# IoT

# The Internet of Things

## Potential and Opportunities in Belgian Market Context

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The present paper aims to investigate the design of the emerging IoT-"Internet of Things" industry. In this new **ecosystem** that integrates and changes value chains across a multitude of industries, the objective of the research is to identify the **driving forces** within the IoT value network and to understand "What are the underlying **value creation** and **value capturing** strategies to develop for the IoT?". The paper tests this **research question** by using the Belgian market context - the context of the simultaneous roll-out of first two infrastructure networks.

The scope of the paper is to identify the role of the IoT partners and their capacity to leverage their core businesses to provide value by creating synergies between product capabilities, connection and infrastructure, maximise their bargaining power and translated through value capture strategies. The study will use analyses such as 5 forces, 1st entrant analyses, lock -in strategies, system-to-system reinforcement strategies, value curve and critical success factors.

Further we seek to provide a broad overview of key concepts and touch on strategic aspects such as developing new business models and products & services for a connected world. Other than the theoretical approach, the project uses as methodology the input of a 3-day open **innovation and co-creation boot camp for corporates** focused on new business ideas using the Internet of Things. Here we hope to experience industry dynamics and the innovation process first-hand.

# 1. The general context of IoT

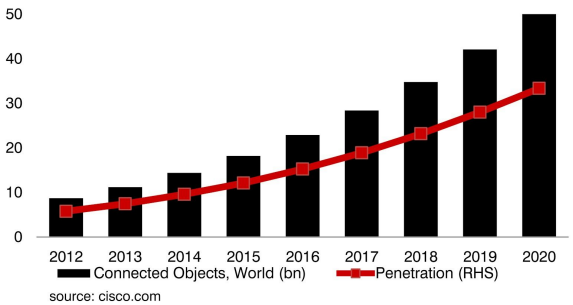
## 1.1. What is the Internet of Things?

**'The Internet of Things'**, also called The Internet of Everything, entails the exponentially increasing interconnection of physical objects collecting and transmitting via the cloud. Nowadays, these physical objects are widely defined as "smart objects."

Although the concept of networked devices has been around since the early 70[1]s, the term was first coined only in 1999 by a British entrepreneur named Kevin Ashton[2]. The forerunner of IoT is the use of M2M (machine-to-machine) communications in the industrial environment, wherein machines are connected through means of point-to-point communication, using embedded hardware modules and either cellular or wired networks.

IoT is a broader and larger scale concept than M2M, combining technological breakthroughs in Cloud Computing, Big Data Analytics and Connectivity. These technologies are driving the exponential growth in adoption of new applications for the Internet of Things since the beginning of this decade.

Cisco estimates the IoT industry at 19 trillion dollar and expects that 50 billion objects will be connected through the internet by 2020[3].



source: cisco.com

[1] 'Forbes Welcome'.
[2] The Internet of Things Is Revolutionising Our Lives, but Standards Are a Must | Media Network | The Guardian'.
[3] 'Cisco Consulting Services The Internet of Everything—A $19 Trillion Opportunity - Consulting-Services-Capturing-Ioe-Value-Aag.pdf'.

## 1.2. Product level 3 components: 'Smart', 'Connected', 'Device'

*« Smart components amplify the capabilities and value of the physical components, while connectivity amplifies the capabilities and value of the smart components and enables some of them to exist outside the physical product itself. The result is a virtuous cycle of value improvement. »* [4]

Therefore, the Internet of things creates an unprecedented opportunity to transform traditional **products into services** and vice versa.

Below, the Porter & Heppelmann[5] definition of the three core elements of a product in an IoT perspective:

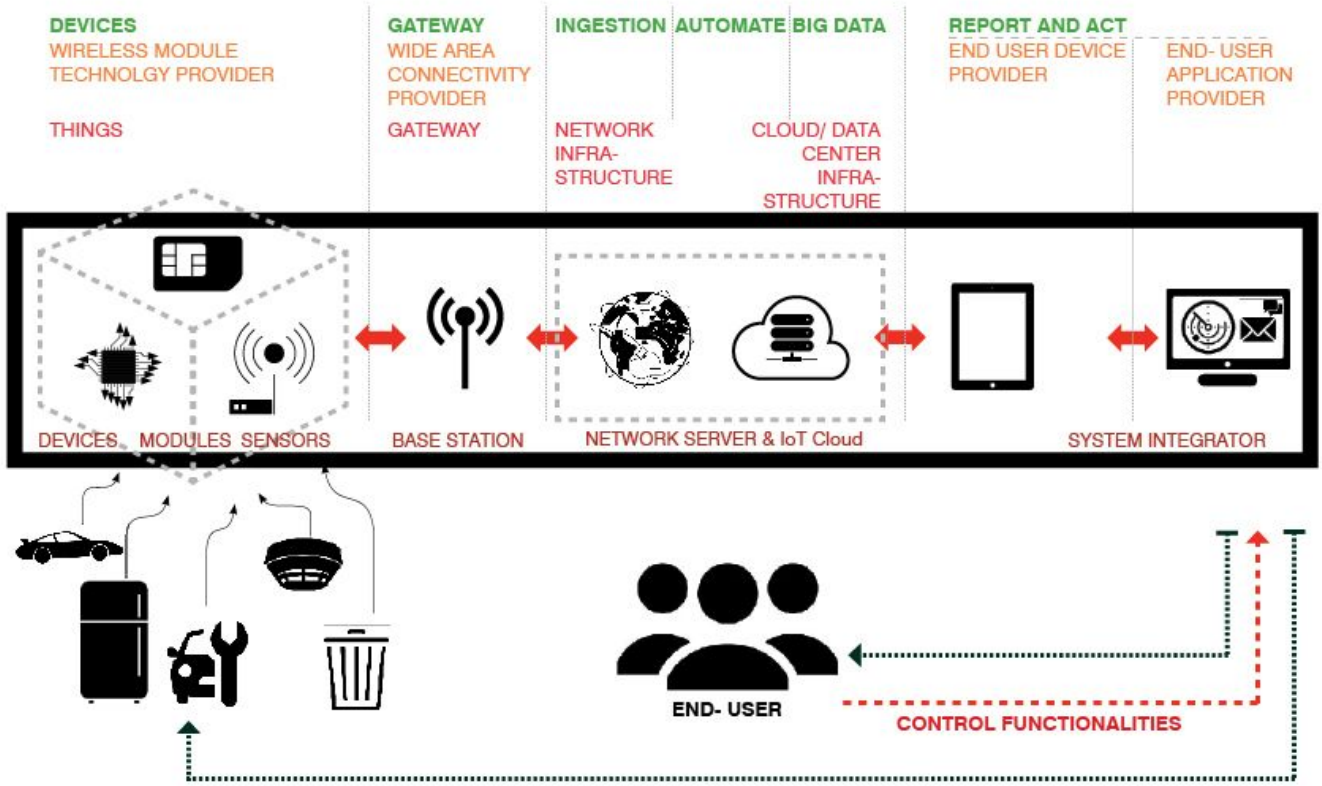
| ***PHYSICAL COMPONENTS*** | ***"SMART" COMPONENTS*** | ***CONNECTIVITY COMPONENTS*** |
|---|---|---|
| *"components comprise the product's mechanical and electrical parts. In a car, for example, these include the engine block, tires, and batteries."* | *"comprise the sensors, microprocessors, data storage, controls, software, and, typically, an embedded operating system and enhanced user interface. In a car, for example, smart components include the engine control unit, antilock braking system, rain-sensing windshields with automated wipers, and touch screen displays. In many products, software replaces some hardware components or enables a single physical device to perform at a variety of levels".* | *"the ports, antennae, and protocols enabling wired or wireless connections with the product."* |

Technological advances have reduced costs in all aspects needed to transform devices into smart devices, which ushers in a global adoption of IoT-enabled solutions. According to Intel[6], in the past ten years, the cost of sensors decreased by half, cost of bandwidth by forty times, and the cost of processing by sixty times.

## 1.3. Internet of Things - an ecosystem

As illustrated in the scheme below[7], the internet of things is an **ecosystem** of **hardware**, **software** and **connectivity providers**. IoT expands industry boundaries by linking the end user with products enhanced with new services, through the mean of data collection and processing and by the use of smart mobile devices, infrastructure and support. This combination of virtual and physical elements is likely to create effective value for consumers, businesses and public authorities[8]. Ultimately, it reaches the fullest meaning[9] of **"ubiquity"** -anytime, anywhere, in any context, with immediate actions, "**convenience"** - effortless, remove human tasks, "**geo-localisation"** - inside & outside precise location, "**personalisation"** - able to integrate contextual factors, instant experiences and related behaviours, **"universality"** and "**unison"** - compatibility and synchronization, meaning any path any network, any service and any business.

[4] Porter and Heppelmann, 'How Smart, Connected Products Are Transforming Competition'.
[5] ibidem
[6] 'Industrial IoT with Intel IoT Gateway & Octoblu'.
[7] *this scheme was designed by the authors of the paper using schemes and information from Intel, Mckinsey (see bibliography)*
[8] The Internet of Things - Digital Agenda for Europe - European Commission'.
[9] Jelassi, Enders, and Martínez-López, Strategies for E-Business.




## 1.4. Settings where IoT creates value

McKinsey[10] identifies 9 physical settings where IoT systems can be deployed (and create value):

1. Human

Smart devices (eg. wearables) enable people, researchers & physicians to gather constant streams of personal data. On a macro level, this will enable **preventive medicine,** individualized care for patients and a general improvement of the wellness of our society while **reducing the cost for the healthcare system**.

2. Home

IoT can improve home **security** (eg. cheaper smart security systems sending out alerts to homeowners and local **emergency services** in case of dangerous events), customize our home environment to our individual needs and usage patterns (eg. Nest learning thermostat[11]) or enhance household tasks (eg. smart cooking appliances).

3. Retail

IoT enriches the experience for the consumers and fades the boundaries between **online and offline shopping** (eg. in-store personal promotions, omni-channel marketing, fit-in-store delivered at home), all while automating and optimizing the supply chain for the retailer (eg. inventory optimization).

[10] 'THE INTERNET OF THINGS: MAPPING THE VALUE BEYOND THE HYPE'.
[11] See Everything That Works with Nest. | Nest'.

4. Offices

Offices consume around **10 percent of energy consumptio**n in advanced economies[12]. Intelligent energy management systems can be used to prevent energy being wasted by heating, cooling, and lighting unoccupied offices. To pursue more employee productivity and health IoT can lift organizational redesign to new levels, by **optimising movement and interaction of employee.**

5. Factories

Industry 4.0[13] is coined as the next wave in factory automation. The term describes the full digitization of production processes, wherein all tools of production can be monitored and optimized. Production can be adapted to real-time demand changes off-premise, at wholesalers or point of sales. Amazon's automated warehouse robots in its distribution centers[14], is a well-known example on how much physical processes can be digitally optimized.

6. Worksites

Typical issues with worksites (custom production processes, like construction) are: "equipment reliability, unpredictability of work, task and supply-chain complexity, and asset integrity"[15]. IoT can deal with these issues monitoring the whereabouts of workers on site, **preventing** accidents or dangerous situations, **monitoring** tools condition to avoid breakdowns and location to avoid shrinkage.

7. Vehicles

On of the most raved about use cases of IoT is the 'autonomous vehicle', the self-driving car. While legal frameworks are still being put in place, Tesla already equips its vehicles with all necessary sensors and systems to activate 'Autopilot' on all cars in states around the world where **self-driving cars** will be declared legal. On big step in the direction of legal adoption is Google's self-driving AI being declared a 'legal driver' in the US[16].

8. Cities

Smart cities are the next step in **improving communities** on a macro level. IoT enables real-time traffic information, monitors air and water pollution, improve city security, controls street lighting to name a few high-impact examples. IoT-enabled initiatives, in combination with Intelligent utility grids can contribute to a more efficient energy market, a lower overall energy consumption and eventually a worldwide reduction of CO2-emission[17].

9. Outside

Verizon claims that "**€100 billion is wasted in time and fuel** each year which can be mitigated using intelligent transportation systems"[18]. IoT can enable smarter navigation and automated logistics rerouting based on the data of multiple devices and sources collecting data. Public transportation and international rail systems can be optimized to enable the preventive maintenance and condition monitoring much like inside industrial settings.

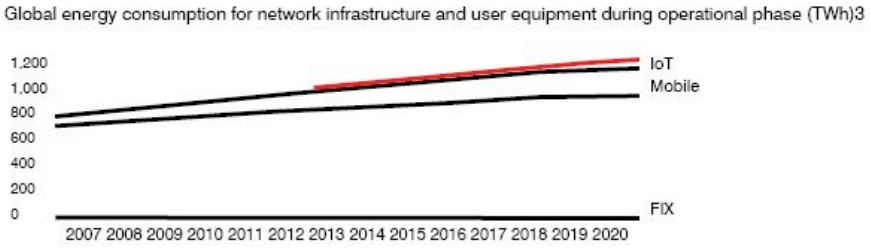
[12] Ibidem.
[13] Baur and Wee, 'Manufacturing's next Act | McKinsey & Company'.
[14] 'Amazon Robotics'.
[15] 'THE INTERNET OF THINGS: MAPPING THE VALUE BEYOND THE HYPE'.
[16] 'Feds: The AI in Google's Self-Driving Car Is Now a Legal Driver - Fortune'.
[17] Jankowski, 'The Sectors Where the Internet of Things Really Matters'.
[18] 'Rp_state-of-Market-the-Market-the-Internet-of-Things-2015_en_xg.pdf'.

# 2. Network infrastructure - the driver of IoT?

## 2.1. The need for a new IoT network infrastructure

One of the major challenges the development of the Internet of Things industry experiences nowadays is the need for a reliable, convenient and scalable infrastructure.

According to Ericsson mobility report 2015[19], M2M is making use of 80% GSM/GPRS-cellular data standard also called **2G/2.5G** technology for mobile phone communications. These systems are suitable for the **limited information transfer** M2M requires and became **very cheap**. However GPRS has restrain coverage and network capacity and is likely difficult to cope with the high **growth expectation of 25% CAGR up to 2021 for IoT**. With the rise of 3G and 4G/ LTE[20] communication technology and the need of Smartphones and tablets for high data traffic, the GPRS[21] is more and more abandoned by telecommunication companies. But the new 4G LTE system has a problem: having **higher costs and power consumption** is likely to fit a **limited category of IoT products**, those with opportunities for **premium pricing**, such as automotive industry, or risk aversion and mitigation related industries in healthcare (emergency medical services) or security.




Ericsson Mobility Report 2015

## 2.2. Disruptive vs. incremental development

The need to develop new systems with **lower consumption patterns**, **wider coverage** and high network growth capacity creates opportunities to **test innovative technological and business models** in order to develop a suitable and sustainable infrastructure for IoT. Under the new technology, called (Low Power Wide-Area networks) LPWANs, there are several **disruptive** connectivity solutions under development, providing a new infrastructure and different ecosystems approaches for/with customers, products and partners.

Today, there is a strong competition between different players[22] , organised in strategic partnerships[23] . Focusingon the **high coverage**, the increase and benefit from **network effects is crucial** for these companies. Being **first in the market** is a potential competitive advantage, considering also that the product cycle and infrastructure testing might considerably **delay** the return on investment. Two systems using slightly different technologies are competing in this category: LoRa and Sigfox.

An opposite approach is focusing on adapting the existent 4G, by the same **incremental improvements** that the mobile

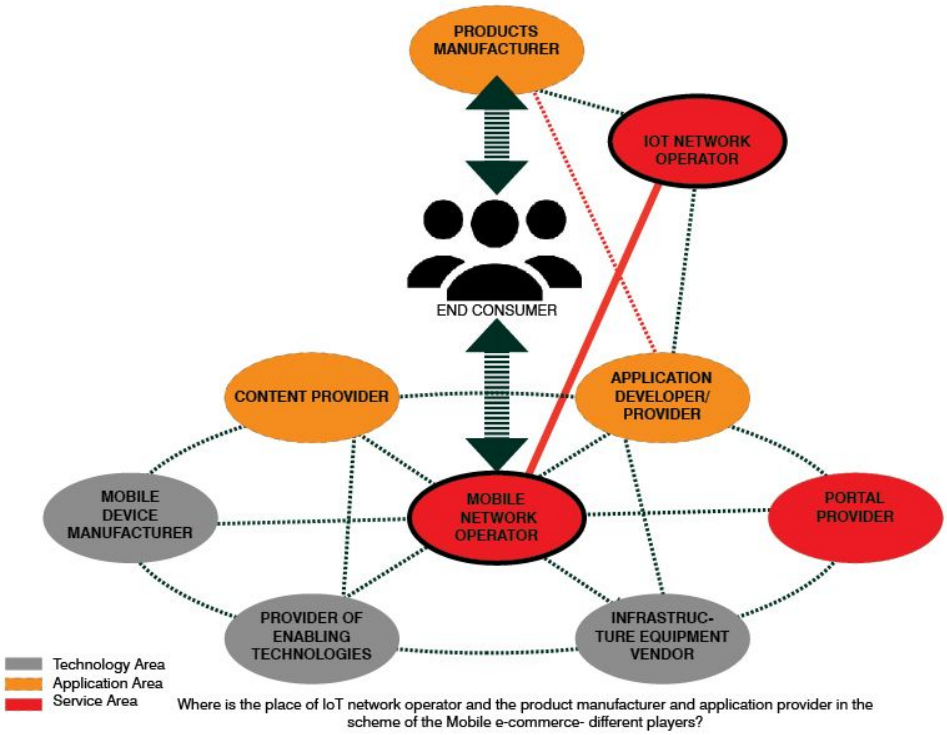
[19] 'Ericsson Mobility Report November 2015 - Ericsson-Mobility-Report-Nov-2015.pdf'.
[20] ibidem
[21] declining with 15% compound annual growth (source ibidem 14)
[22] 'SIGFOX - The Global Communications Service Provider for the Internet of Things (IoT)'.
[23] 'Lora-Alliance'.

network already experienced by successive upgrading from 2G, 3G to 4G. Huawei Advances LTE-M for IoT in China is willing to adopt low energy consumption patterns for the 4G. By the 2020, Intel promises the "convergence of existing networks — 2.5G, 3G, 4G, LTE or Wi-Fi"[24] in an Internet of things 5G support infrastructure. The achievement of these systems will arguably benefit from **synergies and compatibility** with the existing 4G infrastructure, **consolidate and expand the MNO** (mobile network operator) **leadership** in the market, and might be a serious risk for the LPWAN networks.

| | **LPWAN** | **GSM (GPRS, 2G, 2.5G)** |
|---|---|---|
| Number of objects | a lot | little |
| Energy transmission | 50 microWatts | 5000 microWatts |
| Stand-by tile with 2.5 Ah battery | 20 years | 2 months |
| Modem- Costs | less than 10 euros | +/- 20 euros |

This table was presented by an innovation IoT related company at the Gent workshop on 26 of February.

## 2.3. Potential industry reconfiguration



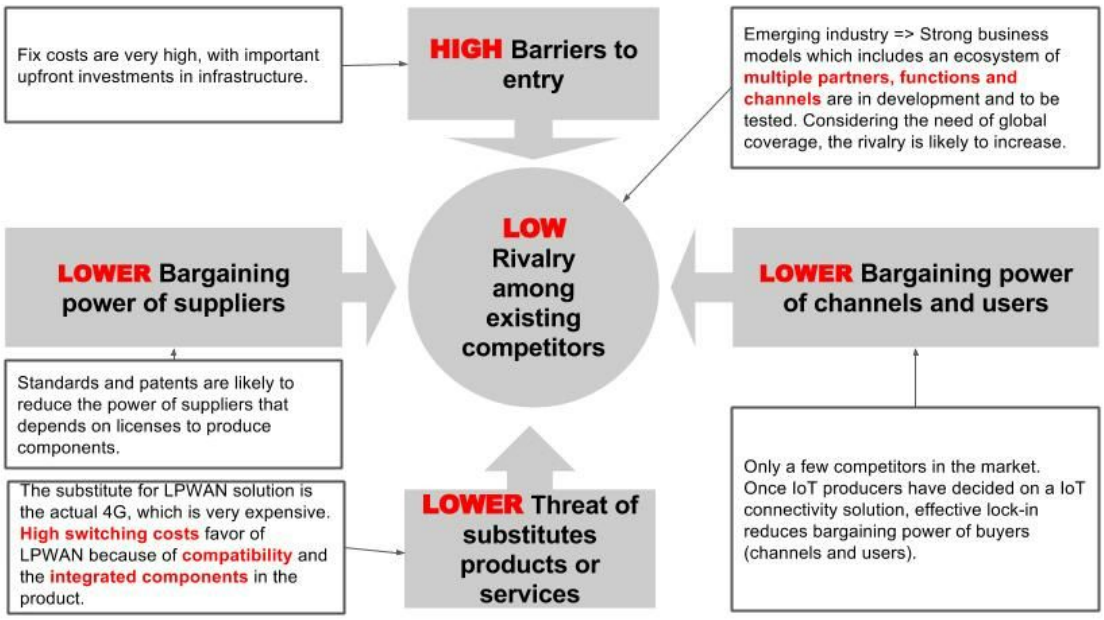

*Scheme adopted by the authors from Tawfik, Albrecht Enders, and Francisco J Martínez-López, 2014*

With the integration of new channels of data communication brought by IoT network, the value network of the industry is expanded: (1) IoT networks will transfer data from products to the cloud, whereas (2) **MNO (mobile network operator)** will remain important due the transfer of data from the cloud to the end-user applications (through smart devices and displays).

[24] Aicha Evans, Intel's Corporate Vice President and General Manager of the Communication and Devices Group

## 2.4. Competitive analysis of IoT infrastructure development

The MNO power will be balanced by the IoT network, that depending on the strategy and business model, will lock-in products and users through standards (compatibility) and industry partnerships. Partnership between mobile network operators and IoT operators are arguably a good strategic decision for both LPWAN operators and MNOs, and will reduce the bargaining power of IoT solution enablers.




## 2.5. LoRa vs. Sigfox strategy approach[25]

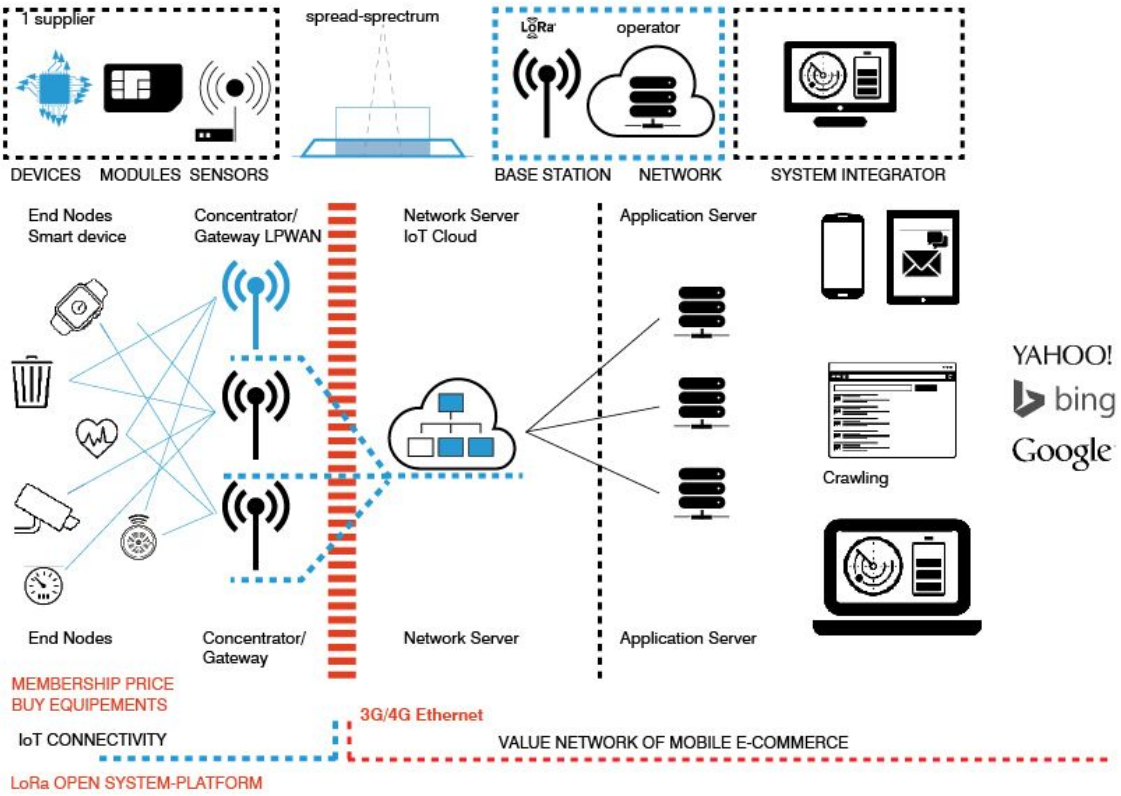
LoRa and Sigfox operate two completely different go-to-market strategies, with different business and value capturing models. A strategic comparison between both system highlights the adopted position related to the industry design and help identify the value captured. Technology is not describe in detail, but only when necessary to explain the strategic choice.

| | ***LORA*** | | ***SIGFOX*** |
|---|---|---|---|
| **vision** | ***Be the global technological platform for companies to develop IoT related products*** | | ***Global operator for Internet of Things*** |
| **objectives** | **OPEN SYSTEM - A FACILITATOR**<br>(membership alliance)<br>Full coverage with a few base stations, anybody can connect with any system<br><br>Being open - the failure of the system do not imply risks for the owner | | **CLOSED SYSTEM**<br>(only end nodes are also open to suppliers<br>Global coverage through partner network<br>Strong lock-in strategy<br>patents and a backend data-cloud<br><br>Being closed system, risk if the system doesn't grow |

[25] All the information compiled in the tables comes from the websites of the two companies; and the offers they are making to the members ( / customers (Sigfox)

| | | |
|---|---|---|
| **value creation** | **CUSTOMISATION AND LOW COST**<br>**Outpacing strategy:** low prices with superior quality based on IT and user generated content.<br>customised- highly differentiated | **COST LEADERSHIP**<br>**Efficient and very low cost,**<br>top-down approach, standardisation required, thus less diversity in solutions |
| **target segment** | Network operators, private networks (private companies), start-ups (roaming network to network)<br>Open system allows crowdsourcing projects => involve and empower members | Mobile network operators (partners) |
| **legal, external** | Shared ownership | Proprietary, patents |
| **partners** | Direct partners all over the value chain Hardware, Gateway, MNOs, Software and complete solution enablers | Partner with MNOs |
| **organisational model** | Membership. 1 proprietor (Semtech) | Venture capital financed - assumption that the organization is vertically structured |
| **revenue and cost model** | COST - cheap LPWAN, but more expensive than Sigfox: more accurate, symmetric bi-dimensional, higher capacity in data transfer => more flexible, in order to fit the customer need. | COST - the lower cost in the market. Cost model is focus on providing effective service with the simplest bi-directional data transfer need.<br>● No sophistication,<br>● Standardisation reduces costs<br>● In order to have lower prices and increase bargaining power they give IP for free to chip providers. |
| | REVENUE - subscription model for all networks for the use of infrastructure | REVENUE - subscription model through MNO partners |
| **strategy alignment** | Hard and soft components , all over the value chain (including antenna, network servers) can be bought by the members and operated in the LoRa system. | Only end nodes (product) silicon components can be bought and assembly by manufacturer. This components are either Sigfox manufactured, or Sigfox patented. |

| Trade-offs | decisive buying criteria | LoRa | Sigfox |
|---|---|---|---|
| **strategy alignment and value curve**<br>From a value curve perspective LoRa and Sigfox align decisive buying criteria (and thus key success factors) to their value propositions.<br>Sigfox is loyal to low cost strategy making trades-off on some factors in order to achieve its value proposal. In order to be reliable Sigfox has to focus on a more limited diversity in use cases.<br>LoRa aims to position with customisation and diversity. Therefore it enhances technical modularity, high precision aspects such as indoor precision location and always-on data transfer to be able to offer the degree of customisation and flexibility the customer wants. | Scalable and high capacity | | |
| | Long range communication | | |
| | Coverage | | better |
| | Fluidity | | |
| | Low cost | | better |
| | Long Lasting Battery | | |
| | Bi-directional | better | |
| | Indoor Precise location | better | |
| | Energy consumption | | better |
| | Security | | |
| | Frequency issues | better | |




## LoRa Creating value: competitive advantages

**GLOBAL COVERAGE OPPORTUNITIES** Adopting an open system allows a multitude of products and services to plug to LoRaWAN model. Cope with the broad coverage capabilities of LPWAN, and leveraging on members capabilities, LoRa is a candidate to achieve **economies of scale and scope.**

**BACKBONE FUNCTION** Partners can connect to the LoRa system by two methods. Either buying system components from LoRa (e.g. gateways), either by using LoRa's one.

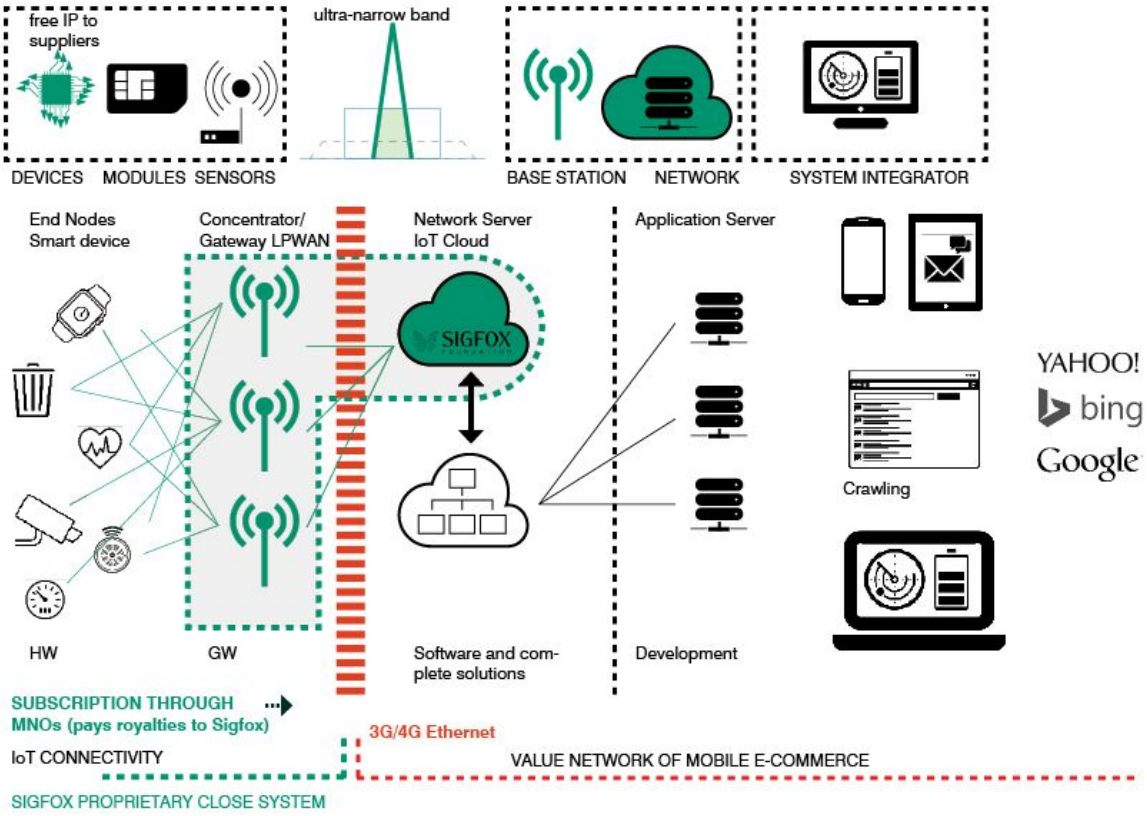
**EFFICIENCY** supply chain populated with partners. This might affect the efficiency of the ecosystem but it does a trade-off with the broader compatibility.

**LOCK-IN STRATEGIES** The radio manufacturer detain the license for the system. Product should stick to it.

**OPEN SYSTEM value creation- (1) encourage interaction**, improve not only the product/ service development through continuous feedback, but also network efficiency and effectiveness by testing different models from **(2) users added value**, such as feedback, crowdsourcing outcome, etc., **(3) customisation,** etc;

## LoRa Capturing value model

It's a simple model where **end nodes, smart devices - products** use/buy LoRa equipment and then pay a subscription membership fee to use the network. LoRa is not directly concerned by the end user price to pay for the product. **Manufacturer**, **service provider**, public authority has to develop their own model of capturing value coped with the server network . (note: the tendency to reduce at maximum/ eliminate the cloud prices, such as Amazon did).




## Sigfox creating value: competitive advantages

**HIGH VOLUME OPPORTUNITIES/ PRODUCT SPECIALISATION** Providing low price reliable technology, to fulfill very efficiently basic needs of the market, Sigfox it is a candidate to to achieve **economies of scales,** focus, access and add value in t**he commodities markets combine with an efficient service**. With its coverage and interesting price, has a big capacity to access the long tail.

**LOCK-IN** As showed on the scheme, Sigfox has a strong lock-in strategy, based on their own standards and components. Its gateways do not communicate directly with a mobile network operator hosted cloud. The data from products and devices is stores before in a Sigfox cloud. This is a very strong strategy creating big switching costs on the user, and interfering in the Mobile Network . It is believed that this design aims to increase the bargaining power of Sigfox over the MNO's. The direct relation from Sigfox cloud and network & cloud exclusive arrangement with MNOs that could harm LoRa coverage.

**EFFICIENCY** a perfect candidate to create value in offering efficient solution.

**COMPLEMENTARITIES-** the core of the industry that highlight the reinforcement between products, MNOs and IoT network capabilities

## Sigfox Capturing value model

Sigfox captures value from Mobile network operators that set the price to customer and end-users, taking in account the royalties arrangement that they have to pay to Sigfox. They have power to control and develop web and network application costs.

# 3. IoT & innovation - how to create new products & services

## 3.1. IoT and the advent of new business models

The beauty in IoT is that it creates unprecedented possibilities to create and capture value in new ways entirely.

### 3.1.1. Value creation & value capturing

The aspects of e-business models[26] still apply for IoT-business models. The value creation process in B2B markets are driven by efficiencies and complementarities between physical & virtual (IoT maximizes value chain and business process optimization). In the B2C market IoT creates value for customers beyond present consumer expectations (driven by novelty, convenience, customization and lock-in). IoT enables end-users and businesses to easily customize their environment to their individual needs (cfr supra) - smart objects often self-learn how to optimize this. This dynamic enables organizations to build deeper relationships with customers.

Furthermore, IoT is blurring industry boundaries, enabling organizations with product-oriented value propositions to enhance offerings to a more holistic "product + service" value proposition - but also vice versa for service-oriented value proposition to "service + product" (cfr. infra).

### 3.1.2. Revenue generation

Traditional e-business revenue generation models like customization, subscription or sales-revenue models are being enhanced by new IoT-specific business models. To capture value, IoT brings together the best of two worlds - the physical and the digital - and now enables, via the cloud, next to Software-as-a-Service also Product-as-a-Service[27] business models[28].

### 3.1.3. IoT business models

#### 3.1.3.1. Product-as-a-Service

In a traditional product/hardware business model manufacturers produce physical objects and sell these to customers, who then receive ownership but become responsible for carrying the costs associated with the use, maintenance and service of those products. In a pure product-as-a-service model this dynamic is turned upside down. The manufacturer retains ownership of the products he sells and carries the responsibility for the performance and servicing of the products. Revenue generation in this model can be through subscription, the customer pays for example a monthly fee, or pay-per-use, where the customer only pays a fee when he actually uses the product - something that easily can be monitored through IoT technology. A step closer to the on-demand economy.

#### 3.1.3.2. Digital Lock-in

Digital Lock-in is a digital variation to the classic Gillette 'razor & blade' & 'lock-in' business model - Gilette razorblade is initially sold at relative low cost but is only compatible with (in relation more expensive) razors from Gilette. Other manufacturers are prevented from producing cheaper compatible razors because of risk of patent violation. Digital lock-in

[26] Jelassi, Enders, and Martínez-López, *Strategies for E-Business*.
[27] Porter and Heppelmann, 'How Smart, Connected Products Are Transforming Competition'.
[28] 'BOSCH-Business-Models-and-IoT.pdf'.

can be applied, for example, through a digital handshake via software which prevents compatibility with competitor's systems, prevents counterfeits or to ensure warranties[29].

Lock-in also exists when users are dependent on a supplier because of high switching costs. Everyone will recognize the digital lock-in business model in the way Apple products seamlessly integrate with each other. Apple users often start off with a Macbook Pro laptop and end up with buying an iPhone and iPad, however this is never advertised as a package deal.

#### 3.1.3.3. Digital Add-on

The digital add-on model describes a business model, where a basic product is sold at an interesting price point, with the expectation that extra digital services will be purchased during the time the customer uses the product. The digital add-on business model is also rooted in Apple's business model where iTunes becomes your go-to-store for music and the App store for a series of Apps you weren't planning on buying, or when you buy extra cloud storage through iCloud (= freemium model) because all of your photo's are no longer being saved - and thus shared with all your other Apple products - automatically.

#### 3.1.3.4. Physical Freemium

In the physical freemium model a basic version of a digital service is included in the sale price of a smart object. The consumer can purchase upgrades or extended services at a premium price.

Many smart security systems, like Netatmo[30], have as basic functionality monitoring spaces in your home and sending alerts to your smartphone when unusual activity is recorded. In the premium package, you can purchase additional services like extra storage space for all your recordings or the services of a call center.

#### 3.1.3.5. Product as a Point-of-sales

Digitization of physical products can transform smart objects in self-standing marketing channels or e-shops and where the product can offer the user digital ads, promotions or can collect loyalty points. The Amazon App[31] now has a bar scanner functionality that allows you to directly and automatically purchase products by scanning the barcode on a product.

#### 3.1.3.6. Remote usage, Condition Monitoring & Object Self-service

IoT enables the possibility to remotely monitor and control smart products. IoT-enhanced products could also self-diagnose their performance and condition and automatically order maintenance or spare parts online. This model allows for performance-based contracts wherein the middle man is cut out.

#### 3.1.3.7. Product-sharing Services

The bike-sharing services offered by the city of Antwerp (Velo) and city of Brussels (Villo) have become a well-known example of a **pay-per-use model** where products are shared between users.

#### 3.1.3.8. Sensor-as-a-service

The interoperability of IoT systems will probably create ecosystems of organizations (cfr. infra) that choose to partner up to design and market solutions that can capture, share and leverage more data than would be the case for each company individually. Sensor-as-a-service is also a feasible model wherein organisations **capture value by selling and sharing**

[29] 'BOSCH-Business-Models-and-IoT.pdf'.
[30] 'Netatmo Official Site'.
[31] 'Use Amazon's Barcode Scanner to Easily Buy Anything from Your Phone'.

relevant data with other organizations. This way more organizations can profit from capturing data.

## 3.2. How do corporates think about IoT innovation? (Field research)

We have had the chance to follow a 3-day open innovation and co-creation boot camp for corporates focused on new business ideas using IoT. The set-up was a facilitated program wherein leading corporates[32] (active on the Belgian market) together with experts (business & service designers, IoT experts, IoT prototypers, IT solution providers) prototyped potentially new IoT-oriented business cases. The program is set-up as a collaborative platform where experts from different organizations were pooled together (to increase value and impact) as maker-teams to facilitate ideation workshops and prototyping; the workshops were further enhanced with inspirational talks & demo's from experts from IBM & Cisco.

**Research questions and outcomes:**

1. **How far are participating corporates in considering IoT-enhanced products and services?**

All participating corporates although in the mid to far end of the digital transformation spectrum have not really incorporated IoT in their service or product offerings. Many participators (director level) stated to have considered this co-creation boot camp a first step from R&D (monitoring the market) into formalising a business case.

2. **Do corporates see value in cross-sector co-creation or collaborations because of IoT?**

Interestingly, the co-creation aspect, wherein all participant jointly worked on business cases for other industries, was well received by all participants and have inspired all participants to look into potential collaborations. Effective joint venture business cases were considered interesting but longer-term projects.

3. **Are corporates willing to pursue a new business model?**

It seems that IoT inherently changes parts of the business model. The participating corporates seeked primarily to approach the existing target market through new ways to create and appropriate value. We have condensed the conclusions in two categories - service & product oriented value propositions. The most interesting conclusion was that all service providers ventured into new 'integrated/ecosystem' service offerings, looking to increase value for customers but with a strong focus on data collection and increasing switching costs. Product manufacturers were focused on creating more value for existing customers.

**IoT-enhanced 'Service' use cases**

| | Industry | Strategic use case | objective | Business Model |
|---|---|---|---|---|
| 1. | Parcel delivery | Software standard for connected mailboxes | First mover / switching costs | Digital Lock-in |
| 2. | Insurance | IoT device integrator + dynamic insurance (+ IoT device reselling) | Differentiation / Switching costs | Digital Lock-in / Digital Add-on |
| 3. | Telecom | Digital business-as-a-service to SMEs | Differentiation/ switching costs | Digital add-on |
| 4. | Utilities | Decentralized energy brokerage | First mover | Product-as-a-service |

[32] Participating corporates came from different industries to promote open innovation: insurance, parcel delivery, telecom, utilities, pharma, food product manufacturer.

**IoT-enhanced 'Product' use cases**

| | Industry | Strategic use case | Objective | Business Model |
|---|---|---|---|---|
| 1. | Frozen Bakery Products | Smart oven for B2B customers | Data collection / automatic ordering | Condition monitoring / Object self-service |
| 2. | Pharma | Lab@Home | Differentiation | Digital Lock-in |

**4. What was the preferred IoT network infrastructure (Sigfox vs. LoRa vs. 4G)?**

None of the corporates considered the type of IoT network infrastructure a determining factor in their ideation. This is arguably due to the fact that we are still in the phase of value proposition design. In a later stage this decision might become more important.

# 4. Conclusion

In this paper we have tried to get a better understanding of the IoT market. We have started out with close to no prior knowledge, and have chosen to combine high-level and deep research on what we considered the most interesting topics.

What strikes us most is the vast amount of information and complexity of aspects characterizing this new industry. Although we realized early on that software enablers play an important role in the value network, we decided to put focus on what we consider the main drivers for IoT adoption: connectivity providers (IoT networks) & innovators.

LPWAN infrastructure is an important driver in the growing adoption of IoT solutions. In a Belgian context, most attention goes to two IoT networks being rolled out in parallel (Sigfox vs. LoRa). We can make a good case for both technologies, concluding that the competitive advantage for one or the other will come from fastest adoption in the market. This translates in both network operators entering the market with force, trying to tackle the same challenge: promoting exponential adoption, while rolling out nation-wide coverage of the network.

We believe that this competitive dynamic will spur innovation in Belgium (and worldwide), mainly coming from corporate innovation and the growing startup ecosystem. The co-creation boot camp has confirmed that innovation efforts focused on IoT-enhanced products and services is still in its infancy. Although we have not discussed the startup ecosystem in this paper, experts we have spoken are from the opinion that current startups are primarily focused on very niche products or software solutions. The Belgian market for IoT-solutions has still to develop.

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