

The Role of the Internet of Things in Innovative Business Models

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Abstract— The Internet of Things technology has already proven its worth for businesses. However, a lot of IoT projects are failed and most of solutions which were successfully implemented still don't uncover the full potential of the IoT. The paper describes why the business models of the organizations should change following the introduction of their IoT strategy. Moreover, in this paper each component of the proven IoT solution architecture is presented and examined in detail. The paper is intended to support the transition of organizations to the new innovative business models which will be able to fully leverage the Internet of Things technologies.

Keywords— Internet of Things (IoT), Cloud Platform, innovative business models, smart ERP

I. INTRODUCTION

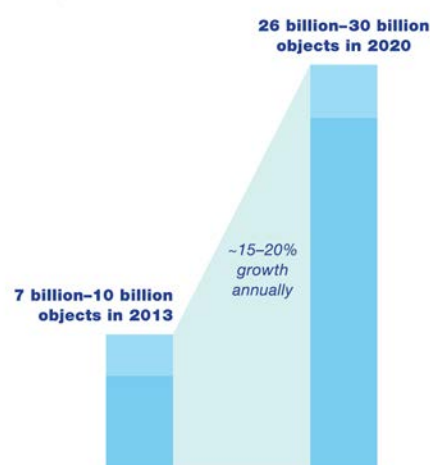
The Internet of Things (IoT) drives businesses forward by generating brand new income streams, optimizing resources and completely transforming the customers' experience. [1] However, not every organization fully recognize the complexity that IoT brings. Today most of enterprises are trying to incorporate IoT solutions without changing their business models or reorganizing their business processes. This approach is applicable, but it doesn't uncover the full potential of the IoT. Therefore, to really succeed in this rapidly changing world of innovations organizations should start with transforming their business to be more innovative. [2]

II. IOT AS A MAIN DRIVER FOR TRANSFORMATION OF ORGANIZATIONS' BUSINESS MODELS

Today there are about 10 billion devices that are already connected to the Internet all over the world. Specialists of the largest research company Gartner predict that by 2020 it will reach the number of 30 billion objects, and half of the large business processes will be integrated with the elements of IoT. [3, 4]

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Some 30 billion objects may be connected to the Internet of Things¹ by 2020.



¹A networking of physical objects via embedded devices that collect and/or transmit information.
Source: Forecasts derived from ABI Research; expert interviews; Gartner; IDC; McKinsey analysis

Figure 1 Dynamic of growth of objects connected to the Internet worldwide

It is obvious that such a market could generate a huge revenue for enterprises. Therefore, many of them have been pondering over the possibility of implementing an IoT solution or have already implemented one. However, the real problem is that companies are now trying to embark on Internet of Things initiatives using very narrow, point-focused solutions with very little enterprise IoT strategy in place, and in some cases, engaging or building unproven solution architectures. [5] As a result, the majority of IoT projects have status 'failed'.

Nevertheless, enterprises will continue to implement IoT projects and solutions, simply because they will be forced to do so by the market itself. There is no doubt that those companies which would be able to deliver optimal performance with the help of complex analytics of IoT data will have the competitive advantage. [6] For instance, let's discover one of the most basic examples: company specializing in discrete manufacturing. In not so distant future those manufacturing companies that are able to identify

problems in the operation of their equipment and conduct its maintenance before (!) it has broken down have the advantage over their competitors. With successful implementation of such a solution, the business takes a big step forward: fewer resources are spent for repairing and maintenance, production processes are optimized, customer loyalty is growing.

In the figures below a very simple business process is illustrated in the states before and after the implementation of the IoT solution.

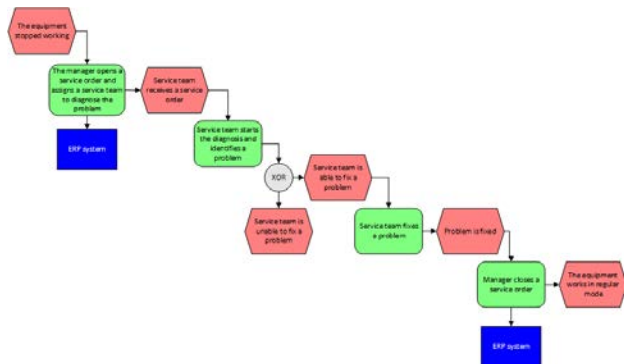


Figure 2 Business process before implementation of an IoT solution

As it shown in the figure 2 the process starts only after the equipment has already broken down and service team doesn't know what is wrong with it. Based on their expertise they may know what could be the issue but they still should check everything manually to clearly understand the problem. And it is rather time and resource-consuming process.

In the figure 3 it is shown how the process is transformed with the introduction of the basic IoT solution.

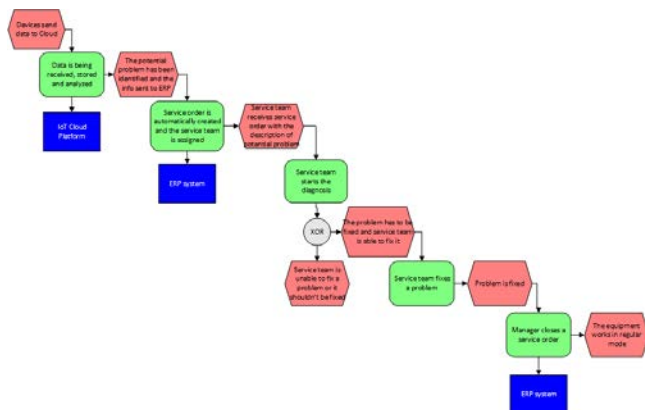


Figure 3 Business process after implementation of an IoT solution

The new process starts with sensors monitoring the state of some equipment and sending data to some IoT Cloud Platform. With the help of predictive analysis, Cloud Platform identifies some patterns that could signalize about potential

failure of equipment. In case the problem has been identified, the information about that is automatically transferred to the ERP system. In the ERP system, the service order is automatically created and the least busy team is assigned to this order. Moreover, the service team is automatically notified about the possible problem and which element of equipment should be diagnosed. These activities significantly reduce the time and resources that service teams spend on diagnosis of the problem. Moreover, this solution provides an opportunity to predict problem and fix it before the equipment has stopped working. Therefore, the financial losses incurred by organizations are much less than before introduction of such a solution.

In the new business world, the reactive business models will become outdated and will be replaced by predictive and proactive models. [7] It means that companies would be forced to deal with the new kinds of technological issues, such as: sensor data connectivity and security; IoT data storage and analysis with the help of Big Data technologies; cloud computing (as a trend that allows almost unlimited expansion of computing power) and many other. Moreover, there would be some organizational issues: companies would have to hire or train specialists of relatively new specializations, such as: micro sensors engineers, data scientists, cloud computing specialists and so on. No need to say that the amount of such professionals is quite few. However, these kinds of issues can be fixed relatively easy – just hire a consultancy company which has all the necessary expertise and the work will be done, hopefully. But there is one question which companies should answer by themselves and it is: what new business models should we deploy to gain or to keep a competitive advantage?

III. ARCHITECTURE OF AN IOT SOLUTION

It is impossible to build a successful business model that could leverage full potential of the Internet of Things without the basic understanding of its architecture. Therefore, in this paper will be described the general architecture of the IoT solution and, precisely, the main part of it – a Cloud Platform.

Basically, the IoT Cloud Platform has three or four main blocks:

- Things
- IoT Gateway
- Cloud Platform

In a complex and advanced IoT solution there is also one more block: on-premise or cloud information system, such as ERP, CRM or other.

Overall architecture of an IoT solution is presented in a figure 4.

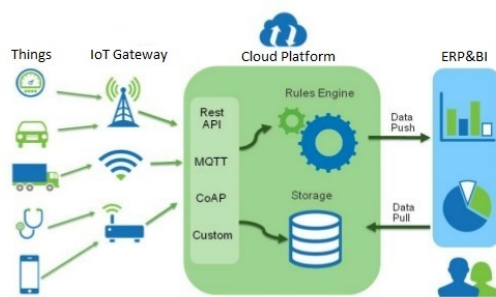


Figure 4 The architecture of a IoT solution

In the following section, each of the elements of this architecture will be superficially described.

Every IoT solution is worthless without IoT sensors or as we call them Things reading data from the object they are installed on. In advanced scenarios, these Things are connected in network which is very agile, flexible and co-operating. In the figure 5 the main categories of IoT sensors are presented.

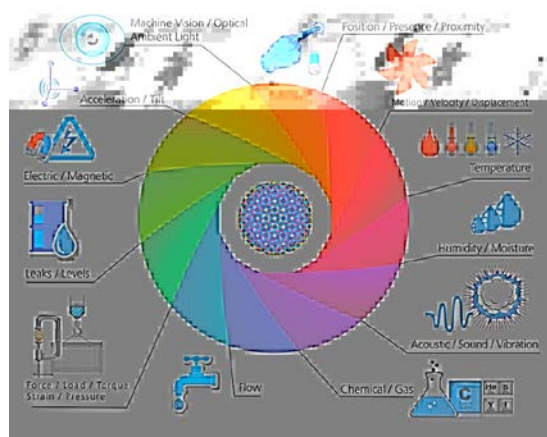


Figure 5 The categories of IoT sensors

Every sensor should be connected to an IoT gateway to transmit the real-time data further. Sensors and gateways could be connected to each other via simple wires, or in a wireless way. Wireless communication is organized through special IoT protocols such as LPWAN and LoRA (for long distance communication) or Bluetooth Low Energy and ZigBee (for short distance communication). For wireless communication over one of these protocols, both sensor and gateway should support it.

IoT Gateway is a microcontroller such as Raspberry PI, Arduino UNO or NodeMCU 12E, but with built-in transmitting unit (for instance, Wi-Fi module). Microcontrollers have to be programmed in a development environment such as Arduino IDE or other in order to correctly read data from devices and to transfer this data to Cloud Platform in a certain period of time (every minute, every 5 seconds and so on). There are several established communication protocols between IoT Gateway and Cloud Platform, such as: Rest API (HTTPS), MQTT, CoAP or even custom ones. "The best" protocol doesn't exist, each of them

has its own benefits and its own drawbacks and it's a job of IoT engineers, developers or architects to decide which one of them suits their needs more than others.

Generally, Cloud Platform is a PaaS which has a set of different services (in some cases over 50) which solve different kind of business tasks, and IoT service is just one of them. This service should support different kinds of IoT protocols to be able to communicate with IoT Gateways and should be based on a powerful database which is able to process and store huge amounts of data. Basically, what IoT service should do is to receive data from IoT Gateway, store it in a database and generate web-service so that IoT applications could consume this data. More often or not, these IoT application are developed with the help of the UX and UI services provided by Cloud Platform. Such services have its own APIs, plugins and templates that can significantly simplify the work of applications developer. Moreover, such application could be enriched with the data from non-IoT sources, such as: on-premise or cloud information systems, web-services, APIs and so on. Another very important part of Cloud Platform is services based on Big Data technologies. These kinds of services allow solving the tasks of processing high volumes of data and building powerful predictive and analytical models using the capacities of a high-performance database.

IV. THE ROLE OF CLOUD PLATFORM IN IOT SOLUTION

Technically, IoT solution could be implemented and function successfully without cloud technologies. However, there are some significant advantages of using cloud.

A. Infrastructure

Instead of buying expensive hardware for the purposes of storing, processing and analyzing IoT data it's cheaper to rent computing units from a cloud services provider. Besides, this approach empowers innovation: today not only big companies can develop ready-for-market IoT solutions, but also individual developers. Therefore, a lot of experts expect a huge growth of IoT applications worldwide.

B. Integration

IoT is not only about sensors and devices communicating with each other, but also various services. By leveraging powerful APIs developers can build IoT applications that can consume data from dozens or even hundreds of data sources. Of course, it's possible without cloud, but it requires much more time and resources expenses.

C. Services

Most of the IoT Cloud Platforms have built-in services that are useful for aggregation and consolidating data from IoT devices as well as for drawing valuable insights from it. [8] This could be done with the help of Predictive Services, Machine Learning and so on.

D. Scalability

While using cloud technologies organizations can either increase or decrease computing resources which they are using

if they find it necessary. It means that businesses don't need to predict how much of the resources they would require in next several years or mistakenly buy expensive hardware which they will never use. For IoT Cloud Platform scalability is one of the most important factors. Generally, companies start small and slow with their solutions, connecting to the Internet only few Things, therefore, they don't need a lot of computing units. However, when technology starts to prove itself organizations tend to expand fast connecting more and more Things and incorporating the data received from them with their business processes, therefore, the number of computing units rapidly increase. Without scalability of cloud this would be a difficult issue.

E. Security

Today the main issue for organizations concerning cloud technologies is security. Some of them just don't want or are not allowed to keep their data on a server shared by a number of users. There are several solutions (private cloud, hybrid cloud, governmental cloud and so on) which can solve this kind of concerns. However, if we look at the issue of security from different perspective, we will find out that cloud technologies even solve some kinds of this concerns. For instance, the devices that are connected in a network can be simultaneously updated or switched off via cloud in case of detecting malware or other threat. [9]

V. THE ROLE OF ERP SYSTEM IN IoT SOLUTION

Without the coalescent technical capability provided by ERP systems, useful data can be easily lost [10]. Therefore, organizations can use the best from ERP and IoT to create more efficient business processes or even new business models. For instance, some time ago Italian company Pirelli has just been selling tires to customers. However, with the emergence of IoT the enterprise has transformed its business model. Nowadays company produces tires with sensors and sells them to their customers, but not just it. Pirelli collects data from every tire and use it to help the customers optimize fuel consumption of their vehicle and maximize the lifetime of each tire. Therefore, today Pirelli has become a service provider.

According to Mark Raben, head of customer innovation at SAP Netherlands, the ERP system is essential for connecting unstructured data from devices with structured data in the business. [11] Moreover, experts predict that in not so distant future ERP systems will be seamlessly interconnected across devices, things and people. [12]

According to Research and Markets the market of IoT-enabled enterprise resource planning is expected to reach \$49.9 billion by 2022. [13]

However, there are some concerns regarding ERP and IoT collaboration:

- ERP system should be able to process huge volume of additional data with high velocity. That means that it should use a powerful database as a backend which could provide the functionality to manage, analyze and display all the data in real time.

- Integration of ERP system and IoT platform is also very important moment. There simply should be no delays in data transfer, because for some processes lag even in several seconds could be crucial.
- Security of communication. The information should be transferred from one system to another via specially opened tunnels and should be highly protected.

Many modern information systems are focused on collecting and processing information from many diverse sources as well as servicing requests for this information from various categories of users. [14, 15] However, traditional ERP systems are now reaching their limits and most likely will not be able to respond for the upcoming challenges and demands from the market. To leverage all market opportunities enterprises need new type of ERP system, smart ERP. This kind of system should be immediate, intelligent and integrated to be able to connect all of the processes of the company and provide its' employees with live information and insights. Moreover, it should be available as software services from the cloud to leverage all benefits of the public cloud.

VI. RESULTS AND DISCUSSIONS

This paper intends to explain why it is necessary to change the business models of the company before introducing the IoT solution, what is the most common architecture of such a solution and what role each of its components has.

The potential of the Internet of Things is hard to overestimate. Most likely, in the next several years there will be hundreds of business models incorporating IoT technologies implemented by businesses of different scale. Some of them will turn out to be successful, some of them not, but there is no doubt that organizations will still be willing to implement IoT solutions and change their business models likewise, even after several unfortunate attempts. The reason for this is quite simple: to gain or not to lose the competitive advantage. In the rapidly changing business world enterprises simply cannot afford not to be innovative, because if they stop their progress there will always be the competitor that will understand the complexity of the future market better and will be more prepared for the new challenges.

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