The Internet of Things (IoT)
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WHAT IS IT?

The “Internet of Things” (IoT) also referred to as the “Web of Things” or the “Internet of Everything” is the evolving vision of more and more devices connecting to smart networks and interacting with humans and with each other through the Internet. In June 2012, the Internet switched over to Internet Protocol Version 6 (IPv6) to prepare for the increasing number of devices with unique IP addresses that want to transmit and receive data. In addition to the expanded Internet, key technology enablers include device miniaturization, more powerful and lower costs microprocessors, and smart sensors, location devices and actuators. Currently applications are focused primarily around smartphones as hubs of connectivity. However, an increasing number of “smart devices” and “smart sensors” are taking on an IP address and connecting to the Internet resulting in ever more complex systems and interactions. Even though predictions on the growth and scope of IoT vary widely, there is agreement that IoT will play an increasing and critical role and will act as a change agent in all industry sectors and in all our lives.

The Internet of Things

More things are connecting to the Internet than people — over 12.5 billion devices in 2010 alone. Cisco’s Internet Business Solutions Group (IBSG) predicts some 25 billion devices will be connected by 2015, and 50 billion by 2020.

Technological limitations are receding exponentially. When billions of things are connected, talking and learning, the only limitations left will be our own imaginations.


...consider that IoT represents the next evolution of the Internet, taking a huge leap in its ability to gather, analyze, and distribute data that we can turn into information, knowledge, and, ultimately, wisdom. In this context, IoT becomes immensely important.


Clink on www.pcmag.com/image_popup/0,1740,iid=376697,00.asp to see a good infographics with some interesting statistics: How the Internet of Things is Raising your IQ, PC Magazine, May 2013
IoT TRENDS AND EVOLUTION

The first stage of IoT implementation is connecting individual devices/sensors that can receive or send any-time, anywhere status data and updates. Examples include: Wireless medical sensors monitoring patients’ health parameters and sending doctors out-of-range alerts; Appliances receiving software updates or alerting manufacturers in case of needed maintenance or repair; Real-time location devices tracking objects, equipment, people...; and Property security monitoring and smart home devices.

In the second stage of implementation, things start to interact with other things without human intervention – also referred to M2M (machine-to-machine) technologies. Examples include: Automated/self-guided vehicles and robots; Smart buildings; Smart warehousing; and Alert-triggered drug delivery systems.

As the proliferation of IoT technologies increases, more complex and integrated interactions will take place between ever expanding networks of disparate device systems, community of users and service providers. Context-aware automation and decision systems will find applications in a wide range of industry sectors, including healthcare, customer management and marketing, process control and optimization, resource management and smart homes, buildings and cities.

The increased availability of low-cost smart sensors will allow the monitoring of a wide range of parameters such as human, animal and physical object location and status, health and fitness parameters, and climate and environmental factors. This widespread gathering of data will support complex analysis of patterns, trends and interactions in real time leading to better informed problem assessment and decisions.

APPLICATIONS

IoT applications will impact every industry sector. Even though today’s connected device market is dominated by mobile phones, a worldwide market research conducted by GSMA (Groupe Speciale Mobile Association) and Machina Research predicts that the cars will become the “top connected application” in 2020. Healthcare applications are also projected to be leading markets including clinical remote monitoring and assisted living.

The GSMA, in partnership with Machina Research, today announced a new study that further examines the market potential of the Connected Life in 2020, when the number of total connected devices will reach 24 billion worldwide. The research explores how the Connected Life will open up new revenue streams, facilitate new business models, drive efficiencies and improve the way existing services are delivered to create a global business impact worth as much as US$4.5 trillion.

“The Connected Life will have a positive impact on many industries; however capitalising on this enormous opportunity requires cross-sector collaboration to fully realise the power of mobile for the benefit of billions of people globally.”

The ‘top ten’ connected applications, listed below, will account for 60 per cent of the global business impact in 2020.

From exoskeleton to nervous system

Until a few years ago, the main function of computer systems in society, and business in particular, was as a digital support system. Applications digitized existing real-world processes, such as word-processing, payroll and inventory. These systems had interfaces back out to the real world through stores, people, telephone, shipping and so on. These computer systems formed a digital exoskeleton, supporting a business in the real world.

The arrival of the Internet and web has added a new dimension, bringing in an era of entirely digital business. Customer interaction, payments and often product delivery can exist entirely within computer systems. Data doesn’t just stay inside the exoskeleton any more, but is a key element in the operation. We’re in an era where business and society are acquiring a digital nervous system.

Why big data is big: the digital nervous system, O’Reilly Strata, August 2012

strata.oreilly.com/2012/08/digital-nervous-system-big-data.html

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How will IoT change our world?

**Personalization:** from home-health and telemedicine to interactive marketing, the IoT will drive organization to develop an ever more accurate picture of individual needs and desires leading to ever more personalized services delivered in real-time.

**Constant monitoring and real-time reporting:** the ability to measure in real-time the use of assets and resources or environmental parameters will lead to more accurate and more responsive strategies for business process and supply chain optimization, environmental control and remediation, and energy and resource conservation.

**Autonomous smart systems:** as the M2M technologies evolve, more complex and autonomous systems will be implemented such as smart cities, autonomous transportation systems and self-optimizing processes that will function independently of human interactions.

**Security and safety:** With the increased complexity and ubiquity of IoT systems, security and safety issues will become increasing concerns. As the network of “things” becomes more complex and more widely dispersed, the potential for tempering and large scale failure or increases exponentially.

Below are just a few examples of ways the Internet of Things is starting to impact our work and personal lives. Most of the current applications revolve around a small set of sensors and fairly straight forward decision systems. As the IoT evolve we can expect more interconnected devices and processes leading to complex autonomous expert systems.

The Data Sensing Lab, a project of O’Reilly Media, has deployed over 500 sensor motes at key locations around the Moscone West centre. Some measure temperature, pressure, noise, humidity and light levels. Others are tracking air quality, the motion of crowds or how many mobile phones are being used nearby. Together, they form a network producing over 4,000 streams of data that are uploaded to Google’s Cloud Platform software for analysis.


Lively is a recent Internet-of-Things company funded [by the VC firm Maveron cofounded by Starbucks CEO]. It will launch in mid-2013. It uses sensors planted in the home to help remotely care for the elderly, such as tracking if medicine was taken on time.

### Sensors for Fresh and Sustainable Food
Sensors can provide information on where food comes from and how fresh it is. It can literally track food from growth to shelf-life in a grocery store. Libelium has deployed their wireless sensor systems, Waspmote sensors that monitor food from production and harvesting to consumption and bio-waste outputs.

The Internet of Things can give business owners insight on the condition and location of assets from anywhere. Sensors can determine product location during transportation. Sensors can also detect whether the assets are in the proper environment. For example, Benjamin Roberts, owner of France 44 cheese shop in Minnesota, uses the Internet of Things to monitor his greatest asset, cheese for his shop. After an HVAC failure caused major product loss, Roberts turned to wireless remote monitoring and control for a fail-proof system.

### Devices that Read Data from Our Bodies
The Internet of Things can collect information from our bodies, store historical data and let our doctors know when something is wrong—even when they aren’t bedside. From wireless EKG machines that allow doctors to collect patient data remotely, to tiny devices and applications like iBGStar which helps people with diabetes track their information, review trends and share data with their healthcare team. Devices can literally listen to our bodies as we go about our lives and tell us when it’s time to take action.

### Increasing Relevant Use of the World’s Resources
Internet connected sensors can control detect unnecessary use and make adjustments. Irrigation systems can turn off when rain is detected, lights can go dim when they aren’t needed and leaking pipes can send a text to landlords. These improvements help us save resources by increasing efficiency and large amounts of money.

### Detection Systems that Allow for Proactive Rescue
The Internet of Things can create the world’s most advanced detection systems for earthquakes, fires and even systems for long-term detection like pollution. For example, Firebreak USA Corp. uses device systems to detect wildfires and to alert local authorities and area residents to protect homes, property and people. The systems are deployed in remote areas where wireline data communication is unavailable. Authorities are alerted of a fire within a matter of seconds.

### Other examples of IoT applications
The Internet of Everything and the Connected Athlete: This Changes... Everything – Cisco Whitepaper, 2013

50 Sensor Applications for a Smarter world - Libelium Comunicaciones Distribuidas S.L
www.libelium.com/top_50_iot_sensor_applications_ranking/

London to create airport of the future with 'Internet of Things' CNN Travel, May 2013
www.cnn.com/2013/05/02/travel/london-city-airport-internet-of-things

2013 Forecast: The Internet of Things is Changing Your World, So Pay Attention, Digi International, May 2013
WHAT DOES IT MEAN FOR TRAINING AND EDUCATION?

The Internet of Things will impact processes in a wide range of disciplines, from engineering to IT to business in almost all industry sectors. Some of the IoT impacts on these disciplines will be transformational and disruptive creating radically new processes and the need for new interdisciplinary skills and knowledge. We will focus below on IT and business professions.

As devices become “smarter” new and existing product development and support professions will require the merging of engineering and embedded programming skills. As more and more devices connect to the Internet a new type of distributed network systems will emerge, bringing a significant shift from the client-server network model to a widely distributed and adaptive system architecture. As location, time and context-awareness increase, new data analysis, reporting and visualization skills will become an intrinsic part of many jobs in the way productivity and office computer skills have permeated almost every profession.

For IT professions, some of the main shifts include:

- **Ubiquitous computing**
  - Seamless and pervasive connectivity of systems and devices where information processing has been thoroughly integrated into everyday objects and activities.

- **Real-time data streaming, parsing and analysis**
  - Sensors generate much more data and at a much higher rate than most commercial applications. The problem with all this data is how to process it, a problem that comes in two flavors.
  - The first one is the real time processing of each data point from each different object as it comes in. The second is extracting useful information from the collection of all available data points, and correlating the information from different objects to add real value to the stored data.

- **Real-time scalability and adaptability of systems**
  - The scale, dynamicity and heterogeneity of the IoT environment require connection, data and processing systems that can scale and adapt rapidly to changing loads. Intermediate and advanced skills that focus on the cloud are already in high demand and short supply and will become increasingly required skills for all IT professionals.

- **Reliability and maintenance of complex systems**
  - As the complexity and physical reach of the system increase, it becomes critical to establish resilient processes that can rapidly identify and isolate or work around malfunctions, prioritize actions based on the impact to the system and users, and implement remediation. These processes are very different from the monitoring and maintenance of traditional network systems.

- **Systems and data security**
  - As a multiplicity of devices becomes more interconnected, these devices can act as “entry-points” into the overall system raising increased security concerns. Security technologies and processes more complex than the even the strategies required by today’s mobile environment will need to be implemented.

Developers, listen up: Everything you’re doing now will be irrelevant within the next ten years. The way you think about and build applications, services, and software will soon be irrelevant. There’s a massive shift happening in technology, and we are failing to recognize its implications. – *Building for the Internet of things (and the demise of the client-server model)* VentureBeat, January 2013

The Cloud is at the Center of the IoT

If all of these sensors act as the central nervous system for the planet, then the cloud is the brain. It’s the place where all the data flooding in will be collected, collated, analyzed and turned into information and that information turned into knowledge. As such the next generation of the cloud will need to be malleable enough to scale autonomously, adaptive enough to handle constantly changing connections and resilient enough to stand up to the huge ebbs and flows in data that will occur. Cloud computing will need to accelerate its evolution and rapidly move past its current form. – *How The Internet Of Things Will Change Almost Everything*, Forbes, December 2012

One of the projects Cisco is currently working on is Seamless Cloud, which is touted to be a multi-faceted, global framework that enables customers to evolve existing infrastructures for the demands of the Internet of Everything. Network resources can be connected, appear as one entity, and be programmed to specific devices depending on demand and performance. – *Cisco pegs potential profit value for Internet of Everything at $14.4 trillion*, ZDNet, March 2013

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For business professions, some of the main shifts include:

- **New business processes and customer interactions we have not even thought about!**
  - The Internet has drastically changed business processes and customer interactions. The IoT brings yet another dimension of real-time and contextual monitoring, control and interaction with a wide range of business processes and customers.

- **Context aware services and personalized experience**
  - Smartphones are the vanguard of real-time contextual interactions, where the system can tell where you are at any moment and what products and services are nearby. The IoT will have a major impact on customer relations and marketing. By bringing sensors into the environment, the system will be able to tell your real-time and over-time behaviors. Using behavioral data for unprecedented consumer micro-segmentation brings a whole new dimension of personalized services.

- **Analytics**
  - Turning this flow of data into meaningful information and effective business decisions will become the responsibility of many business professionals from all organizational units and at all levels. Analytics skills will become a requirement for most business professionals with depth of knowledge and skill commensurate with the specific business role.

- **Business process monitoring and control**
  - As sensors flood the organization, continuous monitoring of key parameters will be possible and as “actuators” become an intricate part of the system, just-in-time adjustments of processes will become a reality. Remote monitoring of assets, systems and people can support increased business efficiencies and adaptive delivery of services. This will require a dramatic paradigm shift in business management and a complete redesign of many business processes.

- **From discrete functionalities to a systems approach**
  - Enabling closed-loop systems that make decisions by considering a multitude of factors, at speeds impossible for humans to match, brings interconnectivity between parameters that used to be measured and analyzed independently of each other, and in some cases removes the human interaction from the decision process. This creates a level of complexity and vulnerability that most business processes are not designed to sustain.
CONCLUSION

IoT is the next evolution of the internet. According to the 2013 Gartner Hype Cycle, IoT has just moved into the “Peak of Inflated Expectations” zone.

The concept of connecting “things” together through a data network is not new and has been implemented for some time but to a limited extent. However, technology has matured to allow realization on a much larger, more complex and rapidly expanding scale which has implications that are difficult to predict.

An increasing number of large industry players are investing significant resources in IoT infrastructure and applications which will drive increased innovation and commercialization. Looking back at how the internet has drastically reshaped our world, we can expect the IoT to bring yet another level of disruption to business processes in all industry sectors, as well as to our professional and personal lives.

Skills and knowledge to support IoT system development and implementation, and to support business process redesign will become a requirement of many existing and yet-to-be-defined new professions.

Internet of Things: you ain’t seen nothing yet! From the web to the 3rd internet revolution – In 2009, the European Union succinctly described the Internet of Things as: “Foreshadowing ‘the Future Internet’, the implementation of the Internet of Things will help to meet a considerable number of current challenges such as an ageing society, deforestation or CO2 emissions through the development in particular of health monitoring systems, connected trees and cars. The interconnection of physical objects will generate a genuine paradigm shift for society.” Zettabytes of data is already being exchanged by smart objects, collected from servers, but the full possibilities in terms of Big Data or the revolution that could take place in our daily lives have yet to be fully utilised.


Everything Changes With The Internet Of Everything

The technology industry is racing to instrument and connect a vast range of things and processes in the physical and digital worlds. Several big companies have identified it as a giant opportunity—Amazon, Cisco, Ericsson, GE, IBM, and Qualcomm among them. They all believe that what many call the Internet of Everything (or IoE) could have an even bigger impact on the world than the Internet that preceded it.

“A lot of people think they know what’s coming, but they have no clue,” says Dave Evans, Cisco’s chief futurist. “The Internet of Everything is arguably the biggest tech transition we’ve seen to date, both in terms of the technology and the scale of the business opportunity.” Cisco calculates that $14.4 trillion in value will be created worldwide between now and 2022. As huge and oddly specific as that number may be, it is not an outlier. General Electric calculates that what it calls the “Industrial Internet” could add $10-15 trillion to global GDP over the next 20 years.