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# The Development of the Internet of Everything

June, 2014

## Executive Summary

Connecting the unconnected is more than a conceptual platitude. Connecting people and things in new ways allow us to create new industries and businesses, address issues of global environmental importance, bring economic stability to unstable nations, educate populations in new ways,  and fuel myriad other public- and private-sector endeavors. In order to address these types of national and global challenges, while spurring business innovation and growth, we must integrate technologies in new ways.

According to MachNation, the Internet of Everything (IoE) is the evolution of technology, business strategies and human-to-technology engagement in ways that re-invent how organizations deliver value. The emergence of the Internet of Things (IoT) – as a key component of the IoE -- is driving market attention to the business opportunities afforded by connecting physical objects to the Internet. We believe that over time, public and private organizations will take a series of technology- and business-related steps to realize the financial and societal benefits of the Internet of Everything (IoE). Organizations today should fully understand the increasing future potential of the IoE and plan their steps in a way that maximize their successes.

This whitepaper explores the impact of the development of the IoE on business strategies and human interaction with technology, as well as on technology adoption across networks/connectivity, hardware/devices, applications and platforms (*See Figure 1).*

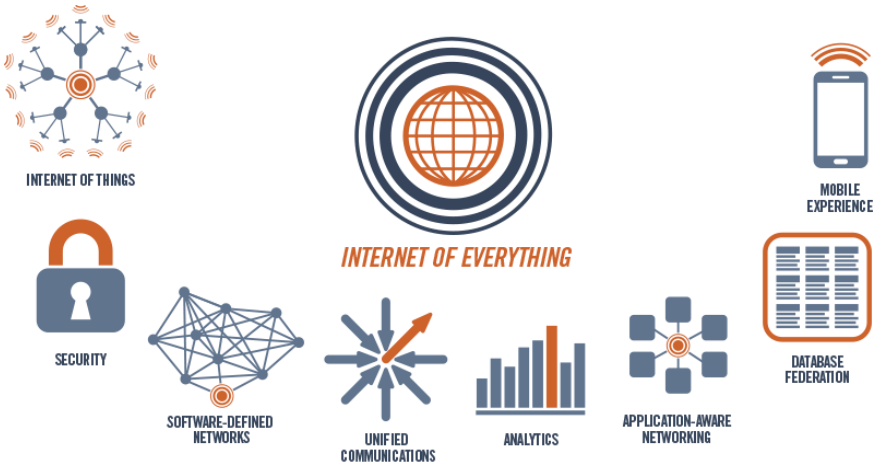


*Figure 1: The Internet of Everything [Source: MachNation, 2014]*

## Definition of the Internet of Everything

According to MachNation, the Internet of Everything (IoE) is the evolution of technology, business strategies and human-to-technology engagement in ways that re-invent how organizations function. Organizations that adopt IoE solutions change their processes to innovate in an inter-connected world where things and people can collaborate in new ways. The IoE includes technology solutions that drive productivity, cost optimization, innovation, community improvement, national development, national security and global resource management for private- and public-sector organizations. IoE solutions are used in both developed and emerging world economies. IoE solutions are deployed in sectors including automotive, transportation, smart homes, energy, utility, security, surveillance, public safety, financial services, retail, healthcare, industrial, warehousing and distribution.

## Key aspects of the Internet of Everything

Today we are seeing a proliferation of connected sensor and device solutions in the market. These solutions – dubbed the Internet of Things (IoT) –can sense and collect data on what is occurring around them and help private- and public-sector organizations to better monitor assets or people. Organizations use the data obtained from these solutions to drive operational savings and, sometimes, create new service-based revenue streams. Some examples of IoT solutions include fleet management, remote-asset management, healthcare-related monitoring devices, oil pipeline monitoring sensors and smart metering. The IoT is the key enabling technology spurring the development of the Internet of Everything, supported by mobility, cloud, big data/analytics and other technologies that are driving increased connectedness between people and things.

Over the next 10 years, we will see continued development in the ways private- and public-sector organizations use connected devices, hardware, networks, platforms, analytics applications and other technologies to achieve their business and civic objectives. This development will impact business strategies, the ways that humans engage with technology and technology implementations. The most progressive private and public sector organizations will

fully understand this future IoE world and take a series of business- and technology-related steps over the next years to benefit from these changes.

## Impacts of the development of the Internet of Everything

The IoE impacts business strategies, human interaction with technology and technology adoption:

- Business Strategies: The transition from product-led to services-led organizations is one of the changes that MachNation envisions in an IoE world. This transition in business strategy has myriad implications for a public- or private-sector organization. According to MachNation research, public- and private-sector organizations have started adopting device-centric solutions or Internet of Things solutions to drive business-process efficiencies. Organizations adopt these IoT solutions – whether simple sensors to monitor factory equipment or applications to monitor fleet vehicles – to help control operating or capital costs. We believe organizations that start using IoT solutions for cost containment will enlarge and enhance their solutions to facilitate innovation. This innovation will drive product-centric organizations to diversify their portfolios to include more services. The IoT is one of the enabling technologies in the evolution of the IoE world, and by taking advantage of IoT, it will help organizations of all types to see the broader set of opportunities IoE connections make possible.

  Organizations adopting IoE solutions will undergo systemic changes that alter the way they engage with stakeholders. While product-centric organizations are built on single-touch engagement models (i.e. a customer consumes a product and does not necessarily have continued engagement with the organization), services-centric organizations are built upon multiple-touch engagement models. Organizations making this transition will need to change their organizations, training, hiring practices and other business processes to take advantage of new technology solutions and meet the needs of customers that consume services-centric offerings. The evolution from single-touch to multiple-touch engagement models is one of the effects of deploying an IoE solution.

- Human Interaction with Technology: IoE solutions increase levels of interaction between humans and technology. This increase in interaction derives from the way IoE technology is

used. Based on MachNation research, there is an exponentially increasing value of IoE solutions as the human-to-technology engagement model increases and the purpose of the IoE solution provides more opportunities for one-way and two-way collaboration between things and people. See Figure 2. Below we describe four types of technology solutions and illustrate the impact on human-to-technology interaction.

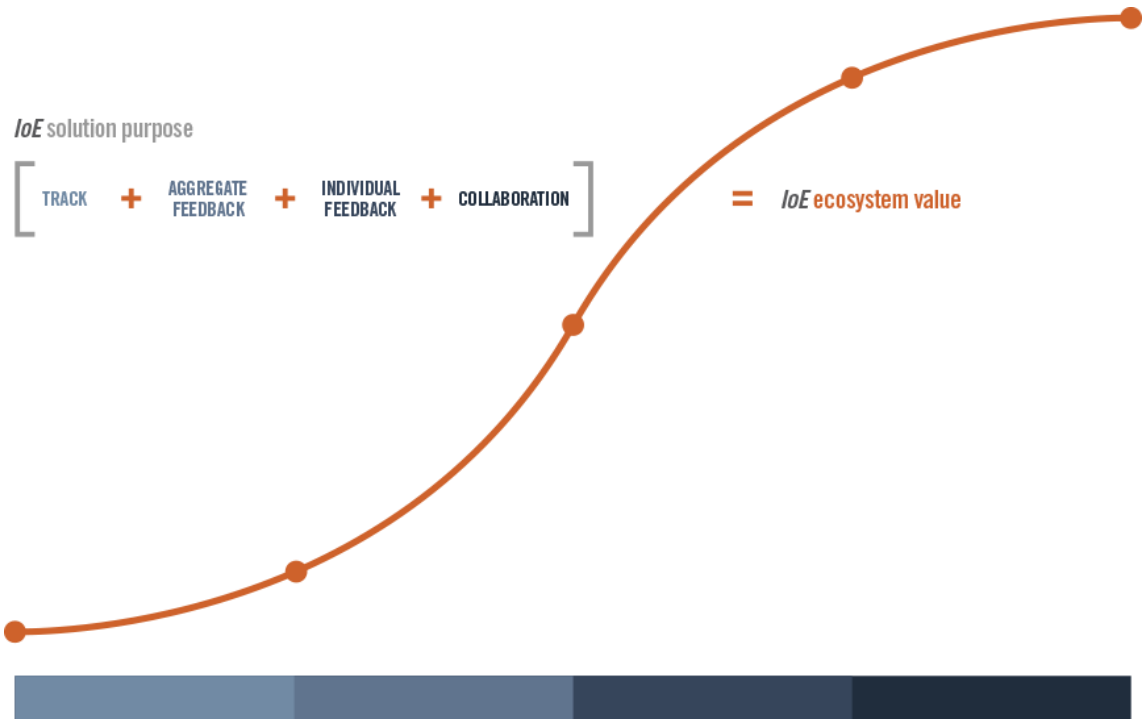


*Figure 2: IoE ecosystem value and IoE solution purposes [Source: MachNation, 2014]*

Solutions that Track: These types of solutions are deployed on things (e.g., pipelines, vehicles and remote assets) or on humans (e.g., consumer devices that monitor human vital statistics and devices that track a person's location for safety purposes). Whether the solution is deployed on a thing or a human, the goal of tracking and/or monitoring is pre-eminent. These types of solutions do not systemically increase interactions between humans and technology, but rather treat humans as trackable objects. These types of solutions yield the least amount of IoE value to the adopting organization. However, the

deployment of these types of solutions is often a first step as organizations plan for the IoE world.

Solutions that Provide Aggregate Feedback: Public- and private-sector organizations deploy these types of solutions to track and/or monitor things or humans, and then provide aggregate data feedback to the thing or human being tracked or monitored. An example of this type of solution is connected consumer devices like Coyote that collect data on the location of law-enforcement speed monitoring and provide the data in aggregate to automobile drivers who subscribe to the Coyote service. This feedback improves some performance characteristic of the thing or human – in this case, it lowers the probability of drivers receiving a law enforcement ticket for driving above the posted speed limit. This results in an increase in the level of interaction between humans and technology. It also shows an increased value in the IoE ecosystem caused by the technology solution. These types of solutions yield a greater amount of IoE value to the adopting organization than solutions that only provide monitoring capabilities.

Solutions that Provide Individual Feedback: Public- and private-sector organizations deploy these types of solutions to track or monitor things or humans, and then provide individual data feedback to the thing or human monitored. An example of this type of solution is personal sporting or healthcare solutions like the Fitbit. The Fitbit monitors a person's levels of physical activity and then provides some level of individual feedback. This might result in changes in performance characteristics – for example, the individual becomes more physically active which has an overall positive impact on the individual who adopted the solution and society overall. Another example would be connected construction site solutions like the one from SK Solutions that enables a construction-services company to track and control the location of all assets including heavy machinery, tools, steel beams, glass panes and workers on a construction site. This reduces accidents and increases efficiencies of construction scheduling. Using real-time analytics, the solution can provide feedback to individuals on the construction site to undertake certain tasks or avoid certain areas of increased danger. Heavy equipment on sites can also receive [real-time? just in time?] feedback to turn on and off various capabilities and systems if a collision between equipment is predicted to occur. Another

example of this type of solution is real-time mobile couponing – a connected mobile experience solution – that uses geo-location characteristics and prior consumption data to attempt to alter human consumption behavior. These types of solutions yield an even greater amount of IoE value to the adopting organization.

Solutions that Fuel Collaboration: Public- and private-sector organizations deploy these types of solutions to track and monitor things or humans, provide individual and aggregate data feedback to the thing or human tracked, and then facilitate collaboration of the tracked things or humans. An example of this type of solution is a connected cardio-vascular disease healthcare monitoring solution that senses an individual's various vital statistics and regularly shares that data with a medical monitoring facility. If a medical technician notices an abnormality in vital signs, she can initiate a video-communications link between the patient and an on-call physician. The physician can perform remote checks on the patient's vital statistics and conduct a virtual examination to determine if the patient should seek immediate medical care at a hospital. This type of IoE solution combines various technologies including connected devices, analytics, collaboration tools and various applications to yield the greatest overall value in the IoE ecosystem.

IoE solutions drive an enhanced level of interaction between humans and technology. Those that drive higher levels of engagement create higher value in the IoE ecosystem and greater economic and civic benefits for private- and public-sector organizations, respectively.

- Technology Adoption: The development of the IoE has many impacts on technology:

  Networks/Connectivity – IoE solutions will rely on hybrid networks and connectivity. Many public- and private-sector organizations will deploy solutions that take advantage of networks with heightened SLAs, security and coverage characteristics that fit the requirements of the IoE solution. Most connected device solutions today rely on either fixed or mobile networks for connectivity with little ability to choose the best network over a given operating period. This lack of flexibility results in a solution with lower overall quality. IoE solutions will take advantage of hybrid networking approaches that

include 3G/4G/5G wireless, Ethernet, various short-range connectivity offerings, satellite communications and others.

IoE networks will take advantage of solutions that offer improved flexibility and programmability as well as better policy management bring. Being able to control networks in new ways – especially in ways that make them more application aware – is a key requirement of IoE-ready networks. Being able to tie together application, network and security policies seamlessly across heterogeneous networks will increase the value of IoE solution to public- and private-sector organizations.

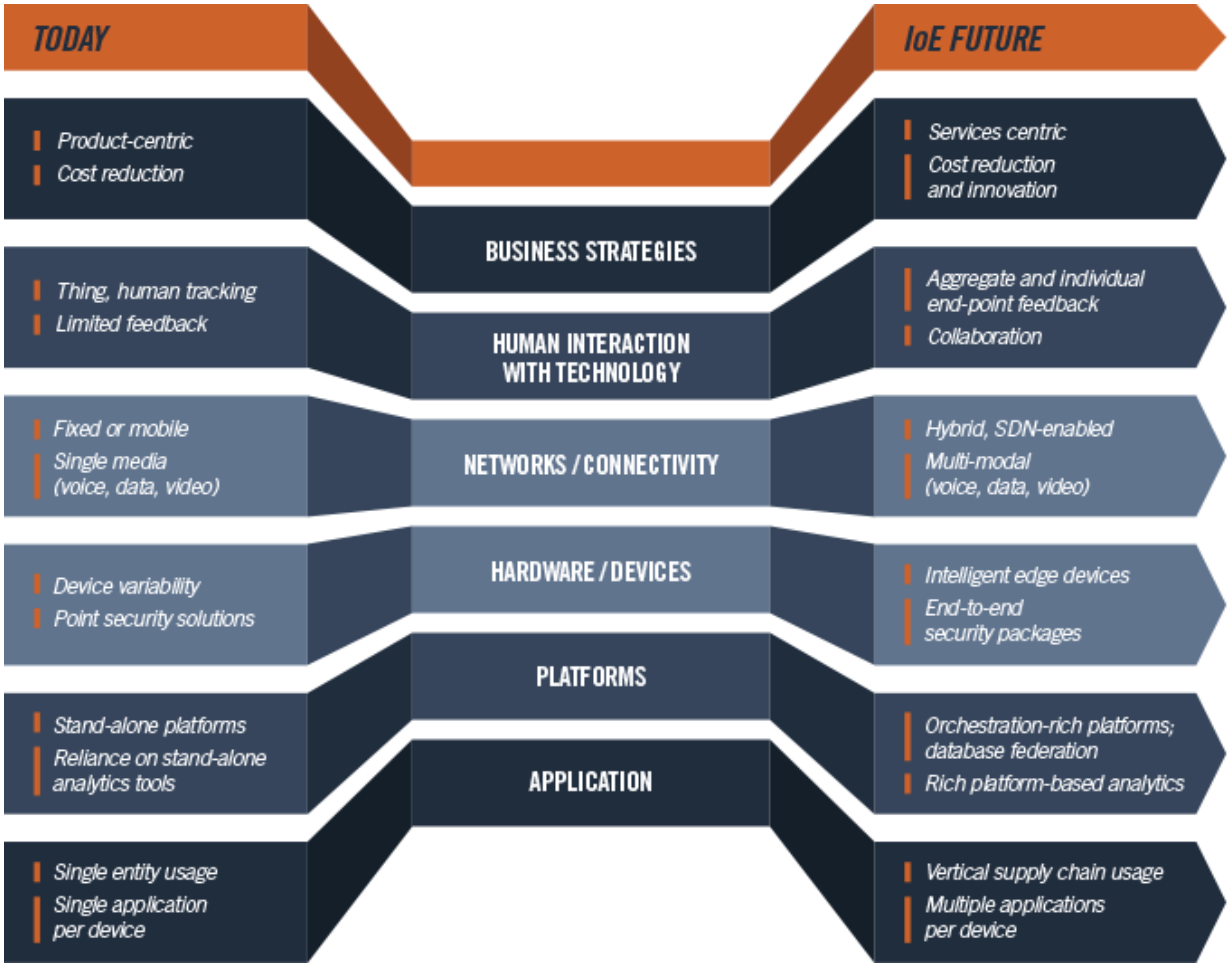


*Figure 3: Development of the Internet of Everything [Source: MachNation, 2014]*

Finally, IoE solutions will benefit from integrated data, voice and video communications. The use of multiple communications media – and applications' abilities to integrate these media – will launch completely new IoE solutions. For example, public- and private-sector security organizations will be able to offer innovative, enhanced security solutions by combining video-based facial recognition, retina scanning, geo-location data, voice-recognition systems and movement-sensor technology.

Hardware/Device: In the development of the IoE, we will see more device intelligence at the edges of networks. While core networks will remain vibrant, the volume of data, complexity of analytic algorithms, and the need for real-time modification of performance characteristics, will necessitate more resources at the edge of the network. The overall value of IoE solutions is not the data, but the actions we take after automated, rapid analysis of the data. Having more intelligent devices enhances our ability to make more informed, rapid, automated business and operational decisions.

We anticipate tremendous device proliferation in the IoE world. IoE devices come in myriad types and forms -- low-power sensors, modules, modems, trackers, gateways, video terminals, handsets, IoT computers and others. Some of these devices have operating systems, some do not. Each type of device has particular security-related characteristics. And each has either one-way or two-way communication capabilities.

Devices with more intelligence create many opportunities for public- and private-sector organizations. For example, pushing intelligence to the edge allows cities that deploy traffic-management systems to address metropolitan regional issues more effectively and coordinate municipal resources more seamlessly. And pushing IoE intelligence to the edge allows more rapid analysis of data and more efficient use of the communications network.

As we think about the value of intelligent IoE devices, consider the value created and productivity enhanced by having smartphones as edge devices rather than the simple feature phones of eight years ago. The innovation of smartphones and their surrounding application ecosystems has fueled tremendous business productivity

enhancements as well as improved ability of people to juggle increasingly complex home and work environments.

Platforms: There are multiple platforms and management tools required in the IoE ecosystem. Platforms are needed to manage the end-point devices; networks and connectivity; and the applications environment that supports the solution. In the IoE world, platforms should be cloud-enabled, workable in a virtualized environment, fully automated, and capable of integration with other cloud- and non-cloud apps through open APIs.

Analytics should be part of IoE platforms. Analytics capabilities are absolutely essential for IoE solutions in order to create unique, actionable insights using data from various end-point devices. These platforms can interface with device-management tools and the platforms upon which organizations build IoE applications.

IoE platforms have orchestration capabilities to better control various activities across the IoE solution. As IoE applications and platforms are integrated with other public- and private-sector organizations' applications, the platforms should have well-designed and flexible orchestration algorithms. These orchestration algorithms should provide heightened abilities to control the sharing of data for operational as well as analytics purposes.

Finally, IoE platforms should facilitate unique types of database manipulation to foster efficient combination of data sets to yield unique, actionable insights. IoE platforms should take advantage of modern database virtualization and federation capabilities to provide the most flexibility and efficiency in accessing, storing, analyzing and visualizing data.

Applications: Public- and private-sector organizations integrate their IoE applications with existing applications, including ERP, CRM/SFA, inventory management, trouble ticketing, dispatch, human resources and others. IoE solutions are often integrated vertically into suppliers' and distributors' supply chains or, in the case of public-sector organizations, with other municipalities. This enhanced level of integration increases the

value generated from the IoE solution and can often create higher levels of service guarantees and higher security requirements.

In addition, IoE solutions generally have multiple applications accessing data from a single device. As an organization prepares for the IoE, we would expect it to adopt single-purpose devices initially. We anticipate organizations will quickly learn the value of this device data and seek ways to leverage and adopt additional IoE solutions. In an IoE world, we will find multiple applications integrated in various ways. Some examples of these types of IoE multi-application solutions would include connected automobiles and smart roads; healthcare chronic care and personal emergency management systems; and port logistics management and smart cities traffic management. Connected automobiles that run multiple applications like emergency call, concierge services, location/mapping, "infotainment," remote-engine diagnostics and others are another example of multiple applications integrated on a single device.

## Drivers of the Internet of Everything

Based on MachNation research, there are three macro-economic drivers of IoE development that impact all industry sectors:

Shifts in regional economic growth. According to data from the International Monetary Fund, growth in world output in emerging-market and developing countries is 2.5 to 3 times that of world output in advanced economies[1]. See Figure 4. These levels of growth place particularly large pressure on enterprises in the advanced economies to excel both operationally – in driving down costs – and with continued innovation – to create new offerings. In order to be exceptional operationally and strategically, enterprises in the developed world are adopting new technologies like IoE solutions that provide a competitive edge.

Consumerization and mobility. Consumerization of the workplace has created a more personal connection between people and technology that, in turn, increases the willingness of public- and private-sector organizations to experiment with new technologies like IoE. Consumerization –

[1] For more information see, "World Economic Outlook (WEO) Update: Is the Tide Rising?", World Economic and Financial Surveys, January 2014

the movement of consumer-centric technology into enterprise and public-sector workplaces – has been a trend over the past seven or so years. The proliferation and acceptance of consumer mobile devices, social networking, consumer cloud services and other technologies have created greater comfort and familiarity with the use of new technologies. In addition, these consumer-centric technologies have created environments where enterprises, public-sector organizations and employees are willing to experiment with using technology in new ways. This experimentation fueled by consumerization speeds the adoption of all sorts of IoE solutions.

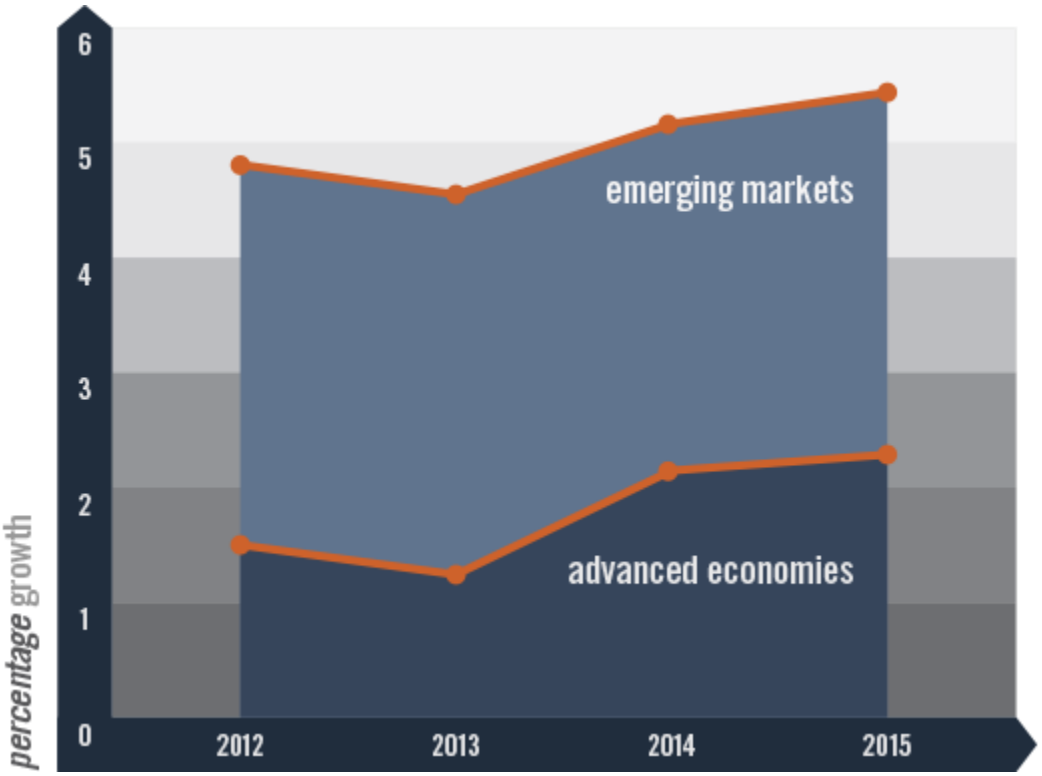


*Figure 4: World output, advanced economies and emerging markets, 2012-2015 [Source: International Monetary Fund, 2014]*

Ubiquity of connectivity. The ubiquity of connectivity has created a technology environment in which public- and private-sector organizations can facilitate adoption IoE solutions. While all modes of connectivity are not available in every location, there is at least one mode of wide-area

connectivity available at virtually all locations by using mobile, satellite, fixed line and other short and long-range communications technologies.

There are many industry-specific drivers of the development of the IoE. These drivers include changing regulation, industry sector requirements for cost containment, compliance issues and technology shifts. The drivers of IoE adoption in the utility sector might be quite different than the drivers in the retail, transportation and manufacturing sectors.

## Conclusions

The development of the Internet of Everything is a natural evolution impacting business strategies, human interaction with technology and technology adoption. It will profoundly impact both public- and private-sector organizations. It will change the way businesses create products and services. It will alter the way municipalities engage with citizens. And it will cause the integration of technologies in fascinating new ways.

The value created for public- and private-sector organizations from the IoE is substantial over the next 10 years. Those organizations that better understand and prepare for the future of the Internet of Everything will be able to take a series of technology and business steps to implement change and innovation that can create long-term competitive differentiation and heightened opportunities to increase stakeholder value.

MachNation (info@machnation.com) is the only dedicated insight services and applications development firm covering the future of the Internet of things (IoT), Internet of everything (IoE), connected device and machine-to-machine (M2M) ecosystems. MachNation specializes in understanding and predicting these technology sectors including developments in hardware, platforms, communication services and applications. MachNation specialists have provided guidance, consulting services and support to the majority of the world's leading IT and communications firms.

MachNation provides strategic, tactical and marketing support for firms that care about differentiating themselves in the connected future.