Internet of Things (IoT): What's Next

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IoT was initially a hype curve based solely around the increasing number of deployed and potential sensors. We can now look out to the future and discuss some focus success factors. Future trends for IoT include IoT applications that will clearly show an economic benefit for an end customer. There's also the trend toward even longer battery life to multiples of years. In any wireless-based IoT monitoring system, the transmission of data consumes power. Therefore, smart partitioning, where sense and process happens at the edge and smaller amounts of data (at a more sporadic or shorter duration) due to local decision making, can substantially add value to IoT systems. Finally, a future critical element will be the ability to operate securely and reliably. Therefore, the focus of IoT designs will move to key performance indicators such as trusted sensors and system up-time for the most successful IoT systems. Analysts predict that low cost development systems are now at the peak of inflated expectations. I predict these IoT platforms will have flooded the mass market within a year and it will be the differentiated or specialized high precision sensors and analog signal chains that will really move the IoT market into the future over the next two to five years.

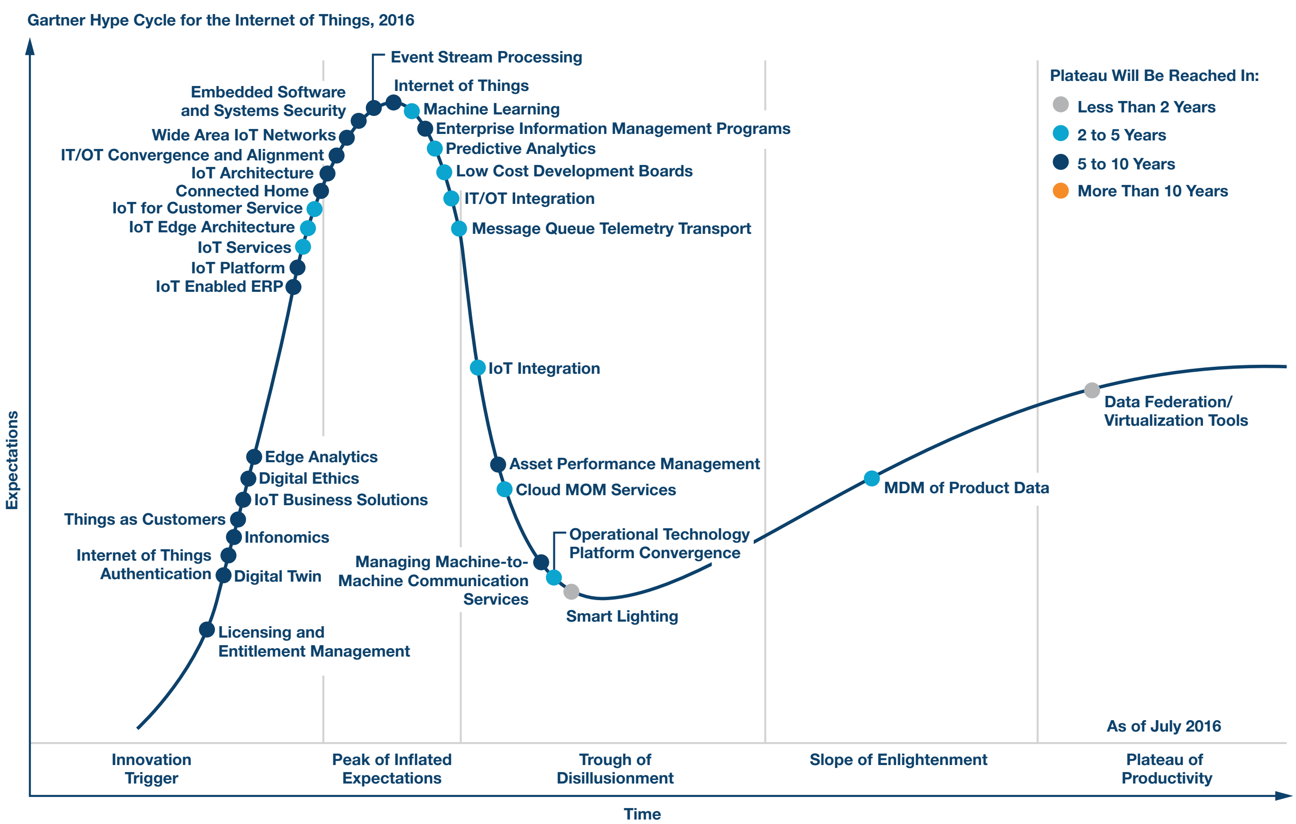

Figure 1a. A hype curve superimposed with low cost development board data points.

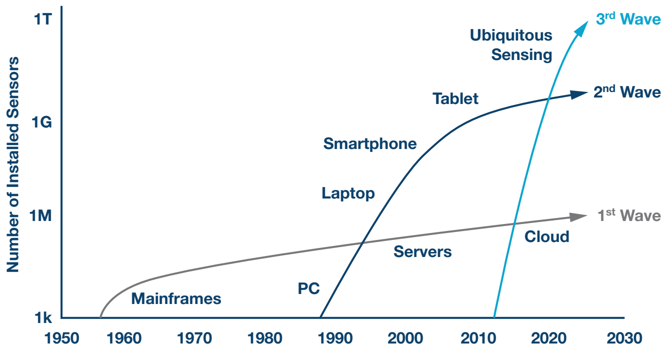

Figure 1b. The three waves of the digitalization of the world.

The Importance of Better Data

One of the key processes for an IoT system is the transformation of an analog signal into a digital representation. And simply put, the better that this is done, then the more useful the data will be. Silicon innovation enables this conversion and interpretation of the world around us by bridging the physical and digital domains with technologies that sense, measure, interpret, and connect.

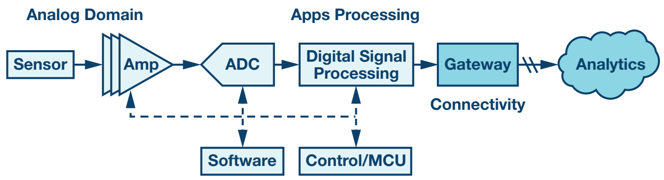

Figure 2. From the sensor to the cloud.

The most effective IoT deployments are where this data can be used to determine change. And the best change is one that that gives the most value to an end customer, such as better efficiency or superior safety—like in a factory where machine learning not only identifies when machine predictive maintenance might be required in the future but that also identifies details to a level that gives much better insight into what actions are required (for example, identifying a unique ball bearing for wear and tear in a motor).

Therefore, the first stage of any IoT system is to sense, measure, and then transform the real-time signals into analytical data. How well this is done will set the stage for success further down the line. If you put garbage in, then you're going to get garbage out of any IoT analytics cloud platform. So the most successful IoT systems will measure and report to a level that no other system can do.

This need for improved measurement and reporting makes good hardware very relevant. Recent Gartner reports agree. They suggest that low cost IoT development boards are rapidly reaching the *trough of disillusionment*. This may be due to the number of low cost development platforms that are available. However, I suggest that it is more likely due to a stronger focus on more challenging IoT applications that deliver real economic value. These rely on data outcomes that rough measurement simply can't support.

IoT System Partitioning Between Node and Cloud

The cloud enables extended and multiple signal chains to include analytics and big data. A major part of IoT applications will need significant intelligence at the edge node—this will be due to a number of factors, including a lack of bandwidth (or to be more precise: the data transfer rate limitation for error-free transmission) to transmit all the data to the cloud or latency issues where the speed of action needed at the node means that the system cannot wait for a response to come back from the cloud. Therefore, there will be multiple control loops at the node, at an intermediate gateway, and in the cloud. The cloud will enable the aggregation of data for a large number of sensors and from this data, the settings at the edge will be adjusted. McKinsey suggests that as little of 1% of cloud data is actually used and the addition of security threats means that keeping data local has advantages.

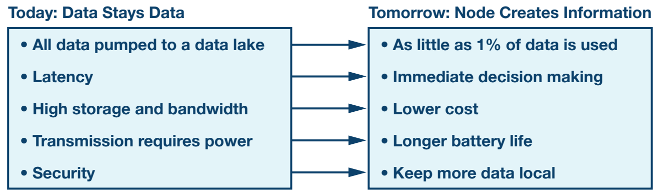

Figure 3. Intelligence at the edge node, today and tomorrow.

Smart partitioning and embedding of algorithms in the sensors allows the most critical data to be interpreted in real time at its source. Algorithms embedded into intelligent sensors and in the cloud allow for interpretation beyond what can be done with silicon alone. In fact, this leads to the possibility for prediction and anticipation of future system behavior. Accelerating adoption of IoT solutions in mission critical applications is dependent on the ability to build secure systems and intelligent partitioning enables this.

Cloud computing allows insight that can be gained from this linking of numbers of rudimentary sensor readings and tying these individual sensor readings according to time, location, and other sensors. There are two pieces to this: the ability to detect changes in data (for example, the drift in machine performance), and the ability to create a digital twin that is a software model of the physical thing (such as a motor) or system. These digital twins can be used to proactively repair equipment or plan manufacturing processes. This is a part of what is envisioned in the explosion of sensors in the coming years and the ability to monetize with software and services.

In industrial automation, active machine monitoring can transform factories by radically improving up-time efficiency both locally for real-time optimization and intervention and in the cloud, where information from multiple systems across multiple factories can be aggregated, analyzed, and acted upon to improve productivity.

So smart IoT system partitioning can ensure that the cloud is used effectively.

Reliable Data Is Key

The final piece important to IoT involves creating a wireless network. The vast majority of connected objects will connect wirelessly back to the cloud using RF and microwave frequencies. Operation will be diverse from short to long operating ranges or low to high data rates. Some devices may go months or years without communicating and some will need to operate across mission critical secure networks. Many of these sensor nodes will also be self-powered through batteries or energy harvesters, so efficient operation will be key. The communication networks are critical to transport the intelligence from sensor to cloud across differing requirements.

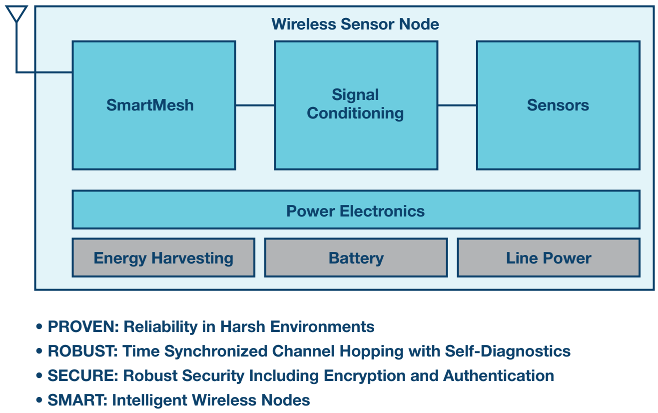

Figure 4. Reliable IoT networks.

But reliable operation will be the most critical element to successful IoT systems. All of these diverging requirements will place major importance on the communication networks needed to transport the intelligence from sensor to cloud. The ability to operate reliably is especially challenging in harsh environments, such as factories built with metal and concrete throughout. Customers ideally want a technology that is low cost, low power, and that has low latency. They also want the ability to scale with unrestricted sensor placement. The ability to create a reliable network, independent of the wireless protocol, will be in the ability to maintain this high reliability by using alternate pathways and channels to overcome interference.

To learn more about low power, secure wireless networks from ADI, visit *www.linear.com/dust_networks*.

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Patel, Mark, Jason Shangkuan, and Christopher Thomas. “What’s New with the Internet of Things?” McKinsey & Company, May 2017.

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