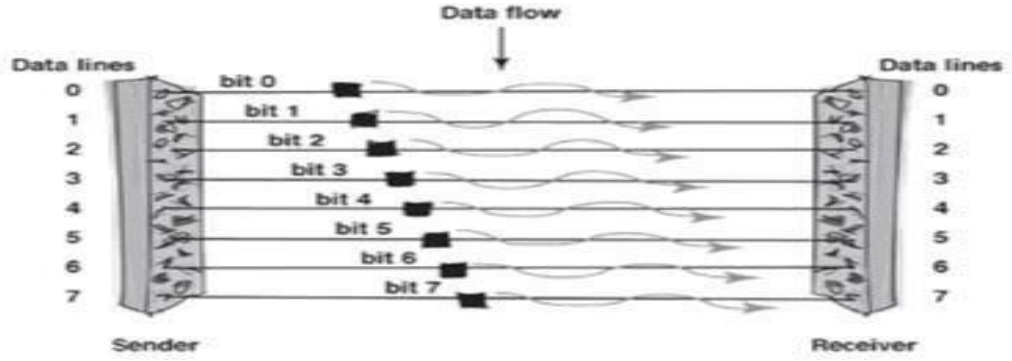
PARALLEL COMMUNICATION:

In data transmission, parallel communication is a method of conveying multiple binary digits (bits) simultaneously. It contrasts with communication. The communication channel is the number of electrical conductors used at the physical layer to convey bits.

Parallel communication implies more than one such conductor. For example, an 8-bit parallel channel will convey eight bits (or a byte) simultaneously, whereas a serial channel would convey those same bits sequentially, one at a time. Parallel communication is and always has been widely used within integrated circuits, in peripheral buses, and in memory devices such as RAM.



2. Product level communication interface (External Communication Interface):

The Product level communication interface" (External Communication Interface) is responsible for data transfer between the embedded system and other devices or modules

It is classified into two types

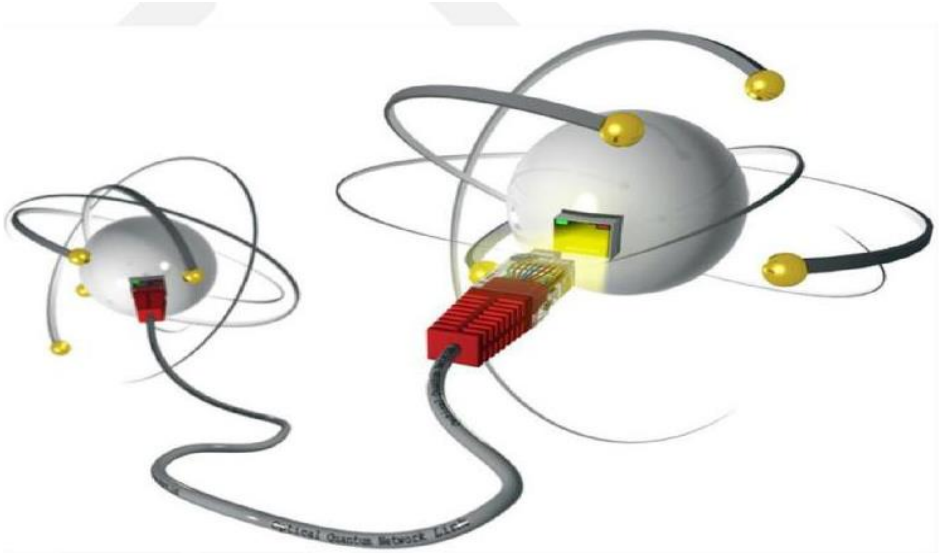
1. Wired communication interface
2. Wireless communication interface:

1. Wired communication interface: Wired communication interface is an interface used to transfer information over a wired network.

It is classified into following types.

1. **RS-232C/RS-422/RS 485**

2. **USB**



RS-232C:

- RS-232 C (Recommended Standard number 232, revision C from the Electronic Industry Association) is a legacy, full duplex, wired, asynchronous serial communication interface
- RS-232 extends the UART communication signals for external data communication.
- UART uses the standard TTL/CMOS logic (Logic „High" corresponds to bit value 1 and Logic „LOW" corresponds to bit value 0) for bit transmission whereas RS232 use the EIA standard for bit transmission.
- As per EIA standard, a logic „0" is represented with voltage between +3 and +25V and a logic „1" is represented with voltage between -3 and -25V.
- In EIA standard, logic „0" is known as „Space" and logic „1" as „Mark".

The RS232 interface define various handshaking and control signals for communication apart from the „Transmit" and „Receive" signal lines for data communication

RS-232 supports two different types of connectors, namely; DB-9: 9-Pin connector and DB-25: 25-Pin connector.

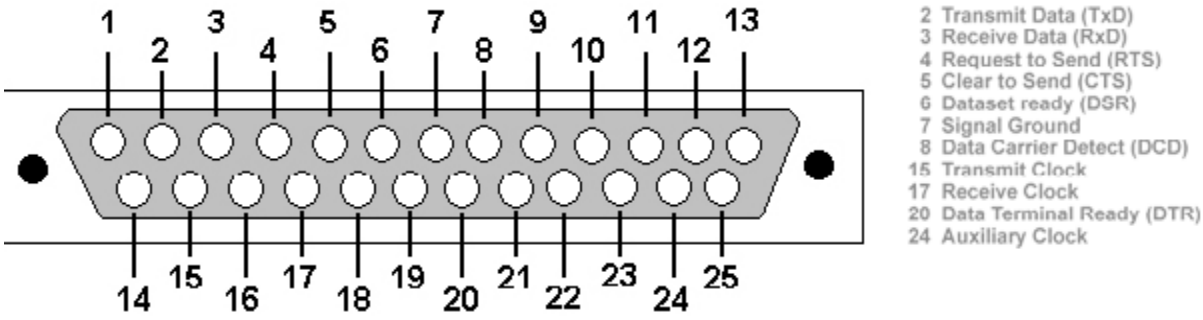
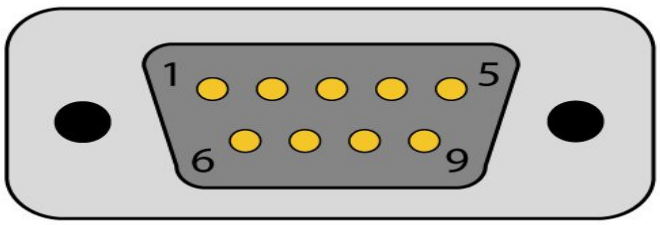


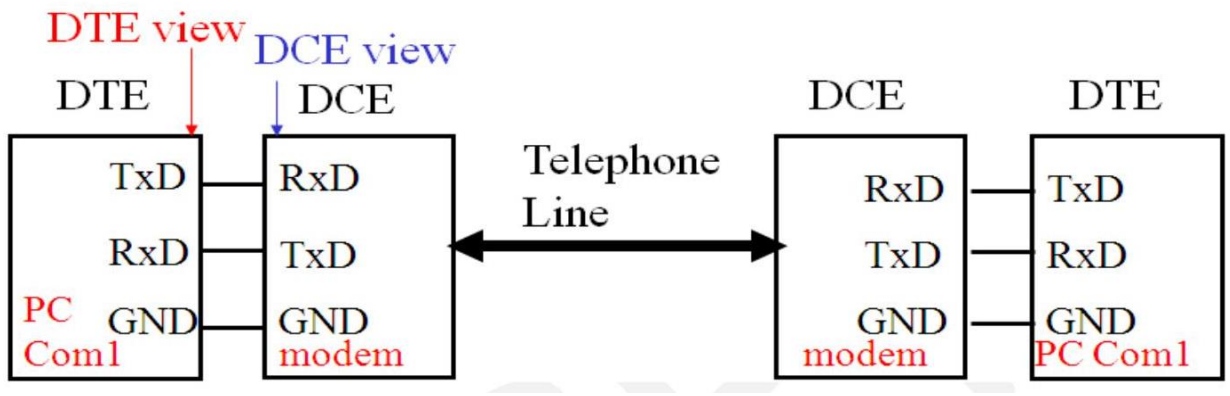
Fig: DB-25:25-Pin connector.



RS232 Pin Out

Pin #	Signal
1	DCD
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

Fig: DB-9:9-Pin connector.



- RS-232 is a point-to-point communication interface and the devices involved in RS-232 communication are called „Data Terminal Equipment (DTE)“ and „Data Communication Equipment (DCE)“.
- If no data flow control is required, only TXD and RXD signal lines and ground line (GND) are required for data transmission and reception.
- The RXD pin of DCE should be connected to the TXD pin of DTE and vice versa for proper data transmission.
- If hardware data flow control is required for serial transmission, various control signal lines of the RS-232 connection are used appropriately.
- The control signals are implemented mainly for modem communication and some of them may be irrelevant for other type of devices.
- The Request to Send (RTS) and Clear To Send (CTS) signals co-ordinate the communication between DTE and DCE.
- Whenever the DTE has a data to send, it activates the RTS line and if the DCE is ready to accept the data, it activates the CTS line.
- The Data Terminal Ready (DTR) signal is activated by DTE when it is ready to accept data.
- The Data Set Ready (DSR) is activated by DCE when it is ready for establishing a communication link.
- DTR should be in the activated state before the activation of DSR.
- The Data Carrier Detect (DCD) is used by the DCE to indicate the DTE that a good signal is being received.

- Ring Indicator (RI) is a modem specific signal line for indicating an incoming call on the telephone line.
- As per the EIA standard RS-232 C supports baudrates up to 20Kbps (Upper limit 19.2Kbps).
- The commonly used baudrates by devices are 300bps, 1200bps, 2400bps, 9600bps, 11.52Kbps and 19.2Kbps.
- The maximum operating distance supported in RS-232 communication is 50 feet at the highest supported baudrate.
- Embedded devices contain a UART for serial communication and they generate signal levels conforming to TTL/CMOS logic.
- A level translator IC like MAX 232 from Maxim Dallas semiconductor is used for converting the signal lines from the UART to RS-232 signal lines for communication.
- On the receiving side the received data is converted back to digital logic level by a converter IC.
- Converter chips contain converters for both transmitter and receiver.
- RS-232 uses single ended data transfer and supports only point-to-point communication and not suitable for multi-drop communication.

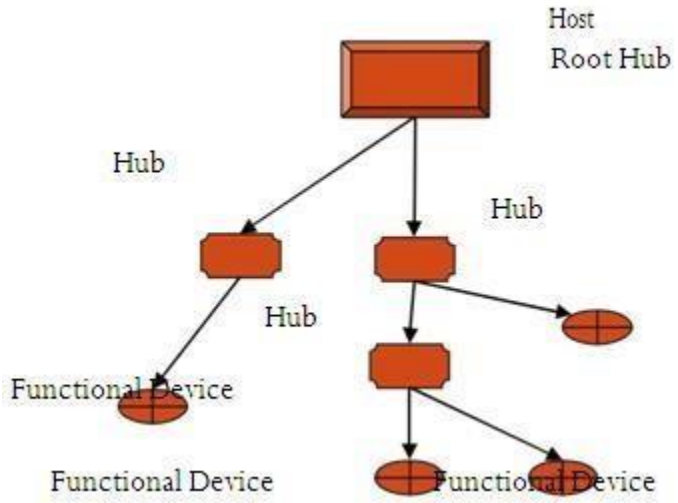
USB (UNIVERSAL SERIAL BUS):

- External Bus Standard.
- Allows connection of peripheral devices.
- Connects Devices such as keyboards, mice, scanners, printers, joysticks, audio devices, disks.
- Facilitates transfers of data at 480 (USB 2.0 only), 12 or 1.5 Mb/s (mega-bits/second).
- Developed by a Special Interest Group including Intel, Microsoft, Compact, DEC, IBM, Northern Telecom and NEC originally in 1994.
- Low-Speed: 10 – 100 kb/s
- 1.5 Mb/s signaling bit rate
- Full-Speed: 500 kb/s – 10 Mb/s 12 Mb/s signaling bit rate
- High-Speed: 400 Mb/s

- 480 Mb/s signaling bit rate
- NRZI with bit stuffing used
- SYNC field present for every packet
- There exist two pre-defined connectors in any USB system - Series “A” and Series “B” Connectors.
- Series “A” cable: Connects USB devices to a hub port.
- Series “B” cable: Connects detachable devices (hot- swappable)

Bus Topology:

- Connects computer to peripheral devices.
- Ultimately intended to replace parallel and serial ports
- Tiered Star Topology
- All devices are linked to a common point referred to as the root hub.
- Specification allows for up to 127 (2^7 -1) different devices.



- Four wire cable serves as interconnect of system - power, ground and two differential signaling lines.
- USB is a polled bus-all transactions are initiated by host.

USB HOST: Device that controls entire system usually a PC of some form. Processes data arriving to and from the USB port.

USB HUB: Tests for new devices and maintains status information of child devices.Serve as repeaters, boosting strength of up and downstream signals. Electrically isolates devices from one another - allowing an expanded number of devices.

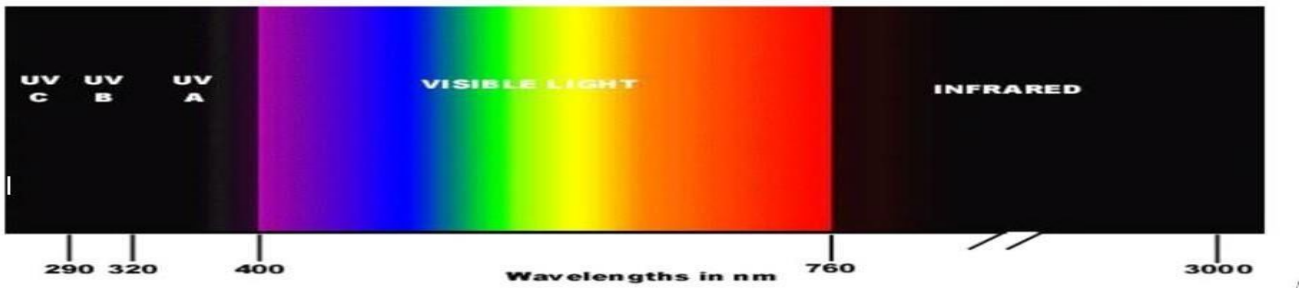
2.Wireless communication interface : Wireless communication interface is an interface used to transmission of information over a distance without help of wires, cables or any other forms of electrical conductors.

They are basically classified into following types

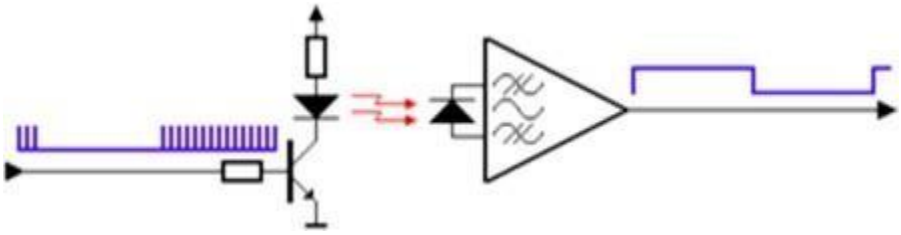
1. **Infrared**
2. **Bluetooth**
3. **Wi-Fi**
4. **Zigbee**
5. **GPRS**

INFRARED:

- Infrared is a certain region in the light spectrum
- Ranges from .7µ to 1000µ or .1mm
- Broken into near, mid, and far infrared
- One step up on the light spectrum from visible light
- Measure of heat



Most of the thermal radiation emitted by objects near room temperature is infrared. Infrared radiation is used in industrial, scientific, and medical applications. Night-vision devices using active near-infrared illumination allow people or animals to be observed without the observer being detected.



IR transmission:

The transmitter of an IR LED inside its circuit, which emits infrared light for every electric pulse given to it. This pulse is generated as a button on the remote is pressed, thus completing the circuit, providing bias to the LED.

The LED on being biased emits light of the wavelength of 940nm as a series of pulses, corresponding to the button pressed. However since along with the IR LED many other sources of infrared light such as us human beings, light bulbs, sun, etc, the transmitted information can be interfered. A solution to this problem is by modulation. The transmitted signal is modulated using a carrier frequency of 38 KHz (or any other frequency between 36 to 46 KHz). The IR LED is made to oscillate at this frequency for the time duration of the pulse. The information or the light signals are pulse width modulated and are contained in the 38 KHz frequency.

IR supports data rates ranging from 9600bits/second to 16Mbps

Serial infrared: 9600bps to 115.2 kbps

Medium infrared: 0.576Mbps to 1.152 Mbps

Fast infrared: 4Mbps

BLUETOOTH:

Bluetooth is a wireless technology standard for short distances (using short-wavelength UHF band from 2.4 to 2.485 GHz)for exchanging data over radio waves in the ISM and mobile devices, and building personal area networks (PANs).Invented by telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS- 232 data cables.

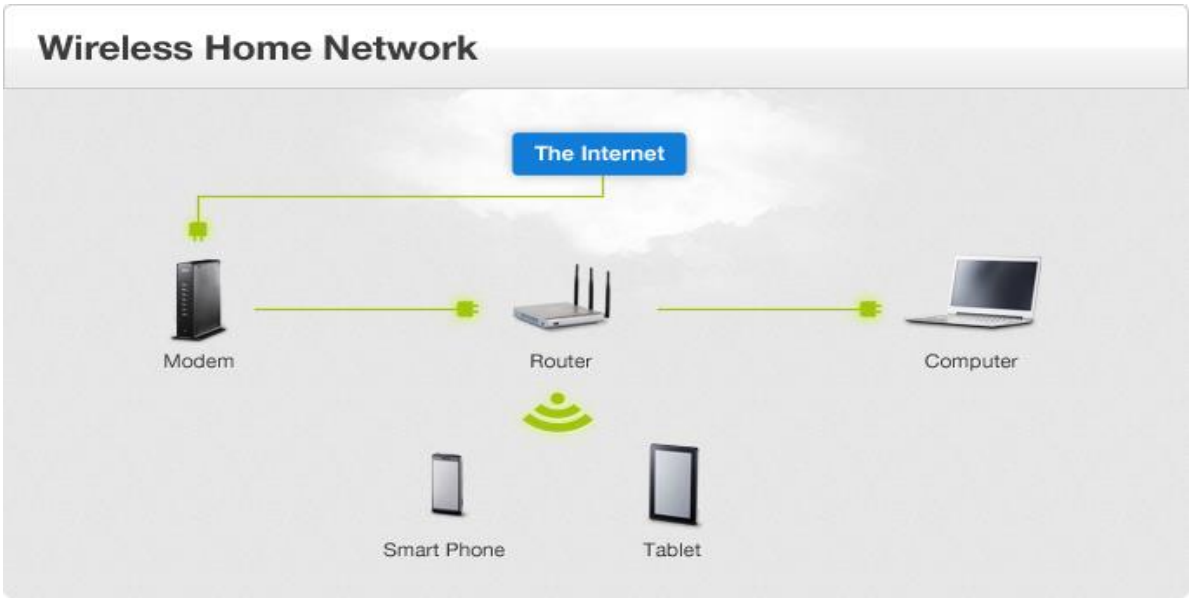
Bluetooth uses a radio technology called frequency- hopping spread spectrum. Bluetooth divides transmitted data into packets, and transmits each packet on one of 79 designated Bluetooth channels. Each channel has a bandwidth of 1 MHz. It usually performs 800 hops per second, with Adaptive Frequency-Hopping (AFH) enabled

Originally, Gaussian frequency-shift keying (GFSK) modulation was the only modulation scheme available. Since the introduction of Bluetooth 2.0+EDR, π/4-DQPSK (Differential Quadrature Phase Shift Keying) and 8DPSK modulation may also be used between compatible devices. Bluetooth is a packet-based protocol with a master- slave structure. One master may communicate with up to seven slaves in a piconet. All devices share the master's clock. Packet exchange is based on the basic clock, defined by the master, which ticks at312.5 µs intervals.

A master BR/EDR Bluetooth device can communicate with a maximum of seven devices in a piconet (an ad-hoc computer network using Bluetooth technology), though not all devices reach this maximum. The devices can switch roles, by agreement, and the slave can become the master (for example, a headset initiating a connection to a phone necessarily begins as master—as initiator of the connection—but may subsequently operate as slave).

Wi-Fi:

- Wi-Fi is the name of a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections
- Wi-Fi follows the IEEE 802.11 standard
- Wi-Fi is intended for network communication and it supports Internet Protocol (IP) based communication
- Wi-Fi based communications require an intermediate agent called Wi-Fi router/Wireless Access point to manage the communications.
- The Wi-Fi router is responsible for restricting the access to a network, assigning IP address to devices on the network, routing data packets to the intended devices on the network.

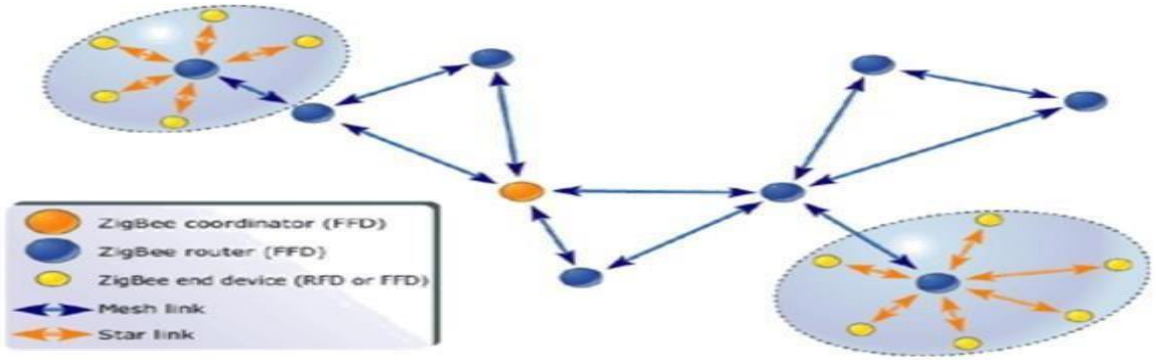


- Wi-Fi enabled devices contain a wireless adaptor for transmitting and receiving data in the form of radio signals through an antenna.
- Wi-Fi operates at 2.4GHZ or 5GHZ of radio spectrum and they co-exist with other ISM band devices like Bluetooth.
- A Wi-Fi network is identified with a Service Set Identifier (SSID). A Wi-Fi device can connect to a network by selecting the SSID of the network and by providing the credentials if the network is security enabled
- Wi-Fi networks implements different security mechanisms for authentication and data transfer.
- Wireless Equivalency Protocol (WEP), Wireless Protected Access (WPA) etc are some of the security mechanisms supported by Wi-Fi networks in data communication.

ZIGBEE:

Zigbee is an IEEE 802.15.4-based specification for a suite of high- level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection.Hence, zigbee is a low-power, low data rate, and close proximity (i.e., personal area) wireless ad hoc network.The technology

defined by the zigbee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi . Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that require short-range low- rate wireless data transfer. Its low power consumption limits transmission distances to 10– 100 meters line-of-sight, depending on power output and environmental characteristics. Zigbee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones.



Zigbee Coordinator: The zigbee coordinator acts as the root of the zigbee network. The ZC is responsible for initiating the Zigbee network and it has the capability to store information about the network.

Zigbee Router: Responsible for passing information from device to another device or to another ZR.

Zigbee end device:End device containing zigbee functionality for data communication. It can talk only with a ZR or ZC and doesn't have the capability to act as a mediator for transferring data from one device to another.

Zigbee supports an operating distance of up to 100 metres at a data rate of 20 to 250 Kbps.

General Packet Radio Service(GPRS):

General Packet Radio Service (**GPRS**) is a packet oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications (GSM).GPRS was originally standardized by European Telecommunications Standards Institute (ETSI) GPRS usage is typically charged based on volume of data transferred, contrasting with circuit switched data, which is usually billed per minute of connection time. Sometimes billing time is broken down to every third of a minute. Usage above the bundle cap is charged per megabyte, speed limited, or disallowed.

Services offered:

- GPRS extends the GSM Packet circuit switched data capabilities and makes the following services possible:
- SMS messaging and broadcasting
- "Always on" internet access
- Multimedia messaging service (MMS)
- Push-to-talk over cellular (PoC)
- Instant messaging and presence-wireless village Internet applications for smart devices through wireless application protocol (WAP).
- Point-to-point (P2P) service: inter-networking with the Internet (IP).
- Point-to-multipoint (P2M) service]: point-to- multipoint multicast and point-to-multipoint group calls.