

# Evolution of Internet Communication up to IoT

<sup>[1]</sup> Vaibhav Bharati, <sup>[2]</sup> Tanvi Chavan

Assistant Professor, Information Technology Department, ACPCE, Kharghar, Navi Mumbai

**Abstract;-** In the current era of connectivity, Internet is playing the major role. This connectivity via internet is radically evolving by creating diverse methodologies. Among all these methodologies of connectivity Internet of Things (IoT) is one of the evolved Internet communications between objects. Objects can be living or non-living things. IoT can flawlessly connect the every real object in world and space media embedded with variety of sensors as per requirement. A large number of Internet connected objects will produce and transfers huge amount of data to make daily life additionally comfortable by providing smart services. This paper includes survey of evolution of various methodologies of the internet communication from wired to wireless to smart communication using IoT. It also focuses on importance of IoT for making life of human being more convenient along with features of technology, issues and future trends in brief. Doubtless, the IoT becomes most popular internet communication methodology in the coming days as it has latent to fetch out many benefits.

**Index Terms—**Internet of Things, Wireless communication, GSM, WLAN, Network Generations

## I. INTRODUCTION

With drastically progressing technologies in communication, society is moving connection as per requirement to “always connected” model [2]. It’s started with the wired connection networks to partially wireless networks to nowadays with totally wireless networks. Every methodology has its own generic architecture, protocols, topologies and communication mechanism. Every methodology is focusing to make human life comfortable by adapting to current situations and needs. Initially it started with the wired communication technology with the purpose of transmission of voice and data over a wire. It includes telephone services, cable TV or internet access and fiber-optic communication services. Both in localities and business hubs telephone networks forms the base for wired communications. Nowadays, inbound and outbound transmissions networks are relying on fiber-optic communication technology which is more efficient for signal quality and ranges of transmission rather than plain copper wire. Various protocols like IP, TCP, UDP, FTP, SMTP, telnet etc. are used for the services of wired communication along with different topologies.

After transmitting data/voice over wire there appears services without wire i.e. with wireless terminals, e.g. mobile phones providing the most altering ability of roaming. At the beginning, there was first generation of network of wireless cellular technology known as 1G providing only voice services which are analog only. Later on, there comes first digital service with the second generation of network (2G) which is instigated on the GSM standard. In this generation spectrum allocation is too efficient rather than predecessor; conversations held on phone were digitally encrypted; and starting with

limited length of SMS text messages as a data service along with picture messages, and MMS (multimedia messages). The successor 3rd generation of network is for faster internet speed. This is based on International Mobile Telecommunications-2000 (IMT-2000) provisions. It’s having wide range of applications like wireless voice telephony and mobile Internet access along with fixed wireless Internet access, video calls and mobile TV with 2Mbit/s information transfer rate. The successor of 3G is fourth generation (4G) includes potential applications like gaming, HD mobile TV, video calling, and 3D TV, web access from mobile, IP telephony. It’s having standards like WiMAX and LTE will be discussed in further sections. Beyond it the proposed next generation of wireless network is 5G, obviously much higher capacity than current 4G in reliability, scalability along with optimal power saving [3].

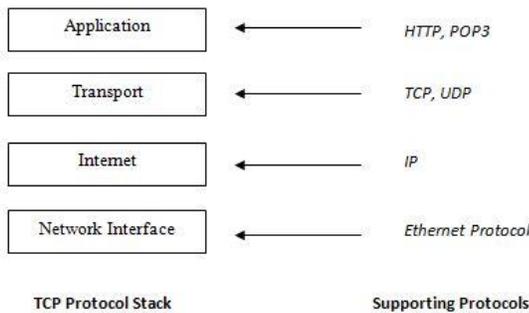
Later there comes combination of wired and wireless communication like wireless local loop (WLL) and wireless local area network (WLAN). WLL [6] is used in the wireless connection links at the beginning or end point of connections for distributing plain old telephone service (POTS) or broadband to customers. It’s also known as a Fixed Wireless Access (FWA). It’s differ from the another counterpart usual mobile terminals which are operating in the cellular networks range, e.g. GSM. In FWA roaming is allowed within very short range with the help of small antenna e.g. desk phone. Along with this Multichannel Multipoint Distribution Service (MMDS) and Local Multipoint Distribution Service (LMDS) are the extended services for wireless local loop. WLAN [7] is wireless at the device to device level connection but ultimately it is connected with the wired at infrastructure level. It covers small bounded distance with providing services of connection to open internet through a gateway.

It cannot be considered as total replacement for the local area network (LAN), but can be considered as extension for LAN by supporting acceptable roaming.

For total wireless connection small area covering network is controlled and known as wireless personal area network (WPAN) [8]. Rather to internet connection it's mainly used for device to device connection which are around the user like PCs, Smartphone, PDA, peripheral devices, pagers, printers, another consumer electronics, etc. In WPAN on small scale connections are made by piconet topology and on large scale the connections are made by scatternet topology. It has various standards as per the requirement of applications will be discussed in further sections.

**II. LITERATURE SURVEY**

**A. Wired Internet Connection**

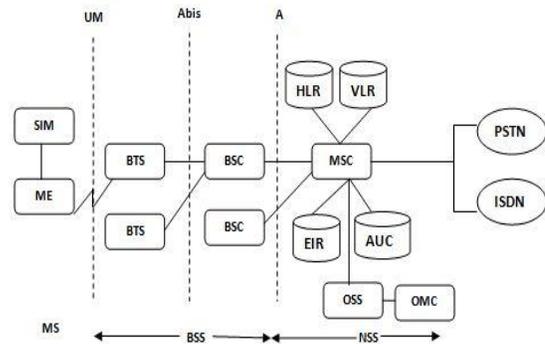


**Fig. 1 Wired Connection**

For exchanging information between sender and receiver needs some standard mechanism called as a protocol. OSI model is used for all type of communications in which nearer layers supports in the functionality of others. For wired connection [4] of communication IEEE 802.3 Ethernet standard which is also considered as wired LAN followed and TCP, IP, UDP, etc. protocols are used. TCP is a connection oriented protocol complementing to IP used for initial network formation, so can be referred as TCP/IP. TCP grants data delivery in the packet format by ordered, reliable and error checking transmission. UDP protocol is used for the communication without pre-connection by sending packets randomly and collecting them sequentially at receiver side with the help of checksum and header. In UDP no mechanism for guaranteed delivery, ordered reception or duplication of packets so where these requirements are must in that case

TCP will be preferred. UDP will be preferable where the applications are time sensitive because without retransmitting packets with delay packet dropping will be preferred.

**B. Mobile communication**



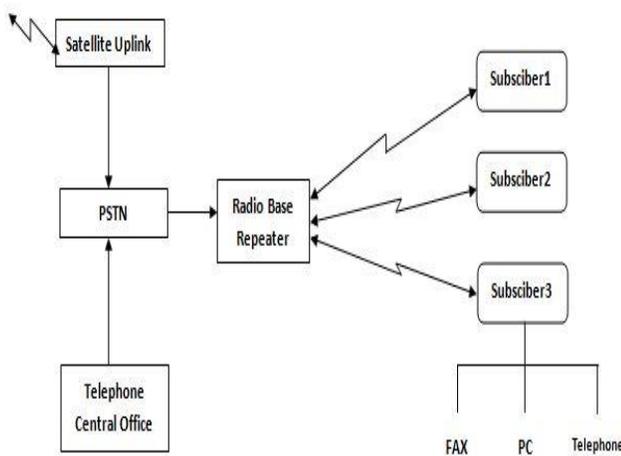
**Fig. 2 GSM Architecture**

For mobile communication initially started with the analog communication by with the support of 1G. It is supporting only audio services which are overcome by the Second Generation of network (2G). In this GSM (Global System for Mobile communication) [5] is the first system of network generations which is using digital technology. GSM is mainly supporting multiplexing technologies as CDMA and TDMA. GSM optimizes the data transmission by compressing and digitization in the 900 MHz to 1800 MHz frequency band. GSM is mostly used technology across the world by 690 mobile network providers, 213 countries comprising of about 82% communications of globe. GSM is providing the scaled roaming capability which allows roaming in foreign countries also with the same service provider. Subscriber Identity Module (SIM) cards is the basic component of the system which holds all the unique data for every individual user useful in providing services.

GSM service mainly designed as a connection oriented i.e. circuit switched system providing direct connection exclusively. In the architecture of GSM there are three basic subsystems, Base Station Subsystem (BSS), Network Switching Subsystem (NSS) and Operation Service Subsystem (OSS). BSS does the beginning level connection of Mobile Station (MS) to initial components like Base Transceiver Stations (BTS) and Base Station Controller (BSC). In the NSS middle part of the mechanism is performed, like making connections with

the base station, storing the information of local users in Home Location Register (HLR) and remote/mobile users in Visitor Location Register (VLR), switching the connections when user is roaming by Mobile Switching Center (MSC). In OSS all the functions related with maintenance of service provided by GSM is managed, like the operations handled by admin of service providers, costing and billing of the services. GSM does working with CDMA and TDMA as multiplexing techniques to handle multiple users at a time. After GSM there is WCDMA as 3G and LTE/3GPP as 4G for extensions of the 2G which are enhancing the services of mobile communication.

**C. Wireless Local Loop**

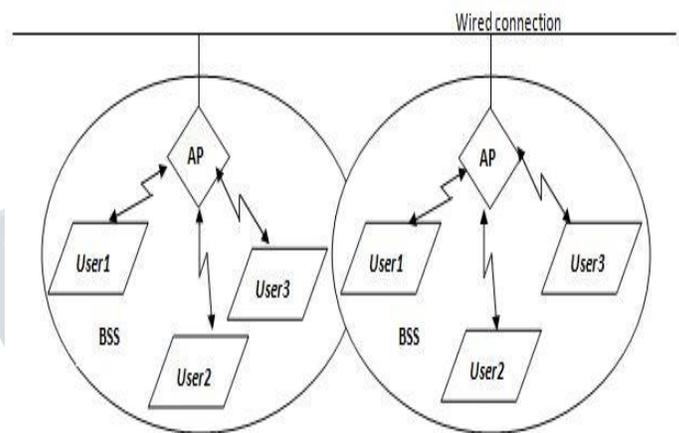


**Fig. 3 Wireless Local Loop Technology**

WLL [6] has a wide range of applications in the field of communication with somewhat roaming feature replacing wired connection in the POTS or broadband by last mile wireless connection so as to mobility. It is very cost effective technology to cover large area with rapid deployment of extension of the network. WLL uses several techniques for the services like Local Multipoint Distribution System (LMDS), Multichannel Multipoint Distribution System (MMDS). In LMDS its target area is within a line of sight radius like connection from local antennas to subscribers like private homes or business firms. It provides last-mile services with high bandwidth solutions to user requirements like replacement for optical fiber installation, adaptation of broadband services by smart TVs, large speed of upstream and downstream 200 Mbps and 1.5 Gbps respectively, etc. MMDS having main

purpose to provide services for multiple subscribers instead of single subscriber so, needs to operate in ultra high frequency range for broadcasting within the range 2.1 GHz to 2.7 GHz. MMDS uses an omnidirectional antennas for broadcasting which are located at highest point of the covering geographical area with coverage of up to 70 miles and has applications in the area like, wireless cable TVs, telephone, FAX.

**D. Wireless Local Area Network**



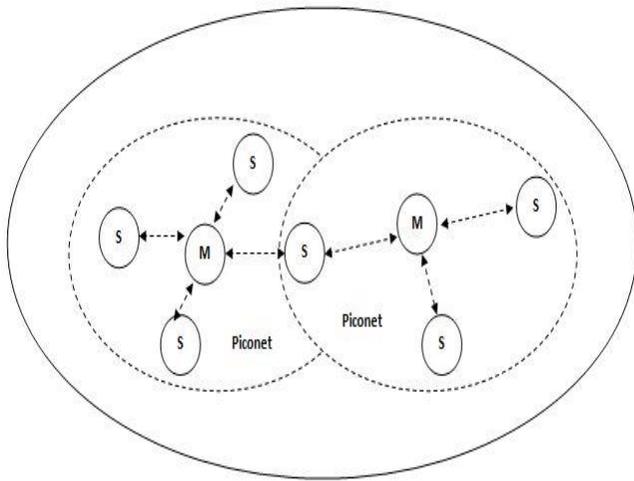
**Fig. 4 Wireless Local Area Network Topologies**

In WLAN devices are connected in LAN wirelessly by the IEEE 802.11 standards group technology and uses 2.4 GHz band. In 802.11 principles of Ethernet and carrier sense multiple access with collision avoidance (CSMA/CA) are followed for path decision and uses wired equivalent privacy (WEP) algorithm for encryption. Some wired part in the LAN connection is replaced by allocation of high bandwidth wireless connection so as to cost of the installment is reduced so WLAN is preferable where wired connections are not still installed.

While connecting devices the various topologies are followed mainly infrastructure based and infrastructure less. In infrastructure less, the devices are connected with the help of ad-hoc connection by point to point connectivity. In infrastructure based there is a basic service set (BSS) which is a primary basic connectivity to connect devices. In BSS there is a access point (AP) which is connected to the BS with wired connection and provides network connectivity to terminals wirelessly and acts as the controller for the connections within the covering area. If devices connected to single AP have to

be communicate with each other in a network still have to communicate via AP only. The services of the BSS can be scaled by extended service set (ESS). In ESS multiple BSS are connected with each other with wired connection with their individual connectivity to set of terminals within their respective covering area. So, multiple devices can communicate with other multiple devices without connecting direct wire connection through AP.

**E. Wireless Personal Area Network**



**Fig. 5 Wireless Local Area Network Topologies**

A WPAN itself indicates the network within a personal workspace in the range of about 10m without wired connection. This technology works on the principles of IEEE 802.15 with the frequency band 2.4 GHz. In WPAN the devices in nearby to each other within small proximity and used for ordinary communication and computation. When the devices comes near to each other's range they will acts as connected by a cable so also known as plugging in technology with the feature of blocking selective users to avoid unwanted interference and unauthorized access. The main objective of WPAN is to provide faultless services for individuals or businesses with more flexibility and more variations.

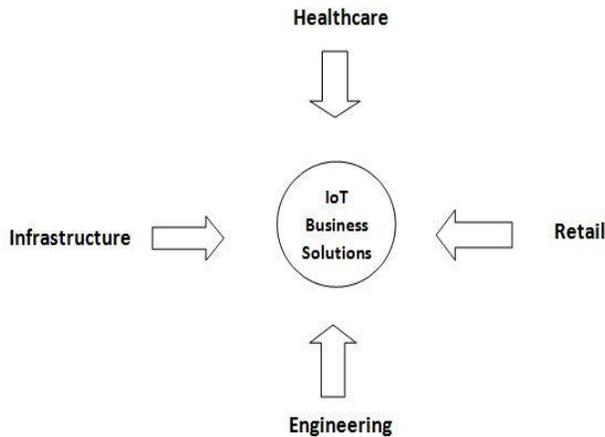
For the services by WPAN technology the devices has to be follow some topology like piconet and scatternet. Piconet is topology in which there are two types of devices, single master device and other seven slave devices. Master device is doing the role of service provision with priority handling, scheduling, and intermediating communication. Any device from the set

of devices in proximity can become a master for the particular communication and others will act as slaves. Piconet is the basic entity of the WPAN. To scale the service area or coverage area, connection of one or more piconets which forms the scatternet can be done. In scatternet there are separate masters for each piconet for controlling it. Master of one piconet can be slave of another piconet. In WPAN devices like laptop, pager, PDA, Smartphone, printer, scanner can forms the network wirelessly.

WPAN having different technologies as per the requirement of various services like Bluetooth, HR-WPAN, LR-WPAN, etc. As explained above Bluetooth is used for small range communication for small amount of data transmission with slow speed by following standards of IEEE 802.15.1. This can be used in file transfer between authenticated devices, Bluetooth headphones, etc. HR-WPAN uses high bandwidth for transmission of large data in Gb's at smaller distances with high speed. This can be used for where data transmission speed is the very critical parameter. It supports the speed up to 55 Mbps by following the standards of IEEE 802.15.3. Besides all, LR-WPAN is used for transmission of small amount of data of the size of Kb's at longer distances with faster speed e.g. Zigbee, WSN. For this type of communication the standard for working used is 802.15.4. Zigbee and WSN have large range of applications for individuals and business firms.

**III. INTERNET OF THINGS**

In the field of communication Internet has an important role and is a living entity which is always keeps evolving. Continuously the solutions for needs of various businesses and applications are created. While evolving methodologies of communications via Internet the technologies are also changed their landscape. Broadband connections are acquiring the market by providing ubiquitous and cheap services upon which connected devices are becoming smart and powerful even reducing size. Devices are made up with the on-board sensors, which is the major evolutionary point in the communication to make devices smart. Large number of devices becoming connected to internet is leading to a new model: the Internet of Things. The Internet of Things is obsessed by extension of the Internet through the enclosure of physical objects clubbed together for the purpose of smarter services to the society as by generating more data and analyzing it for efficient and meaningful conclusion.



**Fig. 6 Wide range of IoT Applications**

In IoT the small, handy, movable devices induced with sensors having multiple functionality connected to internet making able to sense the information, compute the analysis and conclude to take decision for expected action. Initially at the very beginning it started with Radio-Frequency Identification (RFID) tags or barcodes which are scanned by scanners. IoT is the enhancement of this technology for the next generation. In Internet of Things, 'Things' is for the object which maybe living or non-living is connected in the network for sensing the data which is in the form of some information useful to reach any meaningful conclusion. IoT can be defined with the various 'A's, "any-thing, any-time, any-where, any-one", so it's covering 'Everything'. The figure below indicates the generic scenario of IoT including the vast area of applications supported by IoT.

### CONCLUSION

This paper describes the evolution and how internet communication technologies from the beginning of first technology used. Here all the technologies used are described sequentially. In every upcoming technology some overcomes are done on previous ones or some new technologies targeting other area for services. Initially wired connections are removed with wireless technologies then the various wireless technologies are enhanced depending upon various parameters such as frequency band of working, bandwidth supported, speed of transmission, number of devices allowed to connect in network. At the recent time inventions are reached up to Internet of Things which has changed and still changing

the communication of Internet for the sake of human comfort. IoT is converting everything into 'Smart' by using automatic systems independent on operators which leads to 'Smart World'.

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