significant part of the entire TCP/IP suite.

The Internet Protocol (IP) is the foundation of TCP/IP. It sends and receives packets of information over the physical network. IP calls the packet a datagram. Each datagram includes its source and destination addresses, control information, and any actual data passed from or to the host layer. The IP datagram is the unit of transfer of an internet.

IP provides the mechanism by which hosts and gateways are able to route internet datagrams. IP routing is based on the destination address of each datagram. When IP receives a datagram, it checks the destination network number and a routing table. This routing table contains the addresses of known destination networks, gateways, and hosts. IP delivers datagrams with local internet addresses directly. It forwards datagrams with nonlocal addresses to their next destination based on the routing table information.

IP also monitors the size of the datagrams it receives from the host layer. If the datagram exceeds the length of the packet the physical network is capable of sending, IP fragments the single datagram into datagrams of lengths that are manageable by the underlying network hardware. The IP layer on the destination host reassembles the fragmented datagrams into the original single datagram before passing it to the higher level protocols.

IP requires that the higher level (transport or application layer) protocols reliably handle the data.

Following are the responsibilities of this protocol:

- **IP Addressing:** This protocol implements logical host addresses known as IP addresses. The IP addresses are used by the internet and higher layers to identify the device and to provide internetwork routing.
- **Host-to-host communication:** It determines the path through which the data is to be transmitted.
- **Data Encapsulation and Formatting:** An IP protocol accepts the data from the transport layer protocol. An IP protocol ensures that the data is sent and received securely, it encapsulates the data into message known as IP datagram.
- **Fragmentation and Reassembly:** The limit imposed on the size of the IP datagram by data link layer protocol is known as Maximum Transmission unit (MTU). If the size of IP datagram is greater than the MTU unit, then the IP protocol splits the datagram into smaller units so that they can travel over the local network. Fragmentation can be done by the sender or intermediate router. At the receiver side, all the fragments are reassembled to form an original message.
- **Routing:** When IP datagram is sent over the same local network such as LAN, MAN, WAN, it is known as direct delivery. When source and destination are on the distant network, then the IP datagram is sent indirectly. This can be accomplished by routing the IP datagram through various devices such as routers.

**ARP Protocol**

The Address Resolution Protocol (ARP) provides an address conversion function. A host can have a hardware address that is unrelated to its internet address. ARP provides a method of mapping internet addresses to hardware addresses. You use ARP most often in hosts connected to Ethernet networks.

- ARP stands for **Address Resolution Protocol**.
- ARP is a network layer protocol which is used to find the physical address from the IP address.
- **The two terms are mainly associated with the ARP Protocol:**
  - **ARP request:** When a sender wants to know the physical address of the device, it broadcasts the ARP request to the network.
  - **ARP reply:** Every device attached to the network will accept the ARP request and process the request, but only recipient recognize the IP address and sends back its physical address in the form of

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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ARP reply. The recipient adds the physical address both to its cache memory and to the datagram header

**ICMP Protocol**

Although considered an independent protocol, the Internet Control Message Protocol (ICMP) performs an integral function of IP. ICMP allows hosts and gateways to exchange information about the communications environment of the internet. For example, ICMP can allow a gateway to inform a host of a more efficient route. ICMP informationisencodedinthe IP datagram.

- **ICMP** stands for Internet Control Message Protocol.
- It is a mechanism used by the hosts or routers to send notifications regarding datagram problems back to the sender.
- A datagram travels from router-to-router until it reaches its destination. If a router is unable to route the data because of some unusual conditions such as disabled links, a device is on fire or network congestion, then the ICMP protocol is used to inform the sender that the datagram is undeliverable.
- An ICMP protocol mainly uses two terms:
  - **ICMP Test:** ICMP Test is used to test whether the destination is reachable or not.
  - **ICMP Reply:** ICMP Reply is used to check whether the destination device is responding or not.
- The core responsibility of the ICMP protocol is to report the problems, not correct them. Theresponsibilityofthecorrectionlieswiththesender.
- ICMP can send the messages only to the source, but not to the intermediate routers because the IP datagram carries the addresses of the source and destination but not of the router that it is passed to.

**Reverse Address Resolution Protocol**

Diskless machines use the Reverse Address Resolution Protocol (RARP) to find their IP addresses from a server before they can communicate using TCP/IP.

**Network Layer** transmits data segments between networks in the form of packets. When you message your friend, this layer assigns source and destination IP addresses to the data segments. Your IP address is the source, and your friend's is the destination. This Layer also determines the best paths for data delivery.

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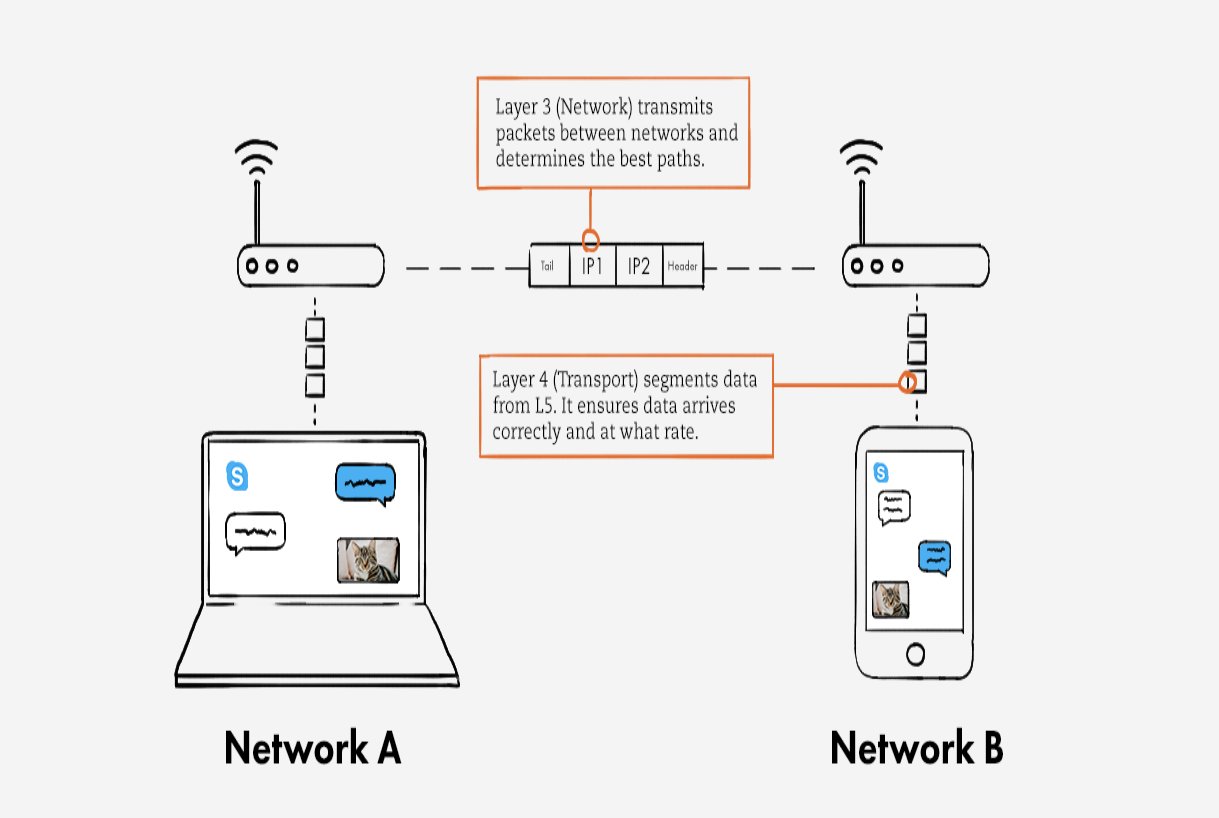


**1)** Services Provided by the Network Layer

- **Guaranteed delivery:** This layer provides the service which guarantees that the packet will arrive at its destination.
- **Guaranteed delivery with bounded delay:** This service guarantees that the packet will be delivered within a specified host-to-host delay bound.
- **In-Order packets:** This service ensures that the packet arrives at the destination in the order in which they are sent.
- **Guaranteed max jitter:** This service ensures that the amount of time taken between two successive transmissions at the sender is equal to the time between their receipt at the destination.
- **Security services:** The network layer provides security by using a session key between the source and destination host. The network layer in the source host encrypts the payloads of datagrams being sent to the destination host. The network layer in the destination host would then decrypt the payload. In such a way, the network layer maintains the data integrity and source authentication services.

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ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 7, Issue 4 , April 2020

**AUTHOR'S BIOGRAPHY**

**Vafayeva Zamira Sevindikovna** Assistant of Department " light industry machinery and equipment " of Bukhara engineering and technological Institute, Bukhara, Uzbekistan.

**Nasilloev Sanjar Baxtiyor o'g'li** Student, Tashkent University of Information Technology named after Muhammad al-Khwarizmi, Tashkent, Uzbekistan