# Brief Introduction To IOT

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***Abstract***

*The IoT is gaining increasing attention. The overall aim is to interconnect the physical with the digital world. Therefore, the physical world is measured by sensors and translated into processible data, and data has to be translated into commands to be executed by actuators. Due to the growing interest in IoT, the number of platforms designed to support IoT has risen considerably. As a result of different approaches, standards, and use cases, there is a wide variety and heterogeneity of IoT platforms. This leads to difficulties in comprehending, selecting, and using appropriate platforms. In this work, we tackle these issues by conducting a detailed analysis of several state-of-the-art IoT platforms in order to foster the understanding of the (i) underlying concepts, (ii) similarities, and (iii) differences between them. We show that the various components of the different platforms can be mapped to an abstract reference architecture, and analyze the effectiveness of this mapping.*

## I. INTRODUCTION

The vision of the Internet of Things (IoT) describes a future where many everyday objects are interconnected through a global network. They collect and share data of themselves and their surroundings to allow widespread monitoring, analyzation, optimization, and control [27]. Until recently this was merely a vision, but in recent years this has slowly developed into a reality. Ever decreasing prices, dimensions, and energy requirements of electronics now allow tiny devices to unobtrusively measure their surroundings. Many devices use low-energy communication technology to send those measurements to other, more powerful components, such as bluetooth gateways, mobile phones, or WiFi hotspots. Devices are increasingly incorporating long-range wireless technologies such as LoRa1 or existing 2G and 3G networks. Local edge processors, hubs, or internet services in turn analyze and process IoT sensor data to create new knowledge, which can be used to act back on the environment through actuators. In short, the IoT can be seen as a giant cyber-physical control loop. In that context, the term "Machine-to-Machine communication" (M2M [9]) is often used to describe such a setting

Different incarnations of IoT systems for varying use cases have been created over the years by companies and research institutions. Smart Homes are one example of such IoT systems In other areas, similar developments are underway, such as Connected Cars Smart Cities Demand Side Management Smart Grids, or Smart Factory systems

While local processing of the data generated by these systems is possible and a reasonable approach for use cases where low latency is required, cloud based platforms are used for processing and analyzing larger data sets [7]. As a result, over one hundred [29] such platforms have been created over the last few years. Some examples include AWS IoT2, FIWARE3, OpenMTC4, and SmartThings5. These platforms come in various shapes and sizes. While standardization efforts are ongoing, there are no generally agreed-on standards for IoT at this time [8]. Rather, development of these platforms has often taken place in silos [38]. These different environments have influenced not only the choice of concepts and technology, but also the choice of terminology. As a result, the platform landscape has become very heterogeneous. At the same time, however, gained through this activity to create automated all these solution do roughly the same things: they allow connecting different devices, accessing and processing their data, and using the knowledge control.

### *Sensor*

A Sensor is a hardware component which captures information on the physical environment by" respond [ing]to a physical stimulus(as heat, light, sound, pressure, magnetism, or a particular motion)"[ For instance ,by measuring the humidity within a room, a Sensor positioned within that room `Sensors transmit the captured information using electrical signals to Devices ,to which they are connected to. This connection can be established(i)by wire or (ii) wirelessly. Wired connection includes an integration of Sensors into a Device.A Sensor maybe configured using software,but cannot run software by itself

***Actuator***

An Actuator is a hardware component which manipulates the physical environment. Actuators receive commands from their connected Device and translate these electrical signals into some kind of physical action or off a ventilation within a room acts on the physical environment by influencing the humidity of the room Actuator

***Device***

A Device is a hardware component which(i)is connected to Sensors and/or Actuators by wire or wirelessly or (ii) even integrates these components. Devices have a processor and storage capacity to run software and to establish a connection to the IoT Integration Middleware. Sensors. Thus, Devices are the entry point of the physical environment to the digital world.A Driver is software running on the Device enabling uniform access to heterogeneous Sensors and Actuators. Devices are either(i)self-contained or(ii)connected to another ,bigger system.The IoT Integration Middleware represents such a system

***Gateway***

In case a Device is not capable of directly connecting to further systems, it is connected to a Gateway .A Gateway provides required technologies and mechanisms to translate between different protocols ,communication technologies ,and payload formats. It forwards communication between Devices and further systems. For instance ,the indoor module of the Net atmo weather station is a Device with integrated Sensors ,acting as a Gateway for the outdoor module of the Netatmo weather station .When the Gateway receives a message in aproprietary binary format from the Device ,it translates the binary format into a more common format, such as JSON, and forwards the data to the intended system over IP ,for example .If necessary ,the Gateway may like wise translate commands sent from systems to Devices into communication technologies ,protocols ,and formats supported by the respective Device

***IoT Integration Middleware***

The IoT Integration Middleware (IoTIM) serve as an integration layer for different kinds of Sensors, Actuators ,Devices ,and Applications .It is responsible for (i) receiving data from the connected Devices,(ii) processing the received data,(iii) providing the received data to connected Applications, and (iv) controlling Devices. An example for processing is to evaluate condition-action rules and sending commands to Actuator s based on this evaluation .A Device can communicate directly with the IoT Integration Middleware if it supports an appropriate communication technology ,such as IP over Ethernet or WiFi ,a corresponding transport protocol, such as HTTP or MQTT ,and a compatible pay load format ,like ,e.g. ,JSON .Otherwise ,the Device communicates over a Gateway with the IoT Integration Middleware

***Application***

The Application component represents software which uses the IoT Integration Middleware (i)t o gain insight into the physical environment and/o r (ii)to manipulate the physical world .It does so by requesting Sensor data or by controlling physical actions using Actuators.For instance,as software system that controls the temperature of a building represents an Application connected to an IoT Integration Middleware.

***Summary***

This section presented the reference architecture consisting of six component types. When implementing the architecture, components can be omitted. This might be the case, if the platform is only used to measure changes of the physical world. For instance, a platform gathering the CO2 level within the air ,may have no Actuators connected, if the system is only used to measure and collect the data .Another example for omitted components are platforms with connected Devices capable of the required technologies to communicate directly with the IoT Integration Middleware, so no Gateway is needed for an appropriate message exchange

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