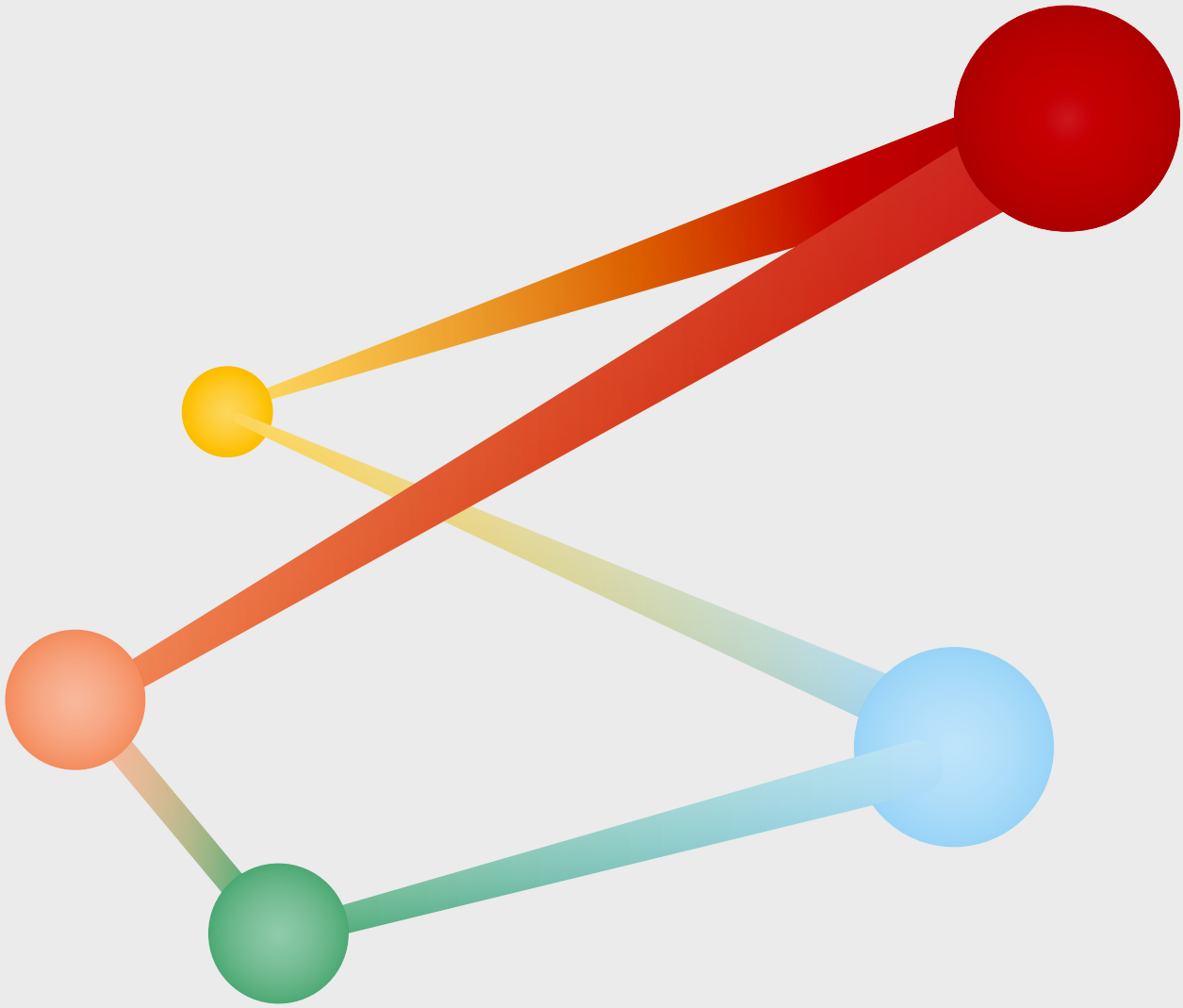
State of the Market: Internet of Things 2016

Accelerating innovation, productivity and value.

verizon



About this report

The Internet of Things (IoT) is much more than the result of seemingly fragmented and complex technologies smashed together. In the following pages, you'll read about how forward-thinking business and public sector leaders, as well as consumers and developers, are turning to the Internet of Things to address some of society's most pressing social, economic and business challenges.

You'll learn how the combination of five macro trends – data monetization, consumer expectations, the regulatory landscape, network connectivity/IoT platforms and security – are helping to speed IoT adoption and deliver measurable results across several industries and sectors.

We also offer recommendations and insights for how we think large and small businesses, consumers and even our planet can derive the greatest benefit from IoT over the next two years.

Sources for the report

- Verizon usage data, including new IoT connections, from 2015
- Verizon-commissioned research by Oxford Economics
- Interviews with Verizon customers: Insights gleaned from customers working on real IoT projects in the private and public sectors
- Interviews with Verizon subject matter experts
- Third-Party Research: We reference reports from Gartner, IDC, PwC and other authorities. For full citations, see page 24

Why Verizon?

Verizon has been in the IoT space since day one. Millions of IoT devices operate on our network today. We've worked side-by-side with developers in our innovation labs to create connected apps and devices. And we've launched our own utility, transportation and healthcare solutions with products like Networkfleet, GridWide, Verizon Share, hum, and one of our newest products, Intelligent Track and Trace.

So we've done our homework. We have experience across the whole IoT ecosystem, and we know where the pain points are at every link of the value chain – from developer to platform to customer. And we've been working for the last two years on solutions that address the structural barriers that have held back the IoT ecosystem.

Through our ThingSpace platform, we are accelerating adoption of IoT by making it easier, faster and more accessible to develop IoT apps that benefit society.

We believe that no one else in the industry has taken this kind of a holistic approach to IoT. We are scaling the systems required to connect billions of devices. And we are changing the model for IoT. Not just for the CIOs, CTOs and rocket scientists, but for everybody.

We're excited to show you what we're doing and we're even more excited to tell you what comes next.

The Internet of Things goes mainstream.

It's what lets a parent monitor and set driving rules for their newly licensed teenager. It's what enables a working mom with sleep apnea to rest peacefully every night.

It's at work in a California vineyard, measuring soil and moisture conditions to improve plant quality, lower operating costs and increase crop value. It's helping to speed up emergency services and reduce fatalities on the nation's roadways.

The Internet of Things (IoT) is in your home, in your car and phone, and, increasingly, on your body. It's connecting citizens to their cities, linking patients to health services, bringing companies in closer touch with their customers and capturing our imaginations. In-vehicle geofencing and other applications considered novel just a year or so ago are rapidly becoming part of our everyday lives.

Beyond just a project

In our view, 2015 was the year IoT gained legitimacy. Businesses budged off a "start small think big" mindset. Today, they're building IoT into future strategies and business models. Companies across all industries now have IoT squarely on their radar. The worldwide Internet of Things market spend will grow from $591.7 billion in 2014 to $1.3 trillion in 2019 with a compound annual growth rate of 17%. The installed base of IoT endpoints will grow from 9.7 billion in 2014 to more than 25.6 billion in 2019, hitting 30 billion in 2020[1].

And while IoT applications range far and wide, when we think about IoT, we largely focus on the following key areas - smart communities/smart cities, energy, agriculture, transportation, healthcare and home monitoring. We've also seen dramatic increases in activity and innovation on the consumer front as well.

IoT by the numbers

IoT network connections – 2014 vs. 2015 % growth

Source: Verizon data

For example, wearables, which already had a head start with fitness trackers, got an even bigger boost in awareness and adoption as more traditional players brought out connected watch solutions. And we'll continue to see a tremendous amount of innovation in smartwatches and other IoT solutions for the consumer, especially as technologies for the individual, the car and the home become untethered from the phone and increasingly converge with other things around them.

Enterprises to scale from millions to billions of connected devices.

Enterprises view IoT as a new revenue stream. A study we commissioned by Oxford Economics shows that revenue growth is by far the biggest factor driving IoT adoption. Throughout 2016 and beyond, we'll continue to see IoT deployed as a mainstream path to generating higher revenue, thanks largely to the rise of four key trends which have come to an inflection point in the past year; data monetization, core IoT networks and low power devices, platforms as a service, and investment in IoT startups.

Data is king

Although the amount of "things" in use is growing rapidly, IoT services will be the real value drivers in the coming years. We believe companies of all sizes will invest in creating and selling new services based on insights generated by data from IoT-connected devices. Gartner estimates that "the Internet of Things (IoT) will support total services spending of $235 billion in 2016"[2]. This is in sharp contrast with what we have seen to date. In the past, the push was to collect and use data primarily for the purpose of improving the operational efficiency of the corporation itself.

Yet, despite the huge revenue potential that data monetization presents, our Oxford Economics study found that today only 8% of businesses are actually using more than 25% of their IoT data[3]. Nearly 50% of businesses already on the IoT journey estimate that in two to three years they will be using more than 25% of their data as companies realize the value in monetizing new products and services, driven by insights from data to drive down costs or increase revenues[3].

Networks at the core

Core IoT networks will enable the cost-efficient connection of millions of Category 1 or "Cat 1" devices, which are sensors and devices containing smaller computer chipsets and requiring less power than smartphones and some other mobile devices. This makes them less expensive to deploy in large numbers. Utility meters fall into the Cat 1 classification. Up until now, the cost to connect such devices to a wide-area network has been a major barrier to widespread IoT deployment, but the evolving IoT network and device ecosystem is rapidly changing to remove this barrier.

Moreover, 5G, the next generation of wireless technology, will provide an end-to-end ecosystem to enable a fully mobile and connected society. With speeds measured in multiple gigabits per/second, latency in the single digit milliseconds and the capacity to handle 1,000 times more consumption than current network technologies, 5G promises to deliver on IoT opportunities like robotics, autonomous vehicles and the massive scale expected in a truly connected world.

Revenue growth is the biggest factor driving #IoT.

Only 8% of businesses are using more than 25% of their IoT data[3].

2 Gartner, Gartner Says 6.4 Billion Connected "Things" Will Be in Use in 2016, Up 30 Percent From 2015, November 10, 2015, http://www.Gartner.com/newsroom/id/3165317

Platforms as a service (PaaS)

Creating, implementing and managing IoT applications is a complex process. It involves sensors and mobile devices, secure network connectivity, storage, big data analytics, the ability to scale new services and ongoing integration and fine-tuning. Not surprisingly, most enterprises, regardless of size, do not have all of these capabilities and skills in-house to make IoT a reality.

We see complexity, a fragmented ecosystem and concerns about security and privacy as the key factors that are driving the proliferation of IoT platforms. These platforms are designed to make building and deploying applications easier, faster, secure and more accessible for everyone.

5G promises to deliver on IoT opportunities like robotics and autonomous vehicles.

In 2016, enterprise IoT startups will generate two to three times more funding than their consumer counterparts.

Investment in IoT startups

As a CEO from one of the largest banks in the world famously declared, “Silicon Valley is coming,” confirmation that the explosion of activity among tech start-ups and larger tech companies is posing a serious threat to business as usual. Tech disruption is not unique to financial institutions. A wide range of industries are under competitive pressure from non-traditional players, leading to some interesting mash-ups. For example, amid changing demographic preferences, the auto industry has taken notice of ride-sharing as an immediate threat which has resulted in large-scale investments from top automakers in companies like Uber and Lyft.

The race to usher in new business models and revenue streams through IoT shows no signs of slowing down in the near future. According to analysis conducted by our venture capital (VC) arm, Verizon Ventures, we estimate that consumer IoT startups raised 15% more VC funding than enterprise-focused startups in 2014. However, in 2015, roles seemed to have reversed with enterprise outpacing consumer by around 75%. In 2016, we believe the enterprise will continue that trend, but by a much larger order of magnitude – roughly 2 – 3 times more than consumer. 2016 will see enterprise IoT VC funding considerably dominate that of consumer.

Consistent with these trends, our experts say that the next 18 months will continue to give rise to tech accelerators specifically tailored for a wide range of industries. Think of accelerators as the intersection of IoT innovation meets Industry X. These programs are designed to fuel growth by providing tech startups with funding, proof of concept resources and mentoring. On the flip side, increased participation in accelerator programs as a corporate partner allows enterprises to learn about new IoT technologies that can either be woven into their existing products and services or to create new products and services intended to drive new revenue opportunities.

Factors accelerating adoption

Evolving regulatory landscape

Regulatory compliance is a huge driving factor behind IoT adoption. We've already seen how the Energy Act (2007) in the U.S. accelerated efforts to monitor energy consumption. Nearly a decade later, the installed base of remote-capable meters with smart grid app support is expected to reach 454 million in 2016 and to more than double by 2020, making it a leading IoT device.

Consider the Drug Supply Chain Act. This legislation gives drug manufacturers until late 2017 to electronically transfer and store transaction histories for their prescription drugs, including shipment information across their distribution supply chain. The law is designed to thwart counterfeit drugs which cost the industry $75 billion annually[4].

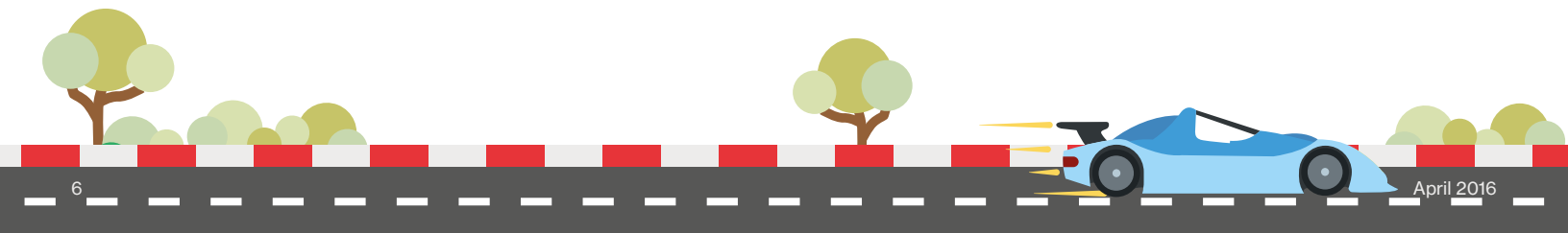
Similar requirements in other sectors such as the beverage and construction industries, where the product can change hands up to 10 times – from manufacturer to consumer – will drive the deployment of millions of sensors to track machines and other assets. IoT will allow small and medium-sized businesses as well as large enterprises to quickly provide critical information to their customers and supply chain partners.

50% of most auto trips are less than three miles[5].

In the US, the agriculture and food industry is deploying sensors on an ever-widening scale to monitor key production conditions, shipping time and other metrics as a means to comply with a new and comprehensive set of reporting requirements under the 2015 Food Safety Modernization Act.

In the public sector, demand is steadily increasing for intelligent traffic and multimodal transportation solutions such as bikes, scooters and skateboards as alternatives to cars. These efforts are designed to enhance livability for residents and reduce congestion for businesses and other organizations such as colleges and universities. However, considering that many municipalities continue to grapple with aging infrastructure, redesigning streets to accommodate expanded modes of transportation is a huge undertaking. Our experts say that public-private partnerships to make funding viable will be key.

Indeed, more and more "things" – ranging from remotely programmable home thermostats and wearable health and fitness devices to aircraft jet engines and the nation's power grid – will be added to the internet every day. Devices, connectivity, and IT services will make up the majority of the projected $1.3 trillion IoT market in 2019. Modules and sensors alone will comprise 23% of that total[1].



Growing consumer expectations

> I want technology to work for me, not the other way around.

Consumers have grown to appreciate their smartphones, but in an IoT-enabled world, they are starting to understand that their phones can do more. With so much potential at their fingertips, consumers expect to remain constantly connected while also feeling in control of how and when they choose to connect to the people and things that matter to them the most.

Our experts say that consumer expectations fall into three buckets.

The connected lifestyle defined

Tech Solutionists: These consumers live through mobile and are willing to try new technologies and apps that can introduce a better way of life.

Growing Networks: Whether watching out for an aging parent or beginning to start a family of their own, the network of things they care about continues to change and expand.

Addicted to Improvement: From Fitbits to Facebook Messenger, they crave frequent updates on the people and things they care about and subsequently seek out products and services that can help with this.

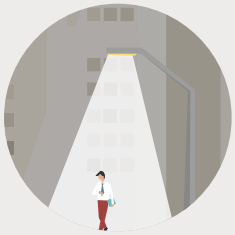
Sizing the IoT market opportunity



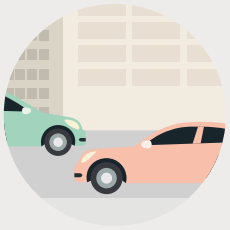
300 million
utility meters



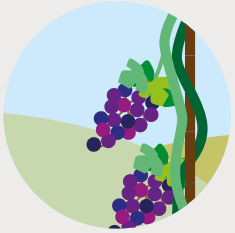
83.1 million
millennials in the US[6]



100 million
street lights



150 million
unconnected passenger cars



1 million
vineyard acres



$75 billion
counterfeit drugs

Source: Verizon data

IoT innovation simplified

Apple has HomeKit, Verizon has ThingSpace, Google has Brillo, IBM has Watson and Cisco has Jasper. These and numerous other platforms populating the IoT marketplace promise a secure infrastructure and a set of tools that enable developers to build IoT applications, then manage the vast array of connected devices and the huge volumes of data those endpoints generate.

One-stop shop for developers

In a nutshell, the platforms work to jump-start the development and deployment of IoT apps by radically simplifying the process for building and managing applications. Platforms provide a one-stop shop for development tools, secure network connectivity and everything else needed to launch, scale and manage apps. With IoT, simplicity is a necessary starting point, and platforms like ThingSpace are designed to create zero friction for developers.

For example: with just three mouse clicks, developers working on ThingSpace can access the platform's growing library of application program interfaces (APIs). They also have access to one of the most advanced data and analytics operations of any industry.

Easing innovation for enterprises

Today's IoT platforms address head on the problems of complexity and fragmentation that up until now have been two of the biggest barriers to IoT innovation. Before, developers had to go through multiple channels and cumbersome processes to access and integrate the tools they need to create and launch state-of-the-art applications. The availability of mature platforms not only simplifies the development process, it allows enterprise users to drive the creation of new product and service categories as a foundation for future contextual experiences for consumers, businesses and citizens. Users can also manage their IoT environments and related data, end-to-end, from device to network to application.

Farming for oysters



In his commitment to efficient and sustainable seafood production techniques, Dr. Daniel Ward, an entrepreneur-scientist, established Ward Aquafarms, a 10 acre, 1,000 cage aquaculture farm located in Cape Cod, Massachusetts. Ward's mission is to deliver the freshest seafood possible. The majority of the farm is dedicated to growing Eastern Oysters. Verizon, in collaboration with systems manufacturer Mobotix AG, has enhanced Ward's ability to monitor the safety of its Oyster harvest-to-bag process and predict growth.

Mobotix onboarded its state-of-the-art thermal radiometry sensor enabled-cameras with ThingsSpace and was up and running on Verizon's IoT platform in less than an hour. With the help of Verizon's Professional Services team, satellite imaging data has been combined with other complex data such as environmental and sub-tidal water temperature, chlorophyll values, and others. Verizon Professional Services analyzes and contextualizes these inputs and provides specific insights that are valuable for Ward's aquafarming operations.

Mass customization of apps

Platforms also work to democratize the process of app development, which is especially important given that the IoT market is not a single, monolithic market but is instead composed of tens of thousands of small markets.

> IoT is not a single, monolithic market but is instead composed of tens of thousands of small markets.

A physician, for example, may have a great idea for an IoT device and app that would help the 400,000 children in the US with juvenile asthma. But amassing the resources necessary to build a solution for such a relatively small market would be challenging. An IoT platform provides the tools necessary to build and launch such a solution in an efficient manner. As one observer put it:

> "IoT platforms enable people living a problem to construct solutions and bring them to market cost-effectively."

Making life more convenient

BuildingLink.com aims to be the gold standard choice for residential property managers looking to upgrade more than 3,200 luxury residential properties. To bring this experience to the next level for residents, BuildingLink used ThingSpace to create a sensor network covering the fitness center and laundry room facilities in a luxury apartment building located in Manhattan. ThingSpace allows residents to check real-time availability of treadmills, stairmasters, washing machines, etc. on a dashboard included in their mobile app. The app provides machine-specific utilization patterns for building management who can then intelligently remove under-utilized machines and add them back in the queue of those most in demand.

Looking ahead, manufacturers and other enterprises will roll out application program interfaces for developers. Developers in turn could create customized applications for say, local and regional markets, adding a new layer of economic value to the IoT ecosystem. The same thing has already happened with the smartphone. Once the platform was opened to the developer community, millions of applications emerged.

We predict a very similar education cycle with IoT. Up until the last year or so, the IoT market didn't fully understand that IoT technologies and apps are just as personal as our homes, our cars and our bodies.

Going forward, as new IoT apps continue to emerge, developers will need to deliver experiences that inform users – whether they're consumers or businesses or citizens – about their world so that they can connect to what matters most, rather than limit those experiences when something goes awry. The takeaway should not be "Oh no, I lost my bag – what happened to that app I installed?" Instead, app experiences in an IoT-enabled world should be more robust and fully integrated in our daily lives.

> Wireless networks of the past were designed for smartphones. Most devices today are not as sophisticated as smartphones. Enabling developers to create applications on devices built for IoT using IoT platforms requires transforming wireless networks into a gateway that developers can program themselves. That's the power of ThingSpace.

Connection, convergence, convenience and the connected car.

Many of the technology, data and integration advancements underway with IoT come together in increasingly connected and cognizant cars. Telematics technology has gained momentum largely due to decreasing costs of hardware, software and connectivity and growing ease of use. Gartner has predicted "a huge increase in connected automobiles over the next five years. By 2020, there will be a quarter billion connected vehicles on the road, enabling new in-vehicle services and automated driving capabilities"[7].

> IoT provides opportunities to share information with customers, to improve the customer experience (75%), and to gain insight into customer preferences (74%)[3].

Data integration and app convergence in the connected car space has worked to streamline and simplify the delivery of solutions that address real-world scenarios and empower consumers in their day-to-day lives. However, retailers note that parents, for example, don't walk into a store and ask for the latest and greatest IoT-enabled gadget. Instead, what they ask for is a way to tell whether their daughter – who just got her driver's license and borrowed the family car – got home safely from school.

On the enterprise front, telematics technology is enabling trucking companies and other fleet operators to comply with regulations requiring them to track and report driving behavior and drivers' hours. Automatic logging and reporting has been tied to reducing highway accidents and fatalities since it alerts drivers when they are nearing their drive time limit. The Federal Motor Carrier Safety Administration is working on rules to require so-called e-logging devices in all interstate trucks and buses as early as 2017.

Verizon Telematics will soon roll out an LTE solution as a standard feature for the OEM automotive market. In recent years, automakers have realized the benefits of having all of their cars and customers connected. For starters, connected cars save lives. In fact, according to our automotive experts, safety continues to rank first in terms of the overall awareness and value that it brings to the connected car. In addition to enhanced safety measures, Verizon's 4G LTE's high bandwidth and low latency will enable features like audio and video streaming as well as over-the-air updates allowing OEMs to deliver an enhanced customer experience. Verizon's all LTE solution is also designed to facilitate global service as OEMs seek to compete in new markets.

Connected cars

hum

Hum by Verizon is a technology designed to make your cars smarter, safer and more connected. The service involves a very simple installation of a plug-in device into a car's on-board diagnostic port. Owners of vehicles manufactured in 1996 or later may gain access to services like boundary and speed alerts, vehicle location and driving history. Especially compelling for consumers is a hum feature that lets subscribers with a car problem talk to a live mechanic via hum's mechanics hotline. Pinpoint roadside and emergency assistance are also included with the service. Consumers also have access for asking questions about where to get the best price on tires or whether a repair estimate is reasonable. For more information about hum, visit www.hum.com.

7 Gartner, Musings From Def Con 23: Internet of Things Risks Are Bad and Likely to Get Worse, 25 September 2015

Big Data streams from connected cars.



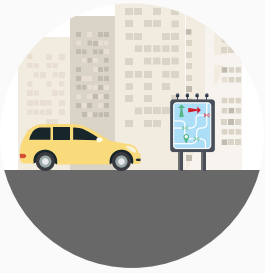
Data source

e.g. Connected car data, network data, contextual data



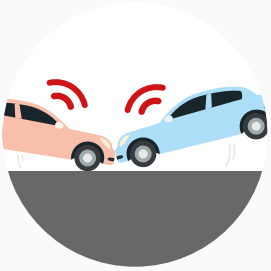
OEMs & dealerships

e.g. Vehicle diagnostics, in-car service consumption



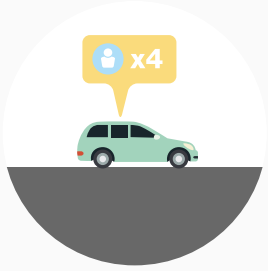
Smart cities

e.g. Real-time traffic flow, incident alert, parking



Insurance companies

e.g. Aggregated/anonymized driving data, incident data



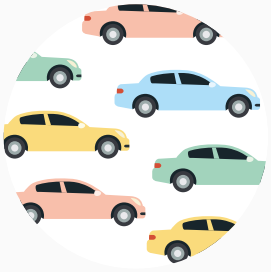
Advertisers

e.g. Customer/passenger demographics



Fleet customers

e.g Fleet performance, compare against competition



Other B2B

e.g. Content usage, frequency, length, etc



Federal / State DoT

e.g. Breakdown data, accident data, environmental data





Beyond dashboards: the analytics of things.

Consumers and businesses want information they can use to improve their lives and the bottom line. They need not just data but a way to analyze it so they can make better decisions.

> The ability to monitor and manage objects in the physical world electronically makes it possible to bring data-driven decision-making to new realms of human activity—to optimize the performance of systems and processes, save time for people and businesses and improve quality of life[8].

Going forward, companies looking to grow their revenue will exploit the information they collect via "things" to better understand and serve customers, improve products and create customized solutions for individual customers.

Big data will move beyond descriptive data collection to predictive and prescriptive analytics.

Advancing intelligent transportation

Take the app for the city bus on your smartphone that alerts you when the next bus is scheduled to depart for your evening commute home. By combining this data with data on your calendar and your friends' calendars, predictive analytics could determine when you might need to take an alternate bus route. Imagine receiving a notification on your smartphone that suggests taking bus No. 57 rather than bus No. 10 so that you can stop at your favorite store on the way home and buy a birthday gift for your family member. It can also re-route buses based on passenger needs at various times of the day.

Let's say that you arrive back at the bus stop near your home late one night, but still need to walk home, which is approximately one mile away. Prescriptive analytics goes a step further, by offering alternate modes of transportation such as a bike or ride-share so that you don't have to walk home alone in the dark which might help prevent an unsafe situation.

This requires a convergence of IoT data and analytics capabilities that can scale to handle the massive volumes of data generated by millions of sensors.

IoT promises to enhance the way you live rather than expecting you to adapt.

Descriptive analytics:

Answers: "What has happened?"

Data aggregation and data mining to provide insight into the past.

Predictive analytics:

Answers: "What could happen?"

Statistical and models and forecasting techniques to understand the future.

Prescriptive analytics:

Answers: "What should we do?"

Optimization and simulation algorithms to advise on outcomes and machine automation.

The supply chain reimagined

Consider, for example, the massive number of touch points in the pharmaceutical supply chain, from plant materials to packaged products on a store shelf. Today, companies widely use RFID technology to track the movement of products, but the technology is limited. It can tell when and where an item was scanned, but there is little to no visibility into what happened between two scanned points.

IoT devices enable companies to track heat, light and other relevant factors. By integrating this data with say, weather and traffic data, the company can make better decisions because it has a more holistic view that is tied to the business.

Companies also can set up rules to govern shipments based on real-time conditions. If it's raining, take Highway 10 because the usual Highway 5 route floods in rainy weather. The ability to collect, integrate and act on data from multiple sources is what enables predictive and prescriptive analytics.

The role of domain experts

Without question, virtually all industries will be inundated with a deluge of IoT data. Contextualizing that data for different kinds of businesses is imperative. Along with analytics capability, subject matter expertise will be an increasingly critical component of IoT platforms and the overall IoT ecosystem.

Agronomists, public health experts, structural engineers and other experts will bring their expertise to data modeling and the creation of algorithms that go into predictive and prescriptive analytics, benefiting the food, health and building industries.

In the event of a power outage, for example, a power company could receive an automatic notification from the meters of every home and business without power – thus helping to detect the source of the power problem – plus have access to a map showing where each of its technicians are located and get prescriptive advice for dispatching them in the most efficient manner.

Up until now, the world of IoT has been a pretty geeky place. Yes, gadgets could learn behaviors but each gadget came with its own software, set up and variations. Now, the platform's capabilities enable apps to learn enough about human behavior around multiple devices so a parent or homeowner does not have to create a set of rules for each and every device. Instead, the platform will automatically ensure that relevant data generated by a thermostat, for example, is communicated to appropriate appliances and adjust them accordingly.

Helping the patient on the go

AMC Health

Verizon is currently working with industry experts like AMC Health that delivers mobile patient monitoring solutions via smart phones and tablets. Customers may continue using services from their home and anywhere the Verizon mobile network is available. For example, by using AMC Health's mobile patient monitoring solution, an active pregnant woman who needs to track her blood sugar can use a mobile device to communicate readings from her glucometer at any time and any place she chooses, and that information is stored securely in the cloud. Her care provider has 24/7 access to her information and can determine whether she, her baby or both are at risk. Using this information, the woman's health care provider can provide more timely and appropriate care for the benefit of both mother and baby.

IoT security and privacy

The sheer volume of IoT devices constantly producing communications, require careful security and privacy considerations. There is no current IoT protection framework that's ahead of the implementation of this technology. The industry is keeping up with the development of technology by looking to the rising threat vectors – some old, some new – that will impact deployments and ongoing operations. Authentication of critical data, and baseline triggers for action are the emerging security focus.

How devices will mutually authenticate to a reliable degree of authenticity to prevent rogue commands and communications or data leakage is a priority consideration. Communications could be interrupted given a variety of factors and unless there is an assurance that corresponding devices are legitimate, there is no basis for secure operations.

The scale of data being communicated within specific ranges or environments is a factor for maintaining consistent operations, but critical data that can be traced and identified requires a privacy technique known as "pseudonomization" of the data – that is, assigning an obscured identifier to the data so that it doesn't readily map to a known person, address, etc. This is not one process, but a series of interactive pieces that will be a priority to test, protect and defend.

Communications between devices that trigger activity is of the highest concern to validate and secure. The timing of response ultimately is what creates the beneficial experience when the technology is functioning as designed, it is always the unintended, overlooked, or malicious capabilities that have to continue to inform security and privacy design, and implementation.

According to our Oxford Economics study, security and privacy concerns are long-standing issues. Respondents noted that success depends on developing systems, policies and procedures for managing the information that IoT generates[3]. Changes to ways of working and new skills are key opportunities.

Security involves multiple layers

Governance, Risk and Compliance

Prepare to manage risk

- Access Governance
- Threat Vector Analysis
- Penetration Testing
- Partner Security Program
- PCI Compliance Program

Threat Management

Protect the perimeter

- Security Configuration Management
- Vulnerability Scanning
- Application Scanning
- Content Scanning
- Cloud- assessment

Authentication and Privacy

Trust the ecosystem

- Data Discovery
- M2M Security
- Managed Certificate
- Application Security
- Smart Credentials
- SSL Certificates

Professional Security Services

Respond to the threats

- Rapid Response Services
- Digital Forensics

Farming with precision.

Industry experts have quipped that the agriculture industry is proof that soon, every company will be an IoT business. Why? Because the benefits that growers are reaping by deploying IoT technologies to their fields – namely bigger crop yields, overall operational efficiencies and reduced costs – are too valuable to ignore.

One of the biggest trends in farming today is precision agriculture, the practice of sensing and responding to variable soil, moisture, weather and other conditions across different plots. Farmers are deploying wireless sensors and weather stations to gather real-time data about things such as how much water different plants need and whether they require pest management or fertilizer. (See page 17 sidebar on Hahn Family Wines.)

> The total market size for digital precision agriculture services is expected to grow at a compound annual growth rate of 12.2% between 2014 and 2020, to reach $4.55 billion[9].

Using this data, growers can customize growing processes. Indeed, one of the biggest benefits IoT offers farmers is the ability to gather much more granular data about smaller parcels of land. With site-specific data, growers can then optimize growing conditions on a plot-by-plot basis, boosting yields, improving quality and cutting costs in the process.

> The agriculture industry is proof that soon, every company will be an IoT business.

In the wine industry, for example, the amount of water that different grape plants require depends on the kind and quality of wine that will be produced from them. Pinot Noir grapes have different soil and moisture requirements than Chardonnay grapes, yet a grower may be cultivating both kinds of vines in adjacent plots. Collecting and analyzing real-time data from different plots enables farmers to fully optimize growing conditions for all plants under cultivation.

Verizon's agriculture IoT solution is designed to gain insights and provide actionable intelligence at a block level. On a multi-acre farm, block level is defined as adjacent acres with unified conditions. Growers can collect sensor data for each block and then calibrate watering or the spraying of herbicides or fungicides for each block.

Site-specific data can also help farmers satisfy the demands of 21st-century consumers who want to know more than ever before about where their food comes from and how it was grown.

According to the United States Department of Agriculture, consumer demand for organically produced goods continues to show double-digit growth, providing market incentives for U.S. farmers across a broad range of products. Organic products are now available in nearly 20,000 natural food stores and nearly 3 out of 4 conventional grocery stores. Organic sales account for over 4 percent of total U.S. food sales, according to recent industry statistics.

To meet organic standards, farmers can't use synthetic pesticides, growth hormones or antibiotics and instead must find other methods to improve soil quality. One alternative being explored is the use of pheromones which could work to disrupt the mating patterns of pests harmful to crops. In this scenario, wireless sensor networks would monitor pest counts and when a dangerous level is detected, a pheromone delivery system would be activated.

IoT-enabled agriculture makes good business sense. But there is an even bigger factor driving adoption across the farming industry.

The Internet of Things is also poised to play a key role in helping farmers comply with anticipated regulatory reporting requirements around issues like water usage. Sensors will automatically monitor irrigation activity and aggregate data at the block level to allow for accurate reporting. More broadly, IoT will help promote the efficient use of resources and will result in high-quality products while preserving the Earth.

> With the world's population expected to grow by 2 billion, to 9.7 billion in 2050[10], and with a limited amount of arable land, finding better methods to feed the planet has become a global imperative.

A new generation of technology-savvy farmers is embracing digital agriculture. As a result, big data analytics is expected to play an expanded role in food production.

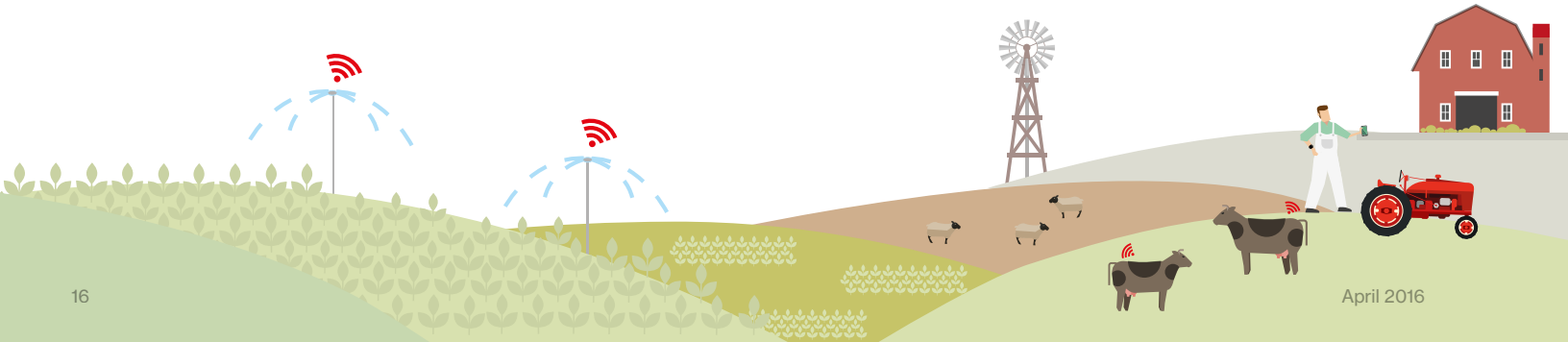
IoT platforms are already becoming populated with agriculture-specific applications developed by university-based agronomy researchers. This will enable even small and mid-sized farmers to share in the benefits of precision agriculture going forward.

Precision agriculture relies on IoT

It makes seeding, irrigation and the application of fertilizers and pesticides more accurate. It monitors livestock for location and movement, so injury, illness or theft can be instantly detected. And it brings new levels of automation to crop harvesting.

Feeding a growing population

IoT is transforming agriculture and enabling farmers to overcome challenges such as water shortages, escalating costs and the limited availability of land, all of which are critical in meeting the food needs of a global population. The demand for food is expected to grow by 70% by 2050[11].



Fine-tuning grape growing at Hahn Family Wines.

Hahn Family Wines, a family-owned winery based in the Santa Lucia Highlands in California's Monterey County, has launched a pilot project with Verizon that uses sensor data and analytics to conserve resources and add precision to watering and fertilizing five six-acre blocks at the company's 1,000-acre vineyard. IoT technology promises to increase yields plus improve the quality of the harvest by targeting irrigation and customizing fertilizer applications to specific plots.

"Water is one of the most important tools we have as vineyard managers," says Andy Mitchell, director of viticulture at Hahn. "With this technology, instead of a 50-, 60- or 100-acre sampling site, we'll be able to micro-manage and get very specific on certain blocks. This will help us get to the next level in approaching world-class status."

Hahn has equipped each block in the pilot with a water flowmeter at the water pump, a battery-operated moisture probe that measures four different levels of soil where the grapes are growing, and a weather station to measure air temperature and other conditions. An IoT gateway continuously monitors data from the various sensors and transmits it wirelessly to Verizon's Ag tech solution on ThingSpace.

Having all of this information will help the company in applying chemicals to different blocks, Mitchell says. The Santa Lucia Highlands has ideal growing conditions for Pinot Noir and Chardonnay wines, but unfortunately, also for mildew.

"We're prone to mildew, so we have to stay vigilant. This additional information will help us be more efficient with sprays," he explains, adding that in the absence of site-specific data, vineyards have used single spraying across their acreage.

In the pilot, Hahn is using the weather station to monitor solar radiation, wind velocity, humidity and temperature in the air above the vine-canopy. Using this data, the company can time and target its use of fungicide sprays to prevent disease and rotting, which can be caused by heavy condensation.

Verizon's Ag tech solution makes data available on a dashboard, and Hahn can check the information in real-time and adjust growing processes accordingly.

"We're really looking forward to getting more and more precise, and we're already looking at variable frequency motors that will let us put out different levels and different pressures of spray to different blocks," Mitchell says.



Making communities smart and sustainable.

The world's population is migrating to cities. Already, 54% of the world's people live in urban areas, with an estimated 180,000 more moving to cities each day[12]. The World Health Organization estimates that by 2050, approximately two-thirds of the global population will be city dwellers[13].

Rapid urbanization is putting a huge strain on city services not to mention aging infrastructure that supports fire and emergency services, public transportation, lighting, sewer and sanitation systems.

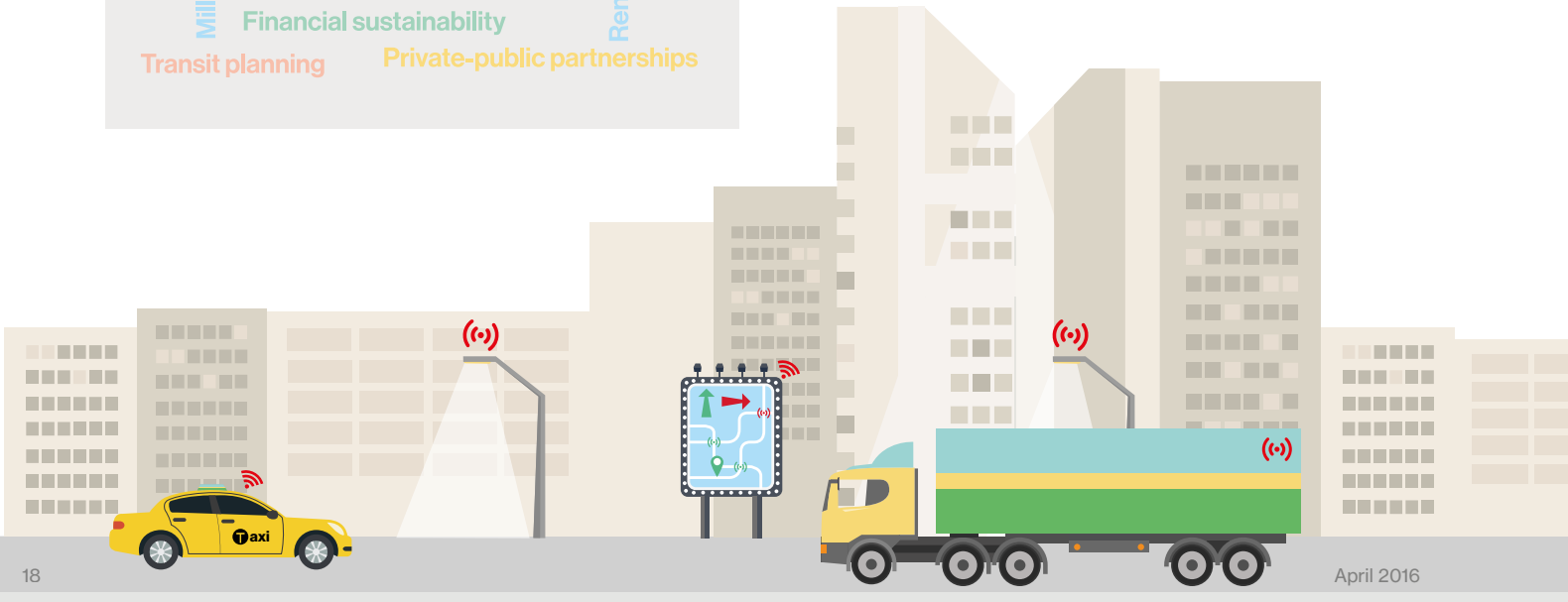
And while IoT is providing the way forward, focusing on smart cities alone is only scratching the surface. Realizing the vision of smart cities requires effectively addressing the needs of even smaller communities including neighborhoods, industrial parks, venues, multi-dwelling units, colleges and universities.

IoT technology is providing a way forward. Smart streetlights equipped with sensors are saving cities energy and money by detecting pedestrians, cyclists and vehicles so that lights brighten and dim when they sense movement. Cities can analyze this data for other useful information about traffic patterns, parking spaces and public safety requirements. At least one smart lighting manufacturer, for example, is exploring technology that would detect gunfire and, with real-time data analysis, pinpoint the location of shots and notify emergency dispatchers to send police officers to the area[14].

In Charlotte, North Carolina, a public-private partnership known as Envision Charlotte has been measuring and continually displaying energy used by uptown buildings, a move the city says has helped to reduce the city's energy use by 16% and keep 220,999 metric tons of greenhouse gases from being emitted[15].

What makes a smart community?





76%

76% of IoT adopters in public sector institutions say that an organizational structure that encourages flexibility and cross-functional work is important for improving performance around IoT[3].

81%

81% of IoT early movers in the public sector believe their citizens increasingly expect them to offer enhanced services using data from IoT[3].

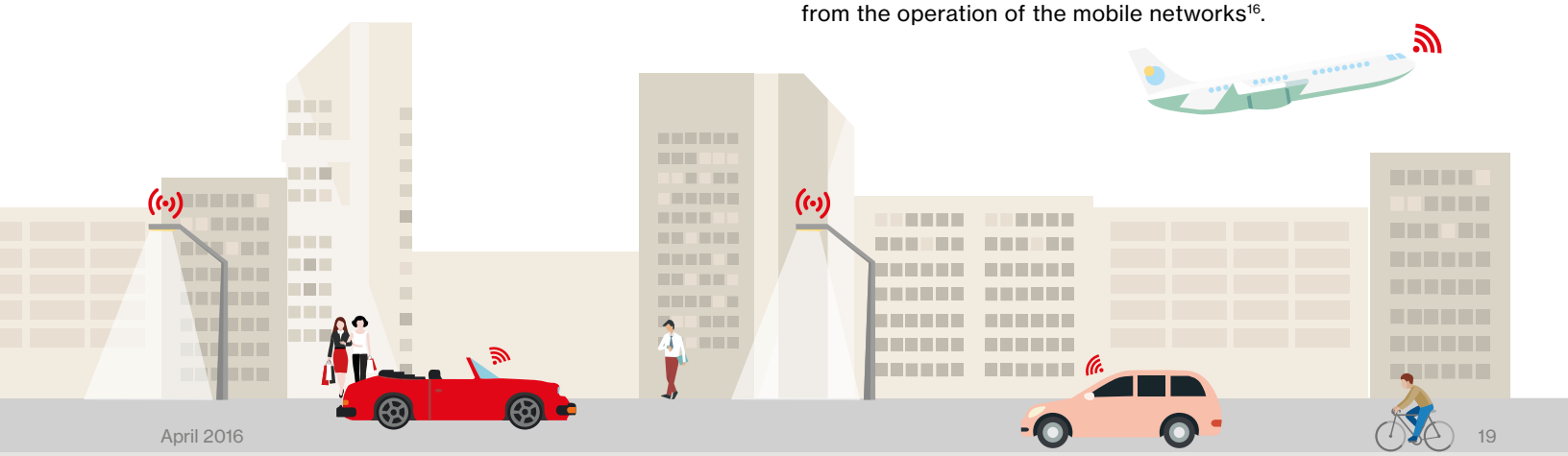
Now, a spinoff group called Envision America has taken the energy conservation and efficiency program to several other cities, broadening it to include water, waste and air as well. Both programs reinforce the adage that "what gets measured, gets done."

San Diego, California, and Jacksonville, Florida both have trials underway that use LED streetlight technology to collect real-time data not only to manage lighting, but also to manage parking, locate and identify potholes and keep track of repairs to municipal streets.

Yet to deliver value to citizens and ensure sustainability, municipalities must do more than monitor and measure. This is where the power of analytics comes in to play. Analytics can integrate and analyze data in new ways to make innovative municipal services possible.

The vision is that of a citywide information network composed of connected, sensor-equipped streetlights that will both save energy costs and enable new city services. Imagine motorists receiving a text message when a parking space becomes available in the vicinity where they want to shop.

Mobile technology is making a considerable contribution to action on climate change according to Mobile Carbon Impact, a report released by the Global e-Sustainability Initiative (GeSI), authored by the Carbon Trust. The analysis found that the use of mobile in the US and Europe alone is already enabling a saving of more than 180 million tonnes of carbon emissions a year, an amount greater than the total annual emissions of the New York State. This abatement, or reduction impact, is approximately 5 times greater than the emissions emitted from the operation of the mobile networks[16].



Bedford Park, Illinois

Forward-thinking city officials like Mayor David R. Brady view smart cities as a means to attract new businesses, a younger workforce and a re-energized tax base to urban areas like Bedford Park, Illinois.

Located immediately south of Chicago's Midway Airport, Bedford Park is an ideal business location. 90% of its land area is devoted to industry and it is home to 380 companies[17].

"Traditionally, we're more of an industrial and commercial area, and we think a smart city will help us compete for more diversified and tech-oriented businesses," Brady says. "It sets us up for the future."

Bedford Park is home to 200 residences and 600 residents, all of which have been equipped with fiber-optic connections to provide residents with internet speeds that are 20 times faster than average. "We did that to attract Millennials," Brady explains. The strategic goal is to make Bedford Park a showcase Smart City Municipal Innovation District that integrates multiple smart village services that benefit the village's businesses and residents.

> In the year ahead, analysts expect to see many new use cases, such as renting large equipment and power tools on a self-service basis.

Bedford Park isn't alone. Municipalities nationwide are working to attract start-ups, new businesses, jobs, and a new generation of workers, homeowners and taxpayers. A critical success factor is a strong digital infrastructure enabling a sharing economy. Millennials are driving a transformational shift away from ownership of cars, homes and other assets. Instead, the overwhelming trend is toward asset sharing, which increases overall sustainability, yet another area where the IoT is poised to play a huge role in the next 18 months or so.

Of those who have tried the sharing economy, 72% say they envision themselves being a consumer in the sharing economy by the end of 2016. Young adults aged 18 – 24 are most excited by the sharing economy[18].

72%

say they envision themselves being a consumer in the sharing economy by the end of 2016[18].

Innova UEV

Verizon is partnering with Innova UEV on a university campus-based car sharing program to provide 4G LTE wireless connectivity within Innova's all-electric Dash vehicles. Innova UEV is also using Verizon's Share IoT solution via ThingSpace to ensure a friendly experience between driver, application and vehicle.

The Innova EV Car Share app powered by Verizon enables the student to locate, reserve, access, utilize, then return the car, using their smartphone or tablet. It also displays how much carbon emissions are saved for each ride. Innova UEV's Founder and CEO, Roman M. Kuropas says that Verizon's Share solution enabled Innova to reduce its development time by two years.

Currently, Innova is running pilot programs at the University of Pittsburgh, the University of Wisconsin-Madison, Colorado State and Washington State. The companies are collecting data from more than 40 vehicle sensors and cameras and analyzing it to enable further program innovations.

For now, the sharing economy pertains largely to vehicles and accommodations – think Uber and Airbnb.

Providing real-time energy insight.

Energy and utility companies are regulated and must modernize their aging infrastructures, all while increasing efficiency and keeping costs down.

IoT is already playing a role in addressing these challenges, and moving forward, its role is likely to expand significantly.

At the center of this ecosystem is data which can be remotely collected from meters, pipes and other equipment and assets, then analyzed to enable a better understanding of not only power usage but also power quality, the location of outages and the condition of critical infrastructure.

New low-power, low-cost grid sensors enable electricity providers to sense environmental events like trees interfering with power lines. With this data, utility crews can schedule foliage maintenance before an accident occurs.

By monitoring voltage, for example, power providers can determine whether a transformer is running too hot and needs to be fixed or replaced. Or, they may have too many users on a particular line and thus need to add other elements to optimize the grid. Right now, power providers don't know exactly how the grid is performing at any endpoint.

The advent of newer "as a service" network models, under which companies pay only when they transmit data, are breaking down certain industry barriers to modernization. Because utilities need to go before public utilities commissions to ask for a rate increase to pay for new technology, they have been slow to move forward. Instead, they tend to ride out existing investments, depreciating them over 10 to 15 years.

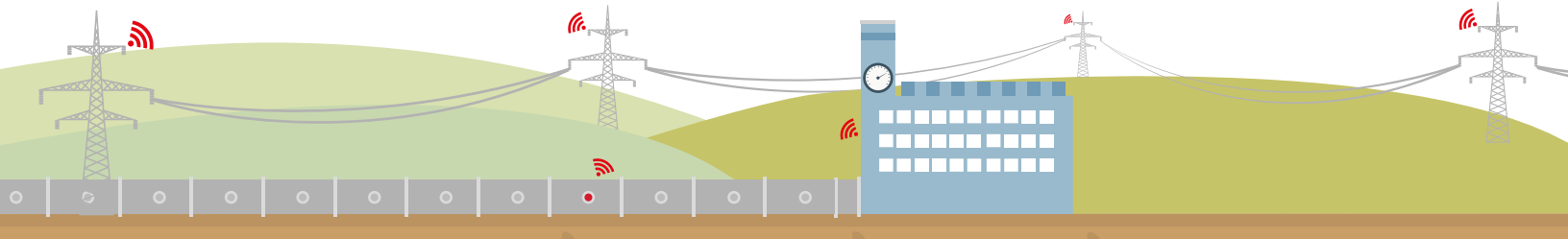
By contrast, with "as a service" models, utilities don't have to swap out the entire meter population at once. They can put in remote readers at say, difficult to reach places and pay only for service to and from those remotely located meters.

> "With an addressable market of more than 300 million electric, water and gas meters in service in the US today, the opportunity for intelligent solutions and services in the utilities market is massive.

The water industry also needs to know about conditions in the water grid. As is the case with power utilities, manual meter reading is expensive. Water utilities are realizing that wireless networks, with their extensive coverage, reliability and security, offer a cost-effective and efficient alternative.

Visibility into energy consumption and efficiency is also gaining importance as states enact legislation requiring monitoring. Nearly 50 states have efficiency requirements specifically for state-owned or funded public buildings. Additionally, legislation regarding energy efficiency in all public buildings was enacted in 13 states in 2015.

IoT core networks coupled with new Cat 1 devices enable water and other utilities to more easily and less expensively monitor pipes and other hard-to-access infrastructure. Prior to these advancements, utilities have been essentially limited to using their own wireless networks to monitor infrastructure. Unfortunately, private networks are expensive to develop, operate and manage.



What does it all mean?

Greater automation for consumers

Over the next 18 months, IoT adoption will grow significantly, thanks largely to falling costs, the continuing convergence of data and services and ever-increasing IoT technology simplification – a factor of utmost importance to consumers in particular. Homeowners can look forward to a simplified user interface to address a range of everyday issues, from controlling and monitoring home security and environmental conditions to monitoring their teenagers' driving habits.

The cost efficiency, convenience, simplicity and security of connecting things will drive wider societal changes. The sharing economy will grow and flourish, expanding to personal vehicles and household gear. Neighbors will check online to see whose car might be available for use, or borrow a chainsaw from the local home store and pay only for the time they use the tool. Eventually, the ability to track usage will create new service categories. Rates for insurance and healthcare will be based on usage and behavior, which can be tracked through IoT.

In three to five years' time, consumers will experience a much higher level of automation and efficiency in daily life, thanks largely to the ability to customize "if-then" scenarios via a streamlined IoT interface.

> If the outside temperature reaches 80 degrees, turn the home air-conditioning unit on when my car signals I am 20 minutes from home.

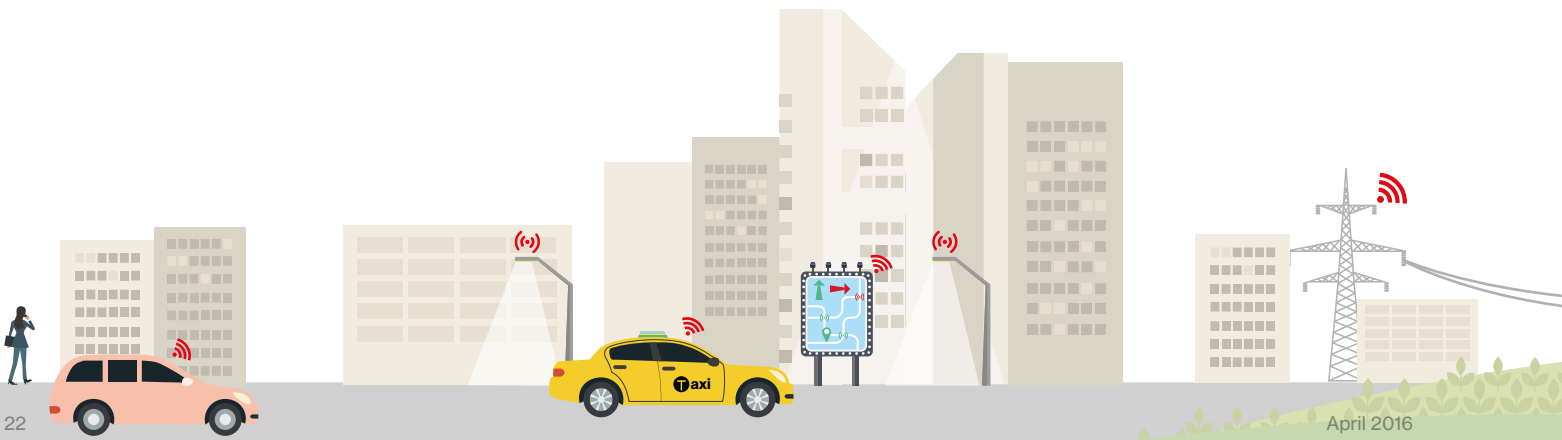
Overall, average consumers – and not just the gadget geeks – will become increasingly willing to try new ideas and services as ease of use and increased efficiencies become apparent. As people begin to experience tangible benefits, IoT adoption will expand quickly, just as cell phone usage did.

IoT usage at home will be less fragmented as well. Companies and services developing products and services will collaborate, enabling users to engage with a variety of IoT applications through a single interface, likely voice, virtual reality and augmented reality, which we see among the major points of interaction in 2016 and beyond.

More tools for developers

Developers can expect to see platforms host a growing library of APIs. Deeper industry-specific expertise will be available to apps they're developing on IoT platforms, which will continue to improve existing services such as device management, integration, security, protocols for data collection and data analytics. This will trigger a proliferation of new IoT use cases as well as greater integration across existing use cases. For example, autonomous cars will interact with smart metering and traffic and lighting systems.

Developers can also look to new edge-computing capabilities in the network, which will become increasingly important as more data from more devices and apps floods the network. Edge-computing capabilities will filter IoT data, sending only relevant bits to central processing platforms for deeper analysis.



New opportunities for enterprise

The same factors driving change among consumers will enable new efficiencies at the enterprise level. New devices – think drones – will proliferate, creating an order of magnitude increase in information – think aerial data, which can be used across a broad array of new use cases across multiple industries. Mining companies, for example, might use aerial data collected by unmanned drones to assess stockpiles or conduct volumetric analyses of supplies stored in remote locations.

New environmental and safety regulations will expand beyond nation-state borders as the economy becomes ever more global, and sustainability issues like carbon emissions and overall planetary health are tackled on a global basis. IoT technologies will enable enterprises to comply with new tracking and monitoring and data reporting and analyses requirements.

New focus for policy makers

Regulators themselves will become more tech savvy as the number of IoT and wearable products and services increase. The head of the US Federal Trade Commission predicted recently that 10 years from now, technologists will need to comprise the bulk of the commission's staff, which is now comprised largely of lawyers and economists. Further advances in consumer-facing technology will demand that this knowledge gap be filled.

Greater potential for society

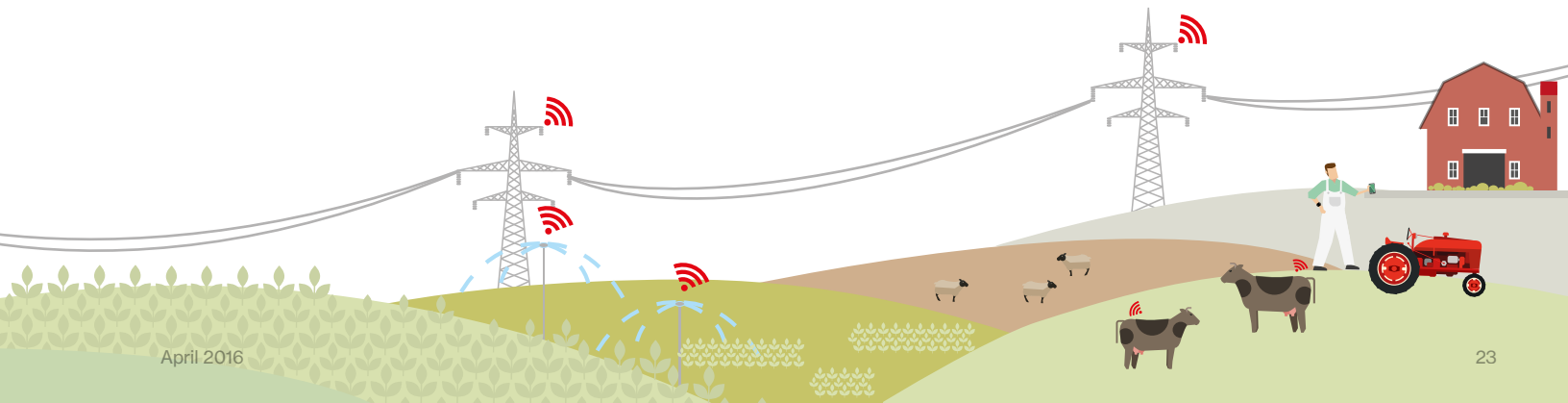
The sharing economy will grow and flourish, producing the "Uberization" of a wide range of new services. Asset tracking will steadily morph into asset sharing. Rates for services such as insurance and healthcare will be based on usage and behavior, which can be tracked through the IoT.

The bottom line

Innovation, productivity and value will thrive as private companies and the public sector both come to the inevitable conclusion that IoT is imperative to delivering the integrated, easy to use and sustainable products and services demanded by an increasingly mobile, tech-savvy 21st-century society.

No single company or country can realize the full promise of IoT on its own. We believe collaboration, experimentation and openness will:

- Create cleaner cities
- Deliver better healthcare
- Make transportation systems safer
- Conserve water
- Boost productivity
- And make the digital world work better for consumers and citizens.



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