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IoT basics: Getting started with the Internet of Things

Author – Knud Lasse Lueth

Executive summary

The whitepaper is aimed at people who are new to the Internet of Things and seek to get a basic understanding of the concept, its applications and its technology.

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IoT Analytics

IoT basics: Getting started with the Internet of Things

The internet is seen by many as the biggest technological disruption of all time.

It has enabled entirely new forms of social interaction, activities, and organization. There are only a handful of similarly important disruptions in the 10,000+ years history of mankind (like the invention of the wheel around 4500 BC or the printing press in 1450).

It looks as though the next major technological revolution is around the corner: The Internet of Things.

1. What is the Internet of Things?

Figure 1: Disruptive technologies of the next decade Potential economic impact in 2025 (in $trillion annual)
(Source: McKinsey)

"Sensors and actuators embedded in physical objects are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet"

Figure 2: A definition for the Internet of Things
(Source: McKinsey)

According to the McKinsey report "Disruptive technologies: Advances that will transform life, business, and the global economy", the Internet of things (IoT) is one of the top three technological advancements of the next decade (together with the mobile internet and the automation of knowledge work). The report goes on to say that "The Internet of Things is such a sweeping concept that it is a challenge to even imagine all the possible ways in which it will affect business, economies, and society."

Definitions for the Internet of Things vary. According to McKinsey: "Sensors and actuators embedded in physical objects are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet."

The idea is that not only your computer and your smartphone can talk to each other, but also all the things around you. From connected homes and cities to connected cars and machines to devices that track an individual's behavior and use the data collected for new kind of services.

"The Internet of things will involve a massive build-out of connected devices and sensors woven into the fabric of our lives and businesses. Devices deeply embedded in public and private places will recognize us and adapt to our requirements for comfort, safety, streamlined commerce, entertainment, education, resource conservation, operational efficiency and personal well-being.", according to Intel's report "Rise of the Embedded Internet".
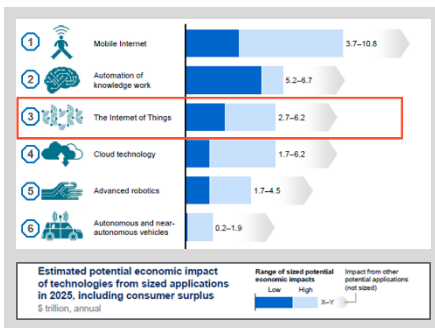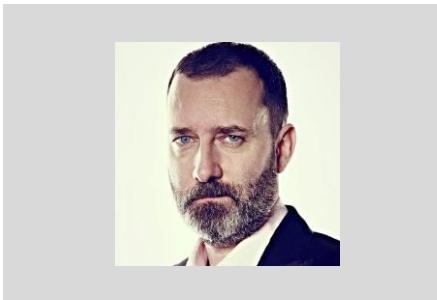
2. History of IoT

Figure 3: Keven Ashton Inventor of the term "Internet of Things"
(Source: Twitter)

The term Internet of Things is 16 years old. But the actual idea of connected devices had been around longer, at least since the 70s. Back then, the idea was often called "embedded internet" or "pervasive computing". But the actual term "Internet of Things" was coined by Kevin Ashton in 1999 during his work at Procter&Gamble. Ashton who was working in supply chain optimization, wanted to attract senior management's attention to a new exciting technology called RFID. Because the internet was the hottest new trend in 1999 and because it somehow made sense, he called his presentation "Internet of Things".

Even though Kevin grabbed the interest of some P&G executives, the term Internet of Things did not get widespread attention for the next 10 years.

The concept of IoT started to gain some popularity in the summer of 2010. Information leaked that Google's StreetView service had not only made 360 degree pictures but had also stored tons of data of people's Wifi networks. People were debating whether this was the start of a new Google strategy to not only index the internet but also index the physical world.

The same year, the Chinese government announced it would make the Internet of Things a strategic priority in their Five-Year-Plan.

In 2011, Gartner, the market research company that invented the famous "hype-cycle for emerging technologies" included a new emerging phenomenon on their list: "The Internet of Things".
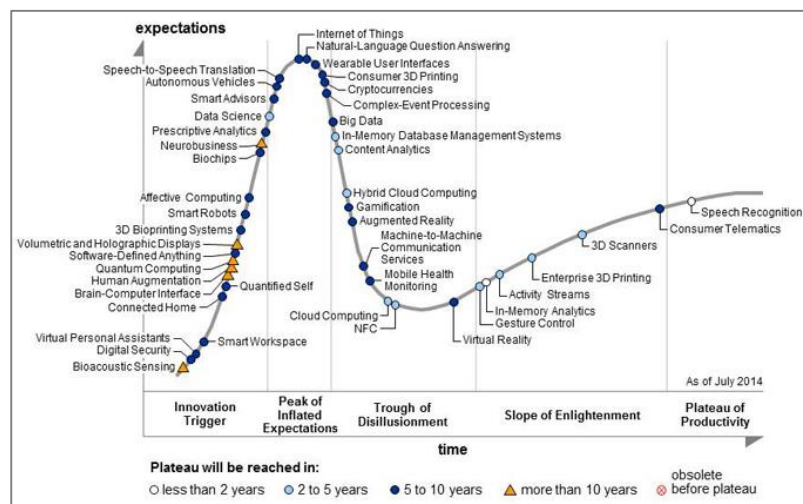

Figure 4: Gartner's 2014 technology hype cycle (Source: Gartner)

The next year the theme of Europe's biggest Internet conference LeWeb was the "Internet of Things". At the same time popular tech-focused magazines like Forbes, Fast Company, and Wired starting using IoT as their vocabulary to describe the phenomenon.

In October of 2013, IDC published a report stating that the Internet of Things would be a $8.9 trillion market in 2020.

The term Internet of Things reached mass market awareness when in January 2014 Google announced to buy Nest for $3.2bn. At the same time the Consumer Electronics Show (CES) in Las Vegas was held under the theme of IoT.
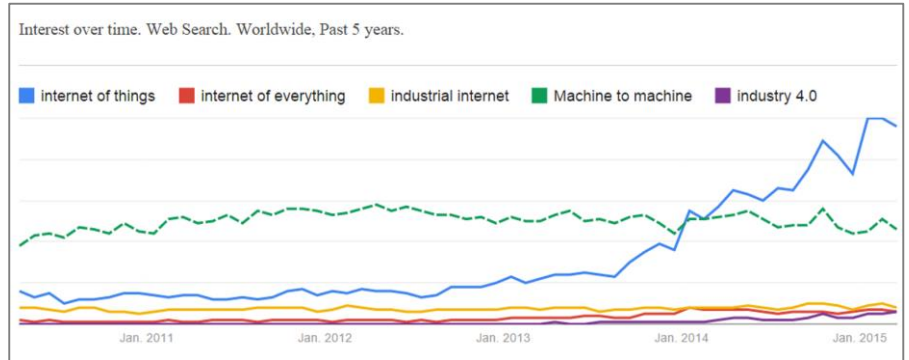

Figure 5: Google Search Trends 2011-2015 IoT vs IoE vs M2M vs Industrial Internet vs Industry 4.0 (Source: Google)

3. IoT compared to similar concepts

While the Internet of Things is by far the most popular term to describe the phenomenon of a connected world, there are similar concepts that deserve some attention. Most of these concepts are similar in meaning but they all have slightly different definitions.
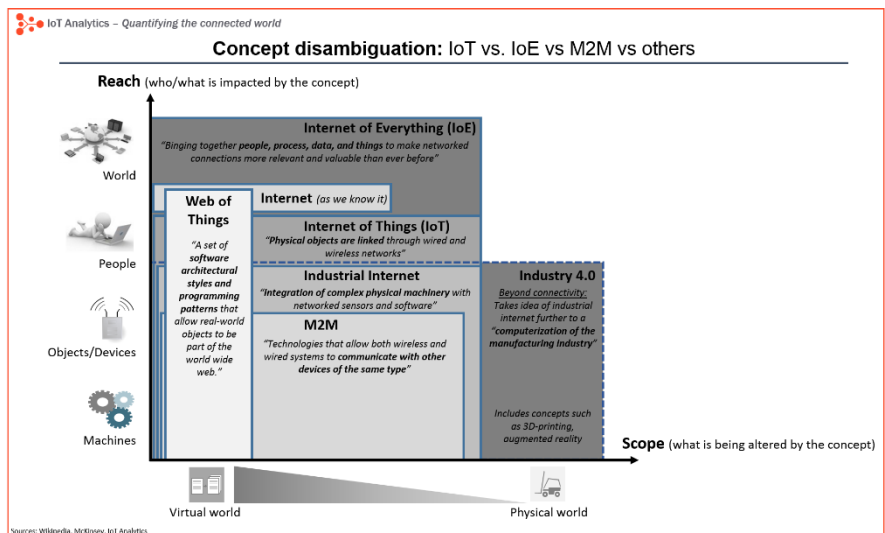

Figure 6: Concept disambiguation: IoT vs IoE vs M2M vs others

- **M2M**
  The term Machine to Machine (M2M) has been in use for more than a decade, and is well-known in the Telecoms sector. M2M communication had initially been a one-to-one connection,

linking one machine to another. But today's explosion of mobile connectivity means that data can now be more easily transmitted, via a system of IP networks, to a much wider range of devices.

- ***Industrial Internet (of Things)***
  The term industrial internet is strongly pushed by GE. It goes beyond M2M since it not only focuses on connections between machines but also includes human interfaces.

- ***Internet of Things (IoT)***
  IoT has yet a wider reach as it also includes connections beyond the industrial context such as wearable devices on people.

- ***Internet (as we know it)***
  In the above graph, the internet is a fairly small box. In its core it connects only people.

- ***Web of Things***
  The Web of Things is much narrower in scope as the other concepts as it solely focuses on software architecture.

- ***Internet of Everything (IoE)***
  Still a rather vague concept, IoE aims to include all sorts of connections that one can envision. The concept has thus the highest reach.

- ***Industry 4.0***
  The term Industry 4.0 that is strongly pushed by the German government is as limited as the industrial internet in reach as it only focusses on industrial environments. However, it has the largest scope of all the concepts. Industry 4.0 describes a set of concepts to drive the next industrial revolution. It includes all kinds of connectivity concepts but also goes further to include real changes to the physical world around us such as 3D-printing technologies, new augmented reality hardware, robotics, and advanced materials.

4. IoT application/segment overview

To the public, IoT currently appears to be a mixture of smart home applications, wearables and an industrial IoT component. But actually it has the potential to have a much wider reach. When the connected world becomes reality, the Internet of Things will transform nearly all major segments – from homes to hospitals and from cars to cities.
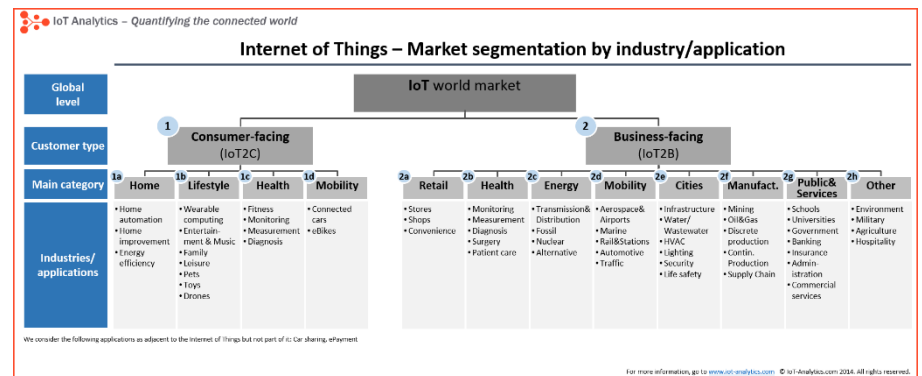

Figure 7: IoT market segments (IoT Analytics)

Most of these segments carry the name "smart" like Smart Home or "connected" like Connected Health. Today's major applications include:

- **Smart home**
  Smart Home or "Home automation" describes the connectivity inside our homes. It includes thermostats, smoke detectors, lightbulbs, appliances, entertainment systems, windows, door locks, and much more. Popular companies include Nest, Apple, Philips, and Belkin.

- **Wearables**
  Whether it be the Jawbone Up, the Fitbit Flex, or the Apple Smartwatch – wearables make up a large part of the consumer facing Internet of Things applications.

- **Smart City**
  Smart city spans a wide variety of use cases, from traffic management to water distribution, to waste management, urban security and environmental monitoring. Smart City solutions promise to alleviate real pains of people living in cities these days. Like solving traffic congestion problems, reducing noise and pollution and helping to make cities safer.

- **Smart grids**
  A future smart grid promises to use information about the behaviors of electricity suppliers and consumers in an automated fashion to improve the efficiency, reliability, and economics of electricity.

- ***Industrial internet***
  Many market researches such as Gartner or Cisco see the industrial internet as the IoT concept with the highest overall potential. Applications among others include smart factories or connected industrial equipment. In 2014 GE reported roughly $1bn revenue with Industrial Internet products.

- **Connected car**
  The battle is on for the car of the future. Whether it is self-driving or just driver-assisted: Connectivity with other cars, mapping services, or traffic control will play a part. Next generation in-car entertainment systems and remote monitoring are also interesting concepts to watch. And it is not only large auto-makers that play a role: Google, Microsoft, and Apple have all announced connected car platforms.

- ***Connected Health*** (Digital health/Telehealth/Telemedicine)
  The concept of a connected health care system and smart medical devices bears enormous potential, not just for companies also for the well-being of people in general: New kinds of real-time health monitoring and improved medical decision-making based on large sets of patient data are some of the envisioned benefits.

- ***Smart retail***
  Proximity-based advertising, In-store shopping behavior measurement and intelligent payment solutions are some of the IoT concepts of Smart Retail.

- ***Smart supply chain***
  Supply chains are getting smarter. Solutions for tracking goods while they are on the road, or getting suppliers to exchange inventory information are some of the Supply chain applications as part of the Internet of Things.

- **Smart farming**
  The remoteness of farming operations and the large number of livestock that could be monitored makes farming an interesting case for the Internet of Things.

The Internet of Things is also expected to change business models in baking, insurance, and government for example. These use cases, however, are not yet as advanced as the business cases listed above.

5. IoT technology overview

The Internet of Things builds on three major technology layers: Hardware (including chips and sensors), Communication (including mostly some form of wireless network), and Software (including data storage, analytics, and front end applications).
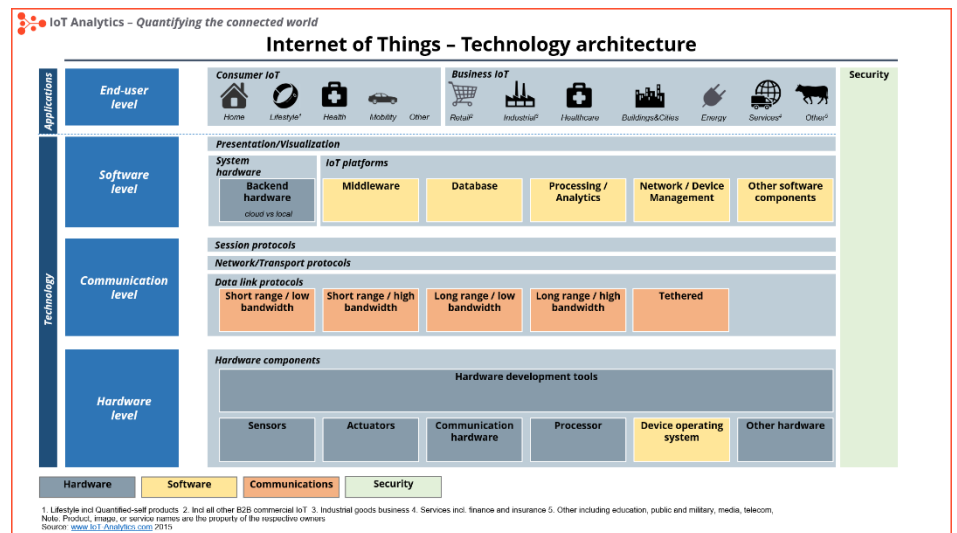

Figure 8: IoT technology architecture (IoT Analytics)

The reason for the Internet of Things coming up so quickly right now is that there have been major technological advancements in all three of these technology layers:

- **Hardware**
  Costs of sensors has declined by 54% over the last 10 years. Moreover, form factors are shrinking quickly. Complete sensor packages that are smaller than fingertips have become the standard.

- **Communication**
  Mobile devices have become a commoditiy for the wider public. At the same time the cost of bandwidth has declined by 97% over the last 10 years.

- **Software**
  The cost of processing has even declined 98% in the same timeframe. Moreover, a number of big data tools and big data infrastructure such as efficient databases have emerged over the last 5 years.

There are plenty of different technologies and competing products in each of the boxes in the above graph. From MEMS accelerometers to Raspberry Pi development boards, from Zigbee communication to next generation LTE-M, and from column-based databases to

streaming analytics engines. Each of these concepts, technologies, and products could fill a whitepaper on their own.

If you are interested to further deep-dive into IoT, make sure to stop by www.iot-analytics.com and check out our other whitepapers and perspectives.

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About the author
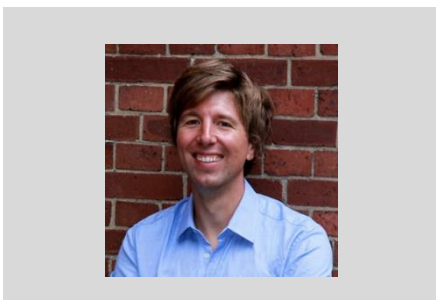
Knud Lasse Lueth is the founder and CEO of IoT Analytics. He builds on 5 years of strategy consulting in industrial companies at BCG and a manufacturing background. His focus areas are the Industrial internet and Industry 4.0

Knud Lasse Lueth

IoT Analytics is a leading provider of competitive intelligence for the Internet of Things (IoT).

For more information visit http://www.iot-analytics.com

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