IoT in Electric Power Industry

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SUMMARY

The Internet of Things (IoT) is a term for networks of various equipment (things) for collecting, receiving and sending data through existing internet. Although the term IoT was 'invented' more than fifteen years ago it has seen its wide use in the last few years, thanks to great development in the field of sensory devices and big improvements in energy efficiency of electronics and wireless communication devices.

This has led to development of wide range of cost-efficient devices for the use in all aspects of our modern lives, such as environmental monitoring, infrastructure management, industry, medicine and health, building and home automation, transport, etc.

There are many opportunities for IoT in the electric power industry. Grid owners and operators are dealing with a large number of equipment and objects. The uninterrupted operation of these grids and quality of energy delivery depends upon the state of this equipment and objects. With new efficient wireless technologies, e.g. LoRa (Long range, low power radio), the data of the state of these devices can be monitored over a long range and in great numbers. The devices for monitoring the state and control of the power grid equipment can be battery powered due to their very low energy consumption. This allows for their installations in places where it was not possible before.

We give an overview of existing and available technologies and give an insight into future development in the field of IoT and new possibilities the IoT can offer to the electric power industry

KEYWORDS

Internet of Things, Electric power industry, Wireless, LoRa, Monitoring, Efficiency, Low power

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1 INTRODUCTION

The Internet of Things (IoT) is a term for networks of various equipment (things) for collecting, receiving and sending data through existing internet. Although the term IoT was 'invented' more than fifteen years ago it has seen its wide use in the last few years, thanks to great development in the field of sensory devices and big improvements in energy efficiency of electronics and wireless communication devices.
The main component is a wireless communication link that enables connection of vast number of devices and their interconnection in:

- offices, shopping malls - connection of devices, routers, switches, security devices
- industry– smart factories will provide upgraded connections between humans and machines and connections between machines themselves, without human intervention
- agriculture - observation and acquiring of different data, e.g. temperatures, animal tagging, control data
- smart grids – electric power industries
- energy metering
- control of home devices
- healthcare and wearables
- traffic surveillance and control

The whole chain of connecting devices needs very capable information-communication technologies. The data is acquired and stored in the cloud which needs to be capable of dealing with a completely new dimension of data quantities. For this big data is the enabler of the benefits we expect from IoT, since it gives new value to data through analyses and processing.

2 IOT FRAMEWORK

There are for main building blocks that enable IoT. They are: fog, cloud, big data and business model (Figure 1).

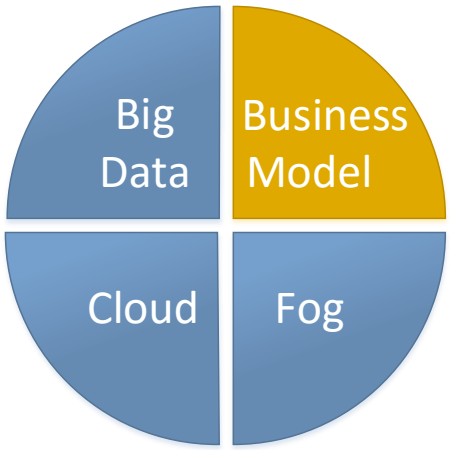

Figure 1: IoT building blocks

The end nodes, sensors, actuators, measurement devices are interconnected in a new environment called the fog. The fog extends the cloud closer to end devices (things) that produce and act on IoT data. This minimizes data latency, offloads gigabytes of network traffic from the core network and keeps sensitive data inside the network [1].
In order to facilitate data acquisition and exchange new infrastructure networks will be deployed. They will enable higher efficiency and lower prices. Managing such infrastructures

will be of key importance. Data from devices is transferred to the cloud. In the future it will be organized much more globally than today – data centre borders will be blurred, data storage will be more spread out. Due to massive amounts of data and needs to manage the data there will be increased need for understanding and analysis of data in the shape of reports, data mining, machine learning and data interpretation.
The biggest challenge lies in identification of appropriate business models that will enable economics of the IoT world. This will be achieved using applications that satisfy different needs, facilitate easier and more accurate decision making or optimization of people behaviour and processes. Business models – benefits and justifications of activities in the IoT world will play a key role in IoT's actual reach.

3 ARCHITECTURE AND ELEMENTS OF IOT NETWORKS

IoT networks consist of end nodes (devices), concentrators, backhaul links, network servers and application servers. Figure 2 shows an example of IoT network using LoRa as a communication medium. LoRa stands for Low power – Long Range radio. LoraWAN is a Low Power Wide Area Netwok (LPWAN) specification intended for wireless battery operated things in regional, national or global network. [2]
The end nodes acquire and transmit state of monitored devices or things. This state is in the form of utility meter readings, geographical position, contact state, transaction data, etc. The state is wirelessly communicated to network servers via concentrators/gateways. Network servers take care of collecting the data and transmitting it to application servers where information from this data is then extracted.

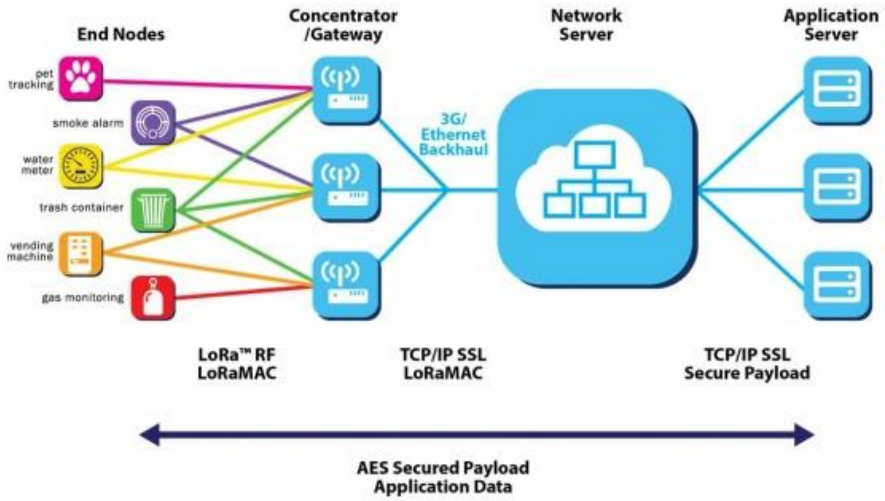

Figure 2: LoRa IoT (Source: SemTech,[3])

The main difference of Internet of Things from classical internet is that acquired automatically, without human intervention. Things also communicate with each other, automatically.

4 USE CASE

One of possible uses of IoT technologies in electric power industry is in substation equipment monitoring. Due to battery powered device and wireless communication there is no need to install additional wires in the substation. The devices can be installed in new equipment or retrofitted to existing high voltage equipment.

Possible uses of the devices are in periodic measurement of different state of equipment parameters, e.g. transformer temperatures, oil humidity levels, gas levels, pressures, etc. The change of state or events can be detected. Data is transmitted as soon as it is acquired.

Figure 3: High voltage substation equipment

A list of possible uses of wireless devices for monitoring equipment in high voltage substation is presented in Table 1.

Table 1: Possibilities of quipment monitoring in high voltage substations using wireless devices

Monitored Parameter	Monitored Euqipment					
	Transformer	Circuit Breaker	Surge Arrester	Cable	Conductor	Instrument Transformer
Temperature	x	x		x	x	x
Pressure	x	x				x
Leakage current			x			
Gas leakage		x				
Partial discharges	x			x		x
No. of operations		x	x			

An example of equipment monitoring in high voltage substations is presented in Figure 4.

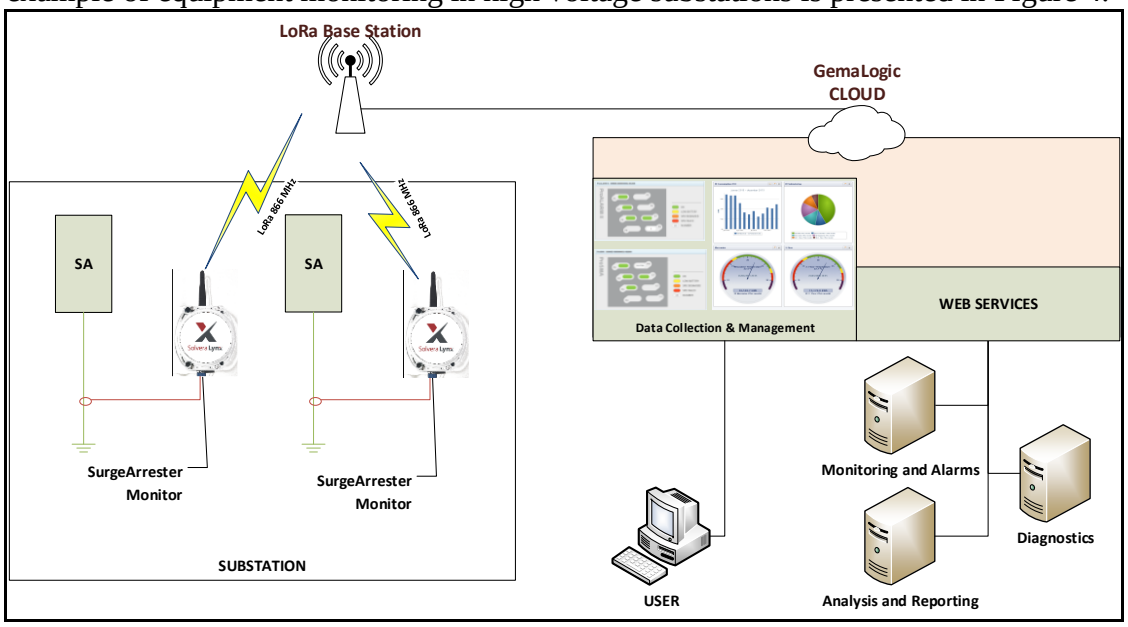

Figure 4: Surge arrester monitoring solution

The end device – surge arrester monitor (SAM) - is a battery powered device. It uses LoRa for communication. It is installed by attaching to surge arrester's ground lead. SAM detects surge

arrester activity, i.e. discharge current and timestamp of the event. After the event is detected, the event data is immediately sent to GemaLogic cloud platform where the event is logged, stored, presented in the web interface and communicated to other information systems using Web Services.

5 CONCLUSION

Connecting multitude of smart devices to the internet and acquiring new data and information in a cost effective and efficient way provides the ground for exciting new applications and insights that were not possible before. It spurs new business models, from which everyone can benefit – the end users, the providers of services, the providers of equipment and networks.
Use of wireless communication protocols and stand-alone battery powered devices for monitoring equipment in high voltage is presented in the paper. The data gathered from monitoring devices can be stored and presented in cloud platform and communicated forward to other information systems.

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