IOT STANDARDS

IoT Standards Matters will look at different segments of the IoT market as it relates to implementation and use of standards. Each column will select a particular vertical, and lay out the relevant standards and technologies that affect the evolving IoT hyperspace. The pace of the columns will start broadly with the vision of narrowing the subject of subsequent articles toward more specific applications of standards, whether in the development, application, test, or commissioning of IoT technologies.

Standards Matters

by Mike Violette
Washington Laboratories, USA

The NarrowBand IoT Standard

The throb of big data on the Internet of Things is not necessarily due to financial transactions, Netflix, and cat videos on Youtube. Much of the rise in digits is/will be the connection of many millions of mundane reports of pressure, temperature, the flow of electrons, or water, or the chattering of soda machines calling for refills.

This is the realm of machine-to-machine (M2M) technologies and Low Power Wide Area Networks (LPWAN), and the deployment of these low data rascals will push the development of enhanced backhauls and deployment to feed them. Narrowband IoT (NB-IoT) is a standards-based M2M technology supported by cellular operators.

Boldly, but unapologetically ripping off Wikipedia:[1]

"NB-IoT focuses specifically on indoor coverage, low cost, long battery life, and high connection density. NB-IoT uses a subset of the LTE standard, but limits the bandwidth to a single narrow-band of 200kHz. It uses Orthogonal Frequency Division Modulation (OFDM) for downlink communication and Single Carrier Frequency Division (**SC-FDMA**) for uplink communications."

If we take each of these sentences apart, we get a sense of the impact of the development of NB-IoT standards.

Indoor Coverage, Low Cost, Long Battery Life, and High Connection Density

"Ubiquitous sensors" that are part of the Internet of Things are already widely deployed, such as in industrial environments and agricultural applications. Many of these verticals are mature and have improved efficiencies and lowered costs for various production scenarios. One example is Duke Energy, which has an aggressive IIoT (Industrial IoT) program with the following features, deployed over 30 installations:[2]

- Identified over 10,000 assets across their facilities, adding more than 30,000 sensors, including:
  - –Accelerometers
  - –Temperature sensors
  - –Oil analysis sensors
  - –Thermal cameras
  - –Proximity probes
  - –Electromagnetic signatures

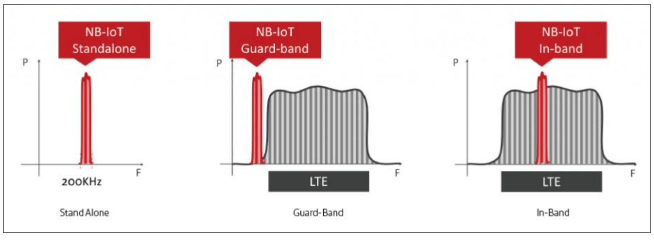


FIGURE 1. Three scenarios for deploying NB-IoT: stand-alone, guard band, in-band.[3]

Their scheme employs constant data collection, which means that there is more time for analysis and predictive maintenance (PM). Ongoing "health status" allows the gradual planning of PM, which improves up-times and helps scheduling. These many thousands of sensors are distributed, but figuring they're all talking at some rate, the aggregate data payload adds up quickly.

A Subset of LTE: A Single Narrowband Carrier of 200 kHz

"Regular LTE," which gives us the magic of gorging on any season of "The Walking Dead" while riding our Uber back from the bar, has a theoretical channel capacity of up to 100 Mb/s (all conditions right, and more if multiple-input multiple-output, MIMO, is employed). This is necessary for streaming video at resolutions that consumers are expecting. Compare this to the NB-IoT channels (frozen in Release 13 of the Third Generation Partnership project, 3GPP, specification), which are a mere 180 kHz wide and can support up to 250 kb/s channel capacities. Latencies are up to 10 s, but who cares? The point is that the data being fed back change very slowly, and just small bits of time/spectrum are needed to carry the information over the network. Of course, put a few thousand of these out there, communicating constantly, and one can imagine the data blooming on the backhaul.

For the wireless industry, the development of the NB-IoT standards and solutions has given rise to many applications that previously would not have a chance of being monitored, much less automated through the web.

Now, who is excited about that? Well, the carriers, naturally. AT&T claims that 80 billion devices will be web-connected by 2025, many by NB-IoT. That's a lot of subscriptions and SIM cards for more and more cellular devices; with data portability now a reality (my T-Mobile account gives me unlimited data overseas — in many markets anyway, which is remarkable). "Global SIM cards" make deployment of IoT devices through distributed networks a true reality.

On the regulatory side of things, the authorities are fostering this growth by largely staying out of the way. In the United States and Canada, anything that uses the cell networks is by definition a "licensed device" and must undergo a two-part process to be deployed. The first part is *certification*, which means measurements of RF parameters (frequency, power, occupied bandwidth, spurious emissions, etc.), followed by a *licensing* process. Now, this is common in mobile devices; the manufacturer of the device is responsible for the certification, and the network operator holds the license. Many IoT solutions will take advantage of "modular certifications," which means that the device integrator doesn't need to fuss with additional platform-level *radio* testing (but must do some electromagnetic compatibility, EMC, testing). It might be as easy as plug and play.

Now, this brings up the problem of interference because the NB-IoT carrier may well be placed (allowed) in the same spectral block of "normal" LTE. Spectrum contention may arise here, especially if the LTE signal is stronger than the NB-IoT signal. To alleviate this somewhat, the device designers may boost the NB-IoT signal by 6 dB or so to overcome the "noise floor" of

Editor's Note: Text appearing in bold indicates a live link in the online version.

the LTE signal. This really doesn't bother the LTE signal because of the brief time of transmit and the fact that NB-IoT is only stepping on a single resource block in the LTE band.

Other ways to implement NB-IoT are to either find some wide open space or to place the signal in a guard band between LTE allocations.

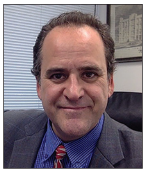
Note the "power boosting" for the in-band signal. The exact power increase would depend on the signal-to-"noise" ratio for whatever throughput is necessary. This example is just one twist on the deployment of NB-IoT devices, which comes at an exciting time for the connected world.

System-Level Issues

Apparently, NB-IoT came out of the study phase very quickly. Much of this is due to the reuse of existing well-known and stable modulation techniques. Frequency-division modulation techniques are well advanced, and chipsets can be (relatively) quickly re-tooled to be installed in whatever use case the developer is after. The Holy Grail here, of course, is cheap and lean. Related technologies are striving for 10-year battery lives and very high reliability.

For system designers, it behooves them to consider spectrum management and planning early in the game. The "nice" thing about these designs is that they are, really, software defined radios, so reconfiguration and re-assigning the operating bands for a certain device doesn't mean that it's back to the drawing board; just a little firmware or time in a GUI can do the trick.

A final comment is that the standard for NB-IoT, while based on existing technologies, came out in a very rapid manner, within something like nine months after the end of the study phase.[4] Deployment of the many billions of things connected through the Internet looks pretty certain to follow quickly.



Michael Violette (mikev@wll.com) is president of Washington Laboratories and director of the American Certification Body. He has over 25 years of experience in the field of EMC evaluation and product approvals, and has overseen the development of engineering services companies in the United States, Europe, and Asia. He is a Professional Engineer, registered in the State of Virginia. He has given numerous presentations on compliance topics and is a regular contributor to technical and trade magazines.

FOOTNOTES

[1] https://en.wikipedia.org/wiki/Narrowband_IoT
[2] http://www.embedded-computing.com/iot/apr18-duke-energy-case-study
[3] https://blog.viavisolutions.com/2017/12/18/3gpp-nb-iot-deployment-and-optimization-challenges/
[4] http://www.3gpp.org/news-events/3gpp-news/1785-nb_iot_complete