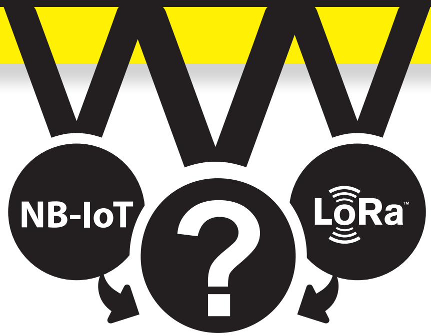
NB-IoT vs LoRa™ Technology

Which could take gold?



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LoRa Alliance™

September 2016

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INTRODUCTION

There are many factors to consider for Internet of Things (IoT) applications, including node cost, network cost, battery lifetime, data rate (throughput), latency, mobility, range, coverage, and deployment model. No single technology will be able to solve all factors simultaneously. NB-IoT and LoRa® technology each have different technical and commercial qualifications that will serve different applications just as Wi-Fi and Bluetooth (BTLE) do. This paper will outline those technical differences between NB-IoT and LoRa and review which technology is likely to fit the demands for different IoT applications.

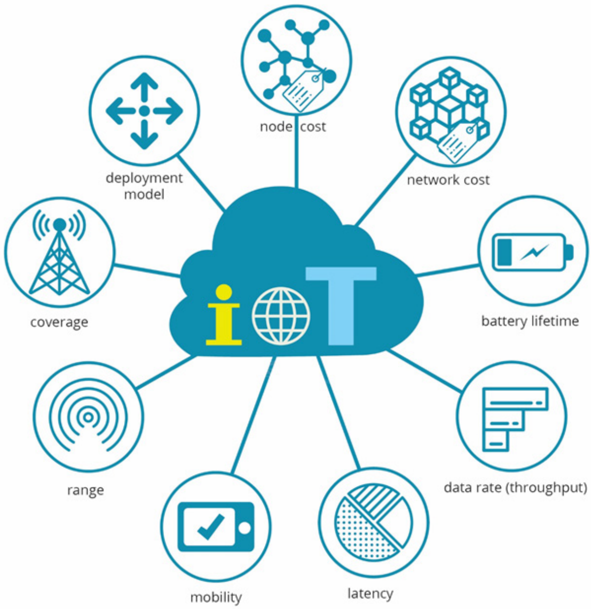

Figure 1 – IoT Application Considerations

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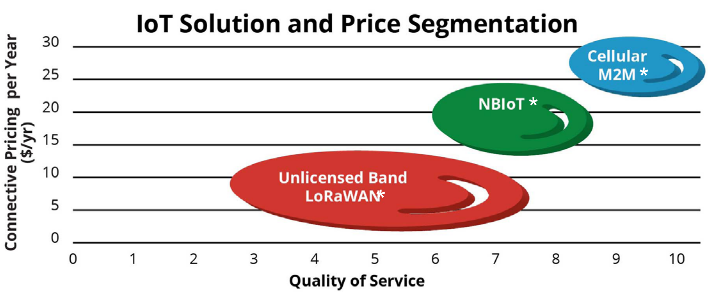
SPECTRUM, QUALITY OF SERVICE AND COST

LoRa is utilized in unlicensed spectrum below 1GHz, which come at no cost to the applications that use it. NB-IoT and cellular communication use licensed bands that are also less than 1GHz. The sub-GHz frequency bands between 500MHz and 1GHz are optimal for long range communication and the physical size and efficiency of antennas.

LoRaWAN™ uses free unlicensed spectrum and is an asynchronous protocol, which is optimal for battery lifetime and cost. LoRa and the LoRaWAN protocol have unique features and were designed to handle interference, overlapping networks, and scalable capacity for very high volumes; however, they cannot offer the same quality of service (QoS) as a time slotted cellular protocol. Licensed band spectrum auctions of the sub-GHz spectrum are typically greater than 500 million dollars per MHz. While the cellular and NB-IoT time slotted synchronous protocol is optimal from a QoS perspective, it does not offer comparable battery lifetime to LoRa, which will be discussed further in Section 3. Due to the QoS and the high spectrum cost, higher value applications that need guaranteed QoS prefer the cellular options, while the low cost, high volume solutions prefer LoRa (Figure 2).



*Market size corresponds to bubble size

Figure 2 – IoT Pricing vs Quality of Service (QoS)

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BATTERY LIFETIME AND DOWNLINK LATENCY

Cellular communication systems are designed for optimal spectrum utilization, which compromises the end-node in terms of cost and battery lifetime. In contrast, in a LoRaWAN network, the end-nodes are optimized for cost and battery lifetime at the expense of the spectrum utilization.

There are two important aspects to consider for battery lifetime: both the end-device current consumption (peak and average) and the contribution of protocol. LoRaWAN is an asynchronous, ALOHA-based protocol, which means an end-device can sleep for as little or as long as the application desires. In a cellular-based synchronous protocol, the end-device must check-in with the network periodically. For example, an average cell phone today has to synchronize with the network every 1.5 seconds even while out of use. In NB-IoT, synchronization happens less often but still regularly, which still consumes additional energy from the battery.

While the modulation used in cellular networks is the most efficient to utilize the spectrum, it is not efficient from an end-device perspective. Cellular modulation (OFDM or FDMA) requires a linear transmitter to create the modulation, and a linear transmitter requires orders of magnitude more peak current than non-linear modulations, such as LoRa. These higher peak currents drain the battery faster and require expensive batteries to support them.

The synchronous nature of a cellular network does create some advantages for applications that require short downlink latency. NB-IoT can also offer faster data rates to support applications that want high amounts of data throughput. LoRaWAN supports class B, which was designed to reduce the downlink communication latency by having the end-device wake up at programmable intervals to check for downlink messages.

For applications with very frequent communication and a very low latency requirement or large amounts of data, NB-IoT will be the best option. However, for applications that need very long battery lifetime and optimized cost, but do not need to communicate as often, LoRa is a better option. “We will deploy multiple solutions to serve as many IoT applications as possible” said Bertrand Waels, head of Alternative Technologies at Orange. “We see strong value proposition in LoRa for certain applications that other technologies options can’t address.”

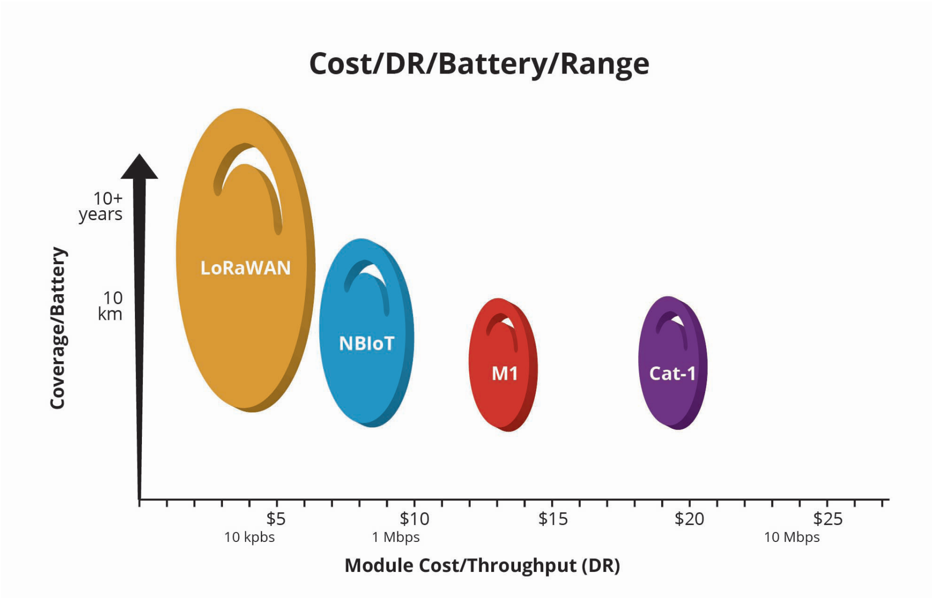

Figure 3– Performance and Cost Tradeoffs

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NETWORK COVERAGE AND TIMELINE FOR DEPLOYMENT

The essential requirement for any volume end-node deployment is network availability. One of the advocated advantages of NB-IoT is that existing infrastructure can be upgraded to deliver the service; however, this upgrade is limited to certain 4G/LTE base stations and is expensive. While this strategy is viable for a dense city environment that has or will have 4G/LTE coverage—which is NB-IoT's projected target area—It is not ideal for rural or suburban regions that do not or will not have 4G coverage. The NB-IoT specification was released in June 2016 with end-device silicon predicted to be available in the first half of 2017. Once they are commercially available, it will take additional time to establish an ecosystem and move the products to mass production, in addition to having NB-IoT network coverage roll-out. Depending application or opportunity, this turnaround time may be too long.

LoRa components and the LoRaWAN ecosystem are mature and production-ready now, while nationwide deployments are still in the rollout phase. One significant attribute of the LoRaWAN ecosystem is the components' operability in the private or enterprise model as well as the public network model. Many large enterprises are planning a hybrid model that deploys a network in their facility and utilizes the public network for coverage outside of their facility. NB-IoT deployments are restricted to a cellular base station public model only.

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DEVICE COST, NETWORK COST AND HYBRID MODELS

For the end-device, the LoRaWAN protocol is more simple compared to NB-IoT and can be easily implemented with low cost, widely available microcontrollers. The modulation of NB-IoT and the protocol is more complex, which increases the silicon area and cost of the solution. NB-IoT, as well as 3GPP, has an issue with IP royalties. Today, a typical royalty for a cellular phone is five dollars, which is too expensive for IoT; however, lowering the royalty could cause price erosion in the cellular market royalties. The 3GPP community will need to come up with a solution to address the high royalties for IoT while maintaining that source of revenue for cellular communication.

Highly integrated, low cost LoRa modules are already available, and new, more integrated options will be release soon. There are no royalty issues to create margin stacking in the LoRa Alliance community so modules under four dollars are much more feasible in the LoRaWAN ecosystem. Certified LoRaWAN modules today are in the $7-10 range but are expected to reach the $4-5 as integration and volumes mature within the ecosystem. Alternatively, today cellular LTE modules struggle to get below $20.

For IoT and LPWAN, different deployment models will be used to lower the CapEx and OpEx costs of deployment compared to traditional deployment models solely based on towers. LoRaWAN deployments will cost much less, utilizing a mix of traditional towers, industrial gateways and in-home pico gateways. The price of tower top gateway is in the range of $1000, industrial gateways are less than $500 and low cost pico cell gateways are in the range of $100. For NB-IoT, upgrades to existing 4G LTE base stations can cost as much as $15,000 each.

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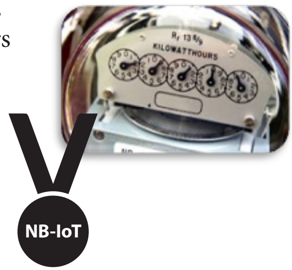
APPLICATION EXAMPLES

NB-IoT or LoRa™– WHICH FITS BEST?

The application requirements, technical differences, deployment models, device costs, and deployment timeline will dictate which technology is used for each specific vertical. As previously stated, not one technology will serve all the different IoT applications equally. Below, different application use case requirements are discussed with a summary of which technology fits the requirements.

a Electric Metering

In the electric metering market, utility companies typically require high data rates, frequent communication, and low latency. Since electric meters have a power source available, they do not require ultra-low power and long battery lifetime. Utility companies need real-time monitoring of the grid so they can make immediate decisions based on load, outages and other interruptions. Electric meters could be implemented with LoRaWAN as class C in order to have low latency, but due to the desired higher data rates and frequent communication, NB-IoT is a better fit for the application. Electric meters are also in stationary locations in mostly densely populated areas so it is easy for cellular companies to provide or guarantee coverage with NB-IoT.



b Precision Farming

For agriculture, very low cost sensors with a long battery lifetime are desired. The use of moisture, temperature, and alkalinity sensors can significantly improve the yield and reduce water consumption for one of the largest global markets. The sensors need to update their information a few times per hour as the conditions do not change radically. LoRa and LoRaWAN are ideal for these requirements. In addition, many farms do not have cellular coverage today and even more do not have 4G/LTE coverage so NB-IoT is not a viable option for the foreseeable future.

c Manufacturing Automation

Real time monitoring of factory machinery can prevent maintenance-related line down and can allow for remote control to improve efficiency. There are many different types of sensors or requirements in factory automation. Some applications need frequent communication and a guaranteed QoS so NB-IoT is a better fit than LoRa. Others need low cost sensors with long battery lifetime to track equipment, monitor status, and conditions which is a better fit for LoRa. Due to the wide variety of requirements for this segment both NB-IoT and LoRa will be utilized.

d Intelligent Building

Monitoring temperature/humidity, security, moisture, occupancy, HVAC, water flow, and electric plugs can provide building property managers with alerts and alarms direct to their mobile device to prevent damage and respond to requests instantly without having manually monitor in the building. The usage and cleaning of buildings can also be done more efficiently. The requirement for these sensors is low cost with a good battery lifetime. They do not require frequent communication or a guaranteed quality of service. Pico cell gateways, which can be placed in basements or underground parking garages to ensure coverage through 100 percent of the property, are also desired so LoRa is a better fit for this vertical.

e Retail Point of Sale Terminals (POS)

Point of sale (POS) systems must have a need for guaranteed quality of service (QoS) since they handle frequent communication. These systems are also powered so there is no constraint on battery lifetime. There is also a strong desire to minimize latency and turn-around time because long latency times can limit the number of transactions a store can make. Due to the QoS and frequent communication, NB-IoT is a better fit for this application.

f Pallet Tracking for Logistics

The key attributes to unlocking high volume in this market are cost and battery lifetime. Being able to track pallets to determine the location or condition of goods is highly desirable. Pallet tracking is a good example of a hybrid deployment solution. Logistics companies can have their own solution so they have a guaranteed coverage in their facilities. Low cost gateways can be easily deployed to cover sorting facilities and also deployed on vehicles as mobile gateways. A LoRaWAN public network can be leveraged when outside the facilities or when goods arrive at customer locations. 4G/LTE for NB-IoT might not be available for all logistic locations, which are typically in rural locations. LoRa also has the unique technical properties, which make the communication more reliable when moving at high speeds than the narrow band signals. Due to the low cost, long battery lifetime, and capability to have a private solution to guarantee network coverage in all sorting facilities LoRa is a better technology choice.

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SUMMARY

There will be no undisputed champion of IoT. Each application vertical will have its specific requirements and considerations which will lead to different technology. This paper has described the different technical and commercial tradeoffs for NB-IoT and LoRa and both will have their place in the IoT market. LoRa will serve the lower cost high volume application segments, NB-IoT will serve the higher value applications that are willing to pay for a higher quality of service where offered.

More information can be found at
www.lora-alliance.org

This white paper is sponsored by the LoRa® Alliance Members.

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