**LoRa vs LTE-M vs Sigfox**

*Or why the IoT is at risk of being stillborn*

There's a battle going on for the infrastructure technology that will support the Internet of Things. Currently the three most talked about contenders are Sigfox, LoRa and LTE-M. There are a lot of other alternatives and it's quite possible that none of LoRa, Sigfox nor LTE-M0 will win, but that's another story. If you search for LPWAN (Low Power Wireless Area Networks) you'll see that the battle for supremacy is a hot topic. It's largely because of the impending loss of the GPRS networks which power much of today's M2M business. As a result, almost every day you'll find another article debating their respective technical merits.

I'm going to argue that these comparisons miss the point. Which technology will win depends far more on the business model than on the underlying technology. The three technologies listed above are interesting to compare, as they exemplify three significantly different approaches to an IoT business, which can be broadly summed up as:

- Sigfox – become a global Internet of Things operator
- LoRa – provide a technology that lets other companies enable a global Internet of Things
- LTE-M – evolve an existing technology to make more money for network operators

Between them they promise to help us get to the predicted 50 billion connected devices in 2020. A winning solution could allow the IoT to take off and make its supporters a lot of money. The ones that fail may be limited to niche applications and lose investors hundreds of millions of dollars. Only one is likely to win. It's also possible that all of the current pretenders could lose. So let's forget the technology and look at the business models.

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The Internet of Things (IoT) has been around as a phrase since 1999, when the phrase was coined to describe the potential of RFID. Since then it has evolved to cover all forms of sensors which send data to the cloud, as well as devices which may be remotely operated. That's not a new market – it's been around for several decades under the name of Machine to Machine, or M2M. The IoT moniker can either be seen as democratising it beyond the vertical sectors of M2M, or as a cynical attempt to revive a flagging M2M market by introducing a more exciting name. Back in 2009, the acronym was brought from relative obscurity into the mainstream when Ericsson made their prediction that by 2020 there would be 50 billion connected devices. Most people missed it, as it was hidden away on page 125 of their annual report. The next year they fleshed it out in the document which changed the industry mindset - their seminal briefing paper "Towards 50 Billion Connected Devices". Network operators in particular seized upon it like a pack of starving hyenas as proof that there would be revenue after smartphones. From that point every operator presentation highlighted the opportunity that the Internet of Things would bring to their business. Most believed the 50 billion. Some analysts set it lower at 20 billion, others suggested it could be as high as 1.5 trillion. Everyone blindly assumed it would mean much more revenue.

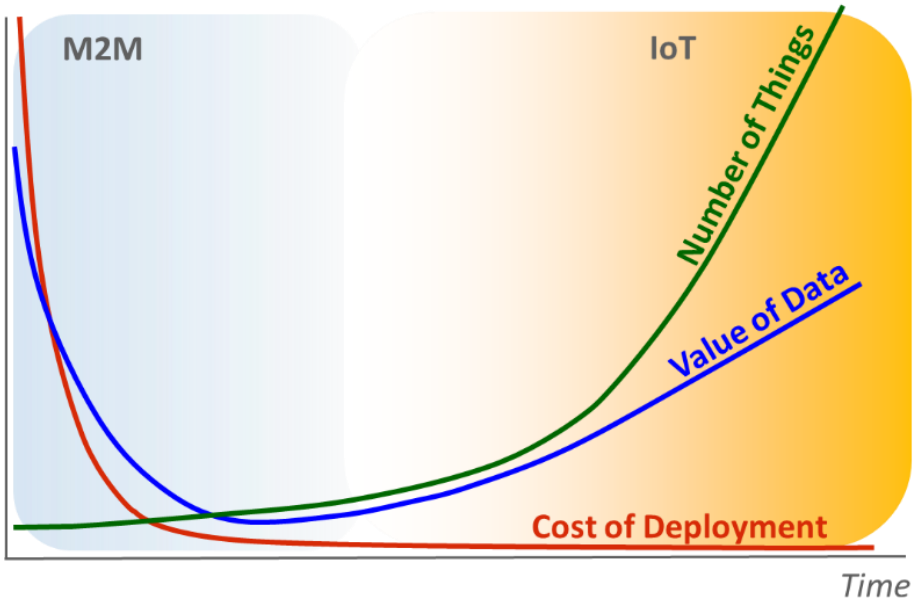
Even in the first Ericsson document there were provisos about what would be needed to get to the 50 billion. They highlighted the fact that network operators would need to "combine technology with services for lower cost, faster time to market and reduced project risks". They also made clear their view that success would come from "leveraging service providers' continuous investments in network build-outs and upgrades", adding that "M2M industry verticals can tap into the best and the latest of fast-moving mobile innovations".

Unfortunately none of that happened. M2M deployments stubbornly stuck to GPRS and 3G and the focus within the 3GPP standards group was on more data and capacity to meet the demands of consumer-led mobile broadband and video. Although the headline of 50 billion continued to be quoted as a hoped-for inevitability, none of the foundations were put in place. In this year's mobility report Ericsson downgraded the 2020 figure for connected devices to around 28 million. The more shocking change (which I'll cover in a future article) is that the number of them expected to have cellular connections has dropped from around the 40 billion number of their 2010 projection to just 1.2 billion.

As it's become increasingly obvious that the cellular industry has taken its eye off the M2M and IoT opportunity, interest has grown in alternative LPWAN networks. That's produced a flurry of reports where analysts and technical advocates have debated their respective technical merits. The problem with technology comparisons is that it inevitably comes back to "which is the best technology", with proponents all insisting that their favourite "best technology" solution will win. These are frequently the same technically blinkered commentators who in previous times waxed lyrical about Betamax VCRs, Sega Dreamcasts, Psion Organisers and Quadrophonic stereo systems. The reality is that best doesn't matter. It doesn't matter because, particularly in the case of mobile, the technology is primarily there to make money for network operators. It needs to be reliable enough to sell contracts, which is what pays for investment in infrastructure. For them, technical specmanship plays second or third fiddle to ease of deployment and the ability to bill. It is a sign of how little the M2M and IoT industry has evolved past a fixation with hardware that they fail to see this. That fact in itself does not bode well for getting another 40 billion devices connected.

This is where we need to look at the economics. The vast bulk of IoT connectivity has a very different trajectory of requirements to consumer mobile. Smartphones have changed the dynamic of mobile ownership. Consumers are increasingly prepared to pay more for a smartphone, and in many cases replace them more often. But at the same time, they expect more and more data for the same contract cost. Networks have effectively become pipes.

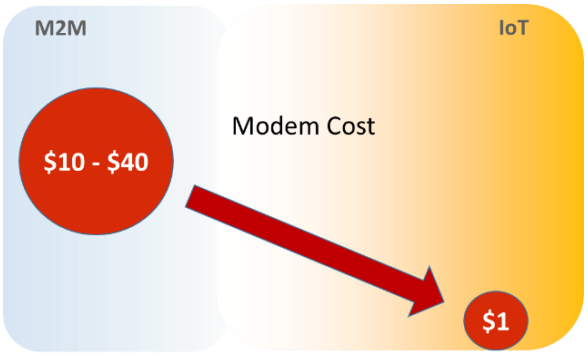
M2M customers, who are the vanguard of the IoT sector, generally want very little data. Some products, like automotive and security do some fairly hefty streaming, but the perceived view of the mythical 50 billion connected devices is that the vast bulk will send and receive a few hundred bits of data every few minutes. At the moment the value of that data is relatively high. It needs to be, as deploying M2M devices is quite expensive, which is why they're confined to a small number of vertical applications where the business model supports the return on investment and ongoing running costs.




The graph above illustrates the dilemma that the industry faces in moving from these bespoke M2M applications to the ubiquitous world of IoT and billions of connected sensors. The red line shows the cost of deployment. That's a combination of hardware price, network charges and the cost of installation, which we'll look at in more detail in a moment. To get to scale, the overall cost of deployment needs to fall. What may be cost effective for a delivery fleet won't be cost effective for a washing machine.

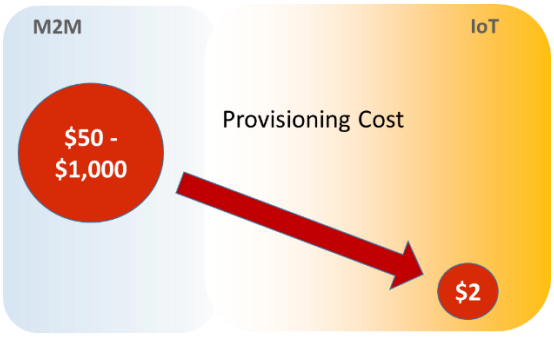
The impact of falling cost in driving numbers up is pretty obvious. The blue curve is less obvious and more interesting, as it charts the value of the data. At the left hand edge of M2M applications the value of data is high. As I said above, it needs to be in order to support the return on investment for these applications. What is generally not appreciated is that as the cost of deployment falls, so does the value of the data that is generated. What happens here is that as sensors become cheaper and less application specific, value will be generated either by building up long term data (as in plotting the failure modes of washing machines), or combining data from multiple sensors (such as in smart city applications). Because it will take time to get enough sensors deployed, or to harvest enough time-series information, it will be several years before the value generated per sensor starts to rise again. To put it another way, the deployment cost has to be low enough to allow the sensor infrastructure to be built up and provide a critical mass of data before we see the financial benefits. It's not until we reach that point, when value starts to be returned from the data, that we start to see the hockey stick of IoT deployment numbers.

It's useful to dig down into the detail of deployment costs, as they underlie the economics. Starting with hardware, we currently have cellular or LPWAN modems that cost $10 or more at moderate volumes. That price is one of the reasons why M2M deployments have been limited to those with a robust return on investment case. The lowest cost is for GPRS modems, but as these disappear and companies get forced to move to 3G or 4G cellular alternatives, the hardware cost gets more expensive.




There's an oft-repeated mantra, which is probably true, that the hardware cost needs to get down to $1 for the IoT to take off. That ought to be possible for most LPWAN solutions, as in general they have been designed so that they carry little baggage. The different owners need to work out how much IP they will licence or give out, particularly LoRa, where Semtech holds the reins on the radio, but those are soluble problems. LTE-M has more of an issue. As it is a subset of LTE and is designed to coexist with other LTE users, it still needs to carry a lot of additional silicon and protocols to allow it to coexist with them. To make an analogy, if you think of 2G as a Model T Ford, 3G would be a Volkswagen Golf / Rabbit and LTE a BMW 7 Series. Like the BMW, there's a reason that LTE modems are expensive – they're complicated. However much of that complexity you try to strip out, you're still going to have an expensive BMW of some form, whereas what you're after for your IoT analogue is just a well-designed bicycle. Until the telecoms standards get to the point where they can throw most of the baggage away and start with a clean piece of paper, any cellular product will have a cost issue. NB-IOT – their "clean slate" approach may deliver that, but it's still a long way away. Incidentally, their claim that it will be ready in March 2016 is one of the biggest IoT fairy tales I've heard this year.

Most analysis of the market stops with the modem cost, but hardware is the easy bit. The next element of deployment cost is the provisioning cost. Within provisioning I'm including the cost of attaching the unit to the network, the cost of maintaining it and the cost of billing it. I'll come to the cost of data later.

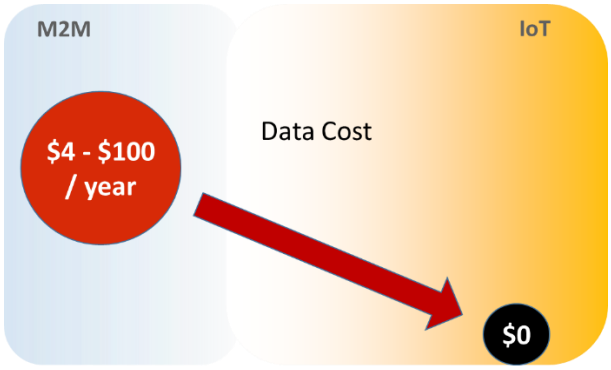



Today almost every M2M device includes a SIM card. The cost of procuring the SIM card for an M2M application, getting someone to physically put it in the SIM card slot and then verify the network connection usually costs upwards of $25. As the same engineer is probably also physically installing the device, which takes 30 minutes or more, that's lost in the overall installation costs, so

no-one really appreciates it. But the prospect of tens of millions of SIMs being fitted into devices every day to get to our tens of billions is a non-starter. The IoT needs products which are taken out of a box, turned on and just connect and work. For LTE-M that means eSIMs, which are still only supported by a few networks. Both cellular and LPWAN networks need ways to register devices automatically, so manufacturers can buy services for multiple units which they pre-provision.

All of this implies a new generation of billing mechanisms which are paid upfront. These don't really exist yet and will take time to develop and deploy. The cellular industry has not got a good track record of innovation in billing, so I don't expect to see these deployed at scale for five to ten years. LPWAN providers also need to start with this new model. They should be faster to support this as they're not constrained by their existing systems, but it will still take time. If we want billions we need a totally new approach to provisioning, where we can get this cost down to a few dollars per unit.

Perhaps the most controversial part of the deployment cost is the data plan – the cost to transfer data from the device to the cloud.




Low rate, cellular data-only plans have fallen dramatically in cost in many countries – I've seen some as low as $0.30/month being offered, although other operators are still trying to get upwards of $100/year. I would contend that if we want to get to the tens of billions of connected devices, data costs need to be free. That may sound shocking, but there are several good reasons for it:

- Once you have tens of billions of sensors connected, the absolute value of data from most of them will be close to zero. Adding a dozen extra sensors in your street may help the value of an application, but the value of the data from any one sensor is miniscule in its own right. If you had to pay for it, it would not be worth installing the sensor.
- When the data revenue falls below a few dollars per year, it costs more to monitor and bill it than you get back, so it's cheaper not to bother with billing it and just take your revenue up front, and
- No consumer is going to sign multiple contracts for dozens of devices – there just is not a business model.

That argues, at least for the very low throughput devices which will make up the tens of billions, that the provisioning cost includes data for life. The network simply routes the data through to the cloud and takes it as a minimum up-front cost. Ideally, provisioning that will be blown in the chip, so that each piece of silicon comes with it. How that gets shared between operators is an interesting

challenge, but it shouldn't be insurmountable. Coming to agreement will certainly keep plenty of lawyers busy for the next few years.

It should be possible for a device to negotiate and "buy" additional data or services once it's connected by requesting a data upgrade from the operator, who will bill those pre-approved charges to a user, who could be a manufacturer, service provider or end customer. But that is application specific.

Put this together and you have a vision of a single chip which can be built into anything from a washing machine, an agricultural sensor, a cattle tag, a smart meter, a dog collar – anything that needs connectivity. As soon as it's turned on it connects, transfers data and continues doing so for as long as the device remains working. The chip vendor and the network operator get paid upfront and there's no ongoing costs, other than processing the data by the ultimate service provider. It gets the cost of connectivity down to a few dollars. Only then will we start to see the growth moving into billions.

This is totally different to current M2M models and operators' understanding of the IoT. I've sat through numerous presentations by cellular operators and infrastructure providers who trot out the 50 billion device number on one slide, followed by data revenue projections of $50 - $100 per device on the next slide, oblivious to the simple arithmetic folly of these numbers – they're claiming an IoT service revenue which is getting on for 10% of global GDP. I don't disagree with Ericsson's new projection that cellular M2M will probably only account for 1 billion connections by 2020. Until we can get to an upfront, all-in cost of just a few dollars, which includes data for the life of the hardware, we are not going to see ubiquitous sensor connectivity at scale. All we will see is more vertical M2M, with IoT waiting for the distant future. What's interesting is that the resulting operator IoT model looks rather like a hardware model of one single upfront payment. But at least that means they can forget about churn, as it's a prepaid subscription for life. Revenue comes from the volume of devices, not the volume of data.

So where does that put our contenders? Assuming that each are good enough for the majority of applications, which they seem to be, the choice of which will win, or perhaps more importantly, of which will fail, comes down to the business model. I should add that although Sigfox and LoRa are getting all of the press at the moment, there are plenty of other equally credible contenders, such as Ingenu (the network formerly known as On-Ramp), SilverSpring's Starfish, Cyan's Cynet, Accellus, Telensa, nwave, Waviot, etc., etc. Unlike Sigfox, LoRa and LTE-M, some of these are already supporting multi-million device deployments – they're just not making as much noise about it.

LTE-M has a big advantage, which is that the infrastructure is potentially already there. Most LTE base-stations can be upgraded to support LTE-M, so it's a no-brainer for network operators. The more pertinent question is when chips will be available to make low cost devices? Qualcomm has come to dominate the market for cellular baseband chips. It owns an extensive range of patents and has been driving innovation and complexity to force up the entry barrier and maintain its leading market position. Until very recently it has shown little interest in ultra-low cost, simple cellular chips. In fact it has largely destroyed the market for them. As a result there are no established competitors for LTE-M; the two main companies are both start-ups – Altair and Sequans. Qualcomm has just announced an offering, but the channel to support and sell to tens of thousands of different product companies is very different from their traditional one of working closely with a very few, very high volume manufacturers. LTE-M also contains a lot of IP, a fair chunk of which is owned by Qualcomm, which could prove problematic for new entrants. So even when chips arrive, the ability of any silicon supplier to support their integration by multiple manufacturers will be challenging.

However, because LTE-M is building on an established platform with a well-developed migration strategy the infrastructure will get deployed. The only question is how much it will get used, because of silicon availability.

At some point, LTE-M will probably be overtaken by NB-IOT, which should be a cheaper alternative, at which point some networks may start to turn off their LTE-M support. This will take years, if not decades, and needs new billing and provisioning systems. So although it may be the eventual winner, the path there may be a fraught one.

To be honest, if both paths weren't so fraught, operators would not be flirting with Sigfox and LoRa, but they're well aware of the impending hole as GPRS disappears, hence they're grasping at contingency plans. They're more afraid of losing out than making the wrong choice.

Taking Sigfox next, modules can be implemented with chips from a number of vendors and there should not be a problem with reducing the hardware cost as it scales. However Sigfox have high expectations. They want to be the global IoT network, running the core service behind every device. They are doing deals with operators to roll out networks, but all of the data comes back to Sigfox servers which then forward that to the individual companies who have deployed devices. The good thing is that the service should be the same everywhere. The flip side is the risk.

Aiming to be a global operator is an immense and somewhat narcissistic ambition. No cellular operator has managed it, although several have spent tens of billions of dollars in failed attempts. Although Sigfox's technology is a much simpler proposition than a mobile phone, the business issues don't necessarily change much. Sigfox is well funded. They have raised around $150 million and their investors probably expect them to be the first French unicorn. The question is what happens if they run out of cash? The network could disappear overnight. No-one can tell whether or not they will succeed, but it is a high risk strategy.

LoRa takes a different approach. The technology is owned by a chip company – Semtech, who acquired it from another French startup – Cycleo. Semtech has formed the LoRa Alliance, which develops the higher layer protocols and makes these available under a royalty free license to members. The LoRaWAN protocol defines how devices are interoperable and how data is transferred by whoever is running infrastructure back to the device owner.

A key difference from Sigfox is that anyone can run infrastructure. Like Sigfox, the LoRa Alliance is out pressing flesh with operators to get them to deploy LoRa networks. But anyone can buy a LoRa base station for a few hundred dollars and set themselves up with a network. Companies can treat it as a private network. Individuals can do it – there's even a crowdfunded initiative – The Things Network, which is deploying a crowdsourced LoRaWAN infrastructure. How well all of this will work together is yet to be proven, but it does allow a company to install their own network if they have a business model to support it, letting them decide where they want to run things. That works very well for localised, as opposed to national deployments, but many applications start that way. It also gives the confidence that if your LoRaWAN infrastructure supplier stops supporting LoRa for any reason, you may be able to rescue your application by installing your own base stations at relatively low cost.

The longevity of the network is something that anyone should take very seriously. In the early days of M2M nobody even thought about the fact that GPRS might one day disappear. It is about to do so. Each generation of cellular is proving to have a shorter working life and that may be true for LPWAN as well. It's a point which Ingenu quite rightly highlight in their marketing presentations,

claiming that have an unparalleled network longevity of 20+ years. If true, that will almost certainly be longer than LTE-M.

Going back to the three business models, we can now add some more detail:

**Sigfox** wants to become a global Internet of Things operator. It's a high risk approach and it means that there is a single point of failure for anyone using them. It is low cost, it's available today, but there is a long way before we know whether they have succeeded in their goal. They are VC funded, so the investors will want to make a return or eventually bail out. That, more than the technology, may determine their longevity and what comes afterwards. But if the path looks rocky, they may change their business model to survive.

**LoRa** is a more distributed concept. Semtech is a well-established, stable chip company. They've invested in the standard and are supporting a multitude of partners to provide hardware and infrastructure. They're letting mobile operators roll out infrastructure, as well as allowing it to be used for public and private networks. How that all connects together is yet to be proven. Each partner is essentially independent, so can succeed or fail. Semtech are the sole supplier of the radio chip, so will end up making around $0.50 on every device that is sold. If volumes reach a billion a year that more than trebles their revenue. Even if it fails as a global network and ends up as a lot of private networks, they still make money selling chips, so there's no one point of financial risk. You'll probably be able to build LoRa devices for decades.

**LTE-M** is there to add more revenue to the operator balance sheet. However, as we've seen above, that may not be very much. If the IoT is to succeed, then operators will need to develop a very different pricing and billing strategy, which they may decide is not worth it. That's also true for the LPWAN options. Where LTE-M has an advantage is that it will come as part of a regular infrastructure upgrade, so support for it just happens. The challenge for volume is getting the hardware price down, where a whole new wave of chip suppliers is needed to disrupt the monopoly that Qualcomm has generated and then to support a diverse range of manufacturers. This takes time. The same thing happened with Bluetooth Low Energy and took at least five years. That was with a far simpler chip with fewer IP issues and a much smaller protocol stack. In theory infrastructure suppliers could configure base station radios to support LPWAN standards, but they are probably too wedded to the 3GPP specification process to want to bring in external, proprietary standards.

Where would I place a bet if I was developing an IoT product? Probably with LoRa, purely because it's an option which is here today and one where I have control over the infrastructure. It plays to applications which are in confined geographic areas, and in time may provide more national coverage. If national or international coverage is important, then it probably needs to be LTE-M. The Sigfox options leaves too many aspects outside my control with no back-up plan.

If another LPWAN offering comes along, will that change my mind? Probably not, unless it had a compelling local infrastructure, which is a powerful consideration. There's not much in the technology to differentiate them – it's all down to the business models behind them. Everything else I've seen adheres to one of those three basic models, so choose the one that's right for you. All three of Sigfox, LoRa and LTE-M are likely to be temporary solutions. We're only having this debate because the network operators and standards groups screwed up by forgetting M2M and data. At some point they should correct that – it might be NB-IOT, or something even better, but that doesn't help companies trying to make products that they can deploy today.

All I can advise is that you think about your product needs, where you will deploy it, how long you need it to work for and what your mitigation strategy is if your network coverage goes away. Forget the tech. Your customer will want IoT because of the value of the data and its reliability. And that's all down to how much you trust your network supplier.

Finally, I cannot overemphasise the importance of bundling data for life into the initial product price – it's the only way that we will get to volume. It's just too expensive to manually provision devices at this scale and then bill them for low value data. If you can't do that at a sensible cost then you've probably either designed the wrong product or are working in a traditional M2M vertical sector, where LPWAN and LTE-M are unnecessary distractions. But once again, it's not about the technology. LPWANs and LTE-M will live or die by their business models.

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