UNIT-IV

INTEGRATEDBILLING SOLUTIONS IN THE INTERNET OF THINGS:

Cost of RFID and the Internet of Things, Benefits of RFID and the Internet of things, Cost Benefit sharing, A technical framework for Integrating Billing Capabilities into the EPC global Network-Business Models for the Internet of Things-Business Models and Business Model Innovation-Value creation in the Internet of Things Exemplary Business Model Scenarios for the Internet of Things.

Integrated Billing Solutions in the Internet of Things

INTRODUCTION

The Internet of Things is one of the most promising technological developments in information technology. It promises huge financial and nonfinancial benefits across supply chains, in product life cycle and customer relationship applications as well as in smart environments. However, the adoption process of the Internet of Things has been slower than expected. One of the main reasons for this is the missing profitability for each individual stakeholder. Costs and benefits are not equally distributed. Cost benefit sharing models have been proposed to overcome this problem and to enable new areas of application. However, these cost benefit sharing approaches are complex, time consuming, and have failed to achieve broad usage.

While RFID and other Auto-ID technologies continue to be major components of the Internet of Things, there are other technologies, such as sensors, actuators, and networked infrastructures that will further add to the ongoing cost discussion.

The major hurdles in the process of deploying the Internet of Things are

- Cost for hardware &Software,
- Integration,
- Maintenance,
- Business process reengineering
- Data analysis.

Some Internet of Things related applications may never come true, because some of the stakeholders would need to spend more on technology and integration than can be justified by internal benefits. There are several problematic aspects in cost benefit analysis and sharing:

- Detailed cost benefit analysis can be time consuming
- It is difficult to identify, measure and analyze all costs and benefits associated with an Internet of Things
- Companies are reluctant to share benefits

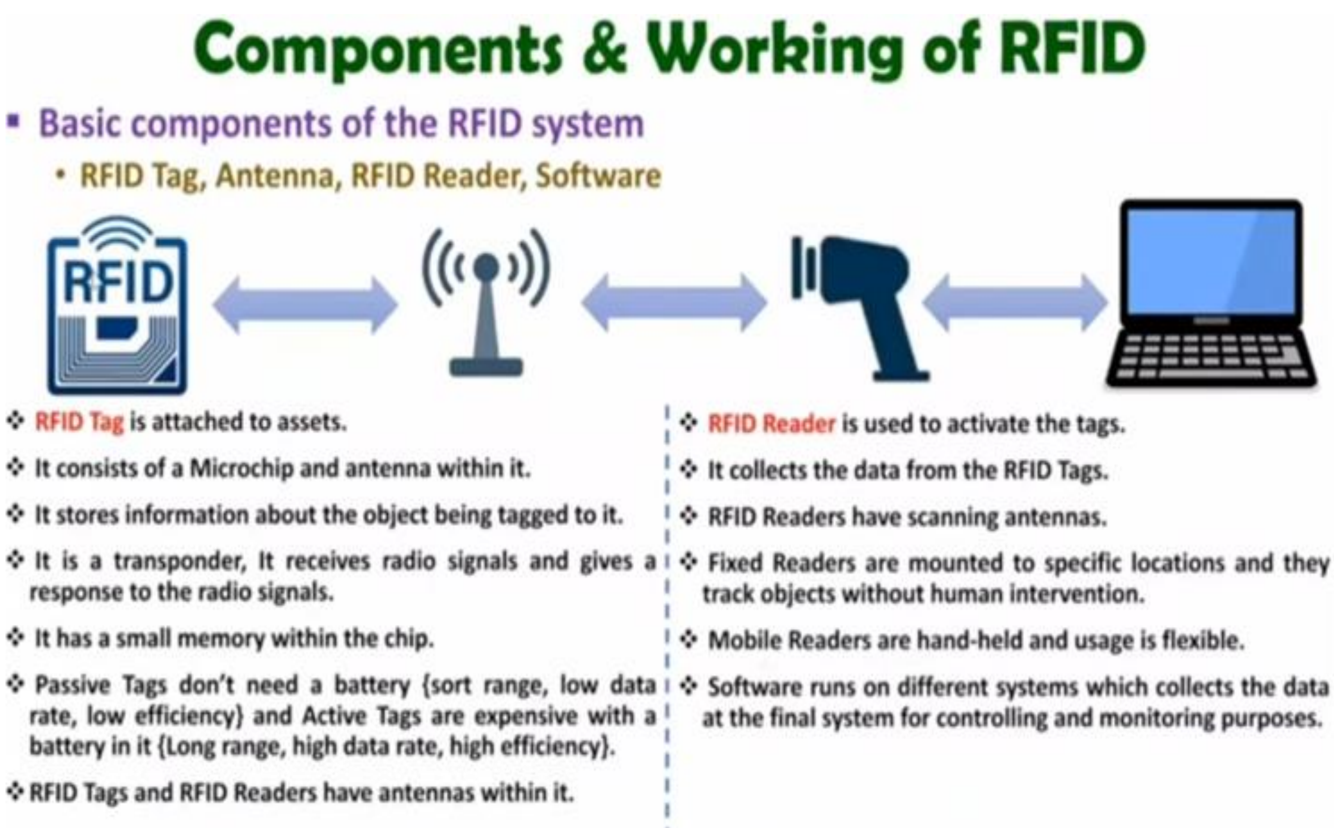
Cost benefit sharing models do not scale, as they are subject to bi-directional negotiations. An alternative solution to cost benefit sharing could be based on selling and buying information that is provided through the Internet of Things. For this, a billing solution is needed to price and bill information. Similar concepts are known from the telecommunications industry, where billing solutions are an integral part of the overall infrastructure, allowing billing of different services, such as

- Voice calls,
- SMS,
- Internet access and
- Premium services

across service providers and different countries.

Basic of RFID

- RFID –Radio Frequency Identification
- RFID is a form of wireless communication that uses radio waves to identify and track objects.
- RFID uses electromagnetic fields to automatically identify and track tags attached to objects.
- RFID can also be used to track animals and birds by attaching tags to them.



Cost of RFID and the Internet of Things

There are numerous costs associated with the adoption of the Internet of Things. While the Internet of Things is not synonymous with RFID, results from cost analysis for RFID can be used as a basis for further calculations. Agarwal (2001) lists six different costs of RFID deployment for manufacturing firms

- The cost of the tag itself,
- Cost of applying tags to products,
- Cost of purchasing and installing tag readers in factories and/or warehouses,
- Systems integration costs,
- Cost of training and reorganization,
- Cost of implementing application solutions.

Feinbier et al. (2008) list relevant costs for RFID installation in detail, based on experiences in the steel industry. On the basis of both approaches, similar cost structures can be inferred for the Internet of Things

Cost level	Cost of tagging (Agarwal 2001)	Cost considerations for RFID (Feinbier et al. 2008)	Cost of Internet of Things adoption
1 Mobile devices	• Cost of the tag itself • Cost of applying tags to products	• Tags	• Cost of mobile technologies, such as data carriers (e.g., tags), sensors, actuators or smart devices • Cost of applying mobile technologies to things
2 Aggregation devices and software	• Cost of purchasing and installing tag readers in factories and/or warehouses	• Readers • Antenna and cabling • Installation • Tuning • Controllers • Software platform (middleware)	• Cost of purchasing edge devices (e.g., readers, gateways, controllers, accessories) and edge ware for fixed and/or mobile environments • Installation and technical optimization costs
3 Integration	•Systems integration costs	• (to legacy systems)	•Systems integration costs including new interfaces as well as necessary updates, extensions, or replacement of existing systems
4 Training and reorganization	• Cost of training and reorganization	• Process (incl. redesign and human elements)	• Training cost • Reorganization / business reengineering / business model innovation
5 Application	• Cost of implementing application solutions		• Cost of implementing internal application solutions beyond existing applications
6 Networking (technical and organizational)			• Cost for networking in an open environment, including e.g., improved security, fine layered access control, multi-directional communication, product data contracts, service level agreements,

			standardized syntax and semantics, data conversion, synchronization, trust concepts
7 Operational		• Maintenance	• Cost for maintenance • Other operational costs for running (e.g., data storage and analysis), extending and improving the system

Benefits of RFID and the Internet of Things

Baars et al. (2008) have identified four different approaches towards systemization of RFID benefits

- **Collecting and grouping** –
  Benefits are collected and grouped.
- **Layer of impact**
  Benefits are structured to impact layers such as short term and long term automation, informational and transformational benefits, proven or potential.
- **Locus of impact**
  These studies highlight who benefits, thus it automatically considers benefits to multiple stakeholders.
- **Indicator system**
  Established evaluation systems, such as Balanced Score cards are used to structure RFID benefits. Collective benefits can be achieved by all of these stakeholders. These include:
  - **Reduced product shrinkage**: reduction of loss of goods through misplacement, spoilage, and theft
  - **Improved information sharing**: product related data may be exchanged to benefit multiple stakeholders, problems resulting from converting paper-based information to digital information are avoided and manual data-entry is drastically reduced
  - **Compensatory benefits**: benefits provided through other stakeholders, including for example cost benefit sharing, funded research, bonus payments, vouchers, information (e.g. sales data)

Companies in general may benefit from:

- **Increased inventory, shipping and data accuracy**: e.g., differences between **real stock** numbers and assumed stock, based **on false data**
- **Subsequent fault reduction**: **inaccurate and incomplete visibility** may lead to false decisions and can be avoided through the Internet of Things

• **Faster exception management (agility):** capability of responding to unplanned events in a timely manner before critical problems escalate

• **Asset management**: better asset utilization may lead to an opportunity to reduce asset inventory, reduced asset shrinkage, better shipment consolidation, reduced energy consumption and improved reverse logistics.

• **Product rotation**: methods of inventory control, such as First In, First Out (FIFO) can be used more accurately to ensure efficient stock rotation e.g. in time sales for perishable goods.

Manufacturers and suppliers benefit mainly from:

• **Production tracking**: tracking of raw material, work-in-progress inventory, assembly status tracking and finished products

• **Quality control**: ensured quality control in production

• **Supply / production continuity**: enabled through improved material tracking

• **Compliance:** e.g., in case of mandates issued for example by large retailers or legislators and regulators

Distributor and logistics provider as well as internal distribution and logistics departments benefit from:

• **Material handling**: time (labor) savings for loading / unloading of trucks, administrative overhead at the goods receipt , cross-docking , customs clearance delivery lead times and reduced delays, faster inventory, goods receiving, loading and unloading as well as reduced human errors through Auto-ID

• **Space utilization**: achieved through reduced buffers and reduction of product storage incompatibilities (e.g., placement of hazardous goods102 Retailer benefits include:), based on better data accuracy through RFID usage

Retailer benefits include: based on better data accuracy through RFID usage

• **Customer service**: RFID can be used to simplify checkouts and payments as well as for promotion management

• **Lower inventory**: reduced stockouts and smaller buffer stocks, due to improved inventory data

• **Reduced stockouts**: substantially reduced stockouts can be achieved through RFID if movements to the shop floor can be tracked

• **Promotion execution**: RFID and the Internet of Things may be used to obtain better visibility for timely placements of promotional items

• **After sales services**: in after-sales service, RFID may be used for warranty issues, repair and goods authentication

Benefits for consumers are:

• **Personal access to product specific information**: e.g., to be able to access the product history of a car, based on a vehicle identification number

• **Active participation opportunity**: e.g., through beta testing, product ratings, field reports, applications and more

• **Interaction with other stakeholders**: e.g., automatic updates and repairs, dynamic safety warnings, product recalls, public applications

• **Home automation and leisure applications**: e.g., room monitoring, smart devices, intelligent toys

Benefits to society include:

• **Consumer protection / safety**: e.g., food and health safety, environmental monitoring

• **Security:** e.g., to avoid terrorist attacks, customs support

• **Trade facilitation**: comparable with the introduction of Infrastructure optimization: e.g., roads, public transportation

Cost Benefit Sharing

- Costs and benefits of the Internet of Things that are not evenly distributed between the stakeholders.
- Cost benefit sharing models may be used as a tool to balance these asymetries.
- Cost benefit sharing in combination with RFID has been researched by several authors.
- Sharing benefits and investments in multi-tiered situations is seen as a core requirement for wide-scale deployment of RFID.
- Hirthammer and Riha (2005) define cost benefit sharing as:

"A systematic and system-oriented incentive system that motivates companies in a network to participate in joint projects that do not benefit them directly. A Joint Project is a cooperative effort to improve the processes or resource allocation in the network. It involves at least two parties in the network."

According to Hirthammer and Riha (2005), the cost benefit sharing process loop can be structured in several subtasks:

1. Detailed process analysis in the network through auditing
2. Enquiry of weak points through benchmarking
3. Development of corresponding actions to solve or lessen the effect of the weak points based on overall strategies and goals
4. Cost benefit sharing
    a. Calculation of costs
    b. Evaluation of benefits

i. Calculate monetary benefits
ii. Calculate qualitative benefits
iii. Evaluate total benefit
iv. Calculate share of benefit
c. Distribution of costs
5. Implementation of actions proposed in step 3
6. Controlling
7. Feedback loop to adjust the system to external dynamics

A Technical Framework for Integrating Billing Capabilities into the EPCglobal Network

The well-known Fosstrak EPCIS software has been integrated with jBilling, an open source billing solution that is mainly being used in telecommunication companies. The jBilling system has been chosen for the following three reasons.

- Firstly, it does not require an upfront investment in software.
- Secondly, it is open source and, therefore, allows modification to the software.
- And thirdly, it aligns well with the technologies used in Fosstrak and therefore may allow a tighter integration

Both products use Tomcat as Web-server, but there are two different relational databases in use, Hypersonic for jBilling and MySQL for Fosstrak. jBilling can run on MySQL, so that Hypersonic could be eliminated in a further integration effort. To combine the two different systems, there are two initial requirements:

1.There should be an integrated login procedure .
2. Selected EPCIS events should be translated to jBilling purchase orders

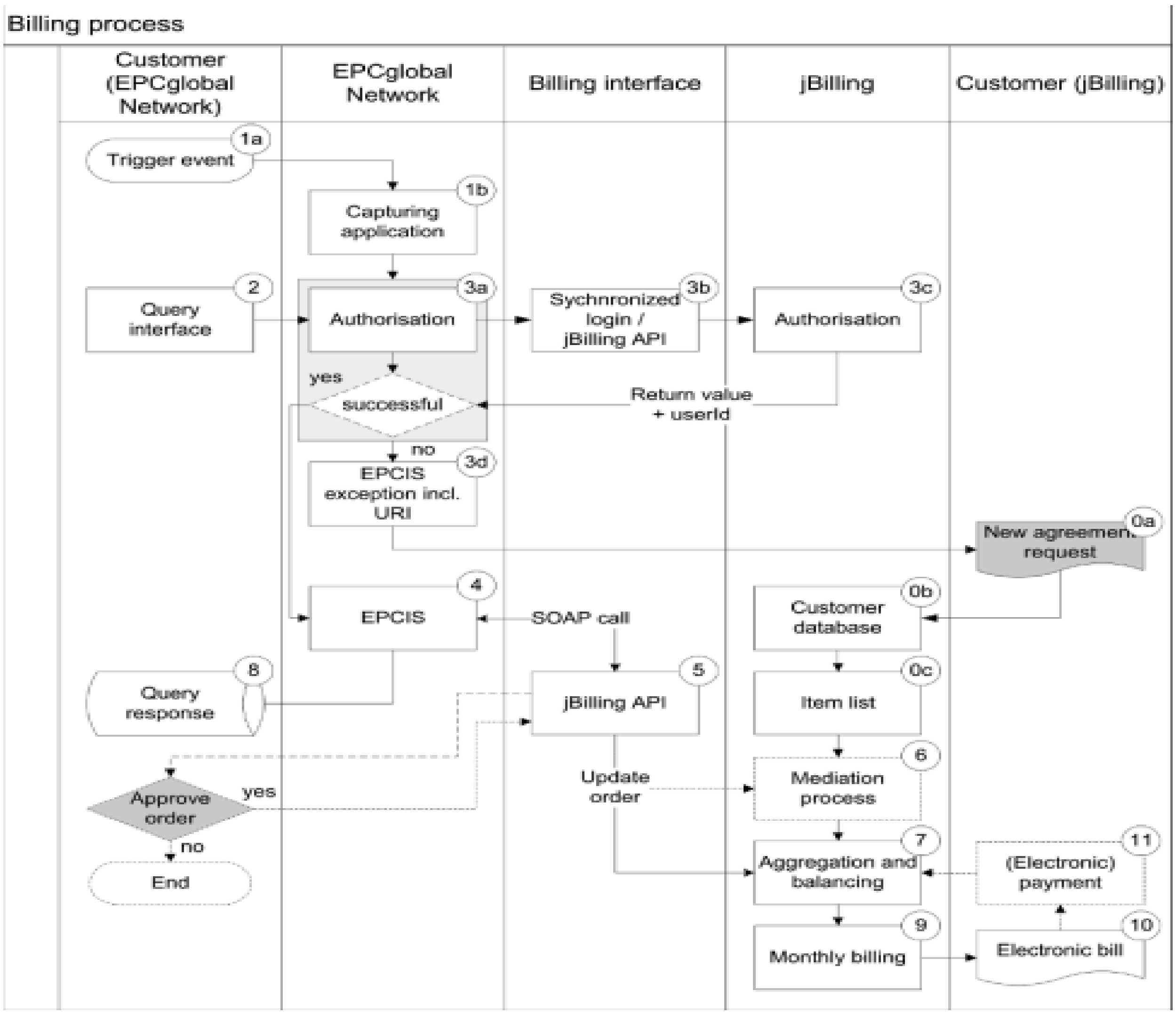
The accounting process may be triggered by an event, such as a pallet with an RFID tag passing a dock-door (1a, 1b). Other billing activities may be started through a query for payable information (2). As part of the Fosstrak authentication process (3a), the access rights, including the availability of a billing account (3c), are checked via the jBilling Application Programming Interface (API).

For this purpose, a combined login process has been implemented as an option in the Fosstrak EPCIS query interface (NextFigure) at the LogDynamics Lab.

- Other billing activities may be started through a query for payable information (2).
- As part of the Fosstrak authentication process (3a), the access rights, including the availability of a billing account (3c), are checked via the jBilling Application Programming Interface (API).
- For this purpose, a combined login process has been implemented as an option in the Fosstrak EPCIS query Interface.
- Currently, only basic authentication is enabled.

- If the input data is null or missing, jBilling generates an API exception (jBilling 2010).
- Otherwise jBilling returns different integer values as described below.
- 0 -The user was successfully authenticated and his current status allows him entrance to the system.
- 1 -Invalid credentials. The user name or password are not correct.
- 2 -Locked account: The user name or password are incorrect, and this is the last allowed login attempt. From now on, the account is locked.
- 3 -Password expired: The credentials are valid, but the password is expired. The user needs to change it before logging in
- If no valid contract in jBilling can be found, JbillingAPIException could be converted into an EPCIS exception, containing a Uniform Resource Identifier (URI) that links to a new agreement request (3d).
- The agreement may contain pricing information, financial details, such as preferred payment service, and payment options (e.g. monthly). b
- For further usage in the Internet of Things it would be favorable, if individual service level agreements and information quality details could be included or linked as well.
- The agreement is stored within the jBilling customer database (0b) and will be used for calculating customer-specific prices later on.
- In a further effort it would be possible to create, update and delete new jBilling users from within the EPCIS, using the jBilling API.
- Consequently, users would not need to deal with two different systems.
- After successful authorisation, the EPCIS queries are processed.
- The EPCIS will make a SOAP call to the jBilling API (5).
- The userID provided during the authorisation process is used to link an order to a jBilling account.
- The createOrder and updateOrder methods are used to transfer events into corresponding orders.
- Optionally, a mediation process (6)can be called to enable dynamic pricing, based on business rules.
- If prices per item are predefined in jBilling and if no changes are required, the mediation process does not need to be called (jBilling 2010).
- The jBilling API updates the account balance (7). Optionally, an approval request for the end-user can be implemented.
- Finally the query response is delivered and the account balance is updated by jBilling.
- Usually, monthly billing will be used to invoice the aggregated values in business scenarios (9).
- In order to avoid problems resulting from analogue to digital media conversions and cost intensive manual labour, electronic bills (10) and electronic payment (11) will be preferred.

- Additionally, an invoice is sent via e-mail or traditional postal services to a defined recipient.



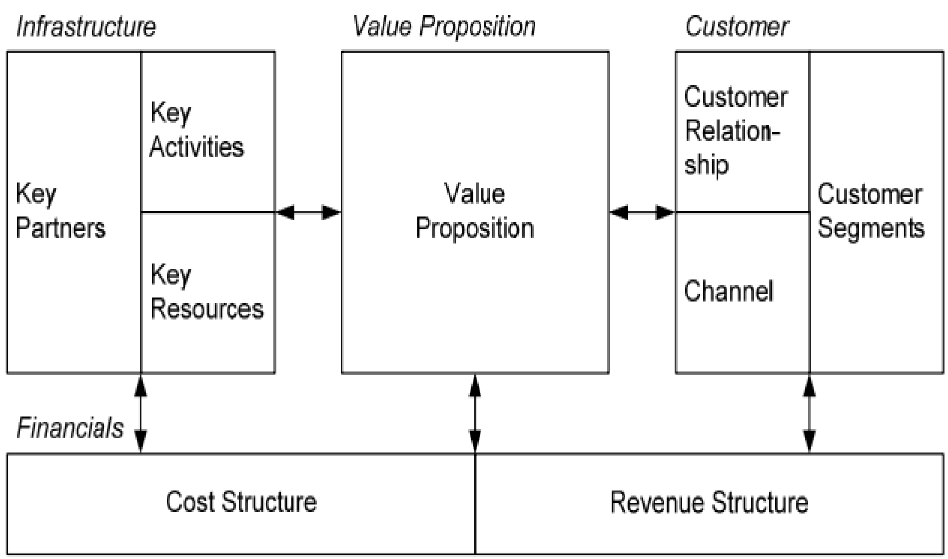
Business Models for the Internet of Things

The Internet has significantly changed the way products and services are marketed and distributed and thus let to a series of new types of business models. Current applications in the Internet of Things generally focus on the optimization of existing processes and associated cost reductions within companies and along value chains. Product Life Cycle Management, Customer Relationship Management, and Supply Chain Management are typical application scenarios.

New application scenarios, sometimes referred to as smart technologies and smart services, are more focused on revenue generation The business model has to be seen as the replacement or complement of the traditional unit of analysis, as a result of the altered

surrounding conditions. Today's business condition is determined by technological progress, service orientation, the digitalization of products as well as increasing relevance of cooperation and ecosystems of different companies, which blur the boundaries of the individual enterprise. Accordingly, each business is implicitly based on a business model, even though it is not always explicitly presented. Timmers (1998) defines a business model as "an architecture of the products, services and information flows ". This includes the involved actors and roles as well as the potential value created for all participants and the source of revenue.

In relation to the Internet of Things we see the business model as a major element to unite its technical developments with its economical business perspective. According to Afuah and Tucci (2000), "a business model can be conceptualized as a system that is made up of components, linkages between the components, and dynamics". Components refer to the elements to be addressed by a business model. Just like the definitions of the term "business model" the proposed components vary largely between different authors. Osterwalder and Pigneur (2009), defined a framework which is referred to as the "**business model canvas**". The applicability of the model is proven by its use in practice



The business model framework depicted in Figure includes four main perspect ives of the business model, namely

- The value proposition,

- The customer,
- Financials
- The infrastructure.

The components are not stand-alone but mutually influence each other. The value proposition specifies what is actually delivered to the customer. This goes beyond the product or service offered. It describes which customer needs are satisfied and details what other quantitative (e.g., price or speed of service) and qualitative aspects (e.g., brand, design, cost/risk reduction) contribute to the offered value. In the Internet of Things we consider raw data about physical objects as well as any aggregated or processed information a core component of the value proposition. The customer perspective includes the customer segments addressed by the company, such as related channels and customer relationships.

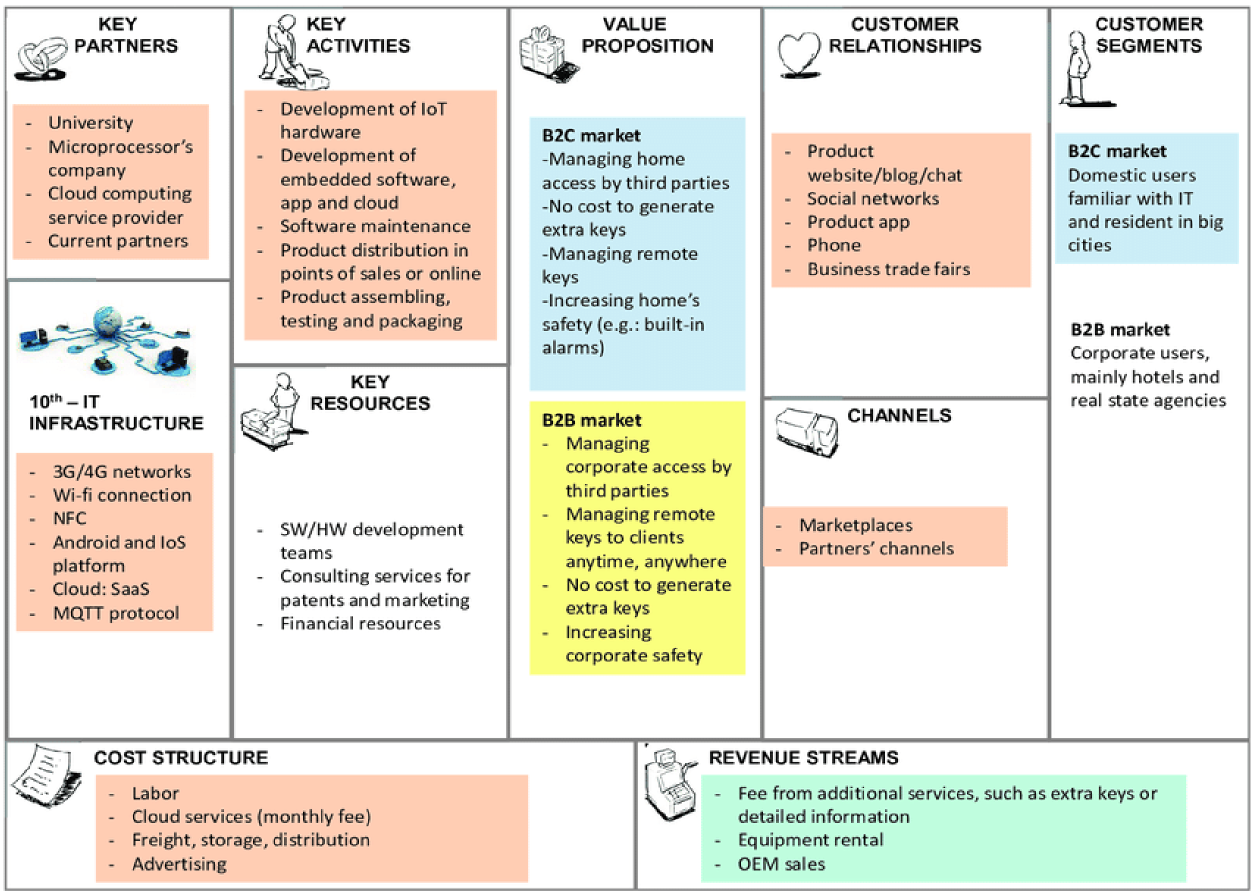
- The **customer segments** define the different groups of people that are served. Different types of customer segments can be distinguished: mass market vs. niche market, segmented vs. diversified or multisided platforms. Multisided platforms will exist, if two or more interdependent customer segments are served by the company (e.g. credit card companies). The company can reach its customers, respectively customer segments through different channels. These can be direct or indirect and owned by the company itself or by partners.

- **Channels** can be aligned to the different phases of the lifecycle, such as creating awareness for the value proposition, evaluation of the value proposition through the customer, purchase, delivery and after sales.

- **Customer relationships** are often determined by the channels used. Relationships can range from very loose (self-service, automated services) to highly engaged (personal assistance, communities, co-creation). The financial perspective comprises the costs as well as the revenues.
- The **revenue structure** depicts the sources and ways of revenue generation. Here, different types of revenue streams can be distinguished: asset sale, usage fee, subscription fee, lending / renting / leasing, licensing, brokerage fee, and advertising.
- The **cost structure** describes the most important costs (variable and fixed) inherent to the business model. The business model can be rather value or cost driven. Companies can use economies of scale or economies of scope to create a successful business model. Key partners, key activities and key resources can be referred to as the infrastructure components.
- The **key resources** are the assets required to make the business model work. Key

resources can be physical, intellectual, human or financial.

- The **key activities** describe the most important actions to be performed by the company in order to create, offer and market the value proposition. These can be producing, problem solving or developing and maintaining a platform, respectively.
- **Key partners** are the network of suppliers and collaboration partners (strategic alliances, outsourcing partners, co-creation) the business model depends on.



Business Model Innovation

Business model innovation is the art of enhancing advantage and value creation by making simultaneous—and mutually supportive—changes both to an organization's value proposition to customers and to its underlying operating model. External factors, such as technological innovations, increased competition, and market changes as well as legal or regulatory changes are seen as the dominant triggers of business model innovation. Business model innovation can help to align innovation activities within the company. Business model innovation as a process resulting in a qualitatively new business model, which differs distinctively from the previous. A deliberate change of one or more key elements of the business model, respectively their interrelations, has to take place. Some of the most successful companies that have used a distinctively new business approach based on the Internet are shown in Table

Company	Traditional business	Initial business model innovation	Further developments
Amazon	Book trade	Online shopping Automated distribution model Collaborative filtering	Shopping portal Digitalisation (mp3, books), Terminals (Kindle), Mobile payments Amazon web services (incl. billing)
eBay	Classifieds Flea markets Auctions	Online auctions	Shopping portal Payment services (PayPal)
Google	Yellow pages	Hypertext web search Prioritized advertisements	Terminals (Android), Video (You Tube), Maps (Google Maps), Web based software (e.g. Google Docs), Digitalized books Payment services (Checkout)
Apple iTunes	Music shops	Music digitalization Terminals (iPod, iPhone, iPad) Applications (apps)	Videos, Newspapers

Value Creation in the Internet of Things

A typical business transaction today is defined by a physical product, information stream, and money stream. The Internet of Things may be seen as an approach to align these different streams. It provides a higher level of visibility and control mechanisms. Moreover, in the Internet of Things, information itself may become a major source for value creation and thus the value proposition. This includes information only made possible through Internet of Things technologies as well as the association of existing information to physical products. Traditionally, the money stream is exclusively dependent on the product stream prices.

A separate price for the information is not defined. Instead, information is most often expected to be free of charge. It is obvious that the costs of information are hidden in the product price. However, the reluctance to pay for information may change over time. In B2C-markets, the willingness to pay for digital goods has increased to 88%. Even though digital goods (e.g. software, tickets, travel, songs, and videos) and information are not synonymous, it is still obvious that there is a change in society to accept the Internet as a business transaction platform. In addition to direct information payments, alternative revenue streams should be considered.

Laws of Information

Even though information is recognized as an asset on its own right, quantitative measurements are difficult to achieve. It consumes a growing number of organizational resources for data capturing, storage, processing and maintenance. While hardware and sometimes software may be capitalized, the value of information in general is not financially recognized in the balance sheets. Information may be considered a product that is produced out of raw data through hard- and software utilization. Moody and Walsh (2002) define seven “laws of information”, explaining the specifics of information compared to other (physical) assets. These “laws of information” provide opportunities for new business and pricing models for the Internet of Things:

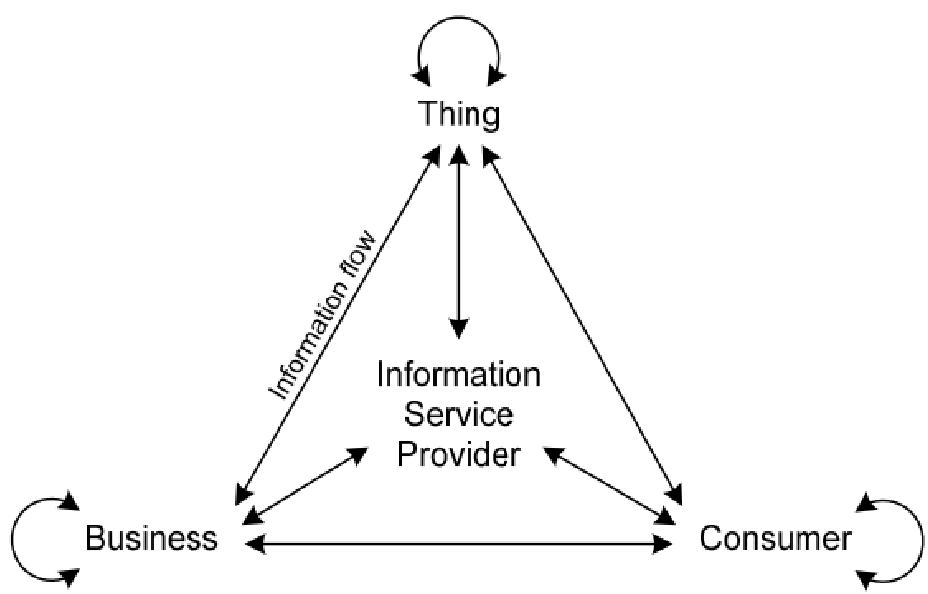
- **First Law of Information**: Information is (Infinitely) Shareable and Can Be Shared with Others Without a Loss of Value
- **Second Law of Information**: The Value of Information Increases with Use and It Does Not Provide Any Value, If It Is Not Used at All
- **Third Law of Information**: Information Is Perishable and It Depreciates Over Time
- **Fourth Law of Information**: The Value of Information Increases with Accuracy.
- **Fifth Law of Information**: The Value of Information Increases When Combined with Other Information
- **Sixth Law of Information**: More Information Is Not Necessarily Better .
- **Seventh Law of Information**: Information Is Not Depletable

Revenue Generation in the Internet of Things

Information may become the main source of value creation and thus a major part of the value proposition in the Internet of Things. Information can be directly associated to things or products and instances of products. The usage, status, and location of things become traceable. This allows for new value proposition scenarios, such as the provision of additional product-related data to or the exact billing of products or services based on the actual use (e.g., rental car, returnable transport items). The following requirements constitute the specifics for the value proposition:

- **Providing the right information** ... – Linked through a unique identifier to a physical product
- **... in the right granularity** … – High information granularity, providing a new dimension of clarity and insight
- **… and the right condition** … – High information accuracy – Aggregation of information from various sources, such as tags, sensors or embedded systems – Correlation, integration, and further analysis of information in a way that allows new insights to be derived – Defined syntax and semantics
- **... at the right time …** – Timeliness of information – Access to real time information as well as to historical data for business analysis – Real-time analytics and business intelligence for high resolution management – Intelligent real-time decision-making capability based on real-time physical events.
- **... anywhere in the network …**– Online access and possibly offline usage – Mobile access
- ... **at an appropriate price.** – Price transparency – Low premium for billing service, the price should be paid for the information rather than the infrastructure

In order to fully understand the information exchange on the Internet of Things the information flows and actors involved have to be considered. Figure depicts information providers in the Internet of Things and information flows between them.



They can be depicted as a triangle of information exchange. Information flows can be direct, such as for example thing-to-thing, business-to-consumer or consumer-to–thing, or indirect, such as from thing-to business through an information provider or from business-to-business through a thing. Things include products that communicate their ID and status through sensors as well as data processing units and actuators.

Exemplary Business Model Scenarios for the Internet of Things

The field of application for Internet of Things technology is much wider then we have seen so far. The control of processes and the quality of goods in manufacturing, logistics, service and maintenance are still valid applications. Moreover, new areas of applications have to be

considered. The following exemplary scenarios will include the use of Internet of Things technology to support the offer of PaaS, the role of information service providers in the Internet of Things, the integration of end-users and opportunities through right-time business analysis and decision making.

Scenario 1: Product as a Service (PaaS)

The shift from providing products to providing services is a major trend in business model innovation. Not only software companies provide SaaS instead of selling software licenses, but more and more manufacturers follow this trend. Hilti, an international manufacturer and supplier of professional construction tools, launched what they call “Fleet Management”. The customer is no longer required to own a tool. Instead, Hilti offers its customers access to a range of tools on a contract basis and monthly fee, including additional services, such as repairs.

Today, the shift to PaaS is often hindered by missing means of performance measuring and billing as well as unsuitable pricing models. The Internet of Things offers a range of possibilities to support such PaaS scenarios. Sensors allow for the tracking of a product and the location of its current position. In addition, the usage times of a product can be exactly documented as well as the condition under which a product was used (e.g. the speed at which a car has been driven). Sensors also enable a company to monitor the condition of the product or parts and tools and thus support maintenance and repairs.

Scenario 2: Information Service Providers

If information can be measured and billed, new business opportunities for information service providers will be enabled. Data centres can provide storage and processing capabilities for

Internet of Things-related data. Information service providers can aggregate and process information from different sources, thus providing a higher value of information. However, the value proposition which was only made possible through unique identification and billing in the Internet of Things differs significantly. Most important cost factors are the acquisition and aggregation of information (data) and the purchase and maintenance of needed information systems. A potential application scenario for information service providers is anti-counterfeiting. The problem of anti-counterfeiting is prevalent in the consumer goods market. Brand items, such as apparel and accessories or even worse drugs or spare parts are copied and sold as original products. This results in economic damage and can have severe impacts on the consumer side. The Internet of Things supports this scenario through the association of information to a product instance. The information service is aimed at the verification of the originality of a certain product in order to detect counterfeits. The information service provider has specialized on the verification of spare parts in the machinery and equipment industry as well as the automotive industry. The consumer – the buyer of the spare part or a service partner installing it – can submit a request to the information provider through the Internet of Things. The information service provider could query its information systems where information from different sources is aggregated and find out whether the serial number is valid

Scenario 3: End-user Involvement

The Internet of Things provides a new level of consumer integration into co-creation processes. While "living labs" have been used to integrate limited user groups into product and service development at a certain stage in the product life cycle, the Internet of Things will link all consumers across the life cycle of a product. Companies that will know how to utilize this huge potential will be in the lead for new business models in B2C scenarios. Other services include a payment scheme for product reviews, that is based on positive review ratings. Ciao11 is offering their users a small financial benefit as low as 0.5 pence every time their product rating is positively reviewed. In any case a high level of security and privacy as well as the freedom of choice to participate are mandatory. Through the use of a mobile phone, the end-user is enabled to supply and retrieve product related information at the point of sale – in this scenario a large supermarket chain. Both actions are supported by the use of RFID-chips or barcodes.

Scenario 4: Right-time Business Analysis and Decision making

In production engineering, real-time usually refers to M2M-systems that record events and responds within milliseconds. In logistics, the time frame is not as well-defined, yet seconds, minutes, or even hours are sometimes still considered real-time, compared to longer traditional processes, such as transportation that causes information gaps of days or weeks.

Real-time is often used as a qualitative rather than a quantitative value to differentiate timely from out-of-date information distribution thus allowing acting instead of reacting. Therefore, it is more appropriate to use right-time business analysis and decision making. The amount of time between a business event and a decision is influenced by time periods, including data capturing latency, analysis latency, and decision latency. For perishable goods manual spot tests and visual inspections are common, but these cannot provide real-time monitoring or proactive strategies.

The Internet of Things provides real-time access and analysis opportunities across supply-chains or product lifecycles. Data analysis can be provided in proximity to things (smart objects), at the business premises or anywhere in the Internet of Things. Agile management strategies are enabled based on real-time availability and analysis of data. The envisioned scenario is based on an intelligent truck that combines different technologies and applications to increase the value of information and to a boost utilization of the Internet of Things infrastructure. Some easy tasks, such as navigation and dynamic routing, can be achieved without the Internet of Things, more complex tasks, such as tracking and condition monitoring, would largely benefit from it.