TATA COMMUNICATIONS

"FIT FOR PURPOSE" CONNECTIVITY FOR IOT

THE CHALLENGES IN DETERMINING THE BEST WIRELESS TECHNOLOGY FOR IOT DEPLOYMENTS

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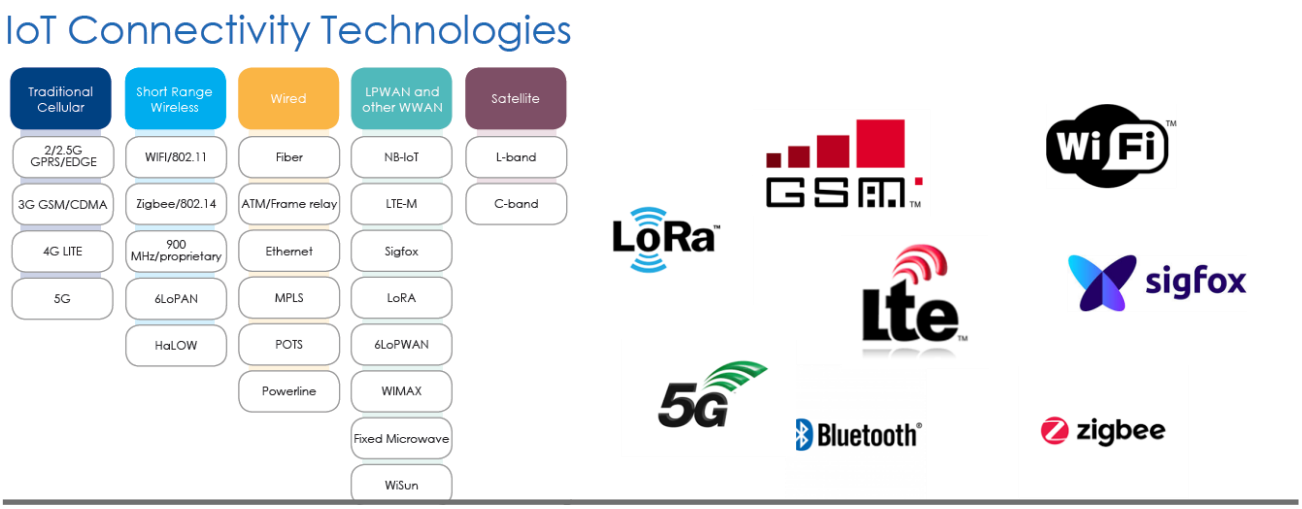
INTRODUCTION

The phrase "VHS vs Betamax" is used to often used to describe a technological standoff based on the long running battle in the 1980s between the competing personal video recorder standards. In the world of IoT wireless technology this is an apt comparison given that there are various competing technologies and it may not necessarily be the most technically advanced solution that wins – as was with VHS, which was considered in many circles to be inferior to Betamax.

For organizations, selecting the best technical solution for their IoT project from the many competing technologies can be a difficult decision. IoT connectivity options fall into 5 broad categories, including use of wireline technology (Fiber, Ethernet, MPLS etc); Satellite; Short Range Wireless (WiFi, Zigbee etc); Low Power WAN (NB-IoT, Sigfox, LoRa, LTE-M etc) – and cellular connectivity ranging from 2.5G through to 5G). This array of technology options is complex enough to understand, but each technology choice also impacts upstream and downstream project decisions, in terms of hardware and software, the amount of data which can be captured and transmitted and importantly, the business case.

It is one of those questions to which there is no absolute correct answer. Several factors are relevant to the use case being addressed including: Project life; Data throughput requirements; Device location; Security; Environment; Degree of device movement amongst others.

This paper concentrates on wireless options and seeks to give a practical and business focused overview of the main competing technologies and the considerations required for an organization in choosing the wireless technology which is "fit for purpose".



Multiple IoT connectivity options exist – the focus for this paper is on wireless IoT connectivity

WIRELESS IOT CONNECTIVITY OPTIONS

THE CHALLENGES OF CHOOSING TECHNOLOGY IN A FAST PACED WORLD

LOW-POWER WAN (LPWAN)

LPWAN solutions have grown rapidly in the early years of the IoT industry gaining traction mainly due to the long battery life which can be achieved. The technology also allows relatively low-cost deployments, the use of unlicensed spectrum (meaning it is free) and the ability to broadcast across long distances.

The relative simplicity of the protocols that are used mean that IoT modules are inexpensive to manufacture, when compared to cellular based devices. This is significant when the deployment business case has a low threshold of monetary benefit. The premise of LPWAN is that a combination of low-cost modules, with low ongoing operational costs, approaching only a few Dollars per year, will be the harbinger of the large number of IoT device deployments that are being predicted.

While LPWAN represents a very cost-effective approach to IoT deployment, it does have its limitations. With the use of unlicensed spectrum, it is possible that interference can be introduced when multiple technologies are deployed, reducing the range and effectiveness of the devices. LPWAN technologies are also designed to transmit relatively small bursts of data at low bandwidths, limiting their application. In addition, coverage within a country may not actually cover large areas outside major metropolitan centres.

Typically, LPWAN solutions are used for localized deployments where devices are static or located within a defined coverage zone. This limits the ability to provide global (or even regional) IoT services using LPWAN technologies.

Leading LPWAN technologies include LoRa and Sigfox, both of which have been expanding in various geographies, but with different operating models.

LoRa

LoRa, sometimes referred to as LoRaWan, is a standard maintained by the LoRa Alliance. LoRa is a more open community than some other technologies noted in this paper, with smaller deployments being common and even a crowdfunded initiative - the 'Things Network', being deployed in Europe. Several large mobile network operators support LoRa in conjunction with their own networks, which indicates that they also understand that connectivity choices need to be "fit for purpose".

Tata Communications is currently deploying what will become the world's largest single LoRa network. This is being deployed across India to support the burgeoning IoT market in India. The network covers >400M people and continues to expand with a target of city coverage across all cities with a population >1M by end 2018 and all cities >50,000 by end 2019.

Sigfox

SIgfox is a propriety network focused on the Internet of Things. Currently present in 36 countries and covering >700M people, Sigfox, as a single entity, does allow interoperability between the various networks allowing for some mobility and cross-border roaming. The idea with Sigfox is that for many IoT applications that run on battery power and only require low levels of data transfer, the Wi-Fi range is too short while cellular connectivity is too expensive and also consumes too much power. Sigfox uses Ultra Narrow Band (UNB) technology and handles quite low data-transfer speeds (10 to 1,000 bps). It consumes a fraction of the power associated with use of cellular connectivity. As with LoRa, Sigfox is supported by some large mobile network operators who have even invested in the company to further its expansion.

Sigfox is however a closed community which means the network expansion is dependent upon the funding and strategy of from Sigfox itself.

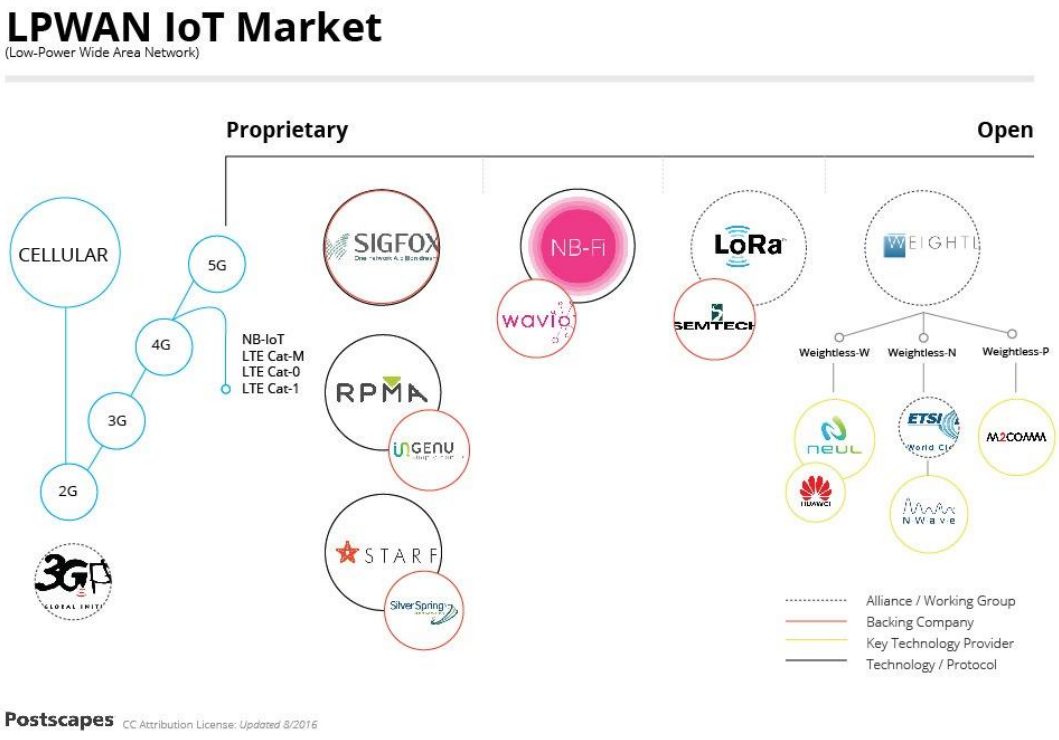
Other LPWA Technologies

Multiple LPWAN technologies are present in the market including Ingenu, RPMA and Silver Spring among other. Some of these are industry specific and are less open than others.

Summary

LPWAN technologies are many and varied however the two leading technology options (LoRa and Sigfox) are both growing in scale. Sigfox has the advantage of interoperability however its limited bandwidth capability as well as being dependent on a single entity to fund network expansion means there are inherent concerns for large scale global deployments.

LoRa, whilst limited in interoperability, has the ability, through an open community, to expand to perhaps a greater degree than its competitors. This type of interoperability challenge of providing a single connectivity layer to multiple networks is firmly in the domain of a global service provider such as Tata Communications to be able to aggregate these network technologies as has been done in voice, messaging, roaming and data over the life of the telecommunications industry.



Overview of LPWAN and Cellular Technologies
(Source: Postscapes)

WIFI

WiFi is a universal connectivity method to aggregate devices to a broadband connection, within a defined, relatively small zone.

WiFi is perhaps an obvious choice for IoT developers, especially given the pervasiveness of Wi-Fi within the home environment. It represents a cost-effective delivery mechanism and allows for long device battery life. Small networks can be deployed privately to cover defined areas and aggregate multiple devices back to a single cellular or fixed connection. This is often done within factories, office buildings, airports and hotels, creating a private WiFi network.

In common with LPWAN, WiFi is limited by range. It cannot be deployed across a wide geographical expanse without additional complex administration or use of un-secured public WiFi access.

Combining WiFi modules with cellular is common. Laptop devices and Mobile handsets support this capability. Technology which can be enabled within the SIM card to allow authentication onto a WiFi or cellular network is currently in use today and is an effective method to have the best of both worlds in terms of the coverage associated with cellular connectivity, along with the cost benefits of WiFi.

CELLULAR IOT CONNECTIVITY

GSM based cellular technology is the most ubiquitous wireless technology, with coverage reaching to most of the inhabited parts of the planet. This lends itself to being ideal for delivery of global IoT deployments.

Through the SIM card, cellular connectivity brings good security and ease of authentication across the globe with roaming across networks and countries being standardized and mature.

2G/3G GSM

2G technology was originally used for the majority of machine-to-machine applications which came with low module costs and relatively long battery life. By definition 3G supports a higher data transfer rate than 2G and has become the de-facto standard for cellular IoT connectivity. Module costs for 3G are falling, but still present a premium over older 2G modules.

4G/LTE

New use cases in IoT are beginning to take shape, requiring higher bandwidth and larger payloads. As analytics and machine learning drive insight into harnessing operational efficiencies and improved customer value so has the need to collect more data. Automotive applications are good examples where original use cases were associated mainly with low bandwidth and low payload telemetry applications, while more recent use cases relate to more real-time connectivity requirements, including software uploads, driver automation and in-car connectivity – all requiring higher bandwidths. For these types of use cases, which add a lot of value for the enterprise and the end customer, the benefit of higher bandwidth and payload requirements means a profitable business case. Increase in demand for LTE modules will also bring cost down.

5G

There is much hype and some real development being done in the 5G space. 5G offers further improvements in efficiency and data speeds – some of which may be of benefit to specific IoT applications. Several operators have now deployed trials of 5G technology, however widespread deployment and adoption is several years away.

CELLULAR SIM TECHNOLOGY

The cost associated with the ubiquity of cellular connectivity is the corresponding higher download costs when compared with narrow band technologies. Pricing pressure has seen this reduce over time, however global deployments still face challenges in this regard particularly when using a mobile network operator from one region where their pricing may be attractive in their home market or region, but not as attractive in other countries or continents.

Improvements in SIM card technology and standards give rise to the opportunity for enterprises using cellular based IoT services, to switch operators and networks much easier than before. The advent of embedded Sim (eSIM) and multi-profile software, affords an enterprise better control of its IoT services over the mobile network. Use of eSIM delivers control and independence for an enterprise and allows smart and more efficient use of mobile network connection and roaming agreements.

At Tata Communications we are advocates of this independent approach for both multi-profile and eSIM. Tata Communications MOVE™ lets multiple mobile network operators be present on the SIM, the service of each of which can be activated in the most appropriate context – whether that be for cost, signal strength, availability or a mixture of criteria. This means a more dynamic approach to routing for a balance of cost and quality, harnessing the power of mobile coverage and minimizing cost. By standardizing connectivity and commercial pricing of mobile network operators in different region, on a single SIM and interface (API or Portal), an enterprise can minimize cost without giving up the convenience of working with a single provider.

With eSIM, if an enterprise wishes to switch to a different mobile network operator, they are able to do so easily and quickly. At Tata Communications we are firm believers in bringing this independence to enterprises and reducing mobile network "lock-in". We strongly support the mobile industry in moving towards this approach.

CELLULAR NARROWBAND

Cellular narrowband is the mobile industry's answer to LPWAN technologies. It combines the coverage of the cellular networks with the low power and increased battery life that is expected in narrowband technology.

The cellular industry pitches the different standards in this field as somewhere between an LPWAN technology such as LoRa and higher bandwidth 3G or LTE.

The rollout of these cellular narrowband technologies is relatively inexpensive for a mobile network operator (in the context of their overall network infrastructure spend), however the business case becomes more difficult to justify as connectivity prices on comparable LPWAN services fall. In a lot of cases relatively simple upgrades to base station software can achieve the benefit of the technology so theoretically mobile operators, once they begin to deploy this technology can achieve scale relatively quickly. However, rarely is anything so clear cut in the cellular industry.

These cellular narrowband technologies are new and only just being rolled out by the mobile network operators. There are currently two different versions of the technology available – namely LTE-M and NB-IoT. The two standards are similar in that both operate on LTE networks, however there are subtle differences.

NB-IoT

NB-IoT uses a "messaging" type approach similar to LPWAN technologies and generally has data throughput of less than 100k bits per second. NB-IoT extends the coverage of traditional LTE networks and utilizes spectrum more efficiently for the mobile network operator. Its main function however is not supporting mobility use cases. The way the technology operates means it cannot hop between cell towers and consequently cannot be used for anything on the move. In many regards it is a natural companion to other LPWAN technologies.

NB-IoT is mainly being trialled and rolled out in Europe where mobile network operators including Vodafone and Deutsche Telekom (T-Mobile) are its biggest proponents.

LTE-M

Not so long ago, LTE-M might have been regarded as the poorer cousin to NB-IoT and expected to only be popular in the North America region, due to system limitations in the networks in that region, preventing easy upgrade to NB-IoT. However, it has been gaining traction within Europe and Asia with Orange, Telefonica, China Mobile and KPN now supporting LTE-M as an adjunct to their own LoRa plans.

LTE-M operation is similar to a slow 3G connection with speeds usually less than 1 megabyte per second. It does support movement between base stations and it also supports voice services. Advocates of LTE-M say that it can address an array of fixed IoT applications (e.g. Smart Meters), as well IoT applications on the move such as freight tracking, also supports use cases requiring slightly higher bandwidths.

Cellular Narrowband Summary

In terms of narrowband cellular it is still early days however both standards are gathering momentum. From a comparison perspective the key differences lies in the higher bandwidths and mobility of CAT-M. NB-IoT has a perceived cost advantage in terms of modules and network cost to the mobile network operator but market forces will determine how this plays out to the end customer. Importantly the SIM card will not change for either technology so it's possible to future proof ahead of the rollout. Is it VHS vs Beta all over again? Time will tell.

"As analytics and machine learning drive insight into harnessing operational efficiencies and improved customer value so has the need to collect more data."

SUMMARY

When choosing IoT wireless connectivity there is no right or wrong answer. It really does depend on the application and so means finding the optimum connectivity which is "fit for purpose".

That may mean choosing more than one connectivity option. As can be seen from the example of mobile network operators deploying both LoRa and LTE-M solutions, showing that different networks types suit different use cases and in some cases complement one another particularly when the best feature of cellular networks (and consequently cellular narrowband) is their coverage. Thus it can make sens to use LoRa WAN in dense urban areas where deployments are more common, complimented with cellular coverage outside of these areas. Module intelligence can look for the lower cost networks first and then fallback to cellular. There are many examples of this today and this mix represenst an attractive approach for enterprises.

In most cases where a global implementation or mobility of devices is required, cellular still provides the simplest solution with a single interface and less upfront deployment costs. However, module costs and data costs are higher than you would see with LPWAN solutions. These must be all factored into an IoT business case and the total cost of ownership including upfront development, module/device costs, download costs, analytics and storage and the cost of servicing.

For small scale data requirements in fixed locations LPWAN is a clear winner for now, however it may be challenged by cellular narrowband solutions. This is of course providing these networks cover the geographical areas required. If this is not the case, then either a higher module cost or different modules are required, using cellular connectivity, which increases logistics and service management. These are costs and challenges often neglected and so will most likely see more multi-modal modules and solutions in place – such as LoRa and 3G/CaT-M/NB-IoT.

At Tata Communications we are developing the integration of WiFi into our SIM cards to allow seamless hand-off to private networks, for choice of secure, private WiFi networks where available. The investment in our LoRa network in India deomonstrates that there is no clear cut "one size fits all" solution. Our agnostic connectvity approach means that we believe Tata Communications is well positioned to help our customers take advantage of these technologies – whichever is "fit for purpose".

Tata Communications MOVE™ IoT Connect solves many of the issues highlighted in this paper. Through a single integration, access is provided to 600 mobile networks, across 200 countries around the world. Data traffic traverses Tata Communications wholly owned IP network, via data nodes deployed in every major region of the world, all of which support eSIM capability. This ensures the communications connectivity that is vital for 'connected' devices is firmly under control, while the ability to swap out mobile network operators connectivity providers no longer has the logistical and operational impact it used to have.

At Tata Communications, we believe every device should be "born connected" and should be simplified with a single interface so enterprises can focus on building value for their customers.

Tata Communications MOVE™ Key features

- Independent 'Things-to-Cloud' connectivity, with global and local access
- eSIM enabled, for independence and flexibility
- Distributed network nodes for high performance
- World class sub-sea network for secure and efficient data delivery
- Intelligent SIM technology brings additional security levels
- Ongoing expansion of coverage for cost optimization
- Flexible, itemized billing as a service to allow new business models

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For more information, visit us at www.tatacommunications.com.

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COMPARISON OF MAIN WIRELESS IOT CONNECTIVITY TECHNOLOGIES

	LoRa	sigfox	Lte	NB-IoT	GSM
Bandwidth	125 kHz	100 Hz	1.08 MHz	180 kHz	200 kHz
Max. Coupling Loss	154 dB	149 dB	156 dB	164 dB	164 dB
Capacity (per Cell)	40,000	50,000	50,000	200,000	50,000
Peak throughput	50 Kbps	0.1 Kbps	1 Mbps	50 Kbps	240 Kbps
Spectrum	Unlicensed	Unlicensed	Licensed	Licensed	Licensed
Location support	Yes	No	Yes (same as LTE)	Yes (Rel-14)	Yes (same as GSM)

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About Tata Communications

Tata Communications Limited (CIN no: L64200MH1986PLC039266) along with its subsidiaries (Tata Communications) is a leading global provider of A New World of Communications™. With a leadership position in emerging markets, Tata Communications leverages its advanced solutions capabilities and domain expertise across its global and pan-India network to deliver managed solutions to multi-national enterprises, service providers and Indian consumers.

The Tata Communications global network includes one of the most advanced and largest submarine cable networks and a Tier-1 IP network, as well as nearly 1.5 million square feet of data centre and collocation space worldwide.

Tata Communications' depth and breadth of reach in emerging markets includes leadership in Indian enterprise data services and leadership in global international voice.

Tata Communications Limited is listed on the Bombay Stock Exchange and the National Stock Exchange of India.

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