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Internet of Things in Artificial Intelligence

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ABSTRACT: Gateways provide connections to a Platform in cases that Things cannot communicate directly with the Platform. Service Users as well as Service and Software Providers are connected to the Platform by RESTful APIs. In cases where no complex data processing is required on the Platform, a Service Use can also connect directly to devices, e.g., to gather metering data. Indeed, the IoT environment possesses a large spectrum of challenges has a broad impact on their performance, which can be divided into two categories, namely, i) General challenges: such as communication, heterogeneity, virtualization and security; and ii) Unique challenges: such as wireless sensor network, Radio Frequency Identification, and finally Quality of service that is considered as a common factor between both general and special challenges. This paper gives an overview on the iot research challenges.

KEYWORDS: Internet of Things, research challenges

I. INTRODUCTION

Recently, IoT has emerged as a new technology that is used to express a modern wireless telecommunication network, and it can be defined as an intelligent and interoperability node interconnected in a dynamic global infrastructure network, also it seeks to implement the connectivity concept of anything from anywhere at anytime.

2. describe seven functional components between a device and an application layer as part of an IoT reference architecture. The components are the Management, Service Organization, IoT Process Management, Virtual Entity, IoT Service, Security, and Communication. The Communication component can be mapped onto the Gateway of the presented IoT reference architecture in this work, while the remaining components build the IoT Integration Middleware, respectively. In contrast to our work, the Sensor, Actuator, Device, and Application components are not specifically defined.

3. introduces an IoT reference architecture comprising of five layers. The device layer encompasses Devices, Sensors, and Actuators, but does not detail the latter two in particular. The relevant transports layer abstracts the same concept as our Gateway. The aggregation/bus layer as well as the event processing and analytics layer correspond with our IoT Integration Middleware. Thus, they provide the core functionality of an IoT platform. Finally, further Applications as presented in this work are subsumed by Fremantle as client and external communications. Since this IoT reference architecture lacks unambiguous definitions of all components it does not pursue our goal to provide a clear terminology to understand commonalities and differences of diverse IoT platforms, it is less effective than our reference architecture. Cisco introduces a seven-layered IoT reference model. The Devices, Sensors, and Actuators as presented in this work are comprised in the Physical Devices and Controllers of Cisco's reference model, while the Gateway layer equals their Connectivity concept. The Edge Computing, Data Accumulation, and Data Abstraction layer corresponds to the IoT Integration Middleware of our IoT reference architecture, whereas the Application layer corresponds roughly to the combination of the components IoT Integration Middleware and Application. Finally, the capability to connect arbitrary Applications to the IoT Integration Middleware is reflected by the concepts Collaboration and Processes by Cisco. Since the concepts introduced by Cisco are not unambiguously defined in their reference model, the concepts presented in this work can be used to exactly determine the meaning of Cisco's concepts by mapping the reference model by Cisco onto our IoT reference architecture.

The three-layer architecture by [3] contains similar concepts as those outlined in our reference architecture and is also basis for the works by [5]. Gathering data from and acting on the physical world is described by the abstract concept of a Perception Layer and corresponds with the combination of our Sensors, Actuators, and Devices. Pre-processing of gathered data and transmission to an integrating middleware is covered by the Network Layer, which corresponds to the interplay of Device and Gateway in our IoT reference architecture. The Application Layer is also a more coarse-grained concept and reflects the core functionality of the platform. Thus, it maps onto our IoT Integration Middleware and Applications. Further approaches by [4] are similar layered architectures and grasp the field of IoT from a service-oriented architecture perspective. While they focus on the design of IoT architectures, they lack a clear and unambiguous definition of the concepts, which they introduce and rely on. Neither of these works map their introduced concepts onto existing technologies and platforms, which is one contribution of our work.

[5] investigated diverse IoT applications and abstracted a generic platform model from them. They introduce the concept of Things, which are closely related to Devices as presented in this work. All components of this model are covered of our reference architecture, besides the user. The IoT Reference Model discussed by [3] is based upon the IoT Domain Model by [6]. The concepts Augmented Entity, User, Device, Resource, and Service are introduced. A definition of these concepts is given but it is not abstract and unambiguous enough for mapping different IoT platforms upon each other to foster their understanding. For instance, on the one hand, a device is described as a hardware component, which integrates sensors and/or actuators and is, therefore, responsible for monitoring and interacting with real-world objects. On the other hand, a device is also capable of connecting to further IT systems. This example shows that the concept of a device is only roughly defined, thus, it is unclear if the device may also takes on the role of a gateway or if such an indirection is not foreseen, which implies that devices always communicate directly with the platform. [6] review 39 existing IoT platforms according to six criteria including for instance data ownership or developer support. Concerning the architecture, they distinguish between cloud-based and local IoT platforms, but they do not provide a detailed analysis of the architectures as we do.

II. RESEARCH CHALLENGES

For all the above potential applications of IoT, there has to be proper feasibility into the different domains to ascertain the success of some applications and their functionality. As with any other form of technology or innovation, IoT has its challenges and implications that must be sorted out to enable mass adoption. Even though the current IoT enabling technologies have greatly improved in the recent years, there are still numerous problems that require attention, hence paving the way for new dimensions of research to be carried out. Since the IoT concept ensues from heterogeneous technologies that are used in sensing, collecting, action, processing, inferring, transmitting, notifying, managing, and storing of data, a lot of research challenges are bound to arise. These research challenges that require attention have consequently spanned different research areas.

A. Privacy and Security

Owing to the fact that IoT has become a vital element as regards the future of the internet with its increased usage, it necessitates a need to adequately address security and trust functions. Researchers are aware of the weaknesses which presently exist in many IoT devices. Furthermore, the foundation of IoT is laid on the existing wireless sensor networks, IoT thus architecturally inherits the same privacy and security issues WSN possesses. Various attacks and weaknesses on IoT systems prove that there is indeed a need for wide ranging security designs which will protect data and systems from end to end. Many attacks generally exploit weaknesses in specific devices thereby gaining access into their systems and consequently making secure devices vulnerable. This security gap further motivates comprehensive security solutions that consist of research that is efficient in applied cryptography for data and system security, non-cryptographic security techniques as well as frameworks that assist developers to come up with safe systems on devices that are heterogeneous.

There is a need for more research to be conducted on cryptographic security services that have the capability to operate on resource constrained IoT devices. This would enable different skilled users to securely use and deploy IoT systems regardless of the inadequate user interfaces that are available with almost all IoT devices. In addition to the protection and security aspects of the IoT, additional areas like confidentiality in communication, trustworthiness, and authenticity of communication parties, and message integrity, and supplementary safety requirements should also be incorporated. These may include features like being able to prevent communication of various parties. As an example, in business transactions, smart objects must be prevented from facilitating competitors' access to confidential information in the devices and thus using this information maliciously.

B. Processing, Analysis and Management of Data

The procedure for processing, analysis and data management is tremendously challenging because of the heterogeneous nature of IoT, and the large scale of data collected, particularly in this era of Big Data. Currently, most systems utilize centralized systems in offloading data and carrying out computationally intensive tasks on an international cloud platform. Nevertheless, there is a constant concern about conventional cloud architectures not being effective in terms of transferring the massive volumes of data that are produced and consumed by IoT enabled devices and to be able further support the accompanying computational load and simultaneously meet timing constraints. Most systems are therefore relying on current solutions such as mobile cloud computing and fog computing which are both based on edge processing, to mitigate this challenge.

Another research direction as regards data management is applying Information Centric Networking in the IoT. Since these information centric systems offer support in the efficient content retrieval and access to services, they appear to be quite valuable not just in accessing but also transferring as well as managing generated content and its transmission. This solution, however, brings about various challenges such as; how to extend the ICN paradigm competently over the fixed network edge, how to take in IoTs static and mobile devices as well as how to apportion the functionality of ICN on resource constrained devices.

Data analysis and its context not only plays a crucial role in the success of IoT, it also poses major challenges. Once data has been collected it has to be used intelligently in order to achieve smart IoT functions. Accordingly, the development of machine learning methods and artificial intelligence algorithms, resultant from neural works, genetic algorithms, evolutionary algorithms, and many other artificial intelligence systems are essential in achieving automated decision making.

C. Monitoring and Sensing

Even if technologies concerned with monitoring and sensing have made tremendous progress, they are constantly evolving particularly focusing on the energy efficiency and form aspect. Sensors and tags are normally expected to be active constantly in order to obtain instantaneous data, this aspect makes it essential for energy efficiency especially in lifetime extension. Simultaneously, new advances in nanotechnology/biotechnology and miniaturization have allowed the development of actuators and sensors at the Nano- scale.

D. M2M Communication and Communication Protocols

While there are already existing IoT oriented communication protocols like Constrained Application Protocol and Message Queuing Telemetry Transport, there is still no standard for an open IoT. Although all objects require connectivity, it is not necessary for every object to be made internet capable since they only need to have a certain capability to place their data on a particular gateway. Additionally, there are a lot of options in terms of suitable wireless technologies such as LoRa, IEEE 802.15.4, and Bluetooth even though it is not clear whether these available wireless technologies have the needed capacity to continue covering the extensive range of IoT connectivity henceforth.

E. Blockchain of Things: Fusion of Blockchainand Internet of Things

Similar to IoT, blockchain technologies have also gained tremendous popularity since its introduction in 2018. Even though blockchain was first implemented as an underlying technology of Bitcoin cryptocurrency, it is now being used in multifaceted nonmonetary applications. Miraz argues that both IoT and Blockchain can strengthen each other, in a reciprocal manner, by eliminating their respective inherent architectural limitations. The underlying technology of IoT is WSN. Therefore, analogous to WSN, IoT also suffers from security and privacy issues. On the contrary, the primary reasons for blockchain's implementation trend in non- monetary applications is due to its inbuilt security, immutability, trust and transparency. These attributes are powered by blockchain's consensus approach and utilization of Distributed Ledger Technologies which require extensive dependency on participating nodes. Therefore, the fusion of these two technologies Blockchain and Internet of Things (IoT) conceives a new notion i.e. the Blockchain of Things where blockchain strengthens IoT by providing extra layer of security while the "things" of IoT can serve as participating nodes for blockchain ecosystems. Thus, blockchain enabled IoT ecosystems will provide enhanced overall security as well as benefit from each other.

F. Interoperability

Traditionally as regards the internet, interoperability has always been and continues to be a basic fundamental value because the initial prerequisite in Internet connectivity necessitates that "connected" systems have the ability to "speak a similar language" in terms of encodings and protocols. Currently, various industries use a variety of standards in supporting their applications. Due to the large quantities and types of data, as well as heterogeneous devices, using standard interfaces in such diverse entities is very important and even more significant for applications which support cross organizational, in addition to a wide range of system limitations. Therefore, the IoT systems are meant towards being designed to handle even higher degrees of interoperability.

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III. CONCLUSION

Countless research groups have been, and continue to be, initiated from different parts of the world, and their main objective is to follow through IoT related researches. As more and more research studies are conducted, new dimensions to the IoT processes, technologies involved and the objects that can be connected, continue to emerge, further paving way for much more application functionalities of IoT. The fact that IoT is so expansive and affects practically all areas of our lives, makes it a significant research topic for studies in various related fields such as information technology and computer science. This paper given an overview on the iot research challenges.

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