Real Time Based Context Modeling for Integrated Internet of Things Services

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Abstract- *The concept of the Internet of Things (IoT) aims at connecting physical objects to the internet and permits them to access different services and to communicate among various objects/ devices. Within the IoT scope, the discovery and control of IoT services remains a massive challenge among various industries mainly because of the vast amount, data processing, mobility, heterogeneity, and wide distribution of services deployed in constrained devices. In fact, the context has a significant role to enable provision of adequate services to the users based on their surrounding environments. This paper exploit our context model in a context aware discovery scenario for a specific domain and extend the model to describe context aware service description for the IoT, and defining a model for describing the different values of the properties that have multiples values such as status properties: available, awake, out of work. In addition, the context can help IoT services to adapt with the dynamic environment changes. In this paper, this paper aim's to address how the context can be described for the IoT environments, and how it affects to the discovery of IoT services in the internet of things. For the same reason, this paper proposes a real-time based model for the IoT context, aiming at describing the different contexts of the main entities constituting the IoT environment. The proposed model is extensible, independent of domain and taking into account the constraints of the IoT like availability.*

Keywords- Internet Of Things, Context Model, Contextual Process, Iot Services, Hospital Environment, Industrial Environment, Realtime Context, Context IoT.

I. INTRODUCTION

In the Real-Time environment context information is the basis for realizing adequate context-aware applications. There are many types of derived definitions for the term context in the research area because most researchers define context for their own user defined specific application scenarios. It presents a generic classification about different type of context data and how they were represented.

A qualified definition to explain these definition scenarios is given by Dey et al[4]. In the work of Dey et al, the term context is defined as follows:

"Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves [4]."

This definition for the term "context" makes it easier for a developer to justify the context model for a given scenario. After defining context, the process simplifies that context modeling is an assistant means to handle our context data or information for existing or defined entities. Another important aspect while developing a context modeling approach is the implementation of context awareness [2]. A context-aware system is described as a basic system which uses context details to provide relevant information and/or services to the user/ client, where relevancy depends on the user's/client's task [4]. In section II the detailed requirements for the Context modeling approach has been explained.

II. REQUIREMENTS FOR CONTEXT MODELLING APPROACH

This section covers the importance of the Context modeling and the factors required for any modeling of context information that every way of proceeding is considered closely with several requirements [4]. The requirements are been stated as follows:

A. Real-Time Composition:

Ubiquitous or pervasive computing is a specialized area of distributed and mobile computing. Therefore any context modeling approach for real-time environments has a lack of a central instance which is quiet responsible for important core functionalities [1], thus distributed composition of real-time data describes the ability of a context modeling attempt to fit in into real-time computing system.

B. Partial Validation:

An important ability of a desired context model is the possibility of partial validation of knowledge using contextual data. Partial validation is important because the complexity of contextual interrelationships makes real-time modeling attempts error-prone zone.

C. Richness And Quality Of Information:

The information delivered by sensors varies from time to time, as well as the richness of information provided through different sensors which distributes different types of entities in a real-time environment [4].

D. Incompleteness And Ambiguity:

Due to various quality and richness indication of context data, the existing or collected context information at any time is usually incomplete and/or inexplicit (e.g. GPS-coordinates). Therefore a real-time context modeling approach will be capable of enhancing this possibility [3].

III. MODULES FOR REAL TIME BASED CONTEXT MODELING FOR INTEGRATED INTERNET OF THINGS SERVICES

This paper focuses on how to model the context for the IoT environment in a real-time scenario such as hospital/ industrial environments and how it impacts to the service discovery solution. Modeling the Real-Time Based IoT context is a very difficult task this is due to the heterogeneous and dynamic nature of the feeds of data received using the IoT context which can have different meanings and values depending on the context [5]. Our paper is organized as follows: In section A is formulated by presenting a background that addresses the IOT Enabled Services for the Real-Time Based IoT context, in section B presents the related work in describing Real-Time Based Context IoT, then in section C presents solution for the interconnectivity of IOT data followed by state of IoT Devices presented in section D as shown in fig. 1.b. The final section presents the process outcome, the conclusion and future research directions.

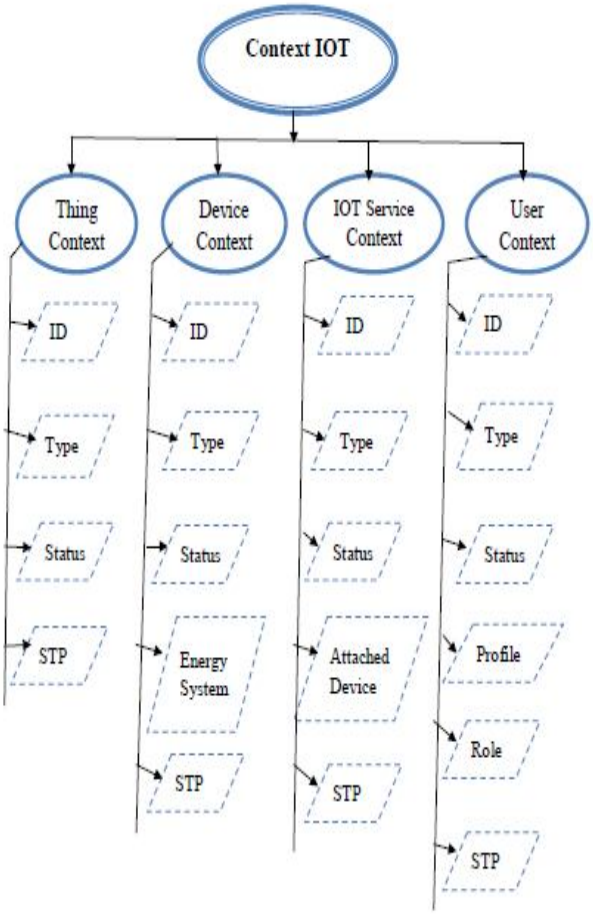
A. IOT Enabled Services

This section consists of the IOT devices that have a major connection between the services and the process flow of the real time environment, the services that have been provided by the IoT are given as follows.

- Connect and Collect - This module ensure that the data produced from the IoT devices are connected to the hospital/ industrial server and the data's are collected to the separate fields allocated to the individual devices.
- Analyze and Trigger - This module helps to find the real data of raw feeds to the hospital/ industrial server and thus provides the tools to analyze the feeds and classify them according to the fields assigned to them, and provide constant trigger to the IoT to collect the data from the various sensors and devices that have been connected to the system.
- Set-up Device Service Processes - The setting up of a Device Service process will help to provide a request to process the IoT in frequent intervals of time and thus coordinate the data's collected from various IoT devices around the network connections [7].
- Automatic Services - The automatic services help to refresh the connectivity of the IoT services using various request forms that have been stored as a trigger in the system to make IoT devices to function continuously in frequent intervals of time.

B. Real Time Based Context IOT (Entity, Service, Resources)

- The Real-time based context awareness should be considered in the IoT service discovery solutions for many reasons:
- Using real-time based context, services can become smarter. Besides a smart provision of services can be achieved.
- Ensure the dynamicity of IoT services in the real time context collection of data's.
- Allow achieving the minimal human interventions requirement for IoT.
- Generally most of the context aware approaches enabling user centric. Thus in real time environment the user can able to optimize the process according to the need of the fresh feeds of data.



1.a. Real Time Based Context IOT (Entity, Service, Resources)

Thing context: describes multiple physical objects in the real world, a thing has an identifier (Thing- Identifier), a type (Thing-Type), a status (Thing- Status) and (Spatio-temporal-properties) including location and time given in fig.1.a. The Thing context is the physical connection of the objects that has been made contact with the devices.

Device context: describes software/hardware devices that has been embedded to the IoT connectivity, a device has an identifier (Device- Identifier), a type of device (Device-Type) which can be sensor, actuator, Biosensor or tag (RFID tag, barcode data..), status of device (Device-Status) can have different values based on the availability of the device such available, active, out of work, etc. Energy system for the device (Device-Energy- System) defines the capabilities and process ratio of the device such battery level, storage capacity, communication capabilities and (Spatio-temporal-properties) including the exact location in real time[6].

IoT Service Context: The functional properties of service are not the true nature of our outcome; our goal is to define the context of IoT service in a real time environment, this latter can be used as a context extension connected to a service description language. An IoT service has a service identifier (Service-Identifier), a service type (Service-Type), status (Service-Status) defines whether the service of the device provided is available, Service attached devices (Service-Attached-Devices) defines where the service can be operative and the sensors of the device can able to expose the device (resource) functionality and (Spatiotemporal- properties) including location in real time.

User context: The user for the given context process has a user identifier (User- Identifier), type (User-Type) can be designated person or software agent, profile of the user (User-Profile) constitutes all relevant information about the user, preferences, interests, status (User-Status) describes his situation such walking, running, sitting, eating, in home, role (User- Role) defines the role of a user in a specific location and range of the location and (Spatio-temporal-properties) including location in real time.

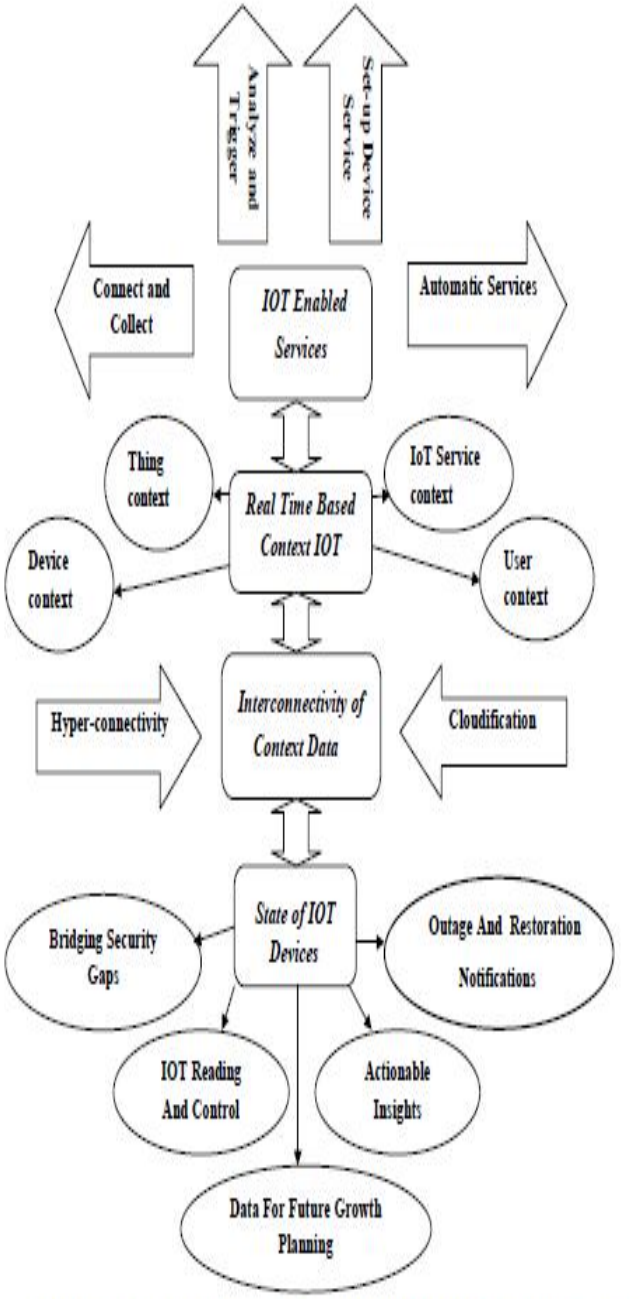
The Real-time Context modeling for the dynamic controlled IoT services must consider the following features:

I. Context acquisition:

Defines the various process involved in acquiring the context information's from various sources of sensors (physical/virtual/logical sensors). These sensors help to gather the raw data for the context processing using various ranges of acquisitions in the IoT devices [8].

II. Context modeling:

The Context Modeling defines the process in representing the collected data in meaningful manner for the IoT devices. The most popular context modeling techniques are: key-value based, markup schemes modeling, graphical based, object based, logic based, and ontology based modeling [9].



1.b. Modules For Real Time Based Context Modeling For Integrated Internet Of Things Services

III. Context reasoning:

Context Reasoning defines the process of inferring new knowledge based on the available of real-time context. Six context reasoning techniques are identified as follows: supervised learning, unsupervised learning, rules, fuzzy logic, ontological reasoning and probabilistic reasoning.

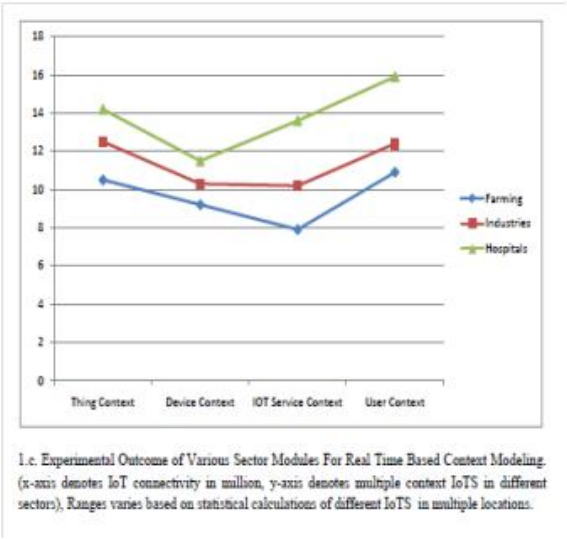
C. Interconnectivity of Context Data

- Hyper-connectivity: A combination of fixed and mobile network technologies that provide high-speed access from hospital/ industrial servers and human sources to powerful computer centers that are themselves interlinked across the globe connecting to various IoT devices in multiple locations for easy access and coordination of data.
- Explosion of Data: The growth impact of hospital/ Industrial infrastructure in the shape of smart phones, tablets and wear-ables has expanded the sources of personal data by orders of magnitude, and helps to interconnect the link between the doctors/ industrialists and patients/ employees in frequent patterns [10].
- Cloudification: The ability to connect hospital/ industrial servers using cloud-based platforms is giving rise to entirely new real-time context models across different medical/ industrial sectors [11]. The availability of cheap, scalable cloud-delivered services is also becoming a powerful mechanism will help smaller hospitals/ industries to reach global scale without the need for large amounts of investment capital.

D. State of IOT Devices

- Bridging Security Gaps: The security gaps are bridged using the coordination and interconnectivity of the various IoT devices. These devices are connected to the dynamic protocol monitoring systems to know the state and functioning modes of the IoT devices. Thus the data are secured using encryption protocols to ensure the minimal or zero loss of data.
- IOT Reading and Control: Determining the process control of the various IoT device data sharing protocol and data control of different flow of data feeds from multiple IoT devices [12]. This process ensures the state of the IoT devices from various modes.
- Outage and Restoration Notifications: This protocol helps to determine and secure the data's from the IoT devices from worst case scenarios. The data can be saved in multiple areas of hospital/ industrial sectors and thus this help to eradicate the data loss and also provide various option of restoration process in the IoT devices [12].
- Actionable Insights: Proper data collections and frequent monitoring of the hospital/ industrial data's must be enabled through different actionable insights to ensure the data from the IoT device has been processed according the need of the user.
- Data for Future Growth Planning: Collect significant hospital/ industrial data for every IoT devices in the

environment for multiple planning strategies [7]. This process will help to coordinate the defective nature of IoT devices and also indicate the different modes in the hospital/ industrial system. This process will help to generate the logs to improve the system in real-time based optimization of IoT Devices [9].



1.c. Experimental Outcome of Various Sector Modules For Real Time Based Context Modeling. (x-axis denotes IoT connectivity in million, y-axis denotes multiple context IoTS in different sectors). Ranges varies based on statistical calculations of different IoTS in multiple locations.

IV. EXPERIMENTAL RESULT

In the entire process of the Real-Time Context Modeling, the multiple layers of hospital/ industrial sectors can be highly profitable using these contextual services. The IoT Enabled Services helps to develop the interconnection between the devices to send the data's to the hospital/ industrial servers. This intellectual services of Real Time Based Context IoT helps to coordinate various fields of data mart into single layer of contextual data and thus provide optimal results for processing those hospital/ industrial contextual data's into multiple segregation of context values. The interconnectivity values are then used to allocate the range of vivid hospital/ industrial process through the entire bridging of the IoT devices. The segregation and segmentation of the IoT devices based on the nature of the sensor, functionality, range, service of sensors, triggering mechanism and physical and biological properties helps the context modeling approach to classify the process of sensors, and associate different feed of data in the various field's hospital/ industrial servers. The state of IoT Devices determines the process outcome, of the multiple IoT services from bridging security gaps to future planning of monitoring and enhancing the data as per details given in fig1.c as follows:

This real time context model for healthcare industry can be implemented to the hospital sectors for multiple patients monitoring. The IoT devices connected throughout the hospital servers helps to improve the feed of patient's data such as patient's blood sugar level, blood pressure, urea content, potassium content, sodium content, toxic waste content in the patient's body. Thus the doctor's can easily monitor the patient's health conditions. The use of IoT helps to improve the connectivity of information between the doctor's and the patient's health.

This real time context model for Production and manufacturing industry can be implemented to multiple layers of quality and quantity management and monitoring. The IoT devices can help to maintain the uniqueness of the production units with various sensors involved in the process based on the fig.1.c. The various sensors can be used in the process are given as follows Electric current or Potential or Magnetic or Radio sensors, Humidity sensor, Fluid velocity or Flow sensors, Pressure sensors, Thermal or Heat or Temperature sensors, Proximity sensors, Optical sensors, Position sensors, Chemical sensor, Environment sensor, Magnetic switch sensor , etc. These sensors will help to improve the tasks in the industry and benefit the investor on various investments in IoT projects.

V. FUTURE WORK

In our future, the IoT devices has to exploit our real time context model in a context aware discovery scenario for a specific domain and extend the real time model to describe context aware service description for the IoT devices, and defining a model for describing the different values of the properties that have multiples values such as status properties: available, awake, out of work. The IoT must also be established in all the fields to collaborate the data's from every aspect of the industry to derive exact results needed for the client/ user.

VI. CONCLUSION

This paper proposed an extensible and independent of real time context IoT model to describe the multiple dimensions in context of the IoT environment, our model takes in consideration the different IoT constraints. As the availability is taken for requirement of the real time context IoT by considering the fact that every constraints of the IoT is calculated to provide exact results to the clients/ users, the IoT services and devices including resources are mobile and available all the time, and they are monitored for the energy and transmission sources based on the need of the sensor, the sensor appear according to the desirable environment for this reason in near future the adoption of the "status property" in the different contexts to test their availability of the sensor/ IoT devices and helps the system that use our context model to

make the right decision. The energy system for IoT devices/ sensors is also adopted by real time context model respecting the IoT requirement addressing the resource constrained devices. Our real time model can be used, extended for the other domains and in the same time the plans to reuse external real time monitoring for the production and manufacturing industry and like GeoNames for the location based services and Semantic Sensor Network ontology for the hospital sensors are also in process.

VII. ACKNOWLEDGMENT

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