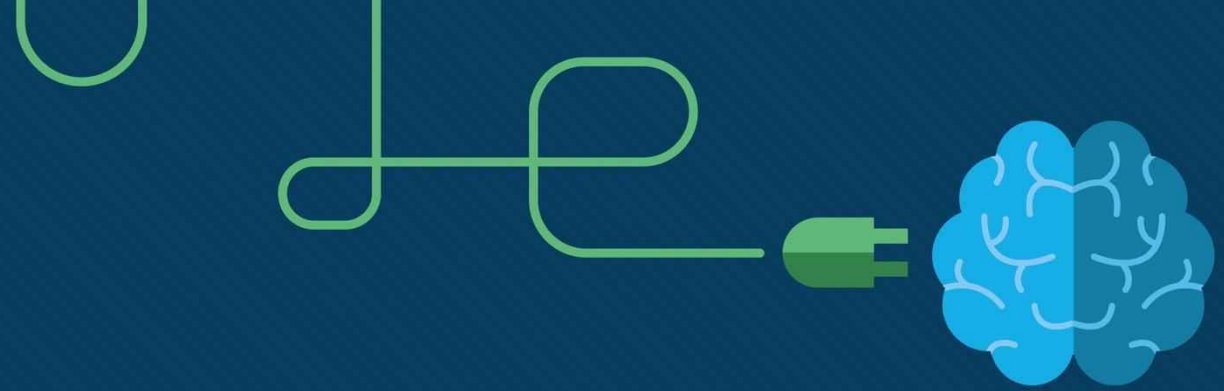


IoT: Networking Protocols

Tassadaq Hussain Cheema

Professor EE Department NAMAL University

February 27, 2018

Digital Transformation Education Perfect Storm

Massive Youth Unemployment

74M

Unemployed Youth

McKinsey Center for Government, Education to Employment

Growing Skills Shortage

63%

of CEOs see lack of skills as a serious concern

PWC, 17th Annual Global CEO Survey

Unprecedented Opportunity

$11.1T

Economic Value Add by 2025

McKinsey Global Institute; IoT: Mapping the Value Beyond the Hype

NAYA DAUR
نیا دور

YOUTH UNEMPLOYMENT IN PAKISTAN

69% population under 30

4 million entering work force every year

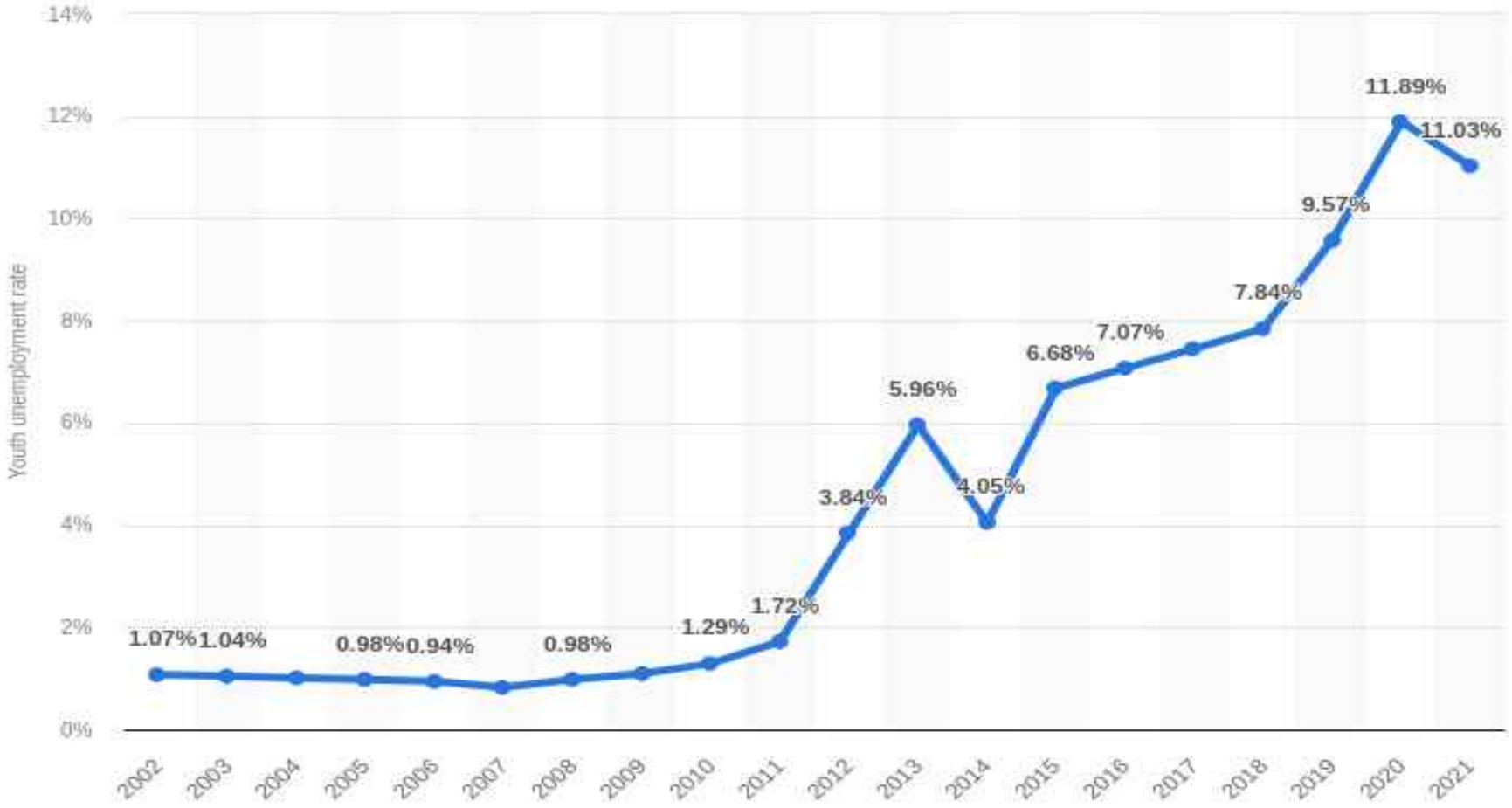
More than 3 million unemployed

60% in unstable jobs

35% in unpaid jobs

YOUTH LITERACY RATE

Source: Jinnah Institute & The World Bank



Digital Technology Impact

Everything becomes **connected**

Everything becomes **software-based**

Everything generates **data**

Everything can be **automated**

Everything needs to be **secured**

Digital Transformation

Connections

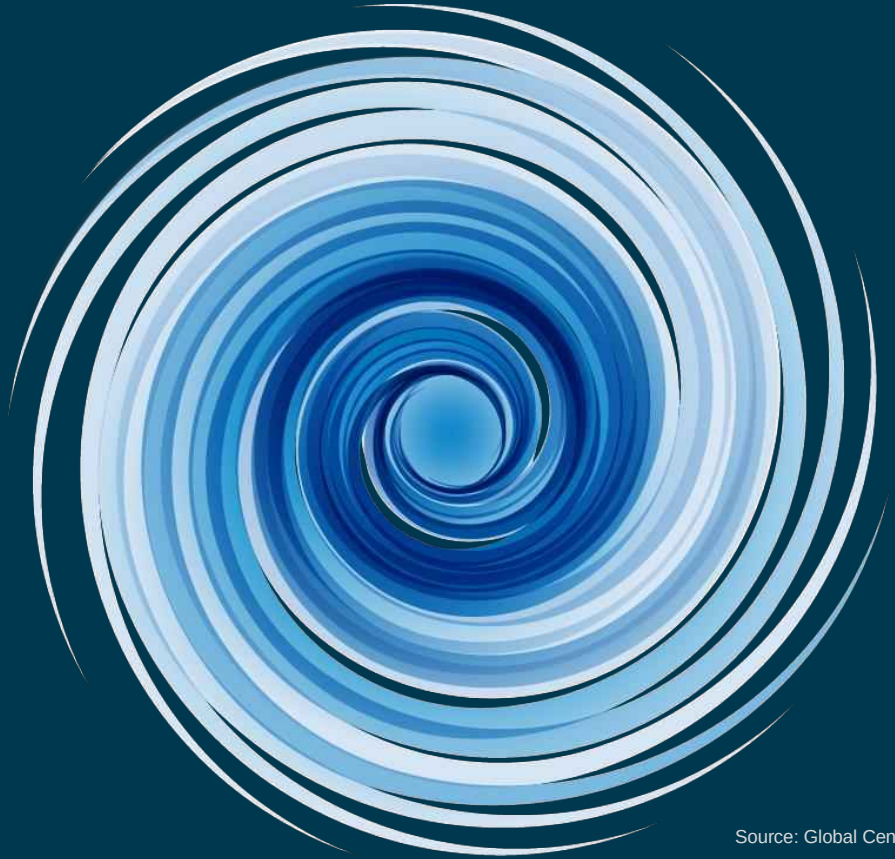
- Internet traffic will be 92 times greater than in 2020 than 2005
- 26.3 billion networked devices and connections

Software Based

- “Shift to Cloud” will affect $1 Trillion in spending by 2020

Data Volume

- More data created in past two years than entire previous history of the human race.



Automation

- Only about 0.5 percent of data is currently ever analyzed.
- AI bots will power 85% of customer service interactions by 2020

Security

- Global spending on cybersecurity predicted to exceed $1 trillion over the next five years

Source: Global Center for Digital Business Transformation, 2015

Digital Transformation across Countries and Companies

Digitization change the sector in the:

- User Experience with Digital Products
- Processes and Value Chain
- Business Model

Smart City

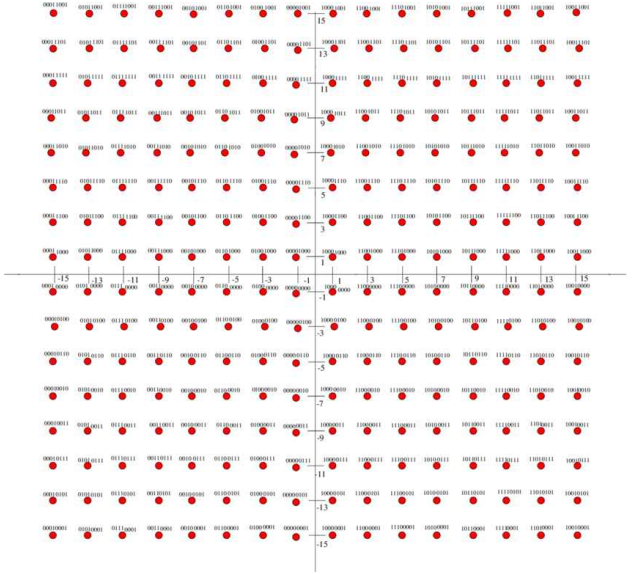
Smart Hospital

Smart Highway

Smart Factory

QAM

QAM (Quadrature Amplitude Modulation) adjusts both the phase and the amplitude of the signal. 16QAM, 64QAM, and 256QAM are commonly used in LTE/5G and 1024QAM is planned for use in the future



Data Communication: Networking

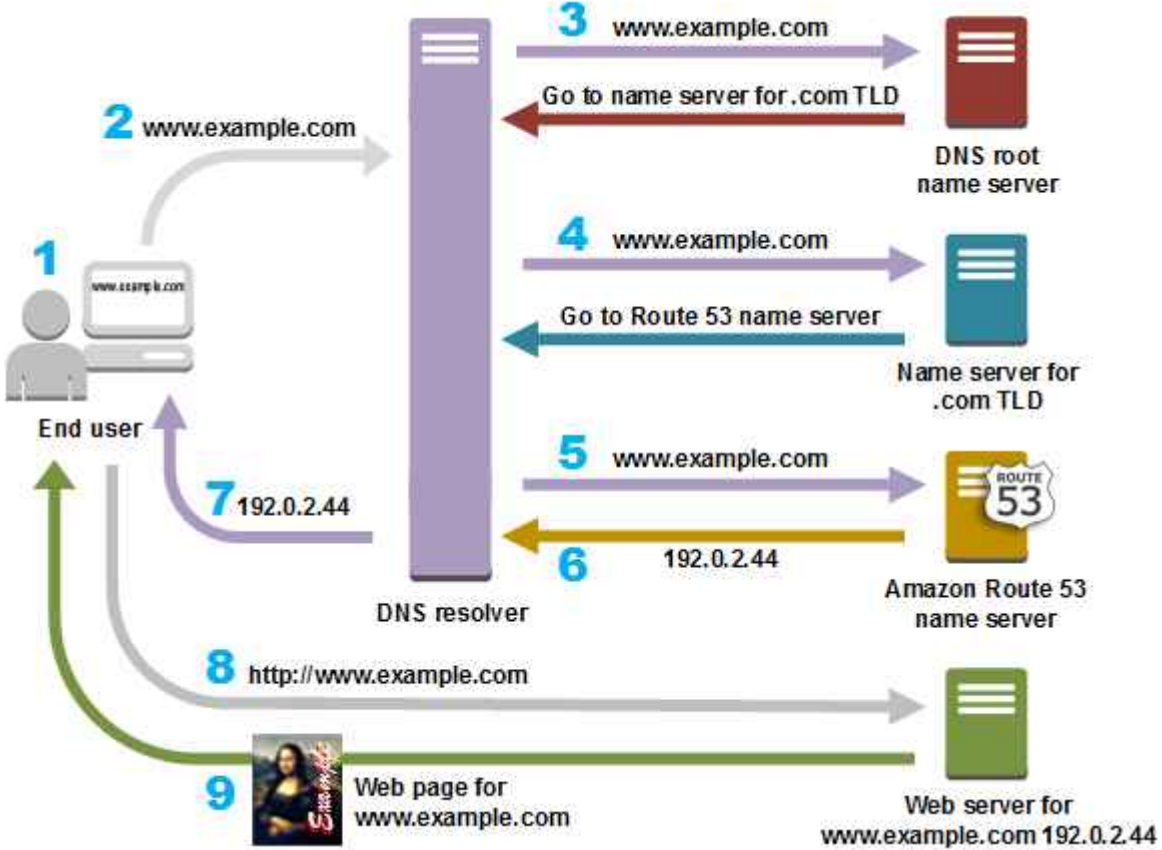
-A network can be defined as a group of computers and other devices connected in some ways so as to be able to exchange data.
-Each of the devices on the network can be thought of as a node; each node has a unique address.
-Addresses are numeric quantities that are easy for computers to work with, but not for humans to remember.
Example: 204.160.241.98
-Some networks also provide names that humans can more easily remember than numbers.
Example: www.javasoft.com, corresponding to the above numeric address.

Addressing

- Internet address
- Consists of 4 bytes separated by periods
- Example: 136.102.233.49
- -The R first bytes (R= 1,2,3) correspond to the network address;
- -The remaining H bytes (H = 3,2,1) are used for the host machine.
- -InterNIC Register: organization in charge of the allocation of the address ranges corresponding to networks.
- -Criteria considered:
- → Geographical area (country)
- → Organization, enterprise
- → Department
- → Host

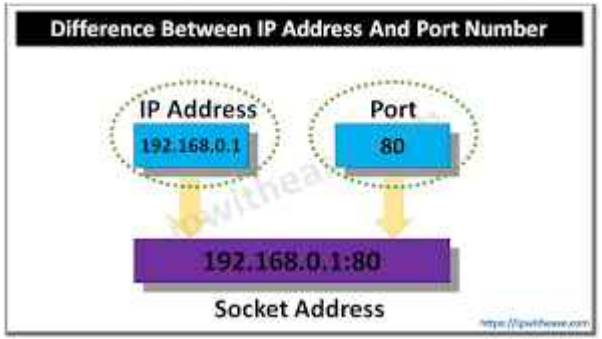
Domain Name System (DNS)

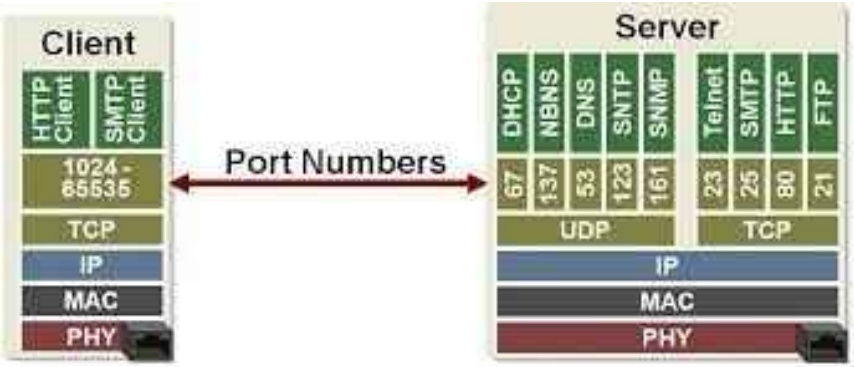
DNS servers are responsible for translating mnemonic textual Internet addresses into hard numeric Internet addresses.



Ports

-An IP address identifies a host machine on the Internet.
-An IP port will identify a specific application running on an Internet host machine.
-A port is identified by a number, the port number.
-The number of ports is not functionally limited, in contrast to serial communications where only 4 ports are allowed.
-There are some port numbers which are dedicated for specific applications.





Subnet Masking

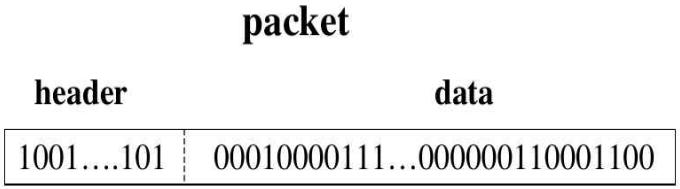
- Subnetting divides a network down into smaller networks called subnets by using some bits of the host ID to create a subnet ID. Masking identifies the boundary between the host ID and the combination of net ID and subnet ID.

Network Address Translation

- NAT is used to map multiple private addresses inside a local network to a public IP address before transferring the information onto the internet

Data Transmission

-In modern networks, data are transferred using packet switching.
-Messages are broken into units called packets, and sent from one computer to the other.
-At the destination, data are extracted from one or more packets and used to reconstruct the original message.
-Each packet has a maximum size, and consists of a header and a data area.
-The header contains the addresses of the source and destination computers and sequencing information necessary to reassemble the message at the destination.



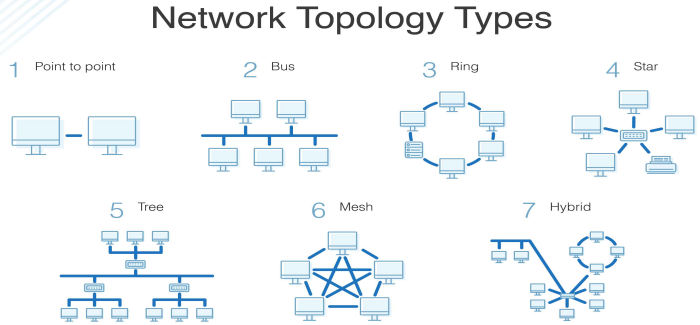
Network Connectivity Type

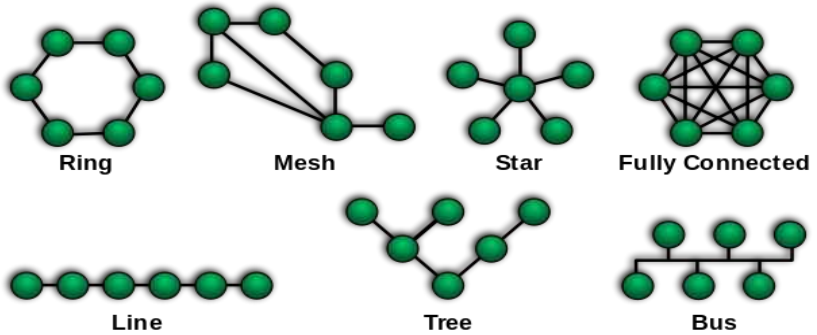
Network connectivity type	Speed	Transmission time for 10 Mbytes
(Telephone) dial-up modem	14.4 Kbps	90 min
ISDN modem	56/128 Kbps	45/12min
T1 connection	1.54 Mbps	50s
Ethernet	10 Mbps	9s
Token ring	4/16 Mbps	
Fast Ethernet	100 Mbps	
FDDI	100 Mbps	
Gigabit Ethernet	1 Gbps	
ATM	25Mbps/2.4Gbs	

Network Topology

A network topology is the physical and logical arrangement of nodes and connections in a network. Nodes usually include devices such as switches, routers and software with switch and router features. Network topologies are often represented as a graph.

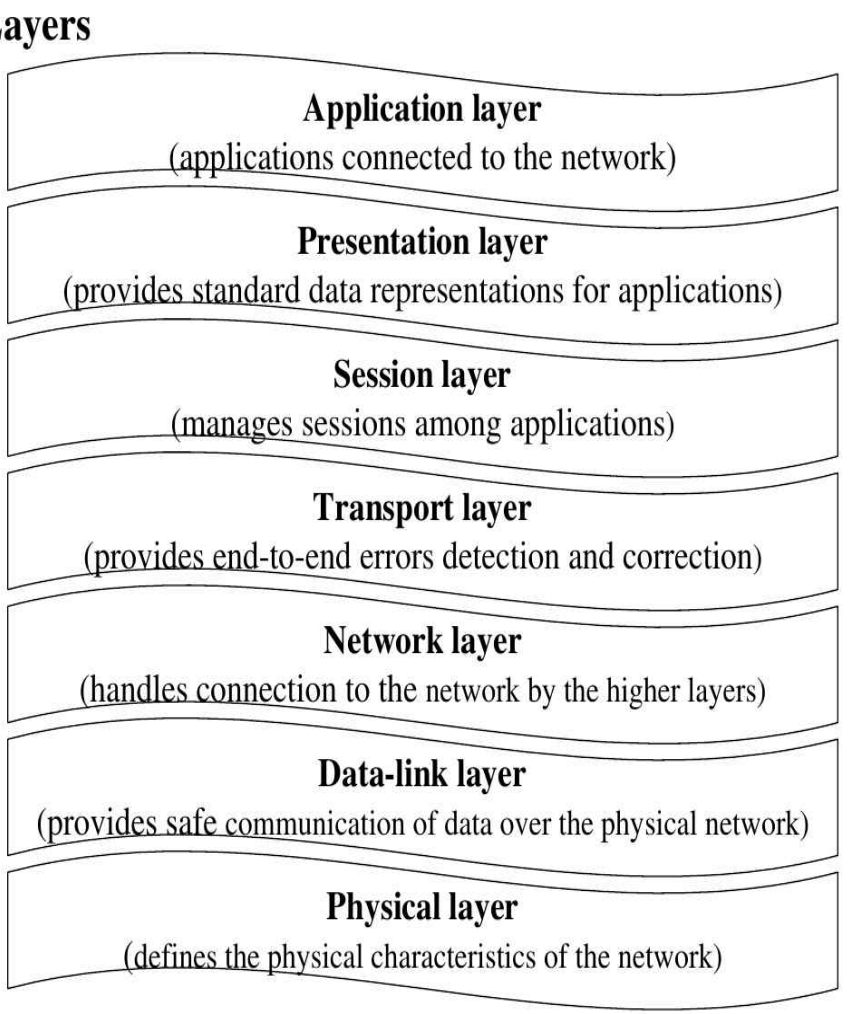
The specification of the network topology diagram requires the definition of the characteristics and entities underlying the network:
-Geographical locations of the different components or subnets involved in the network.
-Description of the LAN topology
-Description of the WAN topology
-Description of the network connectors such as routers, bridges, repeaters, and gateways.



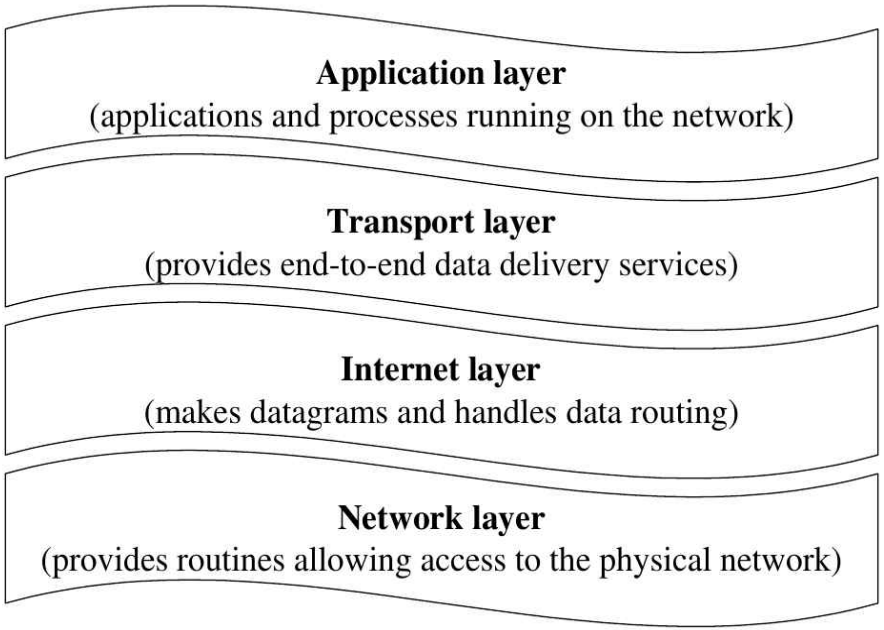


Protocols

-Define the rules that govern the communications between two comput connected to the network.
-Roles: addressing and routing of messages, error detection and recove sequence and flow controls etc.
-A protocol specification consists of th syntax, which defines the kinds and formats of the messages exchanged, the semantic, which specifies the actic taken by each entity when specific eve occur.
Example: HTTP protocol for communication between web browser and servers.



Layers


Application layer
(applications and processes running on the network)
Transport layer
(provides end-to-end data delivery services)
Internet layer
(makes datagrams and handles data routing)
Network layer
(provides routines allowing access to the physical network)

Networks Interconnection/Internet

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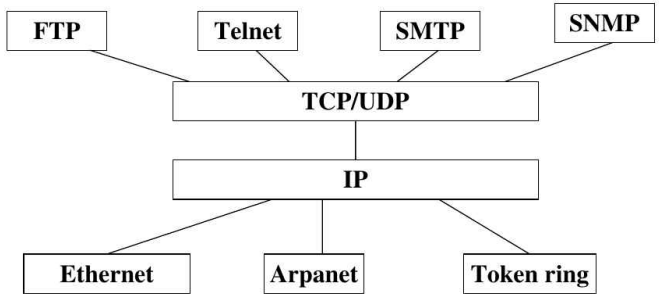

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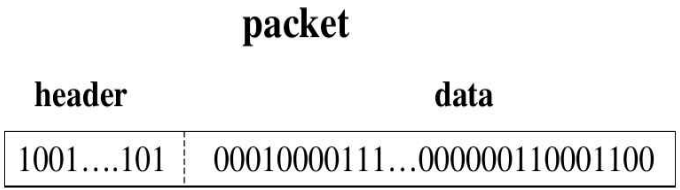
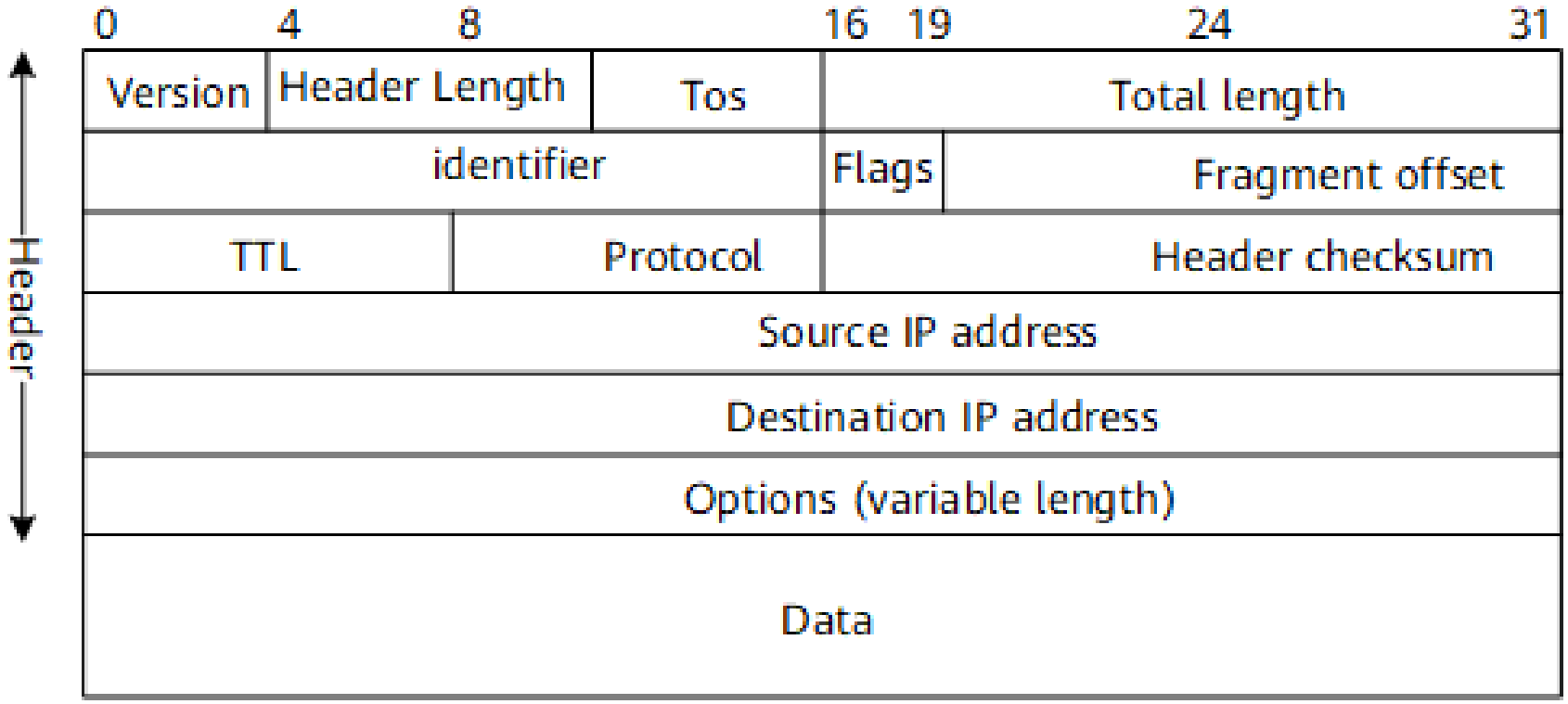


IPV4


0
4
8
16
19
24
31
Version
Header Length
Tos
Total length
identifier
Flags
Fragment offset
TTL
Protocol
Header checksum
Source IP address
Destination IP address
Options (variable length)
Data
Header

Field	Length	Description
Version	4 bits	Specifies the IP protocol version, IPv4 or IPv6.
Header Length	4 bits	Specifies the length of the IPv4 header.
Type of Service (ToS)	8 bits	Specifies the type of service. This field takes effect only in the differentiated service model.
Total Length	16 bits	Specifies the length of the header and data.
Identification	16 bits	IPv4 software maintains a counter in the storage device to record the number of IP datagrams. The counter value increases by 1 every time a datagram is sent, and is filled in the identification field.
Flags	3 bits	Only the rightmost two bits are valid. The rightmost bit indicates whether the datagram is not the last data fragment. The value 1 indicates the last fragment, and the value 0 indicates non-last fragment. The middle bit is the fragmentation flag. The value 1 indicates that the datagram cannot be fragmented, and the value 0 indicates that the datagram can be fragmented.
Fragment Offset	13 bits	Specifies the location of a fragment in a packet.
Time to Live (TTL)	8 bits	Specifies the life span of a datagram on a network. TTL is measured by the number of hops.
Protocol	8 bits	Specifies the type of the protocol carried in the datagram.
Header Checksum	16 bits	A device calculates the header checksum for each datagram received. If the checksum is 0, the device knows that the header remains unchanged and retains the datagram. This field checks only the header but not the data.
Source IP Address	32 bits	Specifies the IPv4 address of a sender.
Destination IP Address	32 bits	Specifies the IPv4 address of a receiver.
Options	0-40 bytes (variable length)	Allows IPv4 to support various options such as fault handling, measurement, and security. Pad bytes with a value of 0 are added if necessary.
Data	Variable	Pads an IP datagram .

Tasks

- How to Set Up Your IoT Devices on a Network
- Crate a separate network for your IoT Devices