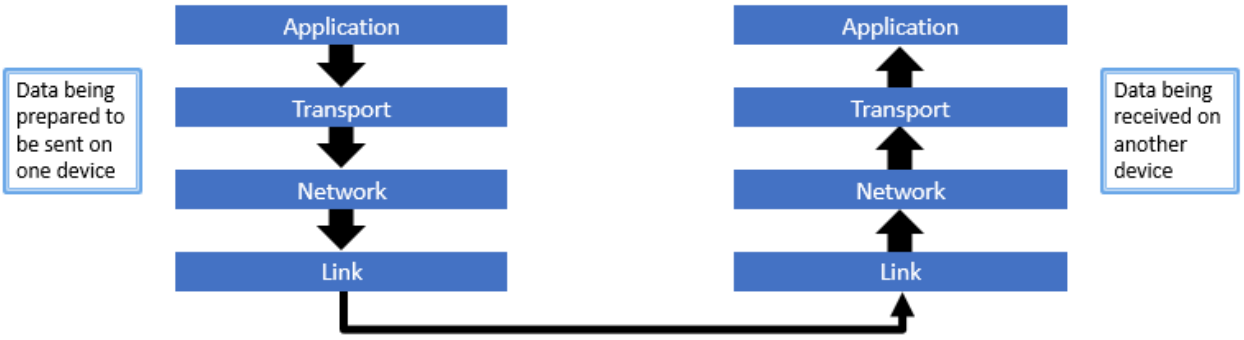
4.9.4.1 TCP IP

TCP/IP – Transmission Control Protocol / Internet Protocol

The TCP/IP stack is the foundation of all internet and network communication.

It is organised into layers of protocols each of which have specific responsibility.

The four layers in the TCP/IP stack are: **Application**, **Transport, Network** and **Link** layers.



Packets travel along cables from router to router

Application Layer

The application layer:

- Chooses the appropriate protocol to provide network services to an application. (e.g. browser, email clients).
- Adds encryption to the data if necessary.

Examples of protocols that may be used in this layer:

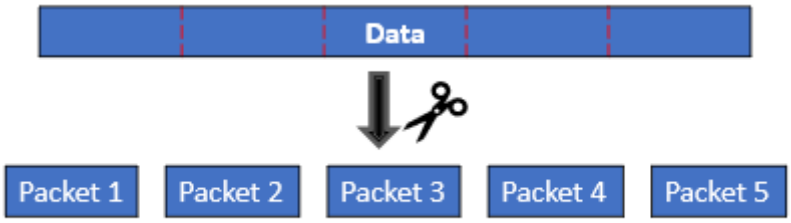
Protocol	Name	Used For
HTTP	Hypertext Transfer Protocol	Web communication
HTTPS	Hypertext Transfer Protocol Secure	Web communication with encryption
FTP	File Transfer Protocol	Transferring files between a server and client
SMTP	Simple Mail Transfer Protocol	Email Services – send emails
POP3	Post Office Protocol v3	Email Services – retrieve emails from a server
IMAP	Internet Message Access Protocol	Email Services – retrieve emails from a server
SSH	Secure Shell	Remote access of a device over a network

Transport Layer

(Key protocol TCP)

The transport layer:

- Manages end-to-end communication between devices.
- Splits data into segments ready for transmission.
- Adds information to the segment header such as:
  - The total number of packets in the message
  - A sequence number to identify the packet's position in the data
  - The port number to identify the application that should deal with the packet
- Adds error detection information to the packets (e.g. checksum) and resend packets that are not successfully received.



The message is split into packets

Information is added to the packet header and footer

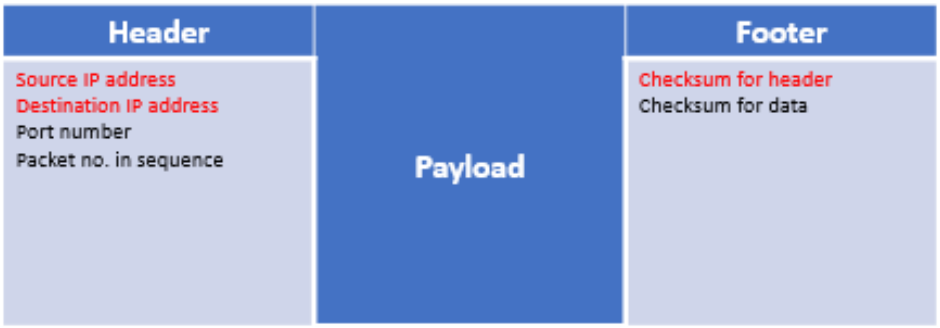
Network Layer

(Key protocol IP)

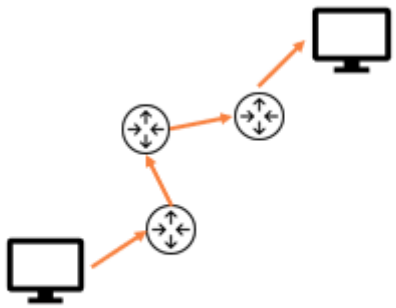
The network layer:

- Deals with routing packets across networks
- Adds the source and destination IP addresses to the packet headers
- Performs error detection on a packet header

A socket is formed which is an endpoint for network communication, identified by an IP address and port number



Source and destination IP address added to the packet header



Packets use the IP address to hop from router to router until they reach their destination

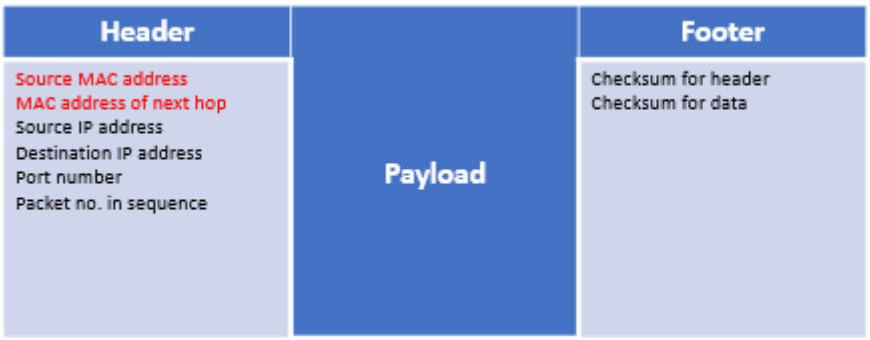
Link Layer

(Key Protocols Ethernet/WiFi)

The link layer:

- Handles the physical connection on the network
- Adds MAC addresses to the packet header

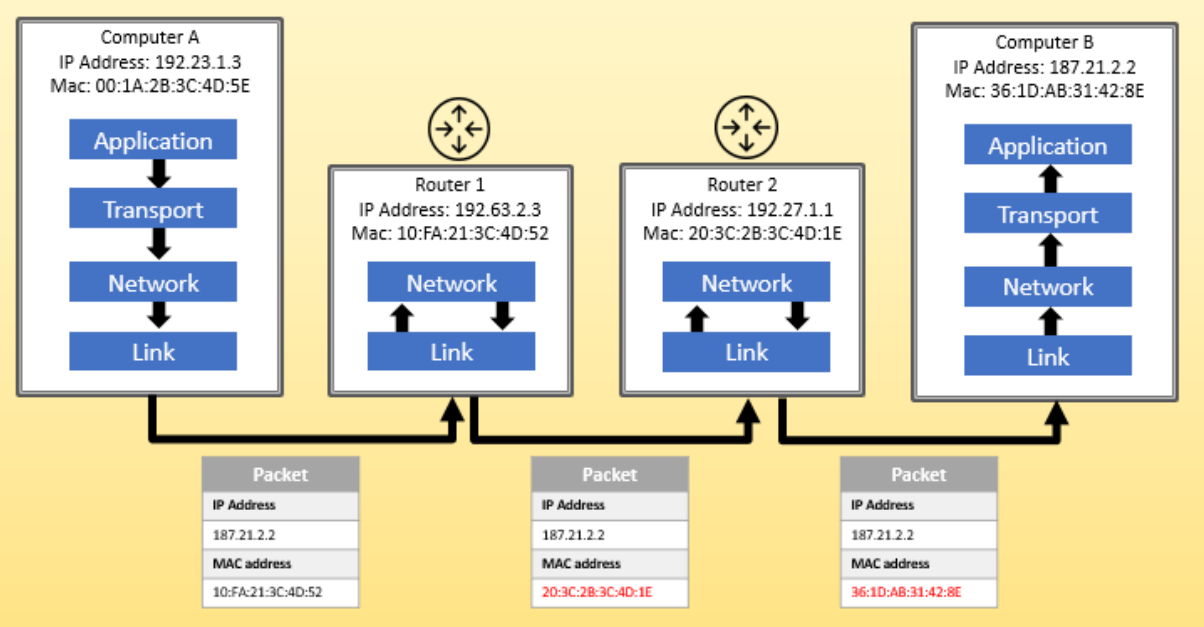
Recall the MAC address is the address of the physical NIC (network interface card).



Source and destination IP address added to the packet header

Router Hopping

- At each router hop, the old MAC header is stripped away.
- The destination IP address is used by the router to determine where to forward the packet next.
- A new link-layer frame is created with the appropriate source and destination MAC addresses.
    - Source MAC = router's own interface
    - Destination MAC = next hop's MAC address



Receiving Data

When receiving data a device reverses the TCP/IP layers and the data is passed up through the layers instead.

Link Layer

- Removes the link-layer frame header containing the MAC addresses.

Network Layer

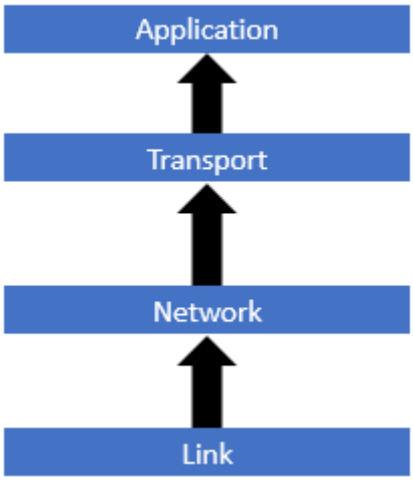
- Removes the IP addresses from the packet header.

Transport Layer

- Checks for errors; if a segment has not been received correctly, the missing/corrupted data can be retransmitted.
- Removes port number.
- Uses sequence information to reorder segments and reassembles the data

Application Layer

- Decrypt the data if it is encrypted.
- Processes the data received, for example displaying a webpage in a browser.



Well Known Ports

Ports are used to specify which application should deal with the data that has been sent by a computer. It is used in combination with the IP address to form a socket which pinpoints the endpoint of the transmission.

Well known ports are port numbers that are reserved for standard, widely used network services.

They have fixed numbers so that clients know which port to use when initiating communication with a standard service

Client ports are assigned temporarily and identify the client application's communication session

Protocol	Name	Port Number/s
HTTP	Hypertext Transfer Protocol	80 and 8080
HTTPS	Hypertext Transfer Protocol Secure	443
FTP	File Transfer Protocol	20 and 21
SMTP	Simple Mail Transfer Protocol	25
POP3	Post Office Protocol v3	110
IMAP	Internet Message Access Protocol	143
SSH	Secure Shell	22