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A Study on Low Power Wide Area Network Technologies for Internet of Things

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Abstract: ***LPWAN is used when other networks are not good fit like Wi-Fi, Zig bee, Bluetooth, because these networks are not suited for long-range applications as they consume lots of power and service, and hardware is also expensive. Hence LPWAN is suited for sending fewer amounts of data over long range keeping longer battery life. LPWAN is used in IOT because some of IOT applications require only fewer amounts of information data to be transmitted .eg parking garage sensor. In LPWAN, the end nodes can be placed even 10 km away from the gateway. Depending on IoT technology LPWAN data to be sent several times of a day and of data rate is 5000 bits per second.***

Keywords: LPWAN; IOT, Zig-Bee, M2M, Range, Gain(dB)

I. INTRODUCTION

LPWAN is the type of low power wireless telecommunication network designed to allow long-range communication for low bit rate among connected objects such as sensors operated on a battery. The needs of IOT and m2m applications, which minimizes some unique features of LPWAN techniques as shown in the figure below.

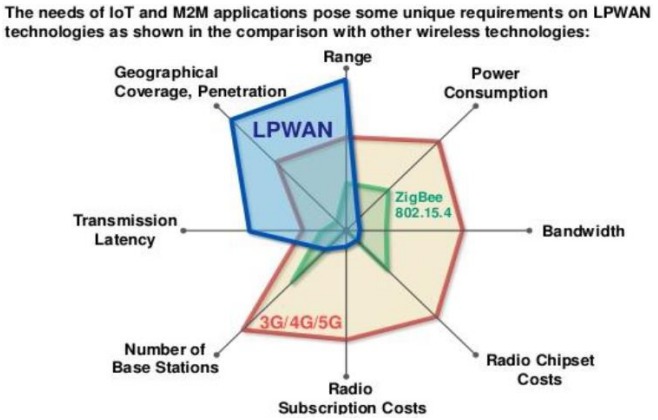

Fig 1. IOT & M2M Applications on LPWAN

The need for long-range wireless connectivity in IoT applications are typically incorporated in fields of identical premises, public places like cafes, industrial plant site etc. Hence using short-range complicate IOT due to the implementation of wired connectivity setup.

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For example-short-range wireless connectivity like Zig-Bee uses a Gateway and it can be moved up to some on-site wired network which is not under control of IOT. So long-range connectivity has the advantage of IoT because it allows direct access to the device in the field. The base station serves a large number of devices thus the cost is very less.

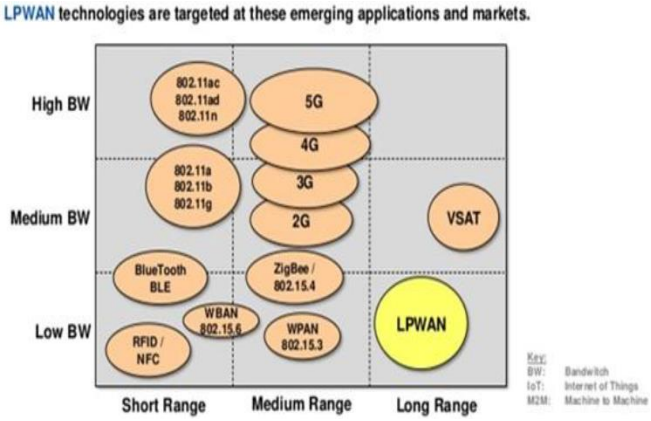

Fig 2. Short Range VS Medium Range VS Long Range

II. LPWAN TOPOLOGIES

The wireless portion of LPWAN consists of star topology which eliminated few needs of complicated wireless mesh protocols which would greatly complicate the complementation of end devices and drive up power consumption

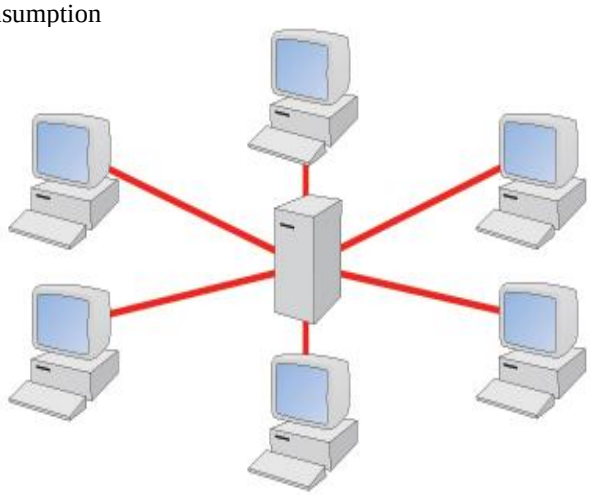

Fig 3. Star Topology

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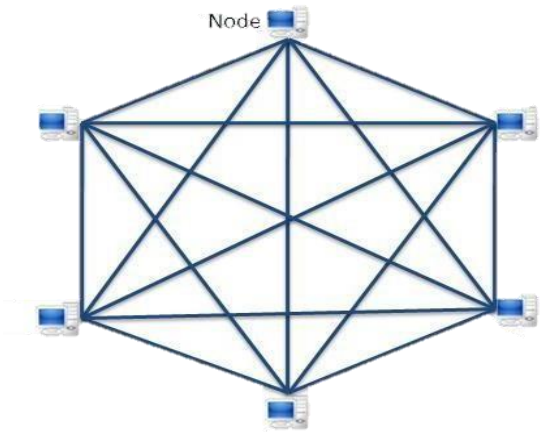

Fig 4. Mesh Topology

A base station provides connectivity to a large number of devices. The traffic is back handled to servers through TCP/IP (internet based networks).the base stations are responsible for protocol translation from IoT protocols such as MQIT on COAP to device application protocols.

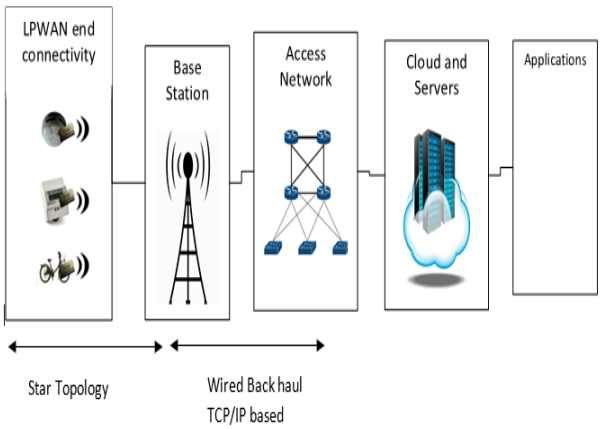

Fig 5. Direct Connectivity

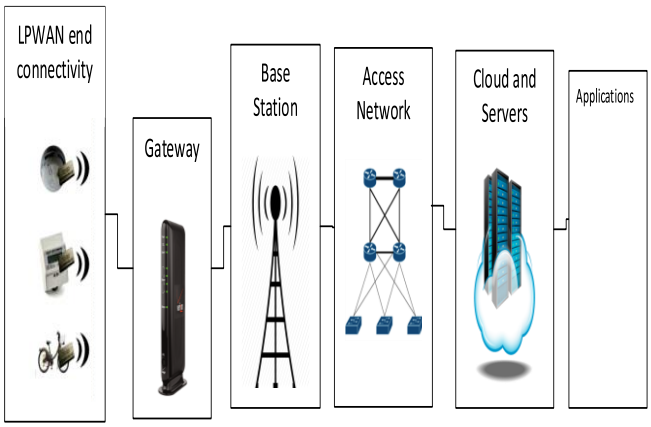

Fig 6. Indirect Connectivity

For short range, local gateway bridges LPWAN connectivity are used hence like zig bee. The gateway typically runs on power mains. Hence it serves large powers and must convert between LPWAN and said radio technologies and protocols. The gateway may help to improve security since more powerful security algorithms can be implemented on the gateway than possible on the constrained device.

III. CONCEPTS OF LPWAN

3.1. Range and Data Rate

When we transmit a signal it needs enough energy to be detected when it is received. Because a certain amount of power is lost along the way as it propagates through space and a material in between there is a baseline amount needed to transmit the signal properly. So the LPWAN technologies in IOT operate with about 140-16 decibels (dB) of the total path which can add up to many miles of range in the right circumstances.

The slower the modulation rate the higher the receiver sensitivity can be. This comes down to the Shannon-Hartley Theorem which states that "the energy per bit is the main lever to change the possibility of a message being heard". So when slowing the modulation rate by half we can increase the link budget on receiver sensitivity by double (3dB).

3.2. Process Gain

Process gain is the ratio of the Radiofrequency (RF) bandwidth to the unspread bandwidth, which is expressed in decibels (dBs).

The simple example is: If we imagine that all are sitting in front of a TV Screen and all we are static. This static can be thought of as a visual representation of noise. When applied in more realistic terms, this process gain shows that when a signal is mixed across the RF spectrum it is only detectable when you have processed all of the noise and we looking at it with a filter. Negative dB signal-to-noise ratio means that the signal is below the noise floor.

3.3. Link budget for LPWAN

As in most ratio system, the link budget is an important measure of a power calculation. The link budget calculates the power received at the receiver and accounts for gains and losses along the transmission path.

$$P_{Rx} = P_{Tx} + G_{Tx} - L_{Tx} - L_{Fs} - L_M + G_{Rx} - L_{Rx}$$

Rx = Received power (dBm)

P_{Tx} = Sender output power (dBm)

G_{Tx} = Sender antenna gain (dBm)

L_{Tx} = Sender Losses (dBm)

L_{Fs} = Free space loss (dBm)

L_M = Miscellaneous losses (dBm)

G_{Rx} = Receiver antenna gain (dBm)

L_{Rx} = Receiver Losses (dB)

S_{Rx} = Receiver sensitivity (dBm)

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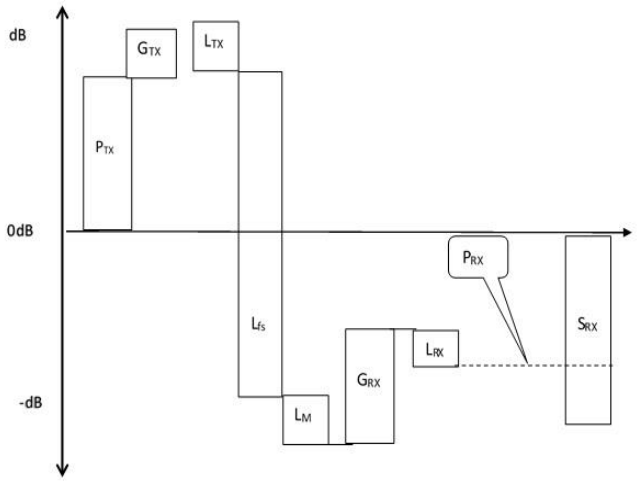

Fig 7. Received Power

3.4. Receiver Sensitivity for LPWAN Devices

The required receiver sensitivity for an LPWAN device derived from the calculated link budget the wireless link can be closed (comm. bet sender and receiver are possible) of the receiver sensitivity S_{RX} equal or is lower than the received power P_{RX}.

$$S_{RX} \geq P_{RX}$$

Due to the long transmission paths that are typical for LPWAN systems, free space loss (path loss) is the dominant factors that greatly reduce the received power at the receiver, so it is essential that LPWAN receivers in device modes have a good receiver sensitivity (≤ -140dBm), i.e. smaller than the transmission level at the sender.

3.5. Data Communication Bet Programmable Logic Controllers

It the Communication in the small applications is not critical them is sufficient to contour these by one PLC. The rare of the Communication is exchanging in connection with a common computer in order to create and transmit the program to PLC and transmit data to superior level for operation's control of technology.

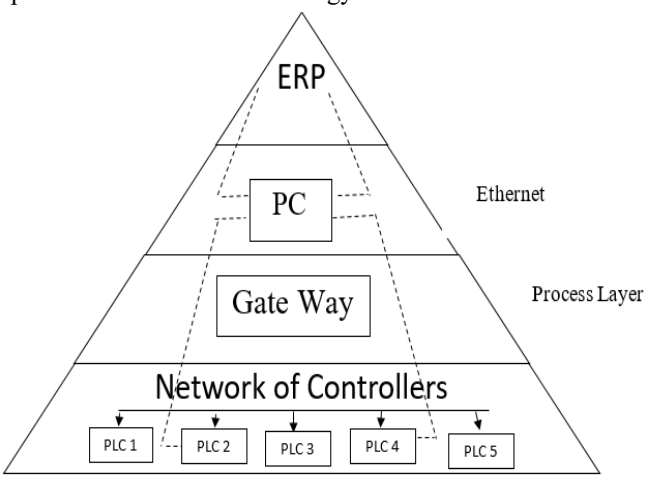

Fig 7. Information Model

The response range is about 10ms depending upon the memory size, procession speed on the longest time of programming repetition cycle. While building distribution control system for controlling large industrial application, it is very important to solve the question of Communication.

IV. CONCLUSION

As the technology is new, the LPWAN scenery is constantly changing and far from mature. With many players in the market, it is unclear who the winner(s) will be, especially as the speed of market expansion is also unknown. Each LPWAN variation is also uncertain after continuous performance, as many are still in their initial rollouts and the testing of real-world at scale has not yet been completed. The levels of security offering by different LPWAN technologies are not similar. Several include device or subscriber authentication, advanced standard encryption (AES), network authentication, identity protection, key provisioning and message confidentiality.

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