SNS COLLEGE OF ENGINEERING

Kurumbapalayam(Po), Coimbatore – 641 107
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Department of Information Technology

Course Name – 19IT503 Internet of Things

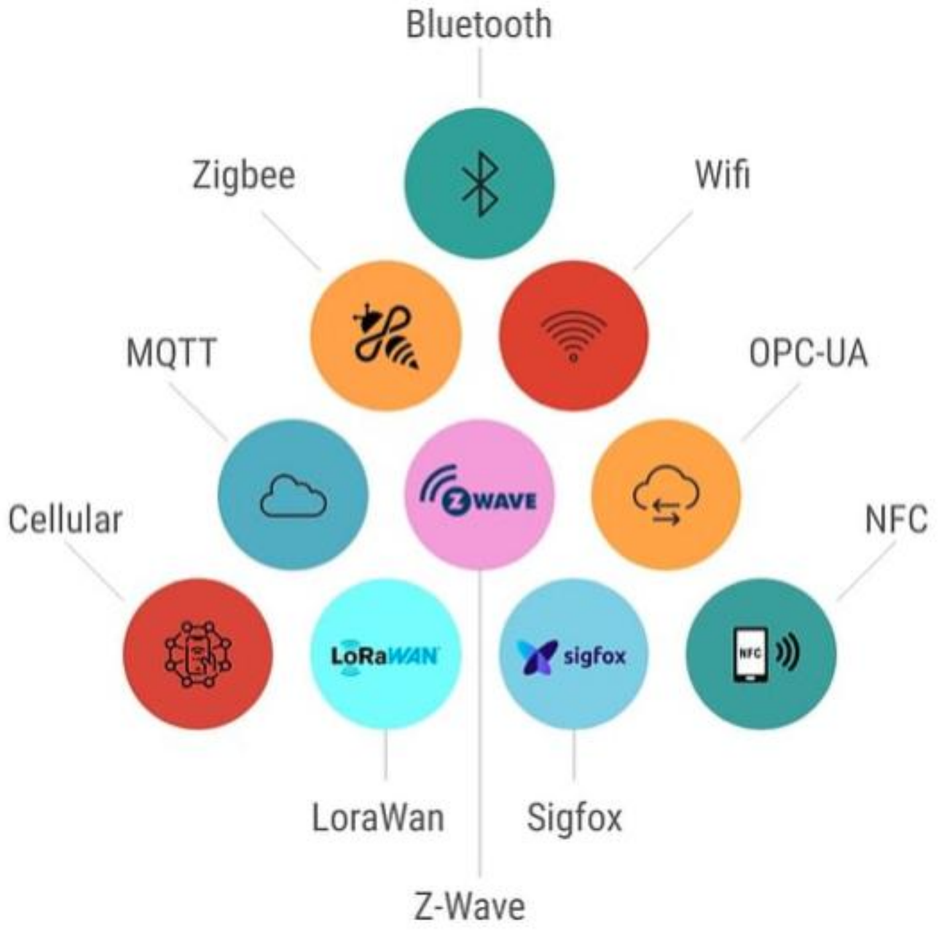
III Year / V Semester

Unit 2 – FUNDAMENTAL MECHANISMS & KEY TECHNOLOGIES

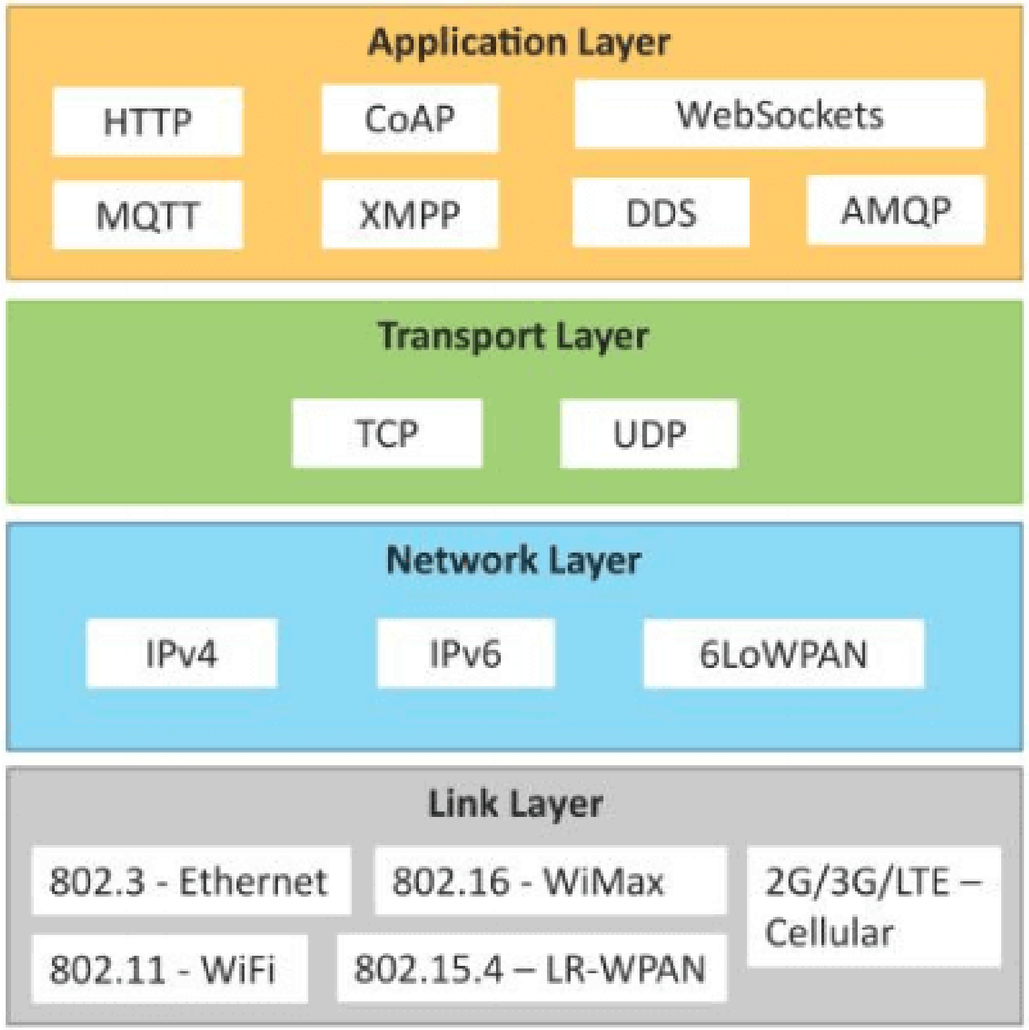
Topic 8- IoT Enabling Technologies– Communication Protocols & Embedded System

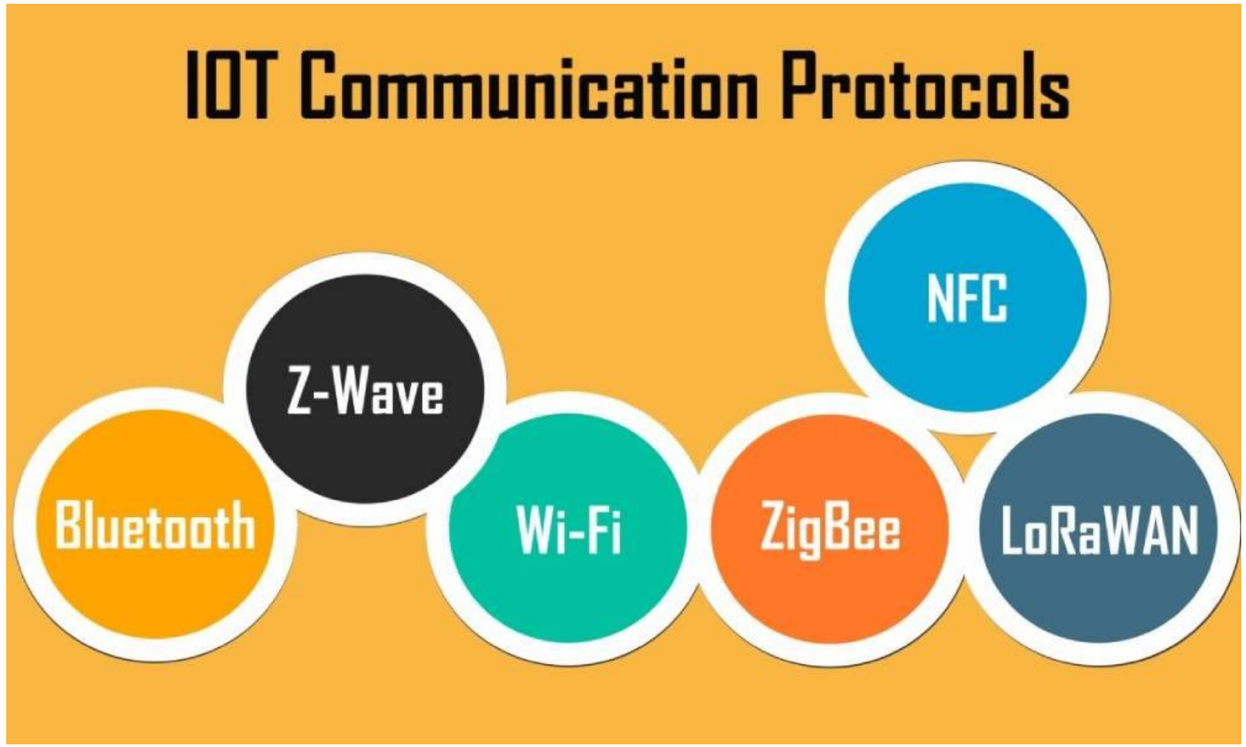
IoT Enabling Technologies – Communication Protocols

- Communications protocols form the backbone of IoT system and enable network connectivity and coupling to applications.
- Communications protocols allow device to exchange data over the network.
- These protocols define the data exchange formats and data encoding schemes for devices and routing of packets from source to destination.
- Other function of the protocol include sequence control flow control and transmissions of Lost packet.



IoT Enabling Technologies – Communication Protocols





IoT Enabling Technologies – Communication Protocols

WiFi

WiFi is a wireless local area network (WLAN) that utilizes the IEEE 802.11 standard through 2.4GhZ UHF and 5GhZ ISM frequencies.

WiFi provides Internet access to devices that are within the range (about 66 feet from the access point).

Common Standards

- 802.11a – 5 GHz,
- 802.11b & 802.11g – 2.4/5 GHz,
- 802.11n - 2.4/5 GHz,
- 802.11ac – 5 GHz
- 802.11ad – 60 GHz
- 1 Mbps to 6.75 Gbps

IEEE Standard	Year Adopted	Frequency	Max. Data Rate	Max. Range
802.11a	1999	5 GHz	54 Mbps	400 ft.
802.11b	1999	2.4 GHz	11 Mbps	450 ft.
802.11g	2003	2.4 GHz	54 Mbps	450 ft.
802.11n	2009	2.4/5 GHz	600 Mbps	825 ft.
802.11ac	2014	5 GHz	1 Gbps	1,000 ft.
802.11ac Wave 2	2015	5 GHz	3.47 Gbps	10 m.
802.11ad	2016	60 GHz	7 Gbps	30 ft.
802.11af	2014	2.4/5 GHz	26.7 Mbps – 568.9 Mbps (depending on channel)	1,000 m.
802.11ah	2016	2.4/5 GHz	347 Mbps	1,000 m.
802.11ax	2019 (expected)	2.4/5 GHz	10 Gbps	1,000 ft.
802.11ay	late 2019 (expected)	60 GHz	100 Gbps	300-500 m.
802.11az	2021 (expected)	60 GHz	Device tracking refresh rate 0.1-0.5 Hz	Accuracy <1m to <0.1m

IoT Enabling Technologies – Communication Protocols

WiMax

- WiMax or Worldwide Interoperability for Microwave Access is a set of compatibility standards for wireless networks supported by the WiMax Alliance.
- WiMAX technology is a wireless broadband communications technology based around the IEEE 802.16 standard providing high speed data over a wide area.
- It is faster than WiFi (75Mbps maximum) and has superior range, of up to 31 miles.
- WiMax is designed primarily for data transmission
- WiMAX technology is a standard for Wireless Metropolitan Area Networks
- 802.16.1a, 802.16.1b, 802.16.n, 802.16.p, 802.16-2017

IoT Enabling Technologies – Communication Protocols

LoRaWAN

- LoRaWAN (Long Range) is a proprietary low-power wide-area network protocol designed to connect battery operated 'things' to the internet in regional, national or global networks

- The LoRaWAN design to provide low-power WANs with features specifically needed to support low-cost mobile secure communication in IoT, smart city, and industrial applications.

- Specifically meets requirements for low-power consumption and supports large networks with millions and millions of devices, data rates range from 0.3 kbps to 50 kbps.

- Range- Approx. 2.5 km(Urban environment), 15 km (Suburban environment)

- Smart street lighting is a practical example, where the street lights are connected with the LoRa gateway that uses the LoRaWAN protocol.

IoT Enabling Technologies – Communication Protocols

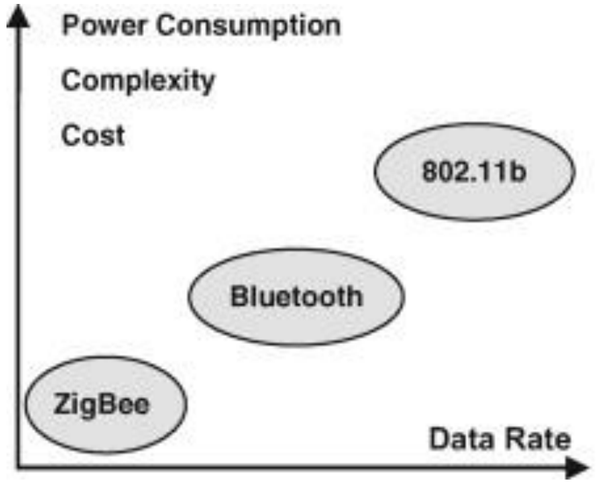
ZigBee

ZigBee is similar to Bluetooth and is majorly used in industrial settings.

It has some significant advantages in complex systems offering low-power operation, high security, robustness suitable for sensor networks in IoT applications.

The latest version of ZigBee is the recently launched 3.0, which is essentially the unification of the various ZigBee wireless standards into a single standard.

Standard- Zigbee 3.0 based on IEEE802.15.4
Frequencies- 2.4 Ghz
Range- Approx. 10-100m
Data Rates – 250 kbps



	Data Rate	Typical Range	Application Examples
ZigBee	20 to 250 Kbps	10–100 m	Wireless Sensor Networks
Bluetooth	1 to 3 Mbps	2–10 m	Wireless Headset Wireless Mouse
IEEE 802.11b	1 to 11 Mbps	30–100 m	Wireless Internet Connection

IoT Enabling Technologies – Communication Protocols

Z-Wave

Z-Wave is a low-power RF communications IoT technology that primarily design for home automation for products such as lamp controllers and sensors among many other devices.

Based on the mesh network topology, Z-Wave based devices can attain a communication distance of up to 40 meters, with the additional ability of messages to Hop up between up to 4 nodes.

Standard- Z-wave Alliance
Frequencies- Various
Range- Approx. 30m
Data Rates – 0.3 to 50 Kbps

It's very scalable enabling control for up to 232 devices.

Frequency in MHz	Used in
865.2	India
869	Russia
868.4	China, Singapore, South Africa
868.40, 868.42, 869.85	CEPT Countries (Europe and other countries in region), French Guiana
908.40, 908.42, 916	USA, Canada, Argentina, Guatemala, The Bahamas, Jamaica, Barbados, Mexico, Bermuda, Nicaragua, Bolivia, Panama, British Virgin Islands, Suriname, Cayman Islands, Trinidad & Tobago, Colombia, Turks & Caicos, Ecuador, Uruguay
916	Israel
919.8	Hong Kong
919.8, 921.4	Australia, New Zealand, Malaysia, Brazil, Chile, El Salvador, Peru
919–923	South Korea
920–923	Thailand
920–925	Taiwan
922–926	Japan

IoT Enabling Technologies – Communication Protocols

2G/3G/4G (Mobile Communication)

- 2G – GSM / CDMA, GPRS, EDGE 9.6 kbps to 384 kbps
- 3G – UMTS / CDMA2000, 2 Mbps
- 4G – LTE – 100 Mbps
- Used through cellular networks

- Any IoT application that requires operation over longer distances can take advantage of GSM/3G/4G cellular communication capabilities.

- While cellular is clearly capable of sending high quantities of data, especially for 4G, the cost and also power consumption will be too high for many applications.

IoT Enabling Technologies – Communication Protocols

Protocol	Frequency	Range	Data Rate	Power Draw	Topology	Proprietary or Open?	Managed By
ZigBee	2.4GHz	~ 900 ft	250 kbps	Low	Mesh	Open	Bluetooth Special Interest Group (SIG)
LoRa	T150MHz-1GHz (lots of option)	up to 10 miles	50kbps	Low	Star	Open	LoRa Alliance
NB-IoT	Below 1GHz	~20 miles (indoors and underground)	100kbps	Low	Star	Open	3GPP, Ericsson, Huawei
Wi-Fi	2.4GHZ/5GHz	115-230 ft	7Gbps	High	Star	Open	IEEE
Thread	2.4GHz	115-230 ft	250kbps	Low	Mesh	Open	Thread Group (Google, Samsung, etc.)
Bluetooth Low Energy	2.4GHz	~300 ft	125 Kb/s to 2Mb/s	Low	Point to point, Mesh	Open	Bluetooth Special Interest Group (SIG)

IoT Enabling Technologies – Communication Protocols

- HTTP – Used in Web browsers, basis for WWW
- CoAP - Constrained application protocol, used in M2M, Uses UDP
- WebSocket - full duplex communication over a single socket connections, sending message between client and server, Uses TCP
- MQTT - Message Queue Telemetry Transport, message protocol based on public -subscribe model
- XMPP - Extensible Messaging and Presence Protocol, real-time communication and streaming XML data between network entities
- DDS - Data distribution service, device-to-device machine to machine communication.
- AMQP - Advanced Message Queuing protocols

IoT Enabling Technologies – Communication Protocols

Protocols	*CoAP*	*MQTT*	*XMPP*	*AMQP*	*DDS*	*REST*
Transport	UDP	TCP	TCP	TCP	TCP UDP	TCP
Publisher/subscriber	Yes	Yes	Yes	Yes	Yes	No
Request/response	Yes	No	Yes	No	No	Yes
Security	DTLS	SSL	SSL	SSL	SSL DTLS	SSL
QoS	Yes	Yes	No	Yes	Yes	No
Low power and lossy network	Exc.	Fair	Fair	Fair	Poor	Fair
Dynamic discovery	Yes	No	No	No	Yes	No
Binary encoding	Yes	Yes	Yes	Yes	Yes	No
Real-time	No	No	No	No	Yes	No
Open source	Yes	Yes	Yes	Yes	Yes	No
Architecture style	P2P	Broker	P2P	P2P Broker	Data Space	P2P
Sponsor	IETF	OASIS	IETF	OASIS	OMG	IETF

IoT Enabling Technologies – Embedded Systems

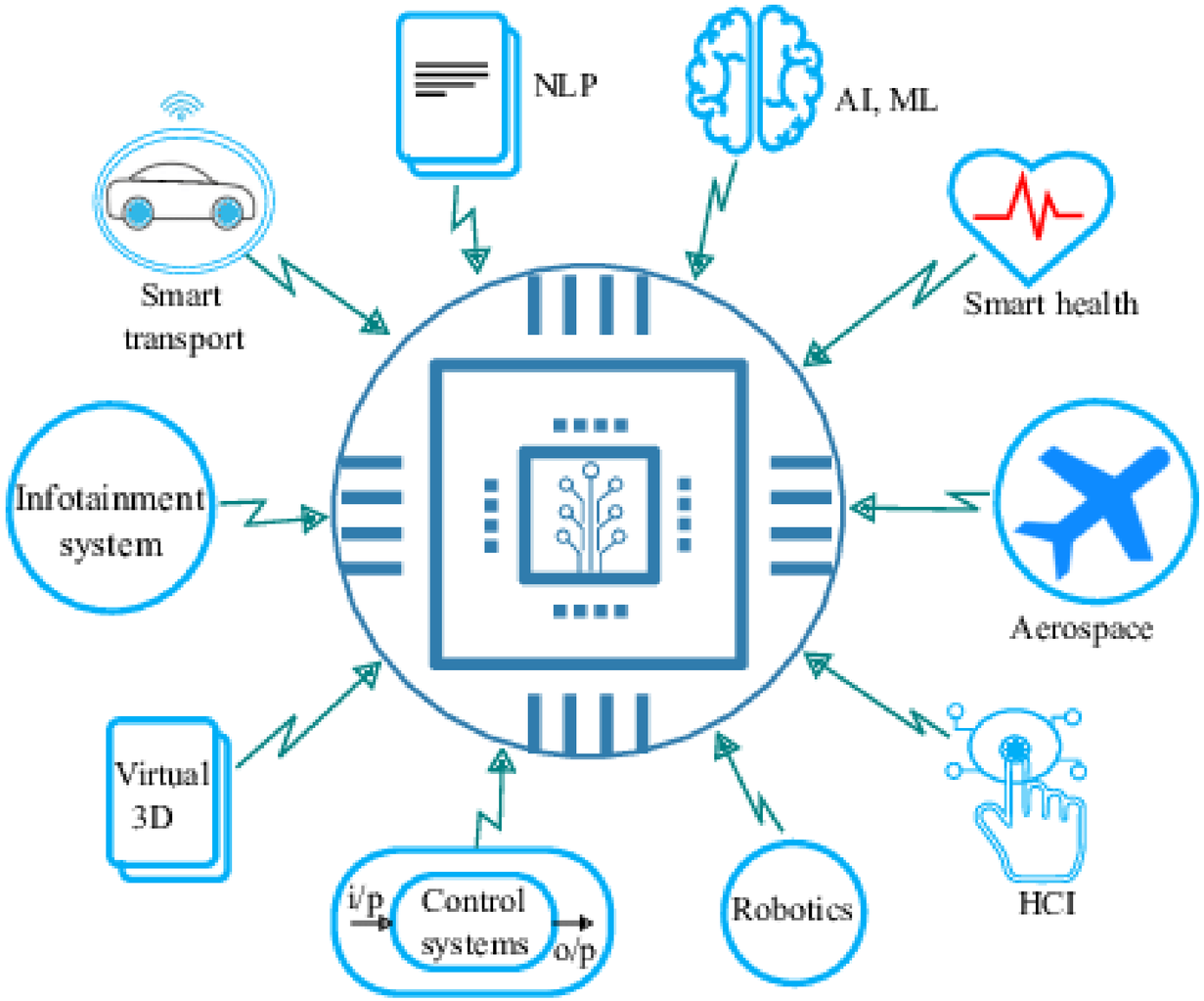
Embedded System

An Embedded system is computer system that has computer hardware and software embedded perform specific task.

In contrast to general purpose computers or personal computers which can perform various types of tasks, embedded systems are designed to perform a specific set of tasks.

Embedded system include Microprocessor and Microcontroller memory Ram ROM cache networking units (Ethernet WI-FI adaptor) input/output unit display keyboard , display and storage such as Flash Memory some embedded system have specialist processes such as digital signal processor DSP graphic processor and application.

IoT Enabling Technologies – Embedded Systems



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