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The Azure platform in measuring - control systems based on Internet of Things concept

Abstract

In the paper, selected issues referring to the usage of Azure platform to build measuring - control systems using Internet of Things concept (IoT) are presented. The most important problems to overcome during the implementation of this type of tasks concerning the functioning of the existing implementations of the Internet and their solutions through the use of some functionality of the Azure platform are discussed.

Keywords: Internet of Things, Cloud Computing, Control – Measurement Systems.

1. Introduction

The evolution of the Internet in direction of the Internet of Things concept, opens up new possibilities for the deployment and operation of measuring – control systems. Their implementation requires a different approach, both at the stage of their design and deployment and maintenance of system infrastructure. One of the new elements of this infrastructure is the Big Data component with cloud computing. In IoT concept, measuring and control data are transmitted from the sensor layer to the Big Data layer where they are stored, processed or additionally analyzed. Usually the results of analysis performed on the Big Data layer can be sent back to the measuring - control system, to enhance their functionalities. Analytic data can also be used by other entities or systems concerning device or systems designers, factories that produce devices or even maintenance services.

The concept of the Internet of Things assumes that each active device connected to the network is uniquely identifiable. The device may but does not have to process large amount of data. The data are collected by the Big Data layer so devices do not have to be equipped with extensive functionality. It may even be a simple light bulb, but with the possibility of remote control via the Internet connection. Of course, large, complex measuring - control systems can also operate in the structure of the Internet of Things. In the form of cloud computing you can hide all kinds of network servers that provide a variety of services. IoT systems can collect data in database servers, run entire operating systems on virtual servers and process data stored in databases by dedicated systems prepared for processing and analyzing large amounts of data so called Big Data. It is also possible to implement artificial intelligence methods for processing the collected data and acquire useful knowledge [3, 6].

One of the assumptions that differentiates IoT system solutions from the classic network solutions is a huge amount of data being processed. Systems for data processing in network structures based on IoT concept must be prepared for the data processing of peta byte sizes (10^{15}). There are systems, as social networking (Facebook, Twitter), that generate such large amounts of data that are processed in suitably prepared cloud computing.

Another important aspect of the functioning of the Internet of Things is the secure data transmission. This is one of the fundamental requirements for the integration of devices with the Internet of Things. Devices cooperating with the system have to be prepared to communicate with it in a secure manner using the newest standards, such as SSL/TLS, for secure communication. Data transmission over the Internet must be encrypted to prevent breaking the security and interception or unauthorized access to the system. Data integrity and user authentication must be also implemented [4].

2. Measuring – control systems in Internet of Things

Currently used measuring - control systems are not always fully prepared for the integration with systems based on the IoT concept. There are some important technological constraints (eg.: protocols, data formats, communication models, security) that make it difficult or even impossible for the integration of multiple devices or systems with systems based on IoT technology.

2.1. Limitations of the classical network installations

One of the basic assumptions concerning the functioning of the Internet of Things is clear traceability of devices on the network. It is estimated that in the 2020 there will be about 20 to 30 billion devices attached to the Internet [1]. The currently used systems still use version 4 of the IP Protocol but its address capacity is not prepared to handle such a large number of devices, and it often happens that there is no free public addresses in the pool. The problem of logical addressing will be resolved after the introduction of the version 6 Internet Protocol.

One of the ways to increase the pool of available logical addresses is the use of private addressing techniques for local networks, which requires NAT (Network Address Translation) on a boarder router. Unfortunately, it has its major limitations, because the devices connected in this way to the Internet cannot be it visible to other devices. They can only refer to other addresses using the service NAT - Fig 1.

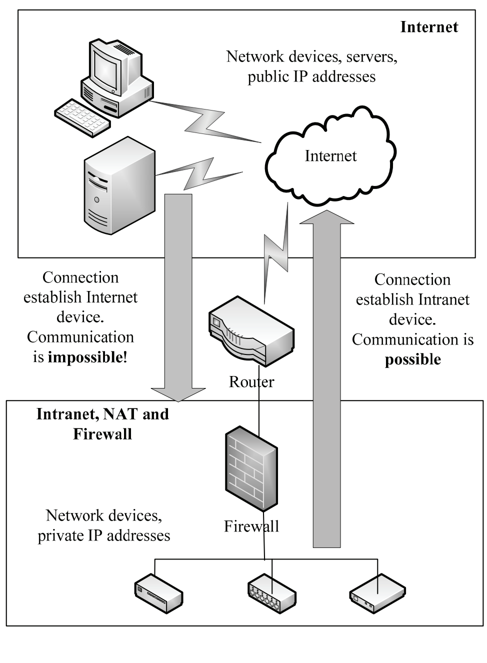

Fig. 1. Limitations of the communication in networks with NAT and Firewall

To increase the level of security of computers and applications on the network, services such as FireWall are implemented which is another limitation in introducing IoT.

2.2. Cloud computing platform

Because there is often no possibility of direct communication with the device or system attached to the network due to the use of private addressing and NAT, it is not possible to provide the local resources to the public Internet. A device with a network interface can serve as a typical server hosting services to external systems because it is not available on the Web. So far, the often used solution has been to use VPN techniques to run secure network connection. However, this solution also requires the use of public IP addressing. To solve this problem, a service provision cloud computing platform that is able to establish a network connection to any network, even behind the NAT and FireWall can be applied.

3. Azure platform

There are several platforms which provide design and start-up tools to develop applications running in the cloud such as Amazon EC2, Google Cloud Platform, HP Cloud System, IBM Smart Cloud and Microsoft Azure. The Microsoft Azure platform is an example of a system sharing comprehensively the developed set of services which run in the cloud, and can be used, among others, to the integration of devices ready for IoT and many other tasks.

It is possible to rent commercial services offered data collecting in the virtual network drives, processing of data in databases, running virtual operating systems, running brokerage services, launching websites, Big Data and others [5]. Thanks to this, IoT technology deployment becomes easier.

3.1. Brokerage and Service Bus functionality

The Azure platform service, which can be used to build measuring - control systems in the concept of the Internet of Things is a Service Bus functionality. It is a brokerage service that offers secure communication, which can be used by systems running according to the IoT concept. In this way, it is possible to overcome the NAT services, Firewall and private IP addressing constraints. To connect a device or system to cloud services, bidirectional outgoing TCP SSL / TLS or HTTPS connection should be established - Fig. 2.

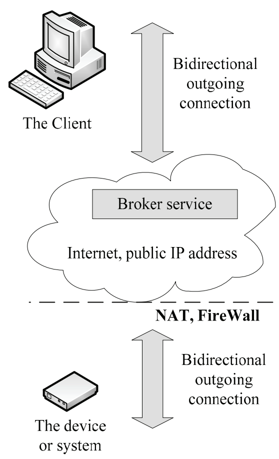

Fig. 2. Broker service operation

Similarly, other client systems can connect to the same services available on the Azure system. In this case, Azure services act as the server and publicly share its functionality through SOAP and REST interfaces.

3.2. Message queue service

One of the simplest programming mechanisms available in the Service Bus is a message queue. This allows building applications that work in a popular Producer – Consumer system model. One side (Producer) sends messages to the queue information - Fig 3.

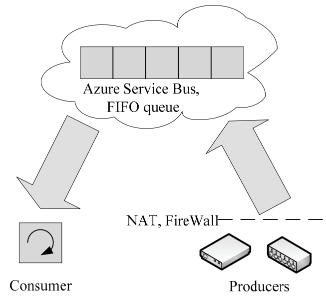

Fig. 3. Message queue

On the other side, Consumer receives messages from the queue and starts the obtained data processing. There might be many Producers but Consumer can be only one. Producer sends the data to the queue and does not have to deal with checking their status, whether they are processed etc. The messages are stored in a queue, which has a number of parameters, such as a name, connection string, a list of authorized users, capacity and storage time. The adequate level of data confidentiality through the mechanisms of authentication and encryption is provided. The Azure Queue service can be handled in parallel by multiple servers, which makes it easier to scale services in case of system expansion. Despite its simplicity, the queue mechanism can be very useful to run a secure and reliable communication between measuring - control systems and the Cloud.

3.3. Topics services

Another functionality which has more possibilities than the Queue service is Topics. In this case, the recipients of the data (Consumer) can run multiple client programs - Fig. 4.

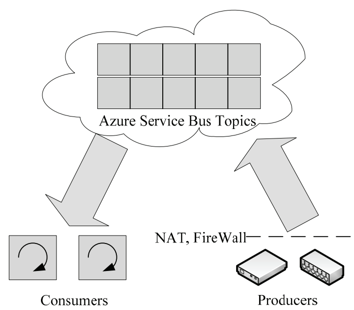

Fig. 4. Topics service operation

Consumers can subscribe selected messages from the declared topics. This solution makes it easy to build a system with a large number of Producers and Consumers. This feature of the Topics services can be very useful for the IoT concept. Processing large amounts of collected data can be organized in a distributed manner by multiple programs or subsystems using the platform services.

3.4. Azure in a private Cloud

For many companies, potentially interested in the Azure functionality, it may be difficult to accept the use of servers, over which they have no direct control. Sensitive data, source code programs are installed and stored offsite. Service providers ensure the appropriate level of security, but there is always an increased risk of access to resources by unauthorized persons.

It is possible to use some local functionality of the Azure platform after installing the Azure Pack module, which is distributed free of charge. Selected services, including Queues and Topics services are supported. The package can be installed on

Microsoft Windows Server servers on the local network in your location entirely under his own supervision. It is possible to build a measuring - control system using the possibilities of modern embedded controllers, such as Raspberry PI 3 [7], which can act as an IoT Hub. It is possible to use different operating systems for these types of modules, such as Windows 10, Linux and others. In the case of building the IoT Hub based on Windows 10, a number of popular development tools like Visual Studio family and a rich library of knowledge and ready-made solutions MSDN [8] are available to the designer. Raspberry modules are equipped with a set of communication interfaces to facilitate attaching the device to a wired or wireless network – Fig. 5.

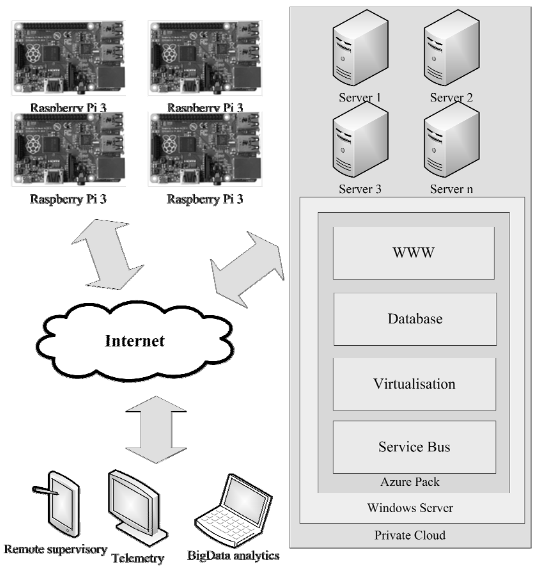

Fig. 5. MS Azure private cloud use

The Azure platform in the Private Cloud version enables building a scalable system that allows running the most important services for the functioning of measuring - control systems in the concept of the Internet of Things. To run private cloud system, it is necessary to run at least one server running under Windows Server. Individual services can be distributed among the other servers.

The built private cloud system allows attaching devices operating on the Internet and Intranet service through Service Bus Queues and Topics. Data gathered from the devices can be stored in SQL Server or MySQL databases. Data presentation layer may be prepared in the form of dynamic web pages ASP.NET or PHP services provided through Internet Information Services (IIS). The frontend and backend application solutions can run on a virtualized Windows system running on one of the servers in the cloud. The software building process can also be carried out on a virtualized environment. In this case, the designer gets access to a remote virtual Windows desktop, where the required software can be installed for developing software solutions like Visual Studio. Such an approach to the system solution may lead to significant cost savings because there is no need to invest in expensive hardware and software. It is possible to rent them. This possibility can be very valuable for companies just starting their business, where there is a considerable risk of failure of the project and the loss of funds invested in hardware and software needed to implement the new generation of the measuring – control system based on IoT concept.

If the system needs to be extended with new services because of the attachment of new devices or systems, it is possible to attach new servers to a private cloud which will handle the appropriate services.

4. Summary

Service Bus functionality offered in the Azure platform can greatly facilitate the building of measuring - control systems in the concept of the Internet of Things. The designer receives ready to use set of tools to help create software applications which provide an adequate level of security and scalability. Services are available for many platforms and programming languages in the form of software SDK packages with documentation and many examples. On the web, there are portals, where many designers exchange their experiences with the use of services in the cloud, allowing one to quickly get information on many issues associated with the deployment and commissioning of solutions based on cloud computing. The presented concept of the IoT based on the Azure platform deployment in measuring – control systems has general purpose features and can be used for other cloud computing platforms.

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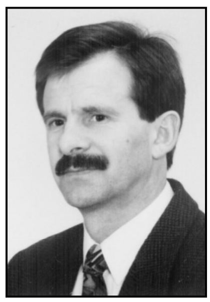

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