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BONUS SUPPLIER GUIDE

INTERNET OF THINGS

Internet of Things: Opportunities for carriers and their vendors

By Martha DeGrasse

Repo

SEQUANS COMMUNICATIONS

"When wireless is perfectly applied the whole earth will be converted into a huge brain, which in fact it is, all things being particles of a real and rhythmic whole."
– Nicola Tesla, 1926.

Ninety years after Tesla made this prediction, vehicles that bear his name use wireless networks to receive and respond to instructions in real time. These connected cars are part of the "Internet of Things," a phrase coined by author Kevin Ashton in 1999 when he was a brand manager at Procter & Gamble and wanted the company's executives to understand how the Internet could help with supply chain management.

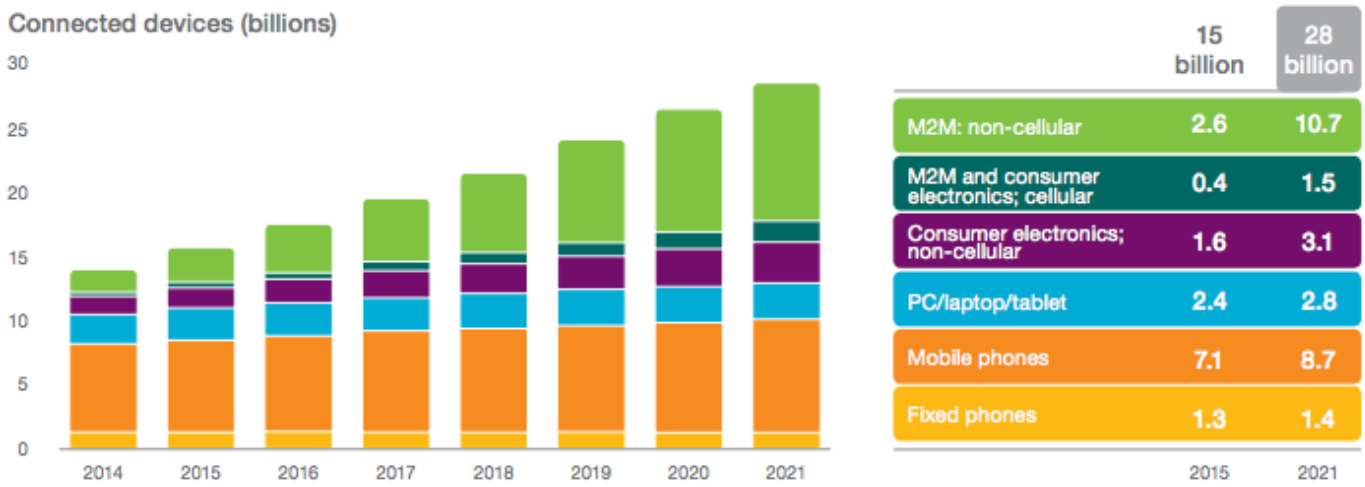
Now as the Internet of Things becomes part of our common vernacular, industrial applications like supply chain management and asset tracking are still seen as the most promising IoT use cases, despite the significant buzz around the wearables market and the connected home. Wireless carriers and device makers often focus on IoT use cases that involve the consumer, but commercial use cases are emerging just as quickly.

While consumers have been driving advances in mobile computing through their voracious appetite for data, the enterprise demand for data of a different kind has driven advances in sensor technology. Now these two trends are intersecting and the Internet of Things is creating new opportunities for businesses in a wide variety of industries.

Where will wireless carriers and their vendors fit in? This report will outline some of the major opportunities for these companies, and will discuss the low-power, wide-area networks that can be seen as competitors to the carriers.

Ericsson estimates 400 million machine connections currently use cellular networks and sees that number growing to 1.5 billion by 2021. Cellular networks will continue to handle many of the high-value IoT connections.

"The technology that's really grabbed people's attention up to now has been cellular and that's been increasing in capability and reducing in price over the last decade," said Robin Duke-Woolley, founder of research



[1] Traditional landline phones are included for legacy reasons
Examples of M2M: connected cars, machines and utility meters, remote metering.
Note: A connected car is herein counted as one "thing" though it may have hundreds of sensors.
Examples of consumer electronics devices include: smart TVs, digital media boxes, Blu-Ray players, gaming consoles, audio/video (AV) receivers, etc.

Source: Ericsson Mobility Report

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Robin Duke-Woolley, Beecham Research

"It's a big business for us, it's a growing business for us and it's a very strategic business for us"
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firm Beecham Research, which specializes in IoT market analysis.

Duke-Woolley said the role of cellular networks could be threatened as more industries start to use low-power solutions to connect sensors to the Internet. Mobile network architects are designing networks to handle as much data as possible, but the Internet of Things will require low-cost, low-power networks to support billions of sensors.

"They're not sending very much data," said Duke-Woolley. "They might need to send data on a regular basis … not very much of it to get across, but there might be an awful lot of them. That's not really an area that cellular can help with in its current configuration."

New configurations are emerging to support more IoT applications over cellular networks and some carriers are also looking at non-cellular technologies. In 2015, mobile operators started to prioritize the Internet of Things as its enormous potential came into sharper focus.

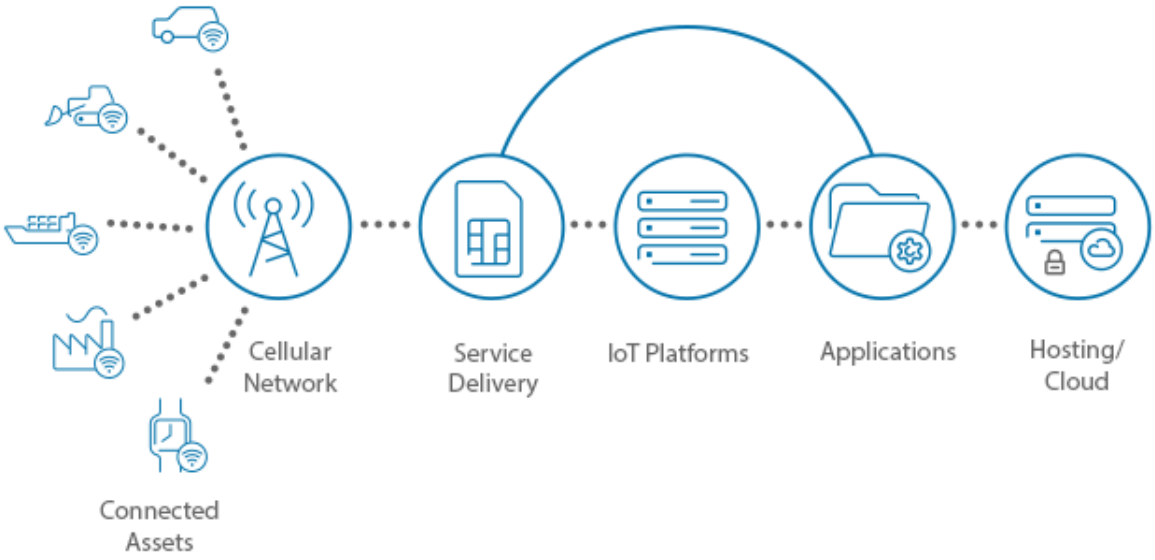
"This year was pivotal for IoT. We saw, and are continuing to see, tremendous global interest and adoption from virtually every industry," said Ralph de la Vega, CEO of AT&T's mobile and business solutions group.

AT&T identifies IoT priorities

Although 25 million non-communication devices are already connected to AT&T's network, the number of devices that will connect to the Internet in the years ahead is orders of magnitude larger. An estimated 20 billion devices will be connected to the Internet within the next three years, but fewer than half of those will use cellular networks.

"The carriers know they can't do this on their own. They need a whole ecosystem of partners. AT&T has really been at the forefront of that," said analyst Stephanie Atkinson, founder of Compass Intelligence.

"What we are looking at from an AT&T perspective is how can we add value even if the connectivity is happening beyond the cellular connectivity," said Mobeen Khan, enterprise IoT practice leader at AT&T Business Solutions. Khan said in the months ahead AT&T will have a series of IoT-related announcements that involve non-cellular connections, like satellites and Wi-Fi networks.



Source: AT&T

"It's a big business for us, it's a growing business for us and it's a very strategic business for us," Khan said.

So far, most of AT&T's non-communication devices have connected to its 2G network using the carrier's global SIM cards. The global SIM is supported by 600 operator networks in more than 200 countries, and is used in factory equipment, farm equipment, ships, watches and vehicles.

In 2015, AT&T signed more than 300 agreements to connect devices in the automotive, industrial, healthcare, shipping, home security and municipal sectors. Of the 25 million IoT devices now connected to its network, 5.8 million are connected cars.

"[The] car is one of the most important areas for two reasons," said Khan. "One is the automobile manufacturers are looking to get better information about what's going on in the car … and the second layer is the back seat entertainment in the car."

Like smartphones, connected cars can be used as mobile hot spots, and this means that they can produce revenue-per-user numbers similar to those seen from smartphone users. In addition, the data collected from connected cars can be repackaged and sold to insurance companies, creating another revenue stream for mobile operators.

Khan said AT&T looks at the Internet of Things in terms of connectivity, platforms and solutions. Connectivity is one part of the picture, but AT&T wants to offer platforms and solutions even in use cases that do not use AT&T's network for connectivity.

Platforms are the application programming interfaces and portals that manage the connectivity, services and policies. Just as standard APIs have facilitated the development of mobile apps, Khan foresees the need for common languages to develop IoT applications.

Solutions are the IoT use cases. Khan said connected cars, smart cities, asset tracking and industrial applications are currently AT&T's main focus areas for IoT solutions.

In early 2016, AT&T said it is launching a smart city framework in Altlanta, Dallas and Chicago. The carrier is partnering with Cisco, Deloitte, Ericsson, GE, IBM, Intel, and Qualcomm to help support its smart cities initiative.

AT&T also announced a new chip solution for smart cities and industrial IoT applications in early 2016. The carrier is launching a low-power Category-1 LTE-only chipset solution for connected sensors and other IoT applications. Category-1 is a flavor of LTE that transmits at much lower data rates than the higher category LTE protocols used by smartphones, but is compatible with current network equipment. AT&T said its LTE-only Cat 1 module supports download speeds up to 10 megabits per second and upload speeds up to 5 Mbps.

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Verizon Wireless focuses on LTE

Verizon Wireless divides its IoT business into customer-facing solutions (like wireless self-service kiosks and digital signage); asset tracking and fleet management; machine monitoring; and telematics, which can be thought of as a combination of asset tracking and machine monitoring.

Verizon has started to talk about the Internet of Things in terms of dollars as opposed to connected devices. The carrier said its IoT-related businesses generated $495 million in revenue during the first three quarters of 2015.

The carrier has not said how many vehicles are connected to its network. While AT&T has partnered with a number of automakers for connected car solutions, Verizon has focused on aftermarket solutions like Hum and Delphi Connect. These are services consumers can purchase to turn almost any vehicle into a connected car.

Like AT&T, Verizon looks at the Internet of Things in terms of connectivity, platforms and solutions/applications. In October 2015, the company told Fortune magazine it foresees 80% of the revenue in IoT coming from applications, 15% coming from platforms and just 5% coming from connectivity.

But for now connectivity remains at the core of Verizon's IoT strategy. While AT&T is clearly looking beyond the cellular network when it comes to IoT, Verizon seems more focused on the potential of its LTE network to connect new devices. Currently the carrier is focusing on LTE connections by adding a dedicated core network that it says will be optimized for Category-1 devices.

"LTE-M or Category M solutions coming online next year are going to really be a very direct replacement for 2G connectivity in terms of price, performance, [and] power."
Craig Miller, Sequans

Verizon is working with LTE modem maker Sequans, which has capped data upload speeds at 10 Mbps in its Category-1 solution. Sequans sees Category-1 as an intermediate step on the road to a version of LTE that will be customized for the Internet of Things: LTE-M or LTE for machines.

"LTE-M or Category-M solutions coming online next year are going to really be a very direct replacement for 2G connectivity in terms of price, performance [and] power," said Sequans marketing director Craig Miller.

As IoT connections migrate from 2G to LTE, Verizon wants developers to create new applications that will encourage enterprises to connect more devices to the Internet. This year Verizon launched an IoT platform called ThingSpace with the goal of giving developers a common language for IoT apps even if they are not Verizon customers. ThingSpace is also a platform for customer device management.

"Despite the exciting potential, IoT is still too complex, too fragmented, too expensive to connect and too hard to scale," said Mike Lanman, SVP for enterprise products at Verizon. "Success in that future relies on a leader that can cut through the complexity and change the IoT model. That's where Verizon comes in. With our experience in networks, devices, platforms and applications, we are taking a holistic approach to simplifying adoption to expand the IoT market from millions to billions of connections."

Other IoT pioneers: Telefónica, SK Telecom and Orange

Several carriers are investing in low-power wide-area network technologies, in addition to working on IoT applications within their existing networks. Telefónica and SK Telecom are investors in Sigfox, a leading developer of low -power wide-area networks.

Telefónica has also developed a platform called Thinking Things that includes hardware with embedded Telefónica SIM cards, APIs for developers, and both Web and

Source: Telefónica

mobile interfaces. The company claims to have connected vending machines, elevators, refrigerators and trucks.

Telefónica provided seafood distributor Ansomar with a "black box" IoT solution to monitor the temperature of its cargo from the country of origin until it reaches the customer. The solution includes an application for monitoring the temperature of the water that cools the fish, and also tracks temperature, location and driving behavior.

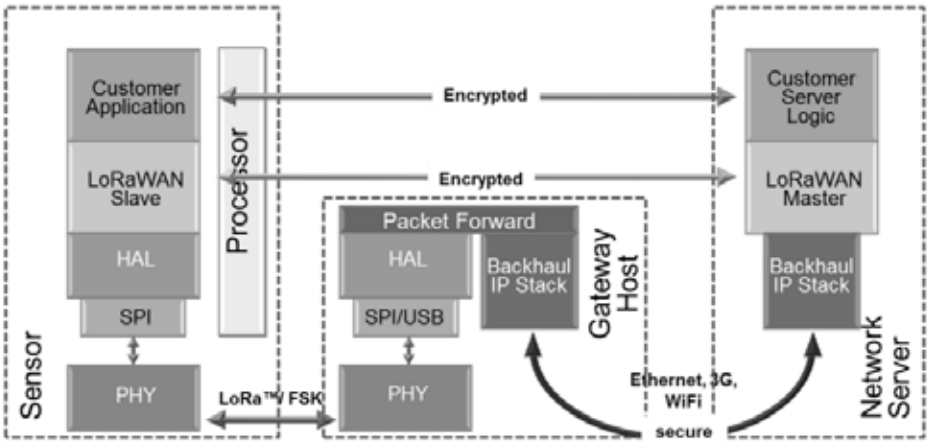
Other carriers are developing platforms that rely on shared standards. SK Telecom has created an IoT platform called ThingPlug based on the OneM2M standard. Formed in 2012, OneM2M is a global organization working to create an interoperable standard for IoT communications and services. Several other groups are also trying to develop standards, and this creates uncertainty for investors, companies, software developers, and network operators.

SK Telecom is also working to interconnect its smart home platform with those of Samsung and LG. The goal is to enable SK Telecom's smart home customers to control and monitor Samsung and LG home appliances with SK Telecom's smart home application.

In partnership with Nokia, SK Telecom has completed over-the-air trials of low-power LTE, using Nokia's Flexi Multiradio 10 base station and IoT devices provided by GCT Semiconductor. The companies said they are able to eliminate non-essential device operations and switch the devices to power saving mode when they do not need to transmit.

Low-power, low-cost LTE is coming, but other chip technologies are specifically designed for low-power transmission over large areas. In France, mobile operator Orange said it will deploy a nationwide IoT network based on long range radio technology.

Orange is an investor in Actility, an IoT service platform provider and sponsor member of the LoRa Alliance, a nonprofit group that also includes IBM, Cisco, Semtech and KPN among others. LoRa



Source: LoRa Alliance

stands for long range radio.

Orange is also working on a cellular IoT trial with Ericsson using spectrum in the 900 MHz band. The companies are working to extend the transmission range in order to connect equipment located in deep basements, on farms and in other remote areas.

"We are very excited about this because we can do this by a pure network software upgrade," said David Hammerwall, strategic product manager in Ericsson's radio group.

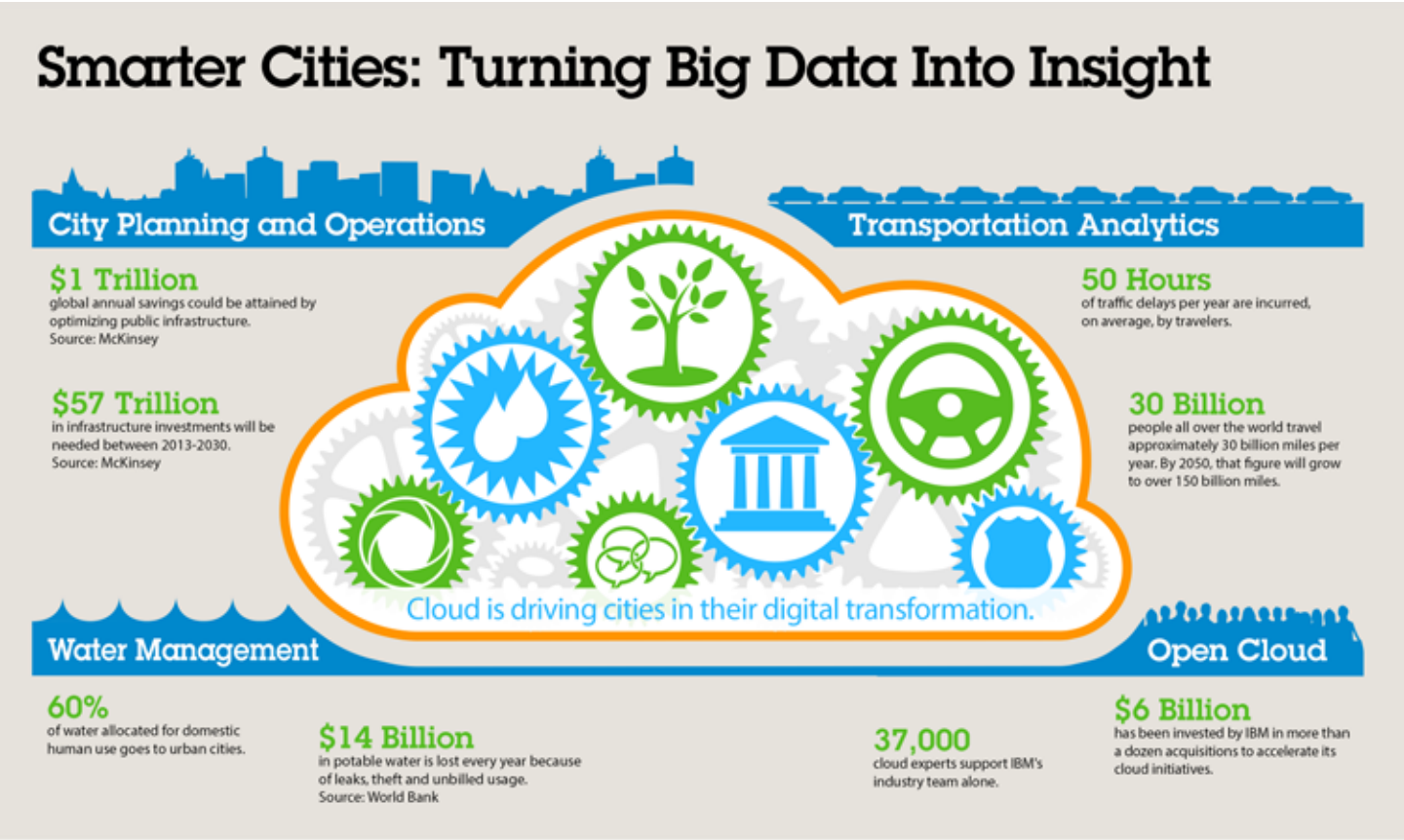
"It works by adding redundancy, so you repeat the transmissions multiple times, so you give the devices on the network multiple opportunities to decode the messages. So by adding this to all the radio channels you are able to then extend the coverage by up to 20 dB or in other words going to seven times the area coverage."

Orange has also announced a "4G Kit for IoT" powered by Sequans' LTE chipset and radio technology from Alcatel-Lucent's Bell Labs, now part of Nokia. The kit consists of Sequans' LTE chipset incorporated into a three-band M.2 module for LTE bands 3, 7 and 20, supporting Orange's LTE network. The module connects to a small form factor Olimex development board and includes plug-in antennas.

Monetizing the IoT

Mobile operators know they will not be able to charge as much for connecting things as they charge for connecting people. The revenue from each IoT connection is estimated at 10% of the revenue from each smartphone connection.

The economics of IoT connections often



Source: Dataflog.com

improve for carriers when data from a non-cellular network can be aggregated at one access point that connects to the cellular network for backhaul. Network equipment maker Belden sees mobile networks expanding in this role.

"We're looking at introducing cellular products to connect things like oil fields, wastewater treatment plants, trains, other places where you want to bring data off of a system and it could be easier or more cost effective to use that already existing network," said Jeff Lund, senior director in Belden's industrial IT division.

Many carriers will have opportunities to do more than aggregate and transmit sensor-generated data. Over time, carriers probably have more to gain from analyzing data than from transmitting it.

"The data is where the value is, not the connectivity," said Cisco's Steve Steinhilber, VP for industry solutions and partner ecosystems. "It's what you capture, how you use it." Steinhilber said there will be intellectual property issues to resolve as connected devices generate more and more valuable data, which could end up belonging to carriers, enterprises or even individuals.

"Business process has to change and data collection and analysis has to change. … Around this bucket of opportunity over the next 10 to 20 years there will be about $19 trillion of economic value," Steinhilber said.

Much of that value will come in the form of new products and services developed as a result of insights gleaned from connected machines. Some will flow to cloud service providers who store, secure and analyze data.

"Some of that becomes mission-critical data that's going to end up in the cloud most likely, and you have to ask the question 'Is that cloud secure, is the data secure and who do you trust?'" said Bob Gessel, head of network and technology strategy for Ericsson in North America. Gessel sees an opportunity for service providers who can offer solid security solutions for connected devices.

According to Oracle, cloud technology is a perfect partner for IoT because it pairs a high degree of agility with flexible costs. Wireless carriers have an opportunity to create private cloud networks to support IoT applications, but they may find themselves competing with software giants like Oracle, IBM, Google and Amazon.com.

Data harvested from connected machines and analyzed in the cloud can yield significant cost savings in many industries. The cost of repairing or replacing machinery is much lower if problems are discovered before they become critical. Data can also help identify assets that are not producing enough revenue so investment in these assets can be curtailed.

Data analysis can also create huge cost savings in the public domain. McKinsey estimates $1 trillion per year could be saved globally from the optimization of public infrastructure.

Smart cities are expected to be one of the most important IoT verticals in the years ahead. Municipalities may be among the first to invest in large-scale IoT deployments because they are often optimizing for other variables in addition to profitability. Blue Hill Research analyzed a connected water meter deployment in a study conducted for SAS, and reported the city expected to save $10 million, but was investing $18 million. However, the city also reported water conservation and better customer service as benefits of the deployment.

Key verticals for IoT investment

Service providers often see the Internet of Things not as a distinct market but as a platform that enables them to more effectively serve a number of existing vertical markets. In addition to municipalities, service providers name energy, manufacturing, shipping, healthcare, connected vehicles and the connected home as target markets for IoT platforms.

The energy industry has been an early adopter of IoT technology. Utilities started out by connecting meters and are now adopting smart grid technology in order to monitor and control energy distribution. Oil and gas companies and their vendors are also using connected devices to cut costs. Verizon is enabling oilfield service provider Halliburton to monitor and control its pumps on oil wells.

Smart meters have attracted investment because they help utilities save money and conserve energy. Ericsson said it has already enabled 42 million connected meters, and recently announced a smart meters as a service solution for utilities.

Silver Spring Networks connects smart meters using the IEEE 802.15.4g wireless interoperability standard, called Wi-SUN.

"We've been servicing the Internet of critical things," said Silver Spring CEO Mike Bell. "We're probably one of the biggest IoT companies in the world in terms of devices that have actually shipped." Silver Spring claims 22 million connected devices and is now opening its application programming interfaces to developers in hopes of expanding the available applications for its network.

In the manufacturing industries, many IoT applications are also related to energy consumption. SK Telecom created a building energy management system and factory energy management system to monitor and control lighting, air conditioning and heating. Other manufacturing IoT applications monitor factory equipment to predict failure or downtime. Predictive analysis enables companies to repair equipment before it breaks and has to go offline.

Some of the world's largest manufacturers are embracing the Internet of Things. GE now describes itself as "the world's digital industrial company, transforming industry with software-defined machines and solutions that are connected." German manufacturing giant Bosch recently purchased a maker of software for smart devices, and CEO Volkmar Denner said he wants his company to be part manufacturer, part information-technology company.

Shipping and asset tracking are a proven use case for IoT technologies. AT&T uses its Cargo View solution to track its own smartphone and tablet shipments. Sensors report on any sudden movement that could damage a smartphone, and continue to record and store data even when the phone is airborne and the sensor cannot transmit data. AT&T is also connecting 280,000 refrigerated containers for shipping giant Maersk. Each remote container device houses a special high temperature 3G SIM card, a GPS unit, a ZigBee radio and antenna, and interfaces for connecting into the refrigerated container's controller.

Connected vehicles are a high-value IoT use case for carriers as drivers tend to use their vehicle connections for voice and data and are willing to pay for connectivity. According to AT&T, 78% of car buyers said they would hold off on a vehicle purchase by one year in order to get a connected car from their preferred brand. The carrier has already connected 5.8 million vehicles to its network, and 1 million of those were added during the third quarter of 2015. Gartner

Source: AT&T

AT&T said its contract with Maersk is one of the largest industrial IoT deployments of its kind.

Source: Chevrolet

Chevrolet vehicles connect to AT&T's LTE network and redistribute the signal through Wi-Fi.

is projecting 250 million connected cars worldwide by 2020.

The connected home is shaping up as a major IoT battleground. Carriers, mobile device makers and providers of short-range connectivity solutions like Thread and ZigBee all want to manage connectivity for home appliances, including smart televisions.

LTE and 3G are not ideal technologies for connecting devices within the home, but carriers do have a key advantage in the smartphone. A truly connected home needs a controller, and the smartphone is a logical choice because most people carry their phones at all times.

But as carriers work to connect their customers' homes, many may find themselves competing with smartphone makers, especially Samsung. The technology giant makes mobile devices, microprocessors, connectivity chipsets, smart TVs, refrigerators, vacuum cleaners, washers and dryers, giving it a direct route into almost all the devices and appliances that are part of a connected home.

Healthcare is an IoT application in which the connected "things" may actually be humans, or devices attached to humans. Equipment that monitors and treats patients is increasingly connected, and by analyzing data streams in real time, providers can significantly improve outcomes for their patients.

AT&T has created a remote patient monitoring solution designed to link caregivers and patients using mobile devices, Bluetooth peripherals and cloud-based software. Devices are dedicated to the remote patient monitoring solution in order to maintain data security and patient confidentiality.

Opportunities for chip vendors

Companies that design and build chips for today's mobile devices see enormous potential in the Internet of Things. Chip vendors approach the Internet of Things from a variety of different backgrounds as there is a wide range of connectivity protocols currently in use for IoT applications.

All the networking technologies listed below are supported by various chip vendors. Semtech is the primary chip vendor for LoRa, which has support from IBM as well. Sigfox chip vendors include Texas Instruments, Silicon Labs and Atmel. In addition, Samsung and Intel are both Sigfox investors. Nemeus, a French semiconductor company, has developed a solution that supports both LoRa and Sigfox.

Neul, which is owned by Huawei, is a chip developer that has supported the Weightless open standard. The Weightless standard also has support from NWave, ARM and Cambridge Silicon Radio, which was purchased by Qualcomm last year for $2.5 billion.

LTE-only chip vendors Sequans and Altair have created cellular solutions for IoT, developing Cat-1 LTE modules that are being used by Verizon Wireless and AT&T Mobility, respectively. Cellular IoT is expected to migrate to LTE as carriers shutter their 2G networks.

In 2016, chip developers are expected to launch solutions for the LTE-M protocol, which is expected in 3GPP's Release 13. By the time these chips hit the market, many enterprise and government customers may have already committed themselves to specialized low-power wide-area networks. Others may wait for a traditional cellular solution, especially when it comes

Technical capabilities	Low Power Wide Area Networks (LPWAN)							Short Range Networks				
	LoRaWAN	Neul	NWave	SigFox	Weightless -N	Weightless -P	Cellular	BLE	WiFI	Thread	ZigBee	Z-Wave
Range (km/m)	2-5 urban; 15 suburban; 45km rural	up to 10km	up to 10km	up to 10km urban; 50km rural	5km	2km	35km GSM; 200km 3G/4G	80m	50m	Mesh	100m/Mesh	30m/Mesh
Deep Indoor Performance	Yes	ISM yes, Whitespace no	Yes	Yes	Yes	Yes	No	No	No	No	-	-
Freq. Band	Varies, Sub-GHz	ISM or Whitespace	Sub-GHz	Frequency independent; 868/902MHz	Sub-GHz	Sub-GHz	900/1800/1900/ 2100MHz	2.4GHz	2.4GHz	2.4GHz	915MHz/2.4GHz	900MHz
ISM?	Yes	Yes, depends on base-station	Yes	Yes	Yes	Yes	Depends	Yes	Yes	Yes	Yes	Yes
Fully Bi-Directional	Yes, depends on mode	Yes	No	No	Uplink only	Yes	Yes	Yes	Yes	-	Yes	Yes
Data Rate	0.3 - 50 kbps adaptive	10 - 100kbps	100bps	10 - 1000bps	30kbps - 100kbps	up to 100kbps adaptive	35-170kbps GSM/ 3 - 10mbps LTE	< 1mbps	600mbps max	-	250kbps	10 - 100kbps
Power Profile	Low	Low	Low	Low	Low	Low	Medium	High	High	Low	Low	Low
Authentication	Yes	-	Yes	Yes	Yes	Yes	High security, back by major telecoms	Trusted devices problematic	Yes	Yes	Yes	Yes
E2E Encryption	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Over the Air Software Upgrades	Yes	-	No	No	No	Yes	Yes	Yes	Yes	-	Yes	Yes
Supports sensors moving between hubs	Yes	-	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes, mesh-based	Yes, mesh-based
Location Aware	Yes	-	No	No	No	-	Yes	No	Yes	-	-	-
Operational Model	Public or private	-	Public or private	Public	Public or private	Public or private	Public or private	Public or private	Public or private	Private/WIFI backbone	Public or private	Public or private
Standard	LoRaWAN	Weightless	Weightless	No	Weightless	Weightless	GSM, LTE etc	Bluetooth 4.0	IEEE802.11	Thread, based on 6LoWPAN IEEE802.15.4	ZigBee	Z-Wave
Scalability	Yes	Yes	Yes	Yes	Limited	Yes	Yes	Yes		Yes	Yes	Limited

Source: Opensensors.io

to connecting high-value assets.

"I think if you've got a fairly expensive asset that you want to keep tabs on, either its location, its health or what have you, you're likely willing to pay a carrier for its reliability and a module vendor for its connectivity," said Sequans' Miller.

Less critical communications are likely to happen over dedicated low-power wide-area networks, unless the prices of cellular IoT radios fall drastically. James Stansberry, SVP and GM of IoT at Silicon Labs, said cellular solutions will be priced out of many markets until they cost less than $5 per module, and added Sigfox is promising a module that will cost less than 50 cents.

"That will be kind of the benchmark that the carriers are going to be measured against for cost," said Stansberry. "Right now the cost of a Cat-10 transceiver is over $50."

Analyst Patrick Moorhead, founder of Moor Insights and Strategy, said less expensive modules are appropriate for low data rate transmissions that are not highly time sensitive, but that more critical communications will rely on higher-priced chips.

"We need that 50 cent solution, but we also need that $35 solution that works globally, is multi-mode, can do voice and

"We need that 50 cent solution, but we also need that $35 solution that works globally, is multi-mode, can do voice and data … that's really what I think is required."

Patrick Moorhead, Moor Insights & Strategy.

data … that's really what I think is required," said Moorhead.

Some applications do not require wide-area connectivity, and many of these are appropriate for short-range network technologies like Thread, Z-Wave and ZigBee. These are all mesh networking solutions, meaning the endpoints communicate with one another directly and do not need backhaul or a core network for all of the connections.

Chips are being developed for all the major mesh IoT solutions. Thread, championed by Google, has support from chip vendors Silicon Labs and NXP (which owns Freescale). Z-Wave is supported by Sigma Designs. ZigBee has support from a large number of chipmakers including Silicon Labs, which purchased ZigBee pioneer Ember in 2012. Other members of the ZigBee Alliance include Samsung, NXP and Texas Instruments.

In 2016, chipmakers that focus on the connected home may try to expand into mobile IoT. Sigma Designs recently agreed to pay $22 million for Bretelon, a company that is 100% focused on research and development for mobile IoT applications.

When it comes to marrying mobile IoT and the connected home, Bluetooth and Wi-Fi are well positioned. Texas Instruments, Nordic Semiconductor, Cypress Semiconductor and Dialog Semiconductor are among the companies making Bluetooth Low Energy chips. Bluetooth Low Energy was developed for devices like smartwatches, heart rate monitors and smartphone-controlled home appliances.

Source: 3D Robotics

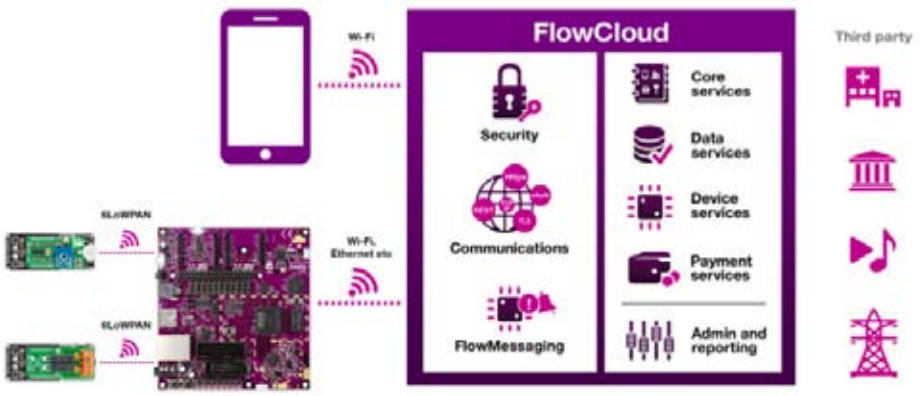
Wi-Fi is of course the most prevalent short-range networking technology, and is widely used for connecting smartphones and laptop computers to wireline networks. The Wi-Fi Alliance wants to expand Wi-Fi to more IoT use cases, and to that end the association has created a new solution called Wi-Fi HaLow. The solution is designed to use spectrum below 900 MHz to enable low-power wide-area connectivity.

Major Wi-Fi chip vendors include Qualcomm (which owns Atheros), Avago (which owns Broadcom), Texas Instruments and Marvell. These companies are likely to support Wi-Fi HaLow as well.

Wi-Fi HaLow also promises better connectivity in obstructed environments. Longer range, more robust Wi-Fi is well suited to a number of emerging IoT applications, including fitness trackers, health monitors and drones.

Qualcomm, Intel and Avago/Broadcom are all targeting the drone market with chip solutions for connectivity and control. Qualcomm is helping to fund drone maker 3D Robotics, co-founded by a former Wired editor who has said drones are in essence moving sensors that will be a key part of the Internet of Things, particularly as new applications enable smartphones to control drones and send the data they collect to the cloud.

Chipmakers are starting to work together to combine different technologies in order to leverage the benefits of two technologies in one solution. Imagination Technologies advocates the combined use of Wi-Fi and 6LoWPAN (the foundation of the Thread standard) to support an end-to-end software stack for IoT applications.



Source: Imagination Technologies

Thread and ZigBee are working together to make the two standards compatible so that one device can use both forms of connectivity. ZigBee has been on the market longer than Thread and therefore has a larger applications library, which Thread-connected devices will now be able to access.

Wireless connectivity is just one part of the IoT opportunity for chipmakers; they also develop sensors, processors and security solutions. Heavyweights like Intel and ARM are starting to embed identity and security directly into chips in order to combat the security risks expected to emerge when more public infrastructure and manufacturing resources become connected.

"You're seeing a lot of market dynamics all at play trying to solve the security problem from many different dimensions," said Bob Gessel, head of network and technology strategy for Ericsson in North America. Gessel said that advances in semiconductor technology will make sensors more secure during the next three years, and that at the network level, demand for private cloud services may increase as enterprises seek to secure their data.

Opportunities for network equipment vendors

Wireless network equipment vendors are working hard to adapt LTE for the Internet of Things. Although LTE was designed for high data rates, it can be modified to support high volume, low data rate transmissions.

"Because it's digital, because it's IP-based … it's possible to segment the [LTE] channels. If you divide them up enough times you can get to a much lower data rate," explained Duke-Woolley of Beecham Research. Lower data rates mean less power consumption and fewer antennas, meaning device costs should be lower.

3GPP is working on standards for three different cellular IoT technologies: Extended Coverage GSM (EC-GSM), enhanced Machine Type Communications (eMTC also called LTE-M) and Narrow-Band IoT (NB-IoT). According to Nokia, NB-IoT by and large follows the solution proposed by Nokia, Ericsson and Intel, formerly called "NB-LTE", which allows work in-band, in-guard band and in new spectrum.

Nokia, Ericsson and Intel are working together to develop and bring to market the products needed for the commercialization of NB-IoT. Nokia supports NB-IoT as an evolution of LTE-M, saying although it is designed for use in the 200 kilohertz band, it can also share spectrum with existing LTE networks, meaning it can be deployed without the need for additional radios or antennas.

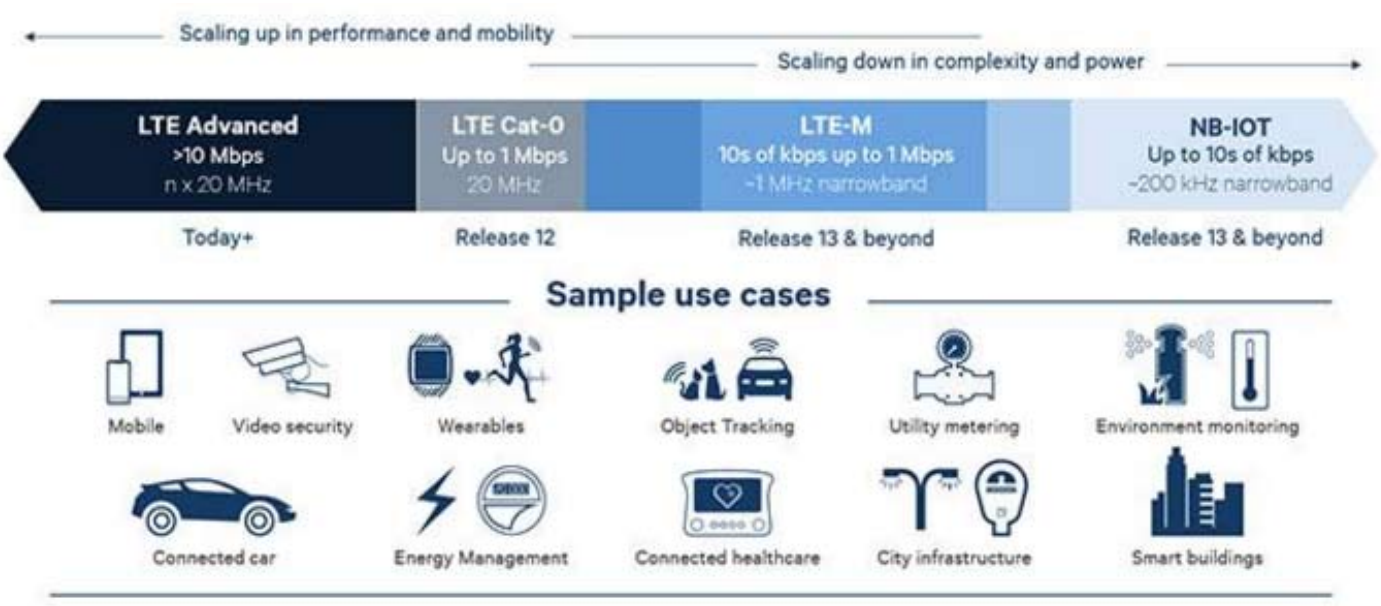
"We believe in building an ecosystem around NB-IoT to speed up the take up of the Internet of Things," said Stephan Litjens, Nokia's VP for portfolio strategy and analytics. "This development will bring consumers benefits such as enhanced and improved connectivity of devices, and at lower cost."

Nokia wants to offer operators a secure connectivity layer to manage IoT traffic and analyze data. In 2015, the company launched two IoT solutions for carriers: an IoT core and an LTE smart scheduler.

The industry expects specifications for Extended Coverage GSM, LTE-M and for the Narrow-Band radio interface to be set sometime during the first half of 2016..

Small cells may become a key enabler of the Internet of Things as cellular technology is adapted to support connected sensors. A company that wants to connect factory equipment or a city that wants to connect traffic lights could use carrier-deployed small cells if they were configured for low-power transmission. In addition, new infrastructure may house both small cells and sensors.

San Jose, California, is currently deploying



Source: Qualcomm

smart light poles created by Philips that house both Ericsson LTE small cells and smart meters developed by Pacific Gas & Electric. The meters measure the amount of electricity used by the mobile network and transmit that data to PG&E, replacing the standalone meters typically installed next to electrical equipment on streets. In addition, the city can wirelessly control the 750 LED lights within the poles to adjust the amount of street light dynamically when necessary.

IoT and signaling traffic

If wireless carriers want to be major conductors of IoT traffic, they will need to route not just data traffic but also the associated signaling traffic. In LTE networks, signaling traffic is the control plane data that tells the network which devices are trying to connect, whether they have access to connect and how much the device owner should be charged for network access.

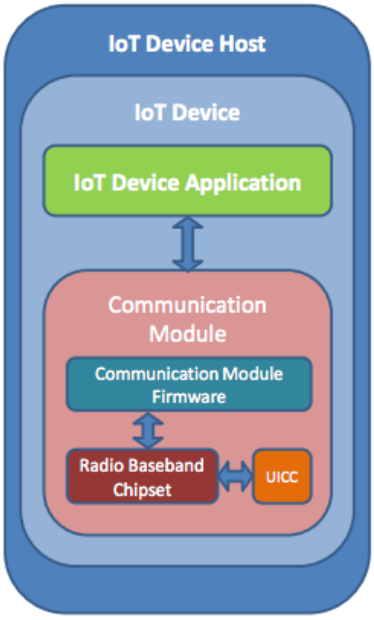
"IoT requires that each device send small amounts of data periodically," explained Ofer Gottfried, CTO of Flash Networks. "When each of these signaling messages are added up and multiplied by the number of devices, the impact on network congestion is even more than the increase in data traffic."

Smart light poles in San Jose combine small cells and sensors.

Gottfried said the solution is traffic orchestration at the network core. Orchestration can include consolidation of non-critical signaling messages into batches that can be sent when the network has unused capacity, often between midnight and 5 a.m. Intelligent orchestration also means duplicate messages can be identified to cut down on overall signaling traffic.

Peter Nas, senior solutions architect at F5 Networks, notes IoT-related signaling traffic has the potential to interfere with customer-facing signaling traffic if carriers do not design their networks thoughtfully. Nas said voice-over-LTE will drive an increase in signaling traffic on LTE networks and carriers need to realize connected devices have the potential to interfere.

Not all network optimization can occur within the core. Devices that are network-friendly are also a key part of a successful



Source: GSMA

IoT Device Host – The application specific environment containing the IoT Device e.g. vehicle, utility meter, security alarm etc.

IoT Device – The combination of both the IoT Device Application and the Communication Module.

IoT Device Application – The application software component of the IoT Device that controls the Communications Module and interacts with an IoT Service Platform via the communications module.

Communication Module – The communications component which provides wide area (2G, 3G, 4G) radio connectivity. Comprising of Communications Module Firmware, Radio Baseband Chipset and UICC

Communications Module Firmware – The functionality within the Communications Module that provides an API to the IoT Device Application and controls the Radio Baseband Chipset.

Radio Baseband Chipset – The functionality within the communications module that provides connectivity to the mobile network.

UICC – The smart card used by a mobile network to authenticate devices for connection to the mobile network and access to network services.

IoT strategy. Connected devices that send data constantly or repeatedly are not needed in all use cases – some smart devices will be smartest when they transmit infrequently, or only when they register an irregular event.

GSMA has created an 81-page document entitled "IoT Device Connection Efficiency Guidelines" with the goal of creating standards promoting efficient use of network and device resources. The report authors note mobile network operators will work with a large cohort of device and application developers as they connect new devices to their networks. Operators will want these partners to design devices and applications that do not overload mobile networks, and GSMA notes device makers also have a big incentive to respect network resources. Devices that continually "ping" the network will require new SIM cards and new batteries sooner than those operating more efficiently.

Low-power wide-area networks

Sigfox and LoRa are the two most prominent low-power wide-area network technologies. Both operate in the unlicensed industrial, scientific and medical spectrum bands. Both offer low-cost modules designed to transmit data at much lower rates than cellular. LoRa networks transmit at 0.30 to 50 kilobits per second and Sigfox at less than 1 kbps.

Lower data rates should mean inexpensive modules that do not need dual antennas and can work for years without a battery change. Base stations are small enough to fit inside a suitcase and can usually be deployed on existing infrastructure. These are seen as ideal solutions for smart city applications. Sigfox has already announced plans to build an IoT network using the 902 megahertz band in 10 U.S. cities: New York; Chicago; Boston; Atlanta; San Francisco, San Jose and Los Angeles, California; and Austin, Houston and Dallas, Texas. Both Sigfox and LoRa have also deployed IoT networks in a number of European cities.

"It's not that it's a choice between Sigfox and a traditional operator. It's a choice between connectivity and no connectivity."
Allen Proithis, Sigfox

"It really allows for a whole new set of use cases," said Sigfox CEO Allen Proithis. "It's not that it's a choice between Sigfox and a traditional operator. It's a choice between

connectivity and no connectivity."

Mobile operators want to change that choice by creating the low-power solutions discussed earlier in this report. The success of Sigfox and LoRa have opened operators' eyes to the low-power opportunity.

"I think the mobile operators would see companies like Sigfox as being direct competitors and stealing into their area," said Duke-Woolley of Beecham Research, who expects to see significant competition between Sigfox, LoRa and the mobile operators as lower cost solutions open up more opportunities for connectivity.

"There are billions of things out there that people want to connect, they want the data from, it has value, but you simply can't connect [them] at the current cost levels of traditional technology," said Proithis, who is positioning Sigfox as a non-traditional technology, and thinks his company will be able to make money from its connections because its modules are so inexpensive.

Sigfox cannot charge much for each connection, but hopes to deploy in very large volumes, and also expects to participate in data monetization. The company recently announced the integration of OVH's data analysis platform into the Sigfox cloud.

The silver lining for mobile operators is Sigfox and LoRa both have the potential to increase traffic on mobile operator networks. The LoRa network relies on IP gateways to connect the endpoints to backhaul, which can be cellular or Ethernet. Sigfox base stations usually use a digital subscriber line connection as the primary backhaul with a GSM connection for backup.

Sigfox and LoRa have also educated both enterprise customers and mobile operators about the potential of low-power wide-area networks. Without these two early success stories the market might have developed much more slowly.

"The emergence of Sigfox and LoRa is similar to the introduction of WiMAX, which failed but played the role of rallying the GSM players to work on LTE," said analyst Chetan Sharma of Chetan Sharma Consulting. Sharma believes Sigfox and LoRa have motivated the mobile operators and their vendors to develop LTE-M and NB-IoT, both of which are expected to be part of 3GPP's Release 13.

IoT and the wireless workforce

It is much easier to predict the types of jobs connected machines can replace than it is to foresee the careers they could create. Chinese companies are already starting to replace workers with robots, as are U.S. farmers. Workers who collect data and monitor machinery could see their jobs threatened by connected machines.

"While we might see some of these jobs being replaced by automation and sensor technology and the Internet of Things, we'll also see a host of new careers and new jobs that will be prevalent in the workforce that will be all directed around managing those devices, securing those devices, the analytics side of the data and being able to process that

Source: Careercast.com

Jobs for meter readers may start to go away as smart meters proliferate.

information and use it," predicts Atkinson of Compass Intelligence.

"There has to be a real change in how we're educating our younger generations," said Cisco's Steinhilber. "We have to start thinking about how to change, and train them for the jobs of the future. Right now we have a big gap. What we're training people to do, and where the jobs and the value are going to be, based on the analysis we've done across multiple industries, we have created an enormous gap. And those industries and countries that figure this out are going to be the ones that create economic value in the future."

Right now, many of the jobs created by the emerging Internet of Things are positions with startups. Telecom recruiter George Orr of Telecom Connections said he is working with a number of young companies that started out as app developers and became IoT companies as they added measurement and monitoring capabilities to their apps.

"We've been doing more and more work with those kinds of companies," said Orr. "Some of them are in m-health and medical areas, some of them are in building automation. … It's my personal opinion that maybe some of this is kind of a spinoff or a result of the explosion that occurred when people were starting to develop apps."

Key takeaways

- The Internet of Things will connect billions of devices, but only a small subset will use traditional cellular networks to connect.
- IoT platforms and applications represent opportunities for mobile operators and may be independent of connectivity.
- Data collection and analysis is seen as the most valuable part of the Internet of Things.
- Key verticals for IoT deployments include energy, smart cities, manufacturing, shipping/asset tracking, connected vehicles, connected homes and healthcare.
- Revenue per user is much lower for connected machines than for connected people, so the price of connectivity needs to be lower. This is accomplished with low-power wide-area connectivity solutions. So far, Sigfox and LoRa are the two most successful implementations of low-power wide-area network technologies.
- The emergence of Sigfox and LoRa has motivated wireless carriers to invest in low-power technologies of their own in order to compete. LTE for machines (LTE-M) and narrowband IoT (NB-IoT) are two new standards that are expected to be part of 3GPP's Release 13.
- Ahead of LTE-M and NB-IoT, carriers are preparing to deploy Category-1 LTE-only chips for IoT use cases. These work with existing network equipment and will ship in the near future.
- Low-power wide-area networks may create new opportunities for wireless carriers to backhaul aggregated traffic, and for network equipment vendors to provide gateways that connect low-power wide-area networks to cellular networks.
- Companies that train workers in data analysis and device management, and companies that hire workers with these skills, are expected to have a competitive advantage.

The role mobile operators will play in the Internet of Things will become more clear in the months and years ahead. Carriers who see IoT as an extension of their mission to connect people to one another through telephony are thinking in the same way Nicola Tesla was thinking 90 years ago. His famous quote about the world as one connected brain continues as follows.

"When wireless is perfectly applied the whole earth will be converted into a huge brain, which in fact it is, all things being particles of a real and rhythmic whole. We shall be able to communicate with one another instantly, irrespective of distance. Not only this, but through television and telephony we shall see and hear one another as perfectly as though we were face to face, despite intervening distances of thousands of miles; and the instruments through which we shall be able to do his will be amazingly simple compared with our present telephone. A man will be able to carry one in his vest pocket."

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Plano, TX 75074
Contact: Jeff Newman
972-422-0877
jnewman@bectechnologies.net
www.bectechnologies.net
BEC, a global leader in Internet access, user equipment and telco grade CPE routers delivers M2M and IoT performance with MX series: MX-1000 vehicle based router for critical communications and fleet management; MX-200 for POS, ATM, digital signage, SCADA and telemetry based IoT applications.

Bluegiga Technologies
Hardware
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www.bluegiga.com
Bluegiga's mission is to design and deliver easy-to-use, wireless connectivity solutions for OEMs, device manufacturers and system integrators.

Bosch
Hardware
Stuggart
www.bosch-si.com
The Bosch IoT suite provides the technological basis for applications in the Internet of Things (IoT) and integrates every feature required for pooling devices, users, companies and partners.

Bug Labs
Hardware
New York, NY
www.buglabs.net
Bug Labs is a technology company headquartered in New York City that began by developing and selling open-source hardware peripherals for rapid prototyping of electronic devices.

Cantaloupe Systems
Hardware
San Francisco, CA
www.cantaloupesys.com
Cantaloupe Systems provides cloud and mobile solutions for Vending and OCS Management, Cashless and Credit Card Vending.

Cisco
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Accelerate your transition to an intelligent, IoT-based infrastructure by deploying theCisco IoT System. Our broad portfolio of IoT infrastructure technologies help you connect, manage, and control previously unconnected devices.

Connect One
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Connect One™ is a leading fabless semiconductor company that provides value-added solutions for connecting devices to the Internet and other IP-based networks.

connectBlue
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connectBlue® was founded in 2000 with the vision to meet the future demand for reliable, cost-efficient wireless systems.

ConnectSense
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ConnectSense wireless sensors enable home automation with cloud based monitoring, powerful rule management and notifications via Text Msg and Phone.

CoreRFID
Hardware
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www.corefid.com
CoreRFID delivers RFID solutions using auto-id technologies to identify, assign, audit and track.

Cubilog
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www.cubilog.com
Ultramodular data acquisition and control hardware with an intuitive and easy-to-use cloud-based data processing and control software.

Dali Wireless
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855-250-5082
www.daliwireless.com
Dali Wireless, a global provider of the advanced all-digital RF RouterÂ® that transcends DAS, can also support Wi-Fi and other IP devices over an integrated system - to enable IoT.

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Digi International
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Minnetonka, MN 55343
Contact: Andrew Lund
952-912-3444
andrew.lund@digi.com
www.digi.com
Digi International is a global provider of machine-to-machine and Internet of Things connectivity products and services. We help our customers create next generation connected products and deploy and manage critical communications infrastructures. Founded in 1985, we've helped customers connect over 100 million things, and growing.

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Katy, TX 77449
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50 Hines Road
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Contact: Matt Massey
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mattm@edgewaterwireless.com
www.edgewaterwireless.com
Edgewater Wireless new IOTair™ platform is backboned by WiFi3™ to deliver 3 (or more) concurrent channels of transmit and receive and enabling 100s of IOT devices on a single IOTair™ connection point. Edgewater Wireless was named one of Canada's Hottest Technology Companies in 2015

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Los Altos, CA
www.electricimp.com
Electric Imp provides an innovative and powerful service platform that makes it simple to connect devices to the Internet.

Ethertronics, Inc.
Hardware
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San Diego, CA 92121
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info@ethertronics.com
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Eurotech
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Amaro, Italy
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Gainspan
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Semiconductor company, designs and markets wireless connectivity products.

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Contact: Michael Street
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mstreet@gpssource.com
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GPS Source is a USA engineering company, offering a full line of GPS Signal Distribution Products. They specialize in moving and splitting the GPS signal with dependable, well built designs with features specifically requested by wireless carriers and system integrators.

Huawei
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www.gethuawei.com
Embedded with chips and sensors, objects have started to'think', 'feel'and 'talk'. The Internet of Things offers a myriad of possible applications. Huawei is eager to harness the potential of this new evolution.

Imagination Technologies
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3201 Scott Blvd.
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Contact: Krishna Yarlagadda
408-530-5000
Krishna.Yarlagadda@imgtec.com
www.imgtec.com
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InHand Electronics
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30 West Gude Drive, Ste. 550
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Contact: Keith Lowe
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Charleston

Lantronix, Inc.
Hardware
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Irvine, CA 92618
Contact: EE Wang
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marketing@lantronix.com
www.lantronix.com
Lantronix, Inc. (NASDAQ: LTRX) is a specialized networking company providing M2M (machine to machine) and IoT (Internet of Things) solutions. By networking and managing devices and machines that have never before been connected, we enable our customers to realize the possibilities of the Internet of Things.

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Contact: Ebrahim Bushehri
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e.bushehri@limemicro.com
www.limemicro.com
Lime Microsystems creates field programmable RF (FPRF) transceivers for a wide variety of wireless IoT applications. They offer an unprecedented level of programmability and allow designers to create systems and networks that run on the vast majority of frequency bands and standards.

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Redpine Signals
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2107 North First St., Ste. #540
San Jose, CA 95131
Contact: Dhiraj Sogani
408-748-3385
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www.redpinesignals.com
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Sierra Wireless is building the Internet of Things with intelligent wireless solutions that empower organizations to innovate in the connected world. We offer the industry's most comprehensive portfolio of 2G, 3G and 4G embedded modules and gateways, seamlessly integrated with our secure cloud and connectivity services. OEMs and enterprises worldwide trust our innovative solutions.

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Hardware
1781 Riverside Dr., Ste. 3D
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925-526-4501
office@ss7ware.com
www.yatebts.com
SS7ware, Inc. provides 2/2.5G and 4G mixed software-defined mobile networks. The company is a subsidiary of Null Team SRL, the creators of Yate.

SS7ware, Inc.
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1781 Riverside Dr., Ste. 3D
New York, NY 10034
Contact: Diana Cionoiu
925-526-4501
www.yatebts.com
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WindyCitySDR
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Contact: Martin O'Shield
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INFRASTRUCTURE COMPANIES

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andrej.grobisa@agm.si
www.agm.si
System integrator in the area of ubiquitous sensing.

B+T Group
Infrastructure
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Tulsa, OK 74119
Contact: Leigh Anne Self
918-587-4630
info@btgrp.com
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B+T Group provides turnkey development and field services to the wireless industry. Services include civil and structural engineering, telecom A&E, site acquisition, tower modification design and construction, audits and inspections and technical services. Licensed in all 50 states with six locations and 200 employees.

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CIC performs several services for the IoT industries, hardware install, software install, system integrator, system monitor, network operations.

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Contact: Kit Nickel
614-541-3011
kit.nickel@diligentsite.com
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Diligent Site Development provides expert local/regional real estate, project management and general consulting services to the wireless industry.

Eastpointe Industries LLC
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Contact: Marty Halliday
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Hutton Communications is a North American value add wireless distributor with over 200 product lines. With our extensive product line offering Hutton brings IoT wireless solutions to the market.

Ingenu
Infrastructure
10920 Via Frontera
San Diego, CA 92127
Contact: Kirsten Garvin
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kirsten.garvin@ingenu.com
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Ingenu is building the first wireless Machine Network, the world's largest IoT network dedicated to connectivity for machines. Operating on universal spectrum, the company's RPMA® technology is a proven standard for connecting IoT and M2M devices around the world, with more than 35 networks deployed over seven years.

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Infrastructure
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London, UK
EC1Y 1AX
Contact: Anthony Wilkinson
44-20-7728-1106
Anthony.Wilkinson@inmarsat.com
www.inmarsat.com/ioeverywhere
Inmarsat plc is a provider of global mobile satellite communications services. Connectivity is mission critical and beyond the reach of land-based terrestrial communications, the only option is satellite. Inmarsat's global wireless network operates with 99.9% availability so you can track, monitor and control fixed or mobile assets, wherever they're located.

Kathrein
Infrastructure
2400 Lakeside Blvd., Ste. 650
Richardson, TX 75082
Contact: Scott Nagel
214-238-8829
snagel@kathrein.com
www.kathreinusa.com
Kathrein is a leading international specialist for reliable, high-quality communication technologies. We are an innovation and technology leader in today's connected world. Our ability to provide solutions and systems enables people all over the world to communicate, access information and use media, whether at home, at the office or on the road.

NetNumber
Infrastructure
650 Suffolk Street, Ste. 307
Lowell, MA 01854
Contact: Kim Gibbons
978-848-2820
kgibbons@netnumber.com
www.netnumber.com
NetNumber provides a common software platform that virtualizes all signaling functions, dramatically simplifying the core network and enabling carriers to offload less financially valued IoT traffic to where it can be handled most efficiently and not put higher revenue producing traffic at risk.

NoviFlow Inc.
Infrastructure
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Montreal, QC
H4C2K1
438-807-4360
contact@noviflow.com
www.noviflow.com
NoviFlow Inc. provides high-performance Programmable SDN switching solutions to network operators, data centres and enterprises seeking greater control and flexibility over their networks. Supporting up to 4 million flows, NoviFlow has high-performance IoT solutions that scale!

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Contact: Peter Fabiano
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Contact: Guy Stout or Lou Ellen Stout
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Stout & Company is a full service tower developer and wireless telecom consulting and marketing firm. We offer a broad menu of services for clients: build to suit towers, collocation, site recon, site acquisition, zoning, permitting, design management, construction management and tower marketing.

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Contact: Phil McCoy
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Contact: Heather Krong
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Tempest Telecom Solutions, LLC is a leading provider of infrastructure equipment and related services, helping telecom carriers and network operators build, expand and maintain their networks faster and more cost-effectively. Tempest's solutions comprise of a wide variety of equipment and service offerings.

TTG/IEEE
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P.O. Box 708
Pacific Palisades, CA 90272
Contact: Ali Karimi
310-459-6552
ali.karimi@ieee.org
IEEE.org

Ventev Wireless Infrastructure
Infrastructure
375 W. Padonia Rd.
Timonium, MD 21093
Contact: Ginny Gullett-Tawes
800-851-4965
gulletttawes@ventev.com
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TESTING COMPANIES

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Contact: Boris Binger
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info@7layers.com
www.7layers.com
7layers provides engineering services, testing and certification for the IoT. We support market access of wireless connected devices, by offering conformance, interoperability testing, type approval and certifications.

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info@adlinktech.com
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Contact: Steve Laya
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Founded in 1954, Elite is a full-service electromagnetic compatibility (EMC/EMI) and environmental stress testing laboratory. With 60+ years of experience, 27 RF chambers, and a dedicated team of 60 iNarte-certified engineers, we have the right facilities to get your testing done right the first time.

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CB259AU
Contact: Kevin Spalding
+4412230810010
kevin.spalding@iotas.co.uk
www.iotas.co.uk
Wireless testing organisation covering cellular, bluetooth, Wi-Fi & IoT.

Keysight Technologies
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800-829-4444
usa_orders@keysight.com
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Contact: Prasad Kallur
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www.orchestratec.com
Orchestra Technology offers fully automated cloud based solutions (testing, monitoring, benchmarking, troubleshooting) for 4G/5G Services (VoLTE, ViLTE, RCS, IMS, Video), Wireless Networks (Cellular, WiFi, Zigbee, Zwave), and Devices (Phones, Tablets, IoT). Additionally, we offer New Product Introduction (NPI) Services to accelerate your innovations to market.

SGS
Testing
15150 Avenue of Science, Ste. 300
San Diego,CA 92128
Contact: Amy O'Regan
858-592-7100
amy.oregan@sgs.com
www.sgs.com
Global Testing Company. Wireless services include SGS's global network of labs offering true end-to-end testing solutions to mobile manufacturers, carriers, ODMs and OEMs.

Teraquant Corporation
Testing
2400 Central Avenue Ste. P-2,
Boulder, CO 80301
Contact: Richard Jobson
719-488-1003
info@teraquant.com
www.teraquant.com
The Teraquant Safkhet Radio Network Test platform is a cloud-based system used to verify the performance, security and availability of IoT/M2M systems and services. It actively monitors the responsiveness of all remote devices and network raising alerts when service degrades.

TRS-RenTelco
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Vector Software
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1351 South County Trail, Ste. 310
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www.acelatech.com
Acela Technologies is a premier technology design/engineering company offering complete life cycle services, support and expertise for Wireless/Mobility, Converged Networking, and Cabling Infrastructure applications. Acela has proudly serves the Healthcare, Hospitality, Education, Federal/State Government and Wireless Service Providers markets for over a decade.

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Contact: Janet Jaiswal
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Janet.Jaiswal@aeris.net
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Aeris is a pioneer and leader in the market of the internet of things – as an operator of end-to-end IoT services and as a technology provider enabling other operators to build profitable IoT and M2M businesses. We strive to fundamentally improve our customers' businesses by dramatically reducing costs, improving operational efficiency, reducing time-to-market, and enabling new revenue streams.

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Arrayent
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www.arrayent.com
Arrayent Connect is the Internet of Things (IoT) platform of choice for trusted consumer brands, enabling them to implement connected products and systems.

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Bogota, Colombia SA
Contact: Benjamin Bursztyn
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Atooma
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Atooma is a tech company based in Rome and San Francisco focused on bringing context awareness to the Internet of Things world.

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BaseN
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info@yankeegroup.com
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Yankee Group's research efforts are focused exclusively on the mobility revolution and its impact on business decisions and strategies. Our goal is to answer the important questions about the mobile economy every day, giving our clients the critical data, insight and advice they need to profit in today's mobile world.

OTHER COMPANIES

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nathaniel.johnson@accu-tech.com
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AllSeen Alliance
Other
www.allseenalliance.org
The AllSeen Alliance is a cross-industry consortium dedicated to enabling the interoperability of billions of devices, services and apps that comprise the Internet of Things

Avren Events
Other
Bedford House
69-79 Fulham High Street
London, SW6 3JW
Contact: Andy Falconer
+44 207 384 7918
andy.falconer@avrenevents
www.avrenevents.com
Avren Events is launching a conference series starting in June 2016 to focus on LPWA Networks for IoT. This will bring together the whole ecosystem of operators, standards bodies, technology vendors and industry verticals to discuss and debate the various options available to deploy a LPWA network to connect IoT devices.

Black & Veatch
Other
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Contact: Chris Perrey
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info@globecomm.com
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Graybar
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InventionShare
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Contact: Keith Taylor
613-225-7236
ktaylo@inventionShare.com
www.inventionshare.com
InventionShare is an invention equity company that has two unique products that could be used with the IoT. These include 5by5 Wireless and Circuit Seed.

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