



# The Internet of Things

## In a Connected World of Smart Objects

### Executive Summary

- **The «things» in the Internet of Things**

- **How intelligent are objects today?**

- **The three basic layers of the Internet of Things**

- **The impact of IoT in business and society**





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# Contents

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<a href="#">What We Mean by "Things" in the Internet of Things</a>	3
<a href="#">Just How Smart are Things Today? The State of the Art of a Promising Technology</a>	5
<a href="#">Understanding the Three Basic Layers of the Internet of Things</a>	9
<a href="#">The Impact of the Internet of Things on Business and Society</a>	10
<a href="#">Key Factors in the Future of the Internet of Things</a>	13

# What We Mean by "Things" in the Internet of Things

**I**magine the city of the future: a "smart" city where mobile phones open doors, sensors spot leaks in drains and publicity hoardings run different advertisements to match the profile of passers-by. Tiny sensors measure the temperature in a room or the number of taxis on the streets. CCTV cameras keep buildings under surveillance and panels at railway stations tell us what time the next train is coming.

All this and much more is the Internet of Things (IoT). Literally, it consists of things with an Internet connection – anytime, anywhere. In a more technical sense, it involves integrating sensors and devices into everyday objects connected to the Internet over fixed and wireless networks. The fact that the Internet is available simultaneously everywhere makes mass adoption of this technology more feasible. Given their size and cost, the sensors can easily be integrated into homes, workplaces and public places. This means that any object can go on line and "manifest itself" over the Net, creating a market worth billions of dollars, with 50 billion units connected (by 2015, it is estimated that there will be 15 billion objects online). Welcome to the ubiquitous society, where objects speak to us and to each other.

Will the Internet of Things end up being a technology as common as electricity or automobiles? 69% of the Future Trends Forum experts believe that the IoT will be adopted in under five years in the retail and logistics sectors. They also believe that the aerospace, automobile and aviation industries will take over eight years to adopt this technology, probably because by their nature, any innovation in these industries needs to meet more formal standards (see Illustration 1).

## Instrumentalising the Planet: the Internet of Things as a Global Neural System

With the Internet of Things, the planet is being instrumentalised and interconnected and at the same time it is becoming "smarter". This is because the billions of people and a never-ending list of objects connected to the Internet (cars, domestic appliances, telephones, cameras, etc.) can now interact, overcoming the barriers of time and space. Around them, "smart" environments are being built, capable of analysing, diagnosing and performing functions. A "smart" power grid, for example can detect voltage surges and reroute the electricity to minimise power cuts.

One way of instrumentalising objects is through radio frequency identification (RFID) tags. In 2010 nearly three billion RFID labels were in circulation around the world. [Violet](#) markets RFID stickers that can be attached to different objects; when they come in contact with a reader, they open specific websites. Want to combine a traditional holiday postcard with photos of your trip? Just stick an RFID tag onto the postcards. Using an RFID reader, the recipient will be able to view highlights of your stay on their computer.



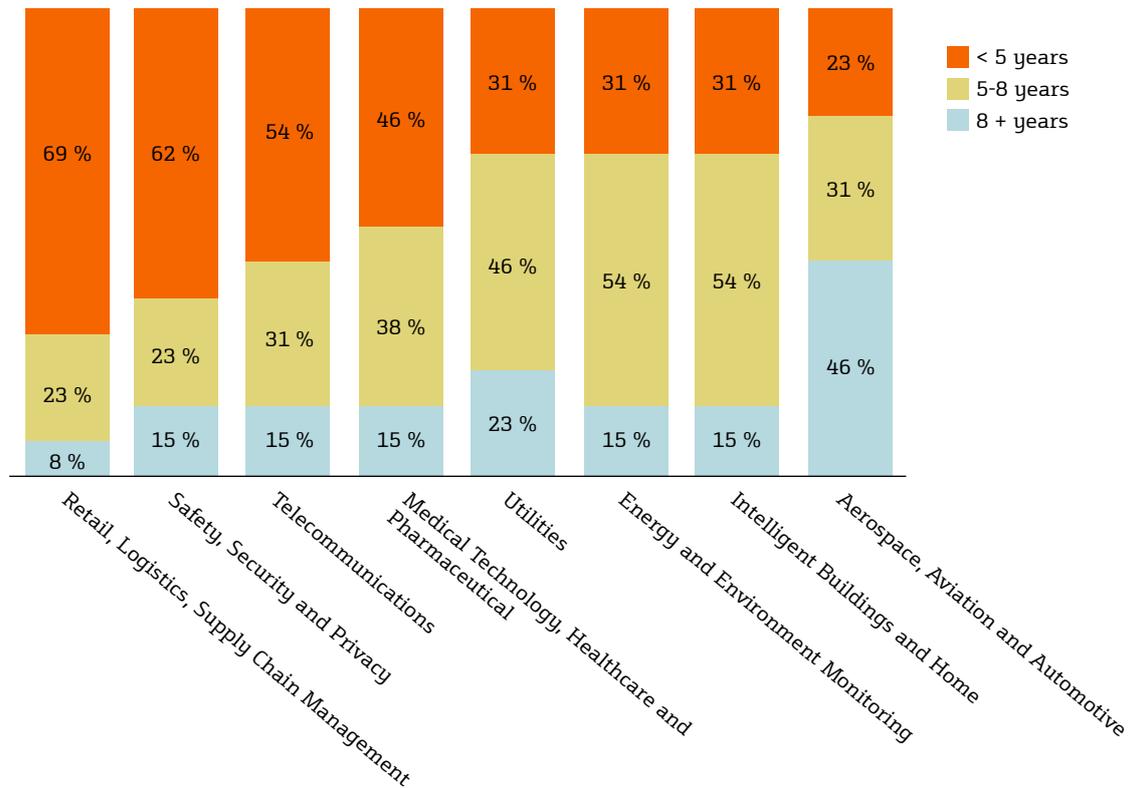


Illustration 1: Speed of adoption of the Internet of Things in different industries. Source: Authors.

### A Global Data Field: When Data Becomes Knowledge

With IoT, any object can be a data source. With all the information now being generated, it is becoming an increasingly complicated task to sort the wheat from the chaff. At the current pace, by 2020 the digital universe will be forty-four times bigger than in it was in 2009 (see Illustration 2). This is beginning to transform the way we do business, the running of the public sector and the day-to-day life of millions of people. For example, the American company Walmart handles over a million transactions... *an hour!* As a result, big corporations and entrepreneurs are in a race to innovate data storage, speed, access and analysis methods. Google has over thirty data centers, equivalent to more than a million servers. In an attempt to catch up, its competitor, Microsoft is investing billions of dollars in putting up to 20,000 new servers online a month. By 2020, the combined power consumption of these centers is expected to exceed that of Germany, Canada and Brazil put together.

Now think of a can. You don't have to open it to know what's inside; you just have to read the label. Metadata, literally "information about information", makes it possible to screen and sort a vast quantity of information. This is crucial in an environment in which decisions are made in a matter of seconds – and companies pay high prices for the privilege. Firms such as [ThinkAnalytics](#) and [Praxis Softek](#) are already offering tools to improve decision making, specifically in the retail sector. The market for data analysis programs is expected to grow by over 30% in under four years, to \$34 billion.

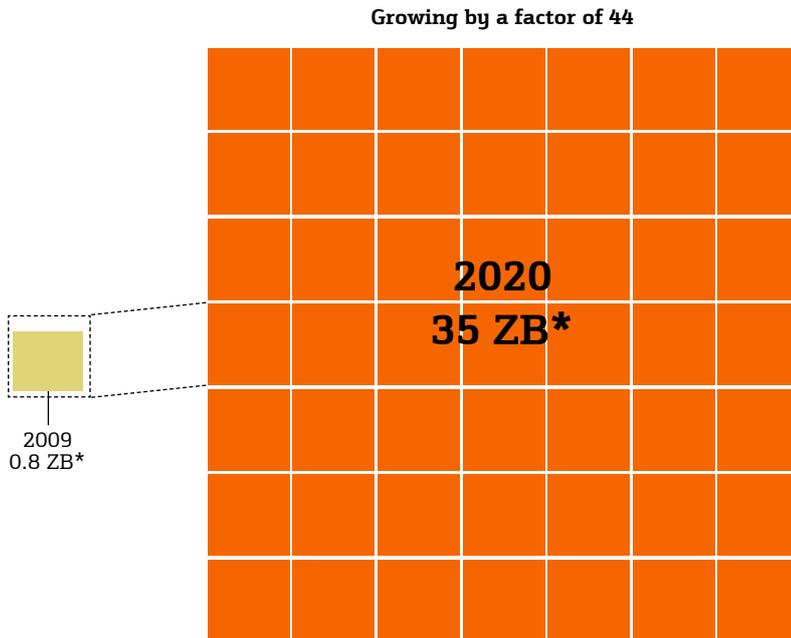


Illustration 2: The digital universe 2009-2020.  
 Source: IDC Digital Universe Study, EMC (May 2010).  
 \* Zettabyte = 1 trillion gigabytes.

## Just How Smart are Things Today? The State of the Art of a Promising Technology

**T**he nineteenth century was the stage for the Industrial Revolution and the twentieth century saw the Information Revolution. With the emergence of TCP/IP, html and wireless technology, we learned to "surf" the Net and use website content. Later we saw the birth of e-commerce and the emergence of crowdsourcing and the "2.0" concept. Popularisation of the Internet and advances in telecommunications have clearly been essential in connecting everything up. What will be next? The next step has been called the Internet of Things.

By 2012, over 60 million devices in Western Europe are expected to be linked up and sharing information using M2M (machine-to-machine) technology. How will these machines be made smart enough to communicate with each other? To get a better idea of how an object can become "smarter", take a look at Accenture's Evolution of a Smarter Object pyramid. At the base of the pyramid, the object takes on a unique identity, using an RFID tag, for example. In the second tier, technology such

as GPS is used to track the object's current position or path. One tier up, the object gains status, in other words, it is capable of communicating its current state and properties. Finally at the apex of the pyramid, the object has context, making it "aware" of its environment (see Illustration 3).

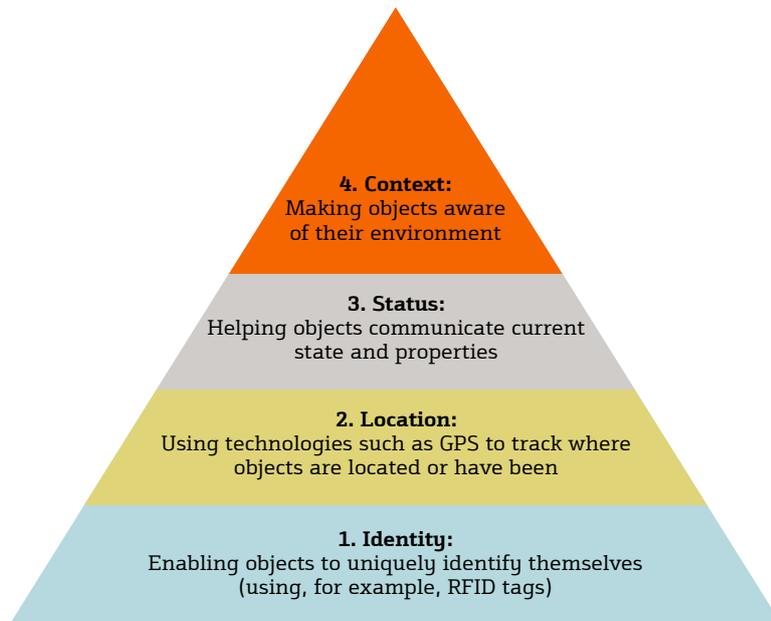


Illustration 3: Developing a more intelligent object.  
Source: Sensor Telemetry, Accenture 2005.

So, for example, insurance firms can use sensor systems to recover information on their clients' driving habits. Fitted in cars, these devices can even trigger an action, such as automatically braking the car before a potential collision.

### First Steps: Adopting IoT in Industry

The IoT applications that receive the most attention in the media tend to be very consumer-oriented. However, they are not easy to scale up to industrial level. The logical question is whether they can be rolled out to wider sectors and whether their processes can be redefined to create efficiency and lasting value. The first sectors to get fully involved in using IoT were logistics and transport, by adopting radio frequency identification tags. In 2010 nearly three billion RFID labels were in circulation around the world. However, these are just the first steps towards widespread adoption of the technology in other sectors. We shall now examine IoT's first incursions into sectors such as healthcare, agriculture, logistics and supplies, where it is allowing all types of machine to be connected – and thus smartly monitored and controlled.

### The Internet of Logistics

In 2008 a batch of baby milk from China adulterated with melamine went on sale. 300,000 children were affected. Using RFID tags, it probably would have been possible to withdraw the contaminated milk before it reached supermarket shelves. The company [Softeon](#) is already offering access to store and order management using smartphone applications which communicate with tags. In the paper-making industry, the temperature in the lime kilns has to be adjusted manually at frequent intervals. Using integrated sensors, it is possible to remotely monitor the shape and the intensity of the flame of the kiln to increase production and improve product quality without human intervention. Danish container transport company [Centralen](#) uses sensor technology to allow horticulturalists to trace their dispatches throughout the supply chain in forty countries across Europe. In essence, logistics managers can use up-to-the-minute information on weather and traffic conditions to plot the routes of their trucks and planes. And IoT is in space too. NASA is planning to use over five hundred sensors in its engines to gather information on nearly all aspects of flights and prevent future failures in launches.

### The Internet of Health

IoT sensors allow early diagnosis of potentially fatal diseases. The moment they detect a problem, they send out a message or trigger a dose; an example would be a sticker attached to the patient's chest to monitor activity and avoid heart attacks. The company [Telcare](#) wants to launch the world's first mobile glucometer. This would allow the results of analyses to be transmitted remotely so that patients could receive instant care online. In the US there are twenty million diabetics and an estimated market of eight billion dollars. [STAR Analytical Services](#) is developing an application that will analyse a patient's cough over their mobile phone. The doctor can compare the sound with a database of one thousand profiles and provide an accurate diagnosis. The promise of a cheaper, less overburdened system can help rationalise health care by distinguishing between the need for one-to-one consultation and the possibility of self-diagnosis. The initiatives are not restricted to tending to patients. Applications such as [Epocrates Mobile CME](#) offer doctors a means of continuous training over their mobile phone by checking online clinical case studies.

### The Environment Internet

Thanks to IoT, Pacific Northwest National Laboratory achieved a 10% saving in energy costs when it allowed its subscribers to monitor their domestic appliances over the Internet and switch them on and off remotely. In the US, buildings account for 70% of all electricity consumption, of which 50% is wasted. As a result, many buildings are being fitted with smart grids, networks that allow them to optimise power generation and consumption using a series of smart meters that choose the best time slots from amongst the different power companies. These initiatives are being replicated throughout the world with the creation of "green" office spaces: the [Green Spaces](#) complex in Delhi (India) and the [Smart IPv6 Building](#) project with a pilot scheme in Geneva (Switzerland)). This more sensible and economic consumption can be reproduced at home with [Ambient Devices' Energy Orb](#), a device which changes colour to show the most expensive times for domestic supplies. The people

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of the city of Dubuque in Iowa are taking matters into their own hands: they want to become the first smart and integrated city in America, with control systems which analyze the interaction between water and electricity supplies and transport.

### **The Internet of Everyone: the Mobile Phone as a Dissemination Sensor**

"Smartphone" is the term used commercially for a mobile phone with an Internet connection. The best-known brands in Spain are Blackberry and iPhone, although models using the Android operating system are also beginning to take off. The latest IDC report shows that there were 302.6 million smartphones in existence around the world in 2010, 74.4% up on 2009. In Spain, two out of every ten people have a smartphone and the mobile phone industry is particularly interested in increasing this proportion.

These phones and cameras are being turned into eyes and ears for applications; motion and location sensors can tell us where we are, what we're looking at, and how fast we're moving in real time. Smartphones have a host of sensors of sound, light and acceleration that gather information and upload it to the Internet. As more users join the platform and more data is generated, more applications will be developed to tap into the gold mine. Some of them are no more than pure entertainment: an application that blows out candles, another that solves Rubik cubes or does Sudoku, [Trapster](#), which allows users to share information on traffic speed traps with other members and [WideNoise](#) which measures noise pollution.

Other initiatives, however, are being presented as the new paradigm for the way users interact with the world. Assa Abloy and OpenWays have launched a system whereby you can open your hotel room door using your smartphone as a remote control. Companies like British Airways, KLM, Iberia and Spanair allow passengers to use their phones as a digital boarding card, which is reproduced on their mobiles and can be scanned before boarding. Iberia has skipped the print-out routine altogether, allowing passengers to scan their mobiles at the boarding gate. And there's no need any more to stand around wasting time while you're waiting for your bus to come. Now you can photograph BiDi codes, which are similar to barcodes, to access interactive online content, such as video games.

IoT also has a place in shops. The ShopKick application allows users to "sign in" to a shop using their smartphone and benefit from appetising discounts and offers in situ. Out on the street, you won't have to ask for directions if you get lost: [Layar](#) offers users a whole universe of information by just pointing their smartphone camera at the surrounding streetscape. The program is capable of superimposing relevant data on a photograph, from local shops to information on properties for sale.

# Understanding the Three Basic Layers of the Internet of Things

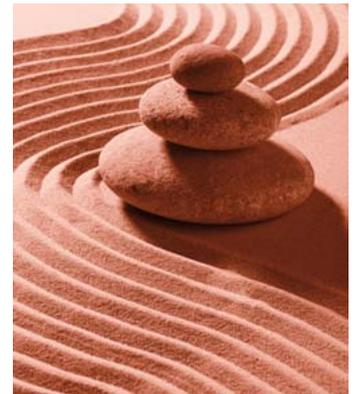
**I**oT has burst onto the stage, bringing life to everyday objects interconnected over the Internet, which constitute inexhaustible sources of information. The phenomenon has required a combination of three developments.

## Miniaturisation: the Hardware that Makes IoT Possible

The first phenomenon is miniaturisation. More than half a century on from the days of mainframe computers that occupied whole rooms, components are becoming smaller and smaller, facilitating the development of faster and more powerful computers. This physical layer occupies less space, making it easier to connect practically anything with no time or space limitations, and no impact on the speed of operation. However, a low-speed Internet connection isn't necessarily a drawback. "Internet 0" (Internet Zero) is a system that allows objects to connect to the Internet at low speeds, but at a vastly cheaper rate. The aim is to allow wide slow-speed access to the Net to prevent high costs and ensure a high degree of compatibility with all types of systems. In this way, innumerable different objects can be fitted with Internet capacity.

## Is the Infrastructure Ready for IoT? The Operators' Perspective

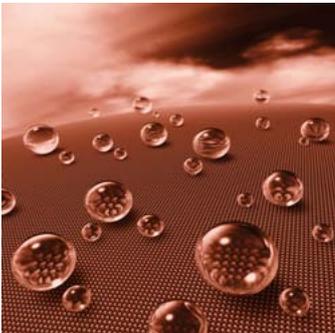
The second phenomenon which has promoted the use of IoT by individuals involves overcoming the limits of the infrastructure. The capacity of mobile phone infrastructures is limited and the proliferation of smartphones is saturating network capacity. Add to this mix the millions of new devices that are still connecting up to the Internet and it is clear that 3G and LTE technology will not be enough. A combination of mobile telephony, wireless connections and optic fibre will be essential to prevent swamping mobile infrastructures. Governments, too, are choosing to share the spectrum with WiFi hotspots. These are public areas—in cafes, airports and libraries—where people can connect their computers, mobile phones to the Internet, either free or for a small fee. The government of China, with a population of 1.3 billion, plans to turn telephone boxes into access points for a giant national network wireless network. The real innovation in IoT may come with the opening up of networks of sensors to the wider public. A fragmented market of microsuppliers will emerge with business models based on locally managed networks that capitalise on assets that can be connected to the IoT and meet the needs of millions of consumers.



### Extracting Value from the Data: the Role of 'Software' in IoT

The third and last phenomenon will be applications and services that use the vast amount of information created from IoT. New IoT algorithms and software need to be developed to allow us to discover and interpret all the data available around us. Only with the right software will IoT be able to realise its vast potential for value creation as an integral part of the Internet of the future. This software will help make the Internet, with all its distributed resources, devices and services, more manageable. [KIVA Systems](#) is a company that uses automation technology for distribution centres. It helps its clients, who include The Gap, Staples and Office Depot, to simplify operations, reduce costs and increase flexibility. By using sophisticated sensors and applying algorithms it can master logistics tasks, as stock management, transport optimisation and event management, all reducing human error. Also thanks to sophisticated algorithms and a magnetic displacement system, passengers on the PRT (personal rapid transit) monorail system in eco-city Masdar in Abu Dhabi (United Arab Emirates) just key in their destination to be whisked there by driverless units.

## The Impact of the Internet of Things on Business and Society



**I**oT is having a major impact on society and business. More than one billion users around the world use the Internet in their daily work and social life. Wireless technology has extended the possibilities of Internet interaction to "anywhere, anytime". As more information and people come on line, technology will be used as a tool of collaboration and decision-making in a world in which the physical and the digital converge. Peer-to-peer information and social networks are examples of how individual effort has the potential to open up to billions of people. This has meant creating a platform of new ubiquity-based products and services, with a high level of innovation. New initiatives no longer require an economic incentive to take off. Just the fact that people want to share technical discoveries and see them as a public-domain value means that the IoT will take on social dimensions rarely seen before – though increasingly frequent.

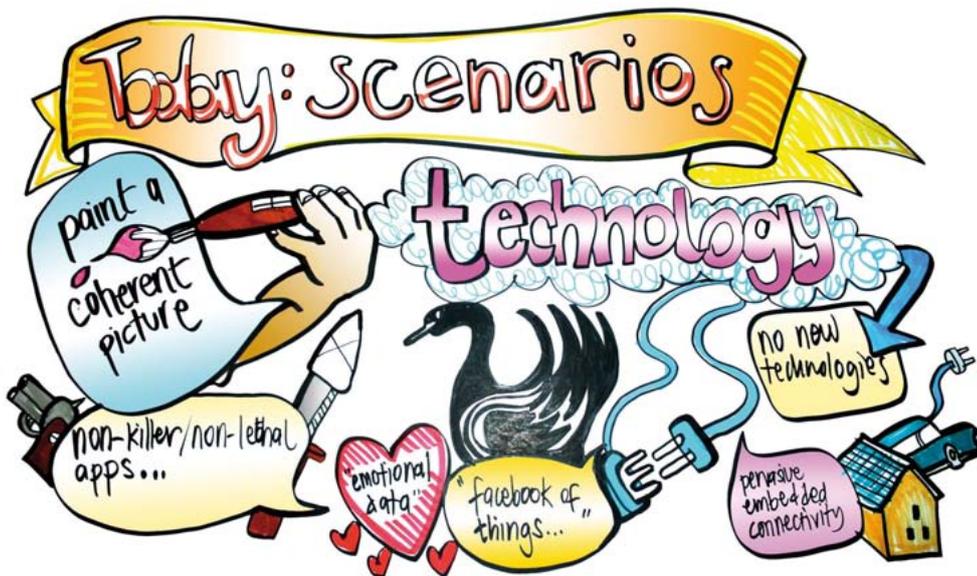
### Connected Consumers: the Impact of IoT on People

Thanks to the possibility of being permanently connected and traceable, a new generation of consumers is emerging as mobile broadband spreads. This segment expects –indeed demands– that the Internet should facilitate everything they want to

do and allow them to be connected wherever they are. They take a wireless connection—and any other technical advance that allows mobility—practically for granted. In other words, the Internet of Things covers everything that can satisfy their needs.

Paradoxically, surveys by the Yankee Group show that while consumers don't have a clear idea which home devices can be connected to the Internet, they do think it is very important for the items they plan to buy in the future to be connectable. In some way, consumers can see the future importance of connectivity, and are not willing to miss out on the opportunity. There are also profound changes in the way consumers behave when it comes to using technology for shopping. In just three months in 2010, the proportion of consumers using their smartphones to compare prices and check product reviews on-line before buying rose by eight percentage points. What's more, the majority took some form of purchase decision based on the information – either going to another shop where the item was on sale at a better price; asking the shop assistant to match the offer or simply deciding not to buy the product.

The possibility of checking, anytime and anywhere, product characteristics, performance and ratings gives consumers unprecedented power. Market comparisons help lower prices and, above all, make consumers better informed and more active. It has become commonplace for consumers to generate contents and interact online with other shoppers to swap impressions of different items. These forums are good



Source: Illustrations resuming Future Trends Forum's presentations.

**A new generation of consumers is emerging thanks to the possibility of being permanently connected and traceable**

starting-points for many people wanting information before they buy. They look for information on a new neighbourhood when buying a house, on the way electronic devices work and on the restaurants with the best service. Aggregate figures based on first-hand experiences –the information that consumers value most– can be accessed at the click of a mouse.

**The Optimisation of Things**

There is also a growing concern today about sustainable development, motivated by a shortage of resources. It is hardly surprising, then, that the optimisation of resource consumption is one of the most promising fields for the Internet of Things. Sensors and automatic control systems integrated into the objects around us enable us to measure different variables that can help engender a change in the way we use scarce resources. Hewlett Packard has built a platform called [CeNSE](#) (Central Nervous System for the Earth). This is a global network of billions of sensors that gather information on variables such as location, temperature, pressure, sound, light, humidity and many other factors. All of these developments are key to making the right consumer decisions.

This collection of information is an essential aid to consumers in making purchase decisions. RFID tags give shoppers all the information they need, literally at their fingertips. Imagine a product in the supermarket with a label that can tell you when it was produced, when it was packaged, how long it took to reach the supermarket, whether it was kept at optimum temperature throughout the journey, previous prices of the product, etc.

# Key Factors in the Future of the Internet of Things

**T**he Internet of Things conjures up a new "2.0 planet" with an emphasis on immediacy and automation. Yet like so many other science-fiction-type advances, it might be a truly earth-shattering development or just another soon-to-be-forgotten fad. We look at the factors that will encourage wider adoption and those that might slow the process.



## The Internet of 'What'? Chief Obstacles to the Internet of Things

The Future Trends Forum experts consider that the greatest challenges to adoption of the Internet of Things are the shortfalls in privacy and security, a lack of global standards and an infrastructure that is incapable of supporting the pace of growth. Is the Internet of Things really an innovation or just a very expensive reworking of existing items?

### Nightmare in Bakersfield

When Pacific Gas & Electric launched a mass smart grid for homes in the city of Bakersfield in northern Los Angeles, local people could hardly have imagined that the remote metering and control devices were going to mean spending more money. When they got their first bill, they soon saw that being "smart" could cost them up to three times more. Although the company claimed that the disproportionate increase was due to a heat wave, the initial euphoria of signing up to the "smart grid" soon evaporated. To prevent situations like this, companies such as [Opower](#) manage customer expectations by offering data on their consumption and that of their neighbours (anonymised) to encourage them to save energy. This means that consumers are now aware that applying IoT requires some effort from them too. The domestic appliance manufacturers [General Electric](#) and Whirlpool have also come under pressure to develop smart versions that monitor customer consumption in this way.

### The Bottleneck

Are we trying to run before we know how to walk? Computers use IP addresses to connect to each other over the Internet. Under the IPv4 version currently in use, there is only room for around 4.3 billion addresses. A third of the world's population (approximately two billion people) is already connected to Internet, leaving little scope to continue connecting all the objects in the IoT. But there's no call for panic. IPv6, the latest version of the protocol, will have the capacity to host around 340 trillion trillion trillion IP addresses, thus resolving the bottleneck. In other words, there will be more than enough for everything on the planet and the rest of the solar system as well. In mid-2011, Google, Facebook, Yahoo and others plan to run a twenty-four hour simulation, offering their content in IPv6.

### **Catch-22**

Sensors fitted in everyday objects to measure values such as temperature and motion and send this information over the Internet are not too profitable at an individual or residential scale. Although the sensors themselves are certainly getting cheaper and cheaper, many of the complementary tools and equipment required to use them require major investment. The same is true of RFID tags. Manufacturers of consumer goods that could benefit from the tags are waiting until there are enough RFID readers on the market. And vice-versa: the reader manufacturers do not want to increase output until a critical mass of products is reached with integrated tags. This Catch-22 situation influences the acceptance of standards. Deciding on the rules too early in the game can hinder innovation, but an absence of any rules discourages investors from putting their money into the technology for fear of possible changes in regulations.

### **Communication Breakdown**

Everything seems to suggest that the great competition of the twenty-first century will be to design the operating system that controls all mechanisms – just like the battle between Microsoft and Apple to create the definitive operating system for personal computers. The sensors that are turning our cities into “smart towns” work on fragmented and incompatible systems, preventing them from interacting and launching automated processes. The FTF experts say that to reduce this fragmentation, it will be necessary to start by identifying “winners” and ensuring that a majority support that *de facto* standard. They think it would be counterproductive to try to pre-determine any one standard, given that it is practically impossible to commercialise an innovative product from scratch without adaptations being needed. In the case of mobile communications, it takes about seven years for an idea to go from conception to consumer acceptance of the standard – a considerable length of time. Although open source has marked a temporary solution, with some applications, such open collaboration systems are not acceptable. Just ask the nuclear power stations, power facilities and oil pipelines that came under attack in September 2010 by the Stuxnet worm which threatened to take over their processes.

### **Big Brother 2.0**

Did you know that Google is developing FBI-type facial recognition technology? All you'll have to do is upload a photo of a person on the street and match it with information available on the Internet, such as a Facebook account. Vast quantities of information will be transferred and made available to many people. Unauthorised personnel will be able to access data and extract information on user profiles for commercial or even criminal purposes. Already a group of nearly 250,000 users have asked [Google Street View](#) (a map service with real photographs of streets and buildings) to blur the image of their houses, under draft legislation in Germany that will toughen up privacy regulations. Innovation or violation of privacy... Has Orwell's dystopia come true? In October 2008, European ministers responsible for the area of Information Technology, aware of this psychological barrier and the need to guarantee maximum security, discussed the challenges to privacy and security involved in moving to IoT.

### Unnecessary Solutions for Simple Problems?

For a moment, let's stop to consider some of the "things" on offer in the Internet of Things. An umbrella with a handle that changes colour depending on the weather forecast? A wonder of science, no doubt. Fortunately, however, there is a much simpler solution: just stick your hand out the window! Many developments simply involve redefining existing objects, and the technology seems to be driven more by a large supply than by demand. But what about the social benefits? A device with a glucose sensor that releases insulin could save diabetics having to visit their overstretched medical centres. The other side of the coin is the resistance to adopting the technology likely to be encountered among elderly people (precisely the target audience for this type of product), not to mention increased unemployment as a result of the growing automation of these services and a lack of human contact – when it is already irritating to be answered by an automatic call system.

Nonetheless, there appear to be great opportunities out there for any company that can provide a wide variety of Internet services under the one roof. Some experts wondered whether in the future our homes would be the battlefield for the big corporations as each one tries to gain control of everything we need to run our homes, from an Internet connection to heating and sprinkler systems.

### Where, When and Who Will Win the Game?

What incentive do companies have to promote energy saving other than complying with government regulations? Any of the potential fields of development for IoT (energy, health and environment) still appear to need strong leadership from the state to steer the field towards scalable models and guarantee the individual rights of those involved with this new technology. Nonetheless, some experts point out that standards such as Apple and Microsoft were not the fruit of government imposition, but of radically new models that ended up becoming the market standard because they were widely adopted as such. The big question, then, is what is going to be the "killer app", the defining application that leads to definitive assimilation of the technology among users. The classic example of a killer app is e-mail which soon took over from the traditional postal system.

FTF experts talk about the need to focus on "what the consumer wants". And that is precisely what makes Apple different to other smartphone manufacturers: they've made a business out of understanding what the consumer wants. Indeed, the experts think that the second most important group in promoting the Internet of Things –after entrepreneurs, of course– are the industry's primary consumers (see Illustration 5). And it is precisely the entrepreneurs who will promote "cheap hack" solutions because they are the ones who are capable of identifying efficient alternatives for solving problems and distributing them efficiently. In contrast to technological standards, cheap hacks are minor modifications to programs or systems, created using resources not provided by the original manufacturer or programmer. Nonetheless, as we saw at the beginning of this publication, the experts consider that there are areas (the aerospace, automotive and aviation industries, for example) that can only evolve through technological standards because their nature involves more formal procedures to accept innovations.

**Everything seems to suggest that the great competition of the twenty-first century will be to design the operating system that controls all these mechanisms**

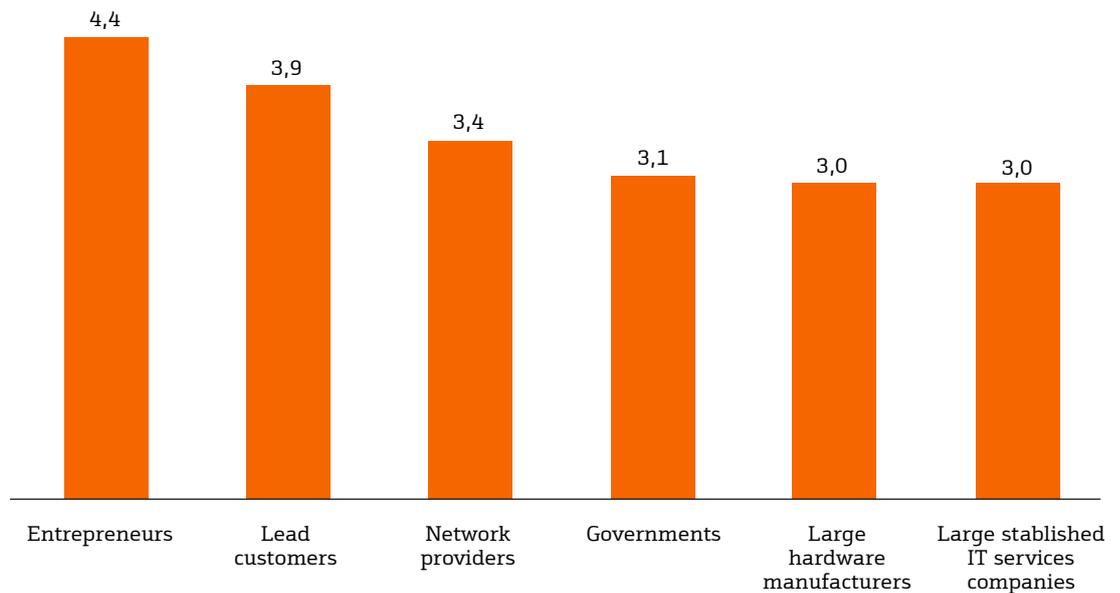


Illustration 5: Rating of agents on a scale of 1 to 5 (1= insignificant; 5= very important) as drivers of adoption of the Internet of Things.

Source: Authors.

As for geographically-based conditioning factors, the Future Trends Forum experts see America as the most likely region to lead the way in different fields of IoT. Nonetheless, some emerging nations have gradually begun to make a name for themselves in areas such as innovation, previously restricted to more advanced economies. The IoT field is no exception. China is catching up, and even overtaking, in the area of telecommunications and supplies. Africa has an important presence in industries such as "smart construction", "medical, health and pharmaceutical technology" and "logistics", while South America is big in "energy and the environment" (see Illustration 6).

### Some Success Stories

[Amsterdam Innovation Motor](#) (AIM) is a joint venture that was set up to try to turn the Dutch capital into a "smart city". Rather than just installing smart metering technology and expecting consumers to pay for it with no further information, AIM tries to appeal to "co-creation" of the project, asking for suggestions from users on ways of saving energy and monitoring consumption. Another interesting initiative is [iJapan Strategy 2015](#), which aims to build a vibrant digital society, driven by citizens applying IoT in the running of government, healthcare and education. After starting the largest smart metering project to date in 2000, Italy now has over 27 million consumers and Britain has plans to fit around 29 million homes with the devices by 2020. Stockholm successfully implemented a toll system capable of recording the registration numbers of vehicles passing control points and sending a bill for the amount to the driver's address or charging it directly to their bank account online. In Spain there are already over two million machine-associated mobile phone lines and national e-government services are among the best in the world.

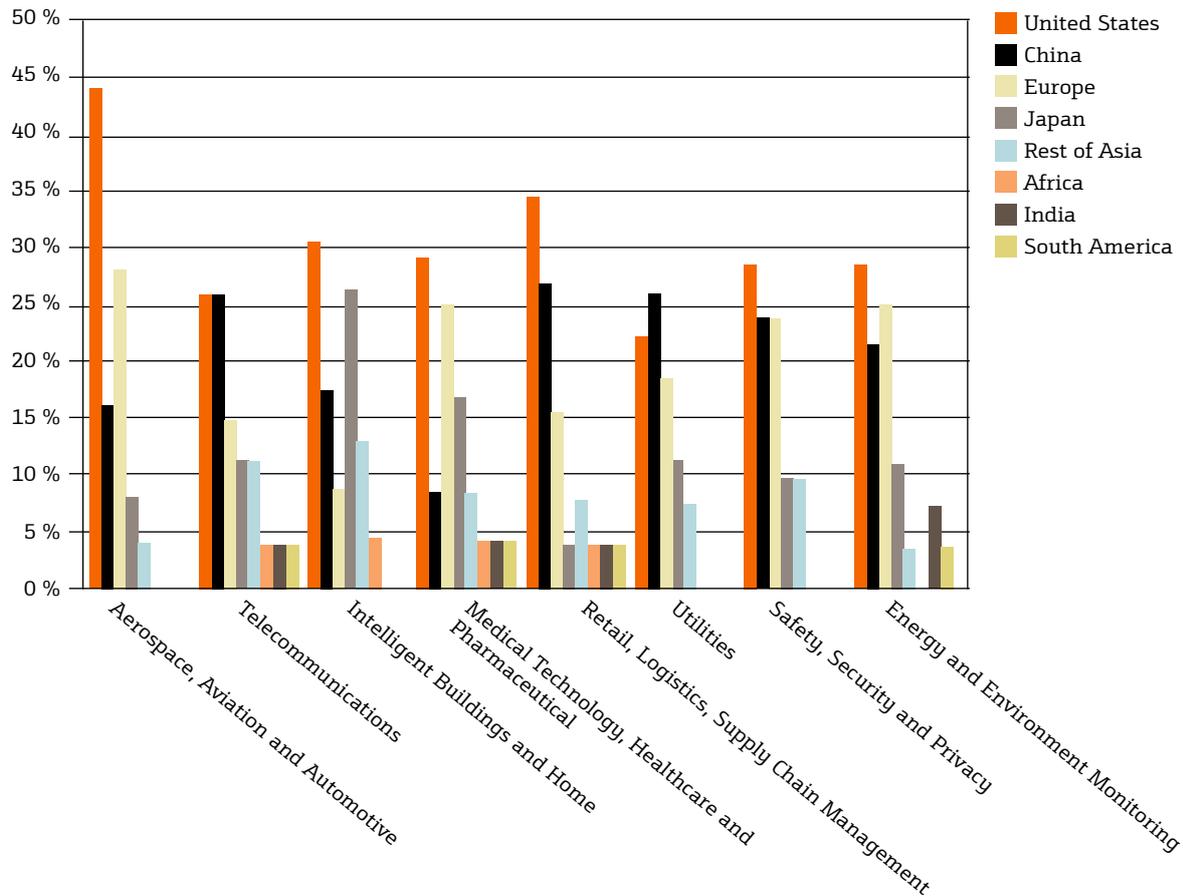


Illustration 6: Pioneering regions in the Internet of Things in different sectors.  
Source: Authors.

### The IoT Giant: China

By the middle of last year, China announced to great hype that it planned to launch a National IoT Plan to position the country as a global leader in the next wave of technological innovation, with the government providing funds and an associated regulatory framework. Indeed, universities such as Jiangnan University already have an IoT engineering school with an extensive associated curriculum. The municipality of Chongqing and the telecommunications company China Unicom last year announced a partnership worth billions of dollars in Investment and tax cuts to potentially generate seven billion dollars a year from IoT within five years. Having launched its technological development late, the Asian giant can take advantage of the latest technologies. This situation contrasts with most developed countries, which have been limited in their further advancement because they have to pay off the costly initial investment. China, however, is promoting a super smart grid to increase the proportion of renewable energy to 15% by 2020. It is also the country with most potential customers on the verge of full-scale consumerism. As a result, Chinese industry wants to move up the value chain and reach the end con-

sumer with Internet-fitted products, supplying its population and countries around the world.

What is the most suitable model for the Internet of Things? Will the western approach of innovation built out of an open and collaborative system triumph? Or will it be a model like the Chinese government's, which acts as an agent capable of financing initiatives on a large scale and establishing a starting point in interoperability standards? And will entrepreneurs be the agents of change in our society, promoting IoT – or will it be driven more by big corporations? What will be the killer apps that revolutionise the market?

\* \* \*

Time will tell. Many "things" are already connected, and there are good grounds for believing that in this context the future is already out there. It might sound a tad futuristic but many segments of the industry are already assessing the usefulness of obtaining information from sensors, sharing it over the Internet and automating responses. The Internet of Things has the potential to be the most complex structure that humankind has ever created. In one generation, there are likely to be one billion nodes measuring anything that can be measured on the face of the Earth, and with the information extracted from the data we will control all aspects of the world we have built. So the next time you hear about some rather frivolous-sounding IoT application, listen up: you might just be witnessing the birth of "the Internet Economy 2"!

To access the complete study,  
please visit:  
[www.fundacionbankinter.org](http://www.fundacionbankinter.org)

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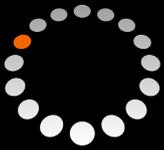
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